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RAILWAY ACCIDENT INVESTIGATION UNIT AT THE MINISTRY OF TRANSPORT, INFORMATION TECHNOLOGY AND COMMUNICTIONS

FINAL REPORT

from

technical investigation of railway accident – derailing of freight train Nr. 90570 on point Nr. 5 upon entrance in Hitrino station on 10.12.2016

2017

FINAL REPORT

Purpose of the Investigation and degree of responsibility

In accordance with the requirements of Directive 2004/49/EC of the European Parliament and the European Council on the safety of railway transport in the Community, incorporated in the Railway Transport Act (RTA), Ordinance Nr. 59 dt. 05.12.2006 on safety management in railway transport, and Ordinance Nr. H-32 dt. 19.09.2007 on the concurrence of actions and information exchange upon the investigation of railway accidents and incidents, the Investigation of heavy accidents, accidents and incidents is carried out by an independent investigation body of the Republic of Bulgaria – the Railway Accident Investigation Unit at the Ministry of Transport, Information Technology and Communications (MTITC) and is aimed at:

Establishing the circumstances and causes having lead to their realization, in view of improving safety and elimination of other occurrences, **without searching for anybody's personal guilt or responsibility.**

CONTENTS

1. Summary

1.1. Brief description of the occurrence

On 10.12.2016 from Druzhba station to Ruse-North station departed freight train Nr. 90570, composed of two electric locomotives pulling the train and 26 wagon-cisterns, of which 23 full and 3 empty ones, designated for guarding purposes (one wagon ahead and two wagons behind the train). The traffic route of the train was Druzhba – Karnobat – Sindel-razpredelitelna – Ruse-North stations. During its travel the train changed its direction twice, respectively at Karnobat and Sindel-Razpredelitelna stations. After its departure from Sindel-razpredelitelna station through the next stations the train passed transit, with no particular observations upon its trafficking being made.

At 05:03 h. the traffic controller on duty at Hitrino station went in front of the reception building of the railway station to meet freight train Nr. 90570.

At 05:37 h. freight train Nr. 90570 entered Hitrino station and upon its passing through the level crossing at the throttle place of the station – Pliska side, the traffic controller saw some sparkling emitted from the wheels (according to his explanations). A little afterwards the lighting at the level crossing switched off and only a part of the train continued its movement towards the station.

The two electric locomotives and the first five wagons arrived at the station. One part of the train had derailed, and the other part had settled in the throttle place accommodating the points at Post Nr.2. The post switchman at Post Nr. 2 called the traffic controller on duty via the station telephone connection line to inform him that freight train Nr. 90570 had derailed. During the conversation the post switchman felt strong suffocating smell which was followed in a while by a powerful explosion, as a result of which an extensive fire burst out, covering a significant area of the station and the village of Hitrino (Figure 1).

Figure 1

As a result from derailing of the train, the reservoir of one wagon-cistern – the 10th one in line, Nr. 33 87 791 5652-4, was punctured, from where the transported load (propylene) leaked off, exploding afterwards.

From the explosion and the resulting fire 7 residents of Hitrino village were killed, heavily injured were 29 residents of Hitrino and 1 employee (post switchman) who was on duty at Post Nr. 2.

The explosion ruined in full or in part 50 residential and public buildings.

Destroyed are buildings and railway infrastructure in the area of Post Nr. 2 at Hitrino station (Figure 2). Many of the train's wagons are damaged.

Figure 2

The affected area in the region of the accident is about 535 000 m^2.

The major cause for the occurrence of the accident is: the signals of the safety provision equipment were not abided to (the indications of the warning and the entrance traffic lights) at Hitrino station. Freight train Nr. 90570 passed through the first point Nr.1 with the speed of 81 km/h and through point Nr.5 with the speed of 78 km/h, upon permission indication at the entrance and the warning traffic lights for entrance of the train with a speed of up to 40 km/h in a deviation on the Third acceptance & departure platform, with stopping.

Besides the above mentioned signals, the signal for limitation of speed up to 60 km/h because of the type of the safety provision equipment at the station was not abided to upon passing of the train through the points to the main platform.

1.2. Summary of major recommendations

The safety recommendations are addressed to the National Safety Authority – the "Railway Administration" Executive Agency, the railway carrier – "Bulmarket Rail Cargo" EOOD, and the Manager of the railway infrastructure – the National Railway Infrastructure Company (NRIC).

Recommendation 1 addresses the "Railway Administration" Executive Agency. The Agency shall recommend to the railway enterprises to acquaint the staff members, connected with the safety of transport, with the contents of the Final Report from the performed investigation;

Recommendation 2 concerns the owners of wagons, requesting them to provide the wagon-cisterns, carrying liquefied hydro-carbonic gases, with pulling-deviating devices with crash elements;

Recommendation 3 is directed to the owners of wagons, carrying hazardous freights, regarding unification of the periods of repairs to 4 years, as are the periods of repair of reservoirs;

Recommendation 4 addresses the railway enterprises, stipulating that wagons shall be accepted at the border stations only in a faultless condition, as per documents and technical condition, from the railway carriers;

Recommendation 5 is directed to the "Railway Administration" Executive Agency regarding the performance of check examinations of the operative staff connected with safety of transport, in accordance with Ordinance Nr. 56 dt. 2003;

Recommendation 6 envisages the "Railway Administration" Executive Agency, asking for the elaboration of technical conditions for a recording device from a confirmed type, which shall be used for equipping the traction rolling stock, operating on the railway infrastructure in the country;

Recommendation 7 is directed to the railway enterprises, requesting that the check of the technical condition of the railway rolling stock shall be carried out by staff members of the railway infrastructure;

Recommendation 8 addresses the "Railway Administration" Executive Agency regarding the periodically performed examinations, the requesting and checking of the professional qualification and professional education and training certificates of the staff members engaged with the safety of transport, in accordance with the requirements of Art. 2, par. 1 of Ordinance Nr. 56 dt. 2003;

Recommendation 9 is addressed at the railway enterprises regarding the assembly in the traction rolling stock of alertness maintenance devices with variable time of activation;

Recommendation 10 is addressed at "Bulmarket Rail Cargo" EOOD regarding the organization and carrying out of training of the locomotive operative staff on the relevant locomotive Series;

Recommendation 11 is directed to "Bulmarket Rail Cargo" EOOD, requesting from them better control upon issuing of transport documents of the locomotives and rendering of pre-shift instructions to the locomotive brigades;

Recommendation 12 is addressed at "Bulmarket Rail Cargo" EOOD, requesting from them better control upon the performance of checks by the control authorities in respect of the technical condition of the railway rolling stock and the staff members connected with safety of transport;

Recommendation 13 is addressed at "Bulmarket Rail Cargo" EOOD, requesting from them, regarding the appointment of staff, to precise the requirements to the locomotive engine drivers for working in the company, to the staff members who have acquired right of a pension, have gained years of experience and age for social security, in accordance with their category of labor;

Recommendation 14 envisages the National Railway Infrastructure Company (NRIC), requesting them to organize and carry out training of staff at all stations regarding their actions upon the occurrence of railway accidents;

Recommendation 15 addresses the National Railway Infrastructure Company (NRIC) and the railway enterprises, requesting them to correct the time schedule for trafficking of freight trains transporting hazardous freights, where possible, to travel transit on the main platforms of the stations, moving with a speed close to the permissible one for the relevant railway sections, providing reserve in the time of traveling;

Recommendation 16 is directed to the National Railway Infrastructure Company (NRIC), requesting urgent building and implementation of control system for the railway rolling stock upon trafficking („Check Point") on the railway network of the Republic of Bulgaria.

Recommendation 17 is addressed at the National Railway Infrastructure Company (NRIC) and the railway enterprises for the construction and implementation of an automatic locomotive signaling system – traffic equipment along the major railway network of the Republic of Bulgaria and on-board equipment of the locomotives and rail motor trains.

2. Direct facts and circumstances

2.1. Date and time of the occurrence

On 10.12.2016 the traffic controller on duty at Hitrino station, after having received "departure of freight train Nr. 90570" from the traffic controller on duty at Pliska station, ordered in writing at 05:25 h. to the post switchman at Post Nr.2 to prepare the route for acceptance of freight train Nr. 90570 on the free Third acceptance-departure platform. According to the traffic

schedule and Plan-II 24 on the acceptance and departure of trains at Hitrino station, there was a meeting with passenger train Nr. 90201 regulated by schedule.

After the accepted written order and the manipulation performed via the Control unit at the station by the traffic controller on duty, the post switchman at Post Nr.2 undertook preparation of the route to the Third platform. The switchman locked point Nr.1 in "+" position, dropped down the guard barriers of the level crossing and reported to the traffic controller on duty. Thereafter the post switchman at Post Nr.2 opened the entrance signal for acceptance of the train on the Third acceptance-departure deviation platform (as evidenced by the manipulations of the Executive unit at Post Nr.2).

At 05:35 h. the traffic controller on duty went in front of the reception building of the station to meet the arriving train. After the train had entered the station and passed through the railway level crossing, found in the throttle place accommodating the points at km 110^{+460}, the traffic controller on duty saw sparkles emitted from the wheels of the train. A few seconds later the lighting at the level crossing switched off, the catenary swung, and only a part of the train continued trafficking towards the reception building. The wagons, from the 6^{th} to the 17^{th} one, derailed, the remaining 9 wagons from the train did not derail and stopped in front of point Nr.1 at Post Nr.2 (Figure 3).

Figure 3

At the same time the post switchman at Post Nr.2 called by the station phone the traffic controller on duty to inform him that wagons from freight train Nr. 90570 had derailed in the throttle place of point Nr.5 and at the railway level crossing (Figure 4). During the call the post

Figure 4

switchman felt strong suffocating smell at the Post and immediately laid on the floor; this was followed by a powerful explosion, as a result of which a vigorous fire burst out, covering a large perimeter around the region of Post Nr. 2.

The derailed wagons from the composition of the train, under the impact of the inert forces generated by the bigger mass weight of the train, were pushed aside from the railway line and continued their movement chaotically, occupying different positions.

Upon these movements they destructed the railway line, heated a pole with a console from the catenary, which felt on the ground and caused grounding of the catenary, as a result of which at 05:40 h. the safety system at the Traction substation (TS) – Hitrino switched off the electric power supply in the outlet, Pliska side.

The operator on duty at TS – Hitrino informed the energy dispatcher on duty of Ivanovo – Ruse – Kaspichan section, who instructed him to perform testing by supplying voltage in the outlet again. After the performed second try for switching on of power at 05:41 h., the operator on duty at TS – Hitrino reported that the outlet "did not hold up" – the breaker could not switch on because of the occurrence of a lasting grounding of the catenary.

As a result from the derailing of the 6th wagon with one of its carts, the train was torn apart between its 6th and 7th wagons after the railway level crossing. The two locomotives, together with the 6 wagon-cisterns attached to them, continued their trafficking, as the 6th wagon moved with its first cart on the Third platform and the second cart moved on the Fourth platform. After 114 m the 6th wagon with its back side hit a pole of the catenary, broke apart from the 5th

Figure 5

wagon and laid aside on the Fourth platform (Figure 5). The other 5 wagons with the two locomotives continued their trafficking and stopped 340 m after the reception building of the

Figure 6

station (Figure 6).

The next wagon-cisterns, from the 7th to the 17th one included, derailed and continued their movement uncontrolled, aside from the railway line. The pulling devices of some of the wagons got free from their catches, others got torn apart, which lead to the occurrence of crashes between the wagons, including in the area of the reservoirs (Figure 7). As a result from such

Figure 7

crashes and the uncontrolled movements, the frame of the 10th wagon-cistern got torn apart from the reservoir, bending on the left towards the frame of the 9th wagon-cistern, which climbed over it. Upon catching together of the two cisterns, the taller of the left buffer of the 9th wagon hit and cut the reservoir in its lower part of the 10th cistern Nr. 33 87 791 5652-4. As a result of the rupture, there commenced intense leaking of the freight (propylene), transported in a compressed state (Figure 8).

Figure 8

The last nine wagons from the train did not derail and stopped in front of point Nr.1 on the railway line in front of Post Nr.2.

Evidencing the situation developed in the station, the traffic controller on duty annulled the already granted permission to Visoka Polyana station for acceptance of freight train Nr. 90201 and signaled at emergency call number 112, requesting them to send first medical aid and fire safety brigades. Regarding the situation having occurred in the station, the traffic controller on duty informed also the train dispatcher, who on his part instructed the traffic controller on duty at Visoka Polyana station to retain passenger train Nr. 90201 in the station and instructed the energy dispatcher not to supply voltage on the catenary of Hitrino station. The post switchman from Post Nr.1, hearing the explosion and seeing the fire, made several attempts to contact his colleague at Post Nr.2 by the station phone, but the attempts were unsuccessful, thereafter called him on the mobile phone. After several tries he got contact with the switchman at Post Nr. 2, and the latter informed him he had got injuries on both his hands and his head, and that after the explosion he had left the building of the Post to hide himself from eventual next explosions and to seek medical help.

The emergency first aid teams, after arriving at the place of the accident, discovered the injured post switchman, rendered him first aid, thereafter he was transported to the hospital in the town of Shumen, later to the Medical Academy in the city of Varna.

For rendering of first aid to all injured, additional teams of first medical aid and fire safety were sent to the place of the accident from the neighboring settlements.

2.2. Place of the accident

Hitrino station is located at km 110^{+100} between the stations of Pliska and Visoka Polyana. It is situated on the Ninth main railway line Ruse – Kaspichan – Varna.

2.3. Classification of the occurrence

On 10.12.2016 at about 05:50 h. the Head of the Railway Accident Investigation Unit (RAIU) with the Ministry of Transport, Information Technology and Communications (MTITC) was informed by phone about the occurrence of a railway accident – derailing in the region of Hitrino station of freight train Nr. 90570, transporting hazardous freights.

The information was provided via the notification system of the Manager of the railway infrastructure – the National Railway Infrastructure Company (NRIC). After receiving the notification, the Manager started immediately to the place of the accident, where together with the investigation authorities of the pre-court procedure initial surveys were carried out for clarification of the situation and the circumstances existing before the accident.

After clarifying the situation and the consequences from the occurrence at place, the Head of RAIU at MTITC, on the grounds of Art. 19, par. 1 of Directive 2004/49/EC and Art. 68, par. 1, item 1 and par. 2 of Ordinance Nr. 59, classified the occurrence as a heavy railway accident.

2.4. Consequences from the occurred accident:

- 7 people killed – residents of Hitrino village;
- 29 people seriously injured and injured with traumas – residents of Hitrino village;
- 1 man injured, post switchman at Post Nr.2 – employee of NRIC;
- 12 wagon-cisterns derailed and completely destroyed;
- including 1 wagon-cistern punctured with spilled propylene gas, self-ignited, with enormous damages caused;
- the railway line towards the Third and the Fourth platform and railway point Nr. 5 destroyed, the facilities and the building of Post Nr.2 strongly damaged;
- the catenary, the poles and its related facilities in the throttle place of points – Pliska side, are destroyed;
- the affected area of the region is about 535 000 m^2, as a result from the explosion and the following fire 50 residential and public buildings of the residents of Hitrino village are destroyed;
- in the same area damages are also caused to the surrounding environment.

2.5. Decision for undertaking of an investigation

The accident investigation is undertaken in connection with the provisions of Art. 19, par. 1 of Directive 2004/49/EC, Art. 115к, par. 1, item 1 of the Railway Transport Act (RTA), Art. 76, par. 1, item 1 and Art. 78, par. 1 of Ordinance Nr. 59 dt. 05.12.2006. On the grounds of the above norms, Order Nr. РД-08-579/13.12.2016 is issued on the appointment of Commission for investigation of a heavy railway accident at the Ministry of Transport, Information Technology and Communications (MTITC). The Commission includes also external experts possessing the relevant professional qualification and professional specialization for the investigated occurrence. The Technical Investigation Commission departed for Hitrino station on 13.12.2016.

Because of the increased risk from gasifying of the region and the probability for the occurrence of next explosions on the same day, the Commission was not permitted access to the place of the accident.

On 14.12.2016 the Commission gained permission for one-time restricted access to the place of the accident, upon preliminary rendered instructions and special directions for movement and action in the area of the station, as well as at the place of accident.

On 15.12.2016 the Commission gained permission for two short-term examinations of 60 min. each for the performance of surveys of the railway line and the railway rolling stock and measurements.

On 16.12.2016 the Commission gained permission for full access and started work for the establishment of facts, circumstances and causes having lead to the derailing of the train. Several surveys were carried out, as well as measurements of the safety provision equipment of the Control and Executive units at the reception building and at Post Nr. 2, of the railway line and the railway points, of the catenary and the railway rolling stock: the two locomotives, the derailed and non-derailed wagons from the composition of the train.

The Commission carried out interviews with the staff members, working at the station, having partaken in the accident.

In the progress of the investigation analyzed were the Report, provided by the Operative group, and the documents collected to the Report, as well as the additional materials requested thereafter.

The Commission appropriated material evidence, on the basis of which technical expertise was appointed:

- technical expertise of a cut part of the intermediate rail of point Nr. 5 at Hitrino station, entrusted to the Institute of Metal Science, Equipment and Technologies with Hydro- and Aerodynamics Centre "Acad. A. Balevski" at the Bulgarian Academy of Sciences (BAS).

- technical expertise on the wall and bottom thickness of the reservoir of wagon-cistern Nr. 33 87 791 5652-4 (punctured), entrusted to the Wagon Construction Plant "Trakcia" AD – Samuil.

After the established legal normative order, the District Prosecutor of the District Prosecutor's Office - Shumen was requested to provide copies from the appointed complex and court procedural technical expertise:

- Complex technical expertise for survey and examination of the safety provision facilities at Hitrino station;

- Complex technical expertise of railway rolling stock (wagons);

- Technical expertise on the derailing of freight train Nr. 90570;

- Court procedural technical expertise of the records of the parameters of movement of electric locomotives Nr. 86003.4 and Nr. 87025.0 upon the derailing of freight train Nr. 90570;

- Court procedural technical expertise on Part "Railway line";

- Protocol Nr. 7 on the performed complex court procedural technical criminological expertise.

The Chairman of the Commission accepted the written opinions of the external experts, included in the Investigation Commission in fulfillment of their entrusted tasks on the performed technical investigation.

2.6. Performance of rescue and emergency recovery activities

The population of Hitrino village and the staff members from the station were evacuated. The access was restricted for all persons, except for the working teams from "Fire safety and protection of population" Chief Directorate – MoI, the District Directorate of MoI – Shumen, "National Police" Chief Directorate, the First Medical Aid Centers – Shumen, Razgrad, Targovishte and Varna, the District Prosecutor's Offices – Shumen, and the National Investigative Service. Additionally included in the operations were structures, organizations and volunteers from the whole country for limiting and liquidating of the consequences from the railway occurrence: the NRIC, "Bulmarket Rail Cargo" EOOD, "Lukoil – Burgas", "Maritza Logistic Service", "Cherno More" Motor Highway, "Patishta" AD, W&S Co. – Shumen, "Energo Pro", the Regional Health Inspectorate – Shumen and the Regional Inspectorate of Environment and Water – Shumen, "Gastrade" AD, etc.

"Gastrade" AD established and applied technology for tapping of leakages on a timely basis. Expediently localized were the leakages from the derailed cisterns, from where propylene had been released in the atmosphere, imposing danger from gasifying and creating possibility for repeating of explosions.

Transfer of the liquefied gases from the derailed wagon-cisterns to auto-cisterns was undertaken, and the emptied wagon cisterns were transported from Hitrino station by auto-transport to a designated site in the city of Ruse, to be safe kept under guard.

After completing of the survey of the derailed wagons on the part of the relevant authorities: the Prosecutor's Office, the National Investigative Service, the Ministry of Interior and the Commission from the Ministry of Transport, Information Technology and Communications, a permission was granted for their pulling back to Pliska station, aimed at providing opportunity for the commencement of recovery works on the railway infrastructure and the capacity.

3. General data, established in the process of the investigation

3.1. Partaking staff members and counterparts:

- the staff members from the shift at Hitrino station – traffic controller on duty and two post switchmen – employees at the National Railway Infrastructure Company (NRIC);
- operator on duty of Traction substation – Hitrino, an employee of NRIC;
- Locomotive brigades of "Bulmarket Rail Cargo" EOOD:
- locomotive engine driver, first person on electric locomotive Nr. 86003.4;
- locomotive engine driver, second person on electric locomotive Nr. 86003.4;
- locomotive engine driver, first person on electric locomotive Nr. 87025.0.

3.2. Data on the rolling stock:

- per order of the railway carrier "Bulmarket Rail Cargo" EOOD for freight transport, NRIC has developed a time schedule, incorporated in the Train trafficking schedule, for a pair of freight trains Nr. 90570/Nr. 90571 transporting hazardous freights on a daily basis, following the trafficking route of: Druzhba – Karnobat – Sindel-razpredelitelna – Kaspichan – Ruse-North stations, and back.
- Freight train Nr. 90570 was composed of two pulling electric locomotives and 26 wagons transporting liquefied gases (propylene and propane-butane) from Druzhba station to Ruse-North station, including 20 wagons full of propylene, 3 wagons full of propane-butane, 2 empty wagons for guard, and 1 empty wagon for repair.

3.3. Data about the carrier having performed the transport:

- the railway carrier having performed the transport of freight train Nr. 90570 on 10.12.2016 from Druzhba station to Hitrino station is "Bulmarket Rail Cargo" EOOD;
- "Bulmarket Rail Cargo" EOOD is holder of:
- License for the performance of railway transport services Nr. 212/14.05.2015;
- Safety Certificates, Part "A" BG 11 2015 0002 and Part "B" BG 12 2015 0002.

3.4. Type, number and category of the train:

- direct freight train with Nr. 90570, travelling on a daily schedule.

3.5. Type and number of the traction rolling stock, having serviced freight train Nr. 90570:

- electric locomotive Nr. 86003.4 - enlisted in the Register of Transport Vehicles;
- electric locomotive Nr. 87025.0 – enlisted in the Register of Transport Vehicles.

3.6. Type and Series of the non-traction rolling stock:

- wagon-cisterns - Zagkks Series, 23 full ones;
- a wagon-cistern – Uas Series, 1 empty, as front guard;
- a wagon-cistern – Zacs Series, 1 empty, as front guard;
- a wagon-cistern – Zacs Series, 1 empty (damaged).

3.7. Description of the railway infrastructure:

Railway line and points:

- Hitrino station has four platforms, from which the Second platform is the main one, the First, the Third and the Fourth platforms and acceptance-departure deviation platforms;
- railway line – rails, type S 49, clad on timber sleepers with fixings of "K" type, with supported joints;
- at Hitrino station in the throttle place of Post Nr. 1 there are 5 pcs. and at Post Nr. 2 there are 5 pcs. of ordinary points with elastic switch rails, of which points Nr. 7 and Nr. 10 are with radius R=190 m, and Nr. 1, Nr. 1A, Nr.3, Nr. 5, Nr. 2, Nr. 4, Nr. 6 and Nr. 8 with radius R= 300 m, with rails of S 49 type on timber sleepers, equipped with locking devices of "Kolben Danek" type;
- at Hitrino station at the intermediary part of point Nr. 5 the railway line is inclined towards the Third platform at 2,5 ‰, ascending; this is the point of derailing of the sixth in line wagon from the composition of the train.

3.8. Signaling system, station safety provision equipment and inter-station interlock system:

- Hitrino station is equipped with Relay Key Dependence System (РУКЗ) with Control unit at the reception building of the station and Executive units at the two points' Posts Nr. 1 and Nr. 2.
- the entrance traffic lights are located at km 110^{+890}, at 334 m away from point Nr. 1;
- the warning traffic lights are located at km 112^{+000}, at 1110 m away from the entrance traffic lights;
- both traffic lights are equipped with headlights and the indications are in accordance with the speed signaling;
- the sections between the stations of Pliska – Hitrino – Visoka Polyana are equipped with Semi-automatic interlocking system.

3.9. Catenary:

- chained compensated.

3.10. Train safety provision system:

- the two electric locomotives Nr. 86003.4 and Nr. 87025.0 are equipped with the alertness maintenance device;
- it was established that the buttons of the alertness maintenance device in the two locomotives are of interrupted seals.

3.11. Communication means:

- Hitrino station is equipped with automatic telephone connection, station telephone connection to the two Posts of points, inter-station telephone connection with the two related stations, and train dispatcher's connection;
- the locomotive brigades in the two locomotives have disposed of mobile phones for official use.

3.12. Performed construction or repair activities close to or at the place of the accident:

- The following repair activities were performed at Hitrino station in November and December 2016 till the occurrence of the accident:

• 29.11.2016 – cleaning of snow from the points;

• 30.11.2016 – manual tightening of fixings on points Nr. Nr. 1, 3 and 5; ръчно притягане на скрепление на стрелки № 1, № 3 и № 5;

• 01.12.2016 – manual tightening of fastenings on points Nr. Nr. 2, 4, 6 and 8;

• 07.12.2016 – preparation of emergency rails of 6 m each.

- By telegram Nr. 1675/25.11.2016 of the Director of "Management of train trafficking and station activities" Directorate – Gorna Oryahovitsa, on the dates of 05; 06; 07; 08 and 09.12.2016 train windows are permitted for tamping of the points with tamping machine in the stations of Visoka Polyana, Hitrino, Pliska and Kaspichan. Because of failure of the points' tamping machine B-41 UE, by telegram Nr. 22/01.12.2016 of the Director of Railway Section - Gorna Oryahovica the permitted train windows are rejected.

- By telegram Nr. 668/30.11.2016 of the National Railway Infrastructure Company (NRIC) on the dates of 02/03, 05/06, 06/07, 07/08, 08/09 and 09/10.12.2016 at the stations of Yunak, Sindel-razpredelitelna and at the railway section between Yunak and Sindel-razpredelitelna stations night train windows are permitted for the performance of Average-size repair works by heavy road repair equipment. The section where the repair works on the railway road were performed, is a part of the route of trafficking of freight train Nr. 90570.

- Because of the performance of Average repair works by railway repair equipment, by telegram Nr. 668/30.11.2016 of NRIC night train windows are permitted at Yunak station, at the railway section between Yunak and Sindel-razpredelitelna stations and at Sindel-razpredelitelna station at the dates of 02/03, 05/06, 06/07, 07/08, 08/09 and 09/10.12.2016, respectively from 20:15 h. till 22:45 h. and from 00:30 till 04:00 h.

In this connection, according to item 3 of the above telegram, the trafficking schedule of some trains travelling in the section was corrected; amongst the corrected trafficking schedules is also the schedule of freight train Nr. 90570 in the section from Velichkovo station to Ruse-North station.

From Druzhba station to Hitrino station freight train Nr. 90570 travelled, being composed of two electric locomotives – supportive one ahead of the train – Nr. 86003.4, and train one – Nr. 87025.0, and 26 wagon-cisterns, including 20 ones full of propylene, 3 ones full of propane-butane, 2 empty ones as front guard and 1 empty cistern transported for repair, 104 wheel axes

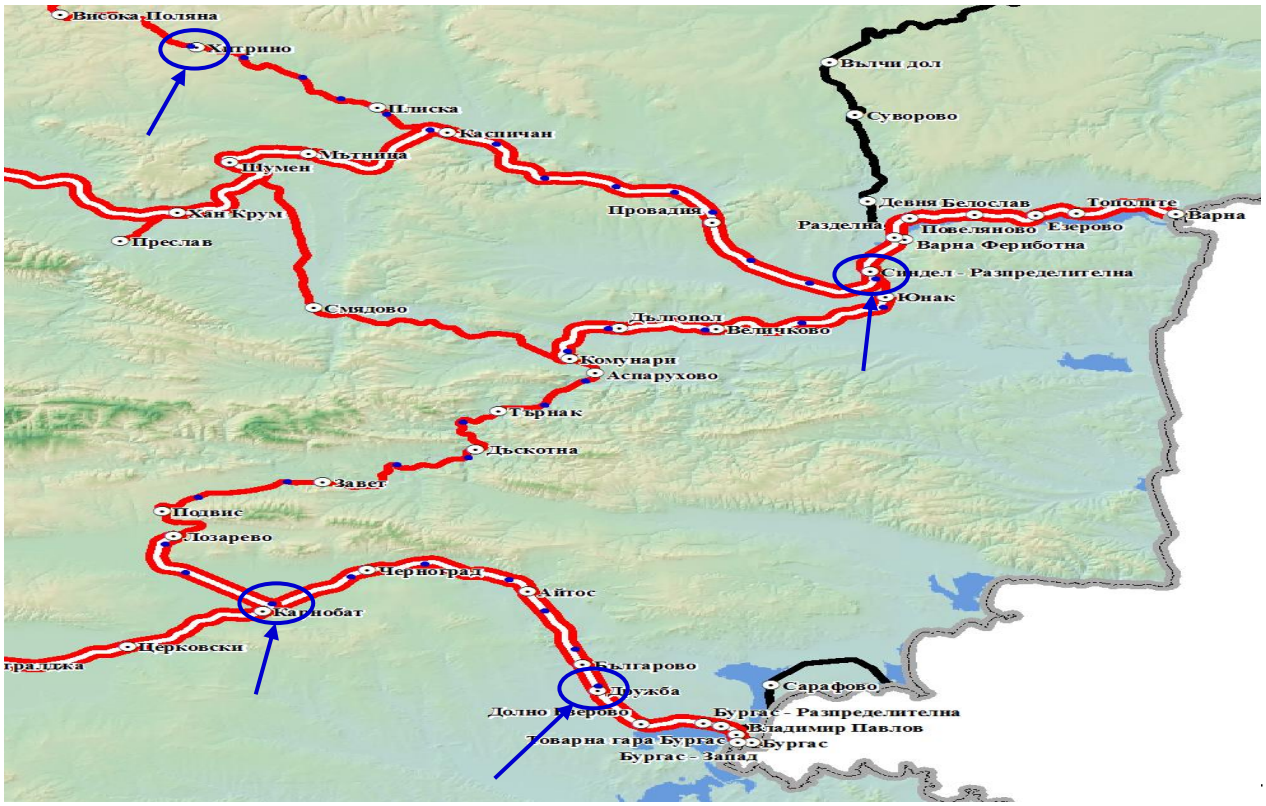


Figure 9

and gross mass weight of 1756 tons (Figure 9).

Up to Karnobat station, where it was accepted on the Third platform at 00:49 h. with 13 min. delay, the train travelled without stopping. After a stay of 7 min. for the execution of a maneuver because of changing the direction of trafficking after Karnobat station, the train departed at 00:56 h. on schedule, as locomotive Nr. 87025.0 was supportive and locomotive Nr. 86003.4 was the train one. At Podvis station the train arrived at 01:20 h. on schedule on the Second platform, where it stayed for 44 min. because of regulated meeting with fast train Nr. 8636 and non-regulated meeting with freight train Nr. 30584.

From Podvis station the train departed at 02:04 h. with 39 min. delay and up to Sindel-razpredelitelna station it travelled without stopping. At Sindel-razpredelitelna station the train was accepted on the Third platform at 04:09 h. with 3 min. earlier of schedule (because of the already rejected train window by the contractor performing the repair works at the section between Yunak and Sindel-razpredelitelna stations. At the station the train stayed for 20 min. for the execution of a maneuver because of changing the direction of trafficking and regulated meetings with freight trains Nr. 30642 and Nr. 30585. From Sindel-razpredelitelna station the train departed at 04:29 h., 3 min. ahead of schedule, as electric locomotive was again supportive one, and electric locomotive Nr. 87025.0 was the train driving one. The train passed transit at 04:51 through Provadia station, at 05:11 h. through Kaspichan station, and at 05:20 h. through Pliska station. Based on the Reports of the staff members from the three stations, it is established that upon the train's transit passing nothing irregular was noticed (as evidenced by the explanations and the interview carried out with them).

3.13. After performed joint surveys and actions on the part of the authorities from the National Investigative Service, the Prosecutor's Office and the Ministry of Interior, the train was dismissed from surveillance for the execution of maneuvers.

3.14. Actions were undertaken on pulling of the non-derailed wagons to Pliska station for freeing of the section between Hitrino and Pliska stations for the provision of access to the railway recovery equipment.

After completion of the surveys, the rescue actions, re-loading of the freight from the derailed wagon-cisterns and their transportation to the specialized platform at the city of Ruse, emergency repair works on the railway road were commenced for recovery of the railway line's capacity.

4. Death cases, injuries and property damages

4.1. Death cases:
- 7 people, residents of Hitrino village;

4.2. Injuries and traumas:
- 29 people, residents of Hitrino village;

4.3. Injured staff members:
- 1 staff member, post switchman at Post Nr. 2, from NRIC.

4.4. Property damages:

- Damages on locomotives Nr. 86003.4 and Nr. 87025.0 – no failures caused;
- By letter Nr. 311/21.09.2017 "Bulmarket Rail Cargo" EOOD provided a check on the damages caused to the derailed wagon-cisterns and the expenditures incurred from them:
- On the wagons – damaged 11 wagon-cisterns to a waste condition, whose approximate value amounts to BGN 774 508,68. The damages are approximate because of the official rejections of the wagons' owners - ERMEVA SAS, AUTOGAS IMPEX SRL and OLTCHIM SA, to provide real values concerning the damages;
- According to a check on the quality of spilled and exploded propylene, it was 45 350 kg, transported in wagon-cistern Nr. 33 87 791 56524. Its cost amounts to BGN 95 859,80.

- Damages caused to the railway infrastructure:

- Railway line and facilities:

The damages for recovery of the railway line, the facilities and the buildings to the National Railway Infrastructure Company (NRIC) amount to BGN 991 593,28.

- Safety provision equipment and communications, radio links and electric power supply:

The damages for recovery of the safety provision equipment to NRIC amount to BGN 25 952,46.

- Catenary:

The damages for recovery of the catenary to NRIC as a result from the occurred accident amount to BGN 775 855,57.

- Buildings:

The damages for recovery of Post Nr. 2 and other official premises of NRIC at Hitrino station amount to BGN 5 984,09.

- Expenditures:

The expenditures for recovery equipment amount to BGN 4 429,63.

- Expenditures for changing the Train Trafficking Schedule:

- The expenditures of "Rail Cargo Carrier – Bulgaria" EOOD for trafficking of the trains on a by-pass route amount to BGN 17 039,19.

- The expenditures of the "Bulgarian Railway Company" AD for additionally scheduled trains on by-pass routes amount to BGN 34 055.

- The expenditures of BDZ Freight Transport EOOD for trafficking of trains on by-pass routes amount to BGN 28 837,38.

- The expenditures of BDZ Passenger Transport EOOD for trans-boarding of passengers and increasing the working hours of the transport brigades amount to BGN 42 430,91.

- The expenditures of "D. B. Cargo Bulgaria" EOOD for trafficking of trains on by-pass routes amount to BGN 4 239,10.

- The expenditures of "Bulmarket Rail Cargo" EOOD for re-loading of the freight from the derailed wagon-cisterns to auto-cisterns, loading, transportation and unloading of the reservoirs of the wagon-cisterns and the wagon parts from the place of the accident to DZS – Ruse amount to BGN 438 106,04.

The total damages and expenditures incurred from the accident amount to: BGN 3 238 891,13.

5. External circumstances – climatic and geographic conditions

Meteorological data on the weather, impacting visibility:

- during the dark hours of the day - 05:37 h.;
- ambient temperature at 6:00 h., +5,4º;
- wind speed – 5 m/s;
- weather – clear for perception of signaling indications.

6. Data on staff members, related with the accident, from the railway infrastructure and the railway carrier

6.1 Locomotive brigades:

- Locomotive engine driver, first person on electric locomotive Nr. 86003.4, employee at "Bulmarket Rail Cargo" EOOD – 18 years of service;

- Locomotive engine driver, second person on electric locomotive Nr. 86003.4, employee at "Bulmarket Rail Cargo" EOOD – 33 years of service;

- Locomotive engine driver, first person on electric locomotive Nr. 87025.0, employee at "Bulmarket Rail Cargo" EOOD – 26 years of service.

6.2. Station staff members:

- Traffic controller – Hitrino station – employee at "Management of train trafficking and station activities" – Gorna Oryahovitsa, the NRIC – 1 year of service;

- Post switchman – Hitrino station – employee at "Management of train trafficking and station activities" – Gorna Oryahovitsa, the NRIC – 18 years of service;

- Post switchman – Hitrino station – employee at "Management of train trafficking and station activities" – Gorna Oryahovitsa, the NRIC – 27 years, 1 month of service.

6.3. Other staff members:

- Traffic controller / Senior train dispatcher – Operative Management Unit (ZOD) Gorna Oryahovitsa – employee at "Management of train trafficking and station activities" – Gorna Oryahovitsa, the NRIC – 9 years of service;

- Traffic controller/ Train dispatcher – Operative Management Unit (ZOD) Gorna Oryahovitsa – employee at "Management of train trafficking and station activities" – Gorna Oryahovitsa, the NRIC – 12 years of service;

- Electric system's technician/ Energy dispatcher – REZ Gorna Oryahovitsa – employee at Energy Section – Gorna Oryahovitsa, the NRIC – 4 years of service;

- Operator of Traction substation – Traction substation "Hitrino" – employee at Energy Section – Gorna Oryahovitsa, the NRIC – 9 years of service;

- Technician – mechanic, wagon's revision – Druzhba station – employee at "Bulmarket Rail Cargo" EOOD – 32 years of service;

- Technician – mechanic, wagon's revision – Dolno Ezerovo station – employee at "Bulmarket Rail Cargo" EOOD – 27 years of service.

6.4. Professional capability documents:

The staff members from the National Railway Infrastructure Company (NRIC) are holders of:

- certificate for occupying of the relevant job position;
- certificate of professional capability;
- certificates for successfully passed examination in accordance with Ordinance Nr. 56 dt. 2003;
- Traffic controller at Hitrino station - 30.10.2015;
- Post switchman at Post Nr. 1 at Hitrino station - 15.05.2014;
- Post switchman at Post Nr. 2 at Hitrino station - 16.05.2014.

The locomotive drivers from "Bulmarket Rail Cargo" EOOD, having driven electric locomotives Nr. 86003.4 and Nr. 87025.0, are holders of:

- certificate for occupying of the relevant job position;
- certificates for successfully passed examination in accordance with Ordinance Nr. 56 dt. 2003;
- locomotive engine driver, first person on locomotive Nr. 86003.4 – 03.07.2014;
- locomotive engine driver, second person on locomotive Nr. 86003.4 – 01.07.2014;
- locomotive engine driver, first person on locomotive Nr. 87025.0 – 01.07.2014;
- certificate for capability for driving of the relevant series of locomotives, the issued certificates are in contradiction with the requirements of Art. 9, par. 1 and Art. 38, par. 3 of the Law on professional education and training and Art. 44, par. 1, item 1 of Ordinance Nr. 56/2003.

6.5. Duration of rest before the working hours of the staff members related with the accident:

According to the requirements of the Labor Code and Ordinance Nr. 50 dt. 28.12.2001 on the working hours of the managerial and executive staff engaged with the provision of passenger and freight transports in the railway transport, the requested rest hours were ensured to the staff members, related with the accident, before starting work.

- "Locomotive engine driver", first person on electric locomotive Nr. 86003.4, rested from 22:10 h. on 07.12.2016 till 22:00 h. on 09.12.2016;

- "Locomotive engine driver", second person on electric locomotive Nr. 86003.4, rested from 00:00 h. on 08.12.2016 till 22:00 on 09.12.2016;

- "Locomotive engine driver", first person on electric locomotive Nr. 87025.0, rested from 23:00 h. on 08.12.2016 till 22:00 h. on 09.12.2016.

6.6. Pre-shift instructions:

- The locomotive brigades, having serviced freight train Nr. 90570, have undergone through pre-shift instructions, rendered by the "technician – mechanic, revision of wagons" at Druzhba station. They have declared by their personal signatures in the instruction records that they were of fresh standing, well rested and had not used any alcoholic drinks or any other drug substances.

- The station staff members, having worked at Hitrino station on 09/10.12.2016, have undergone through pre-shift instructions. They have declared by their personal signatures in the instruction records that they were of fresh standing, well rested and had not used any alcoholic drinks or any other drug substances.

7. Data from other investigations. Summary of witnessed evidence

Other similar investigations have not been carried out.

The Investigation Commission does not dispose of any witnessed evidence on the investigated accident, as the accident has occurred during the early hours of the day.

8. Safety management system (SMS) of the National Railway Infrastructure Company and "Bulmarket Rail Cargo" EOOD

8.1. Observance of the procedures from the safety management system of the National Railway Infrastructure Company (NRIC):

The Investigation Commission requested and got acquainted with the procedures provided by the safety management system of the NRIC and established that they had been fulfilled by the staff members of Sub-division "Management of train trafficking and station activities", Gorna Oryahovitsa. This is also evident from the Report of the Operative Team and the additionally requested materials to the Report, as well as from the interview carried out with the staff members of Hitrino station.

8.2. Observance of the procedures from the safety management system of "Bulmarket Rail Cargo" EOOD

The Investigation Commission requested the procedures from the safety management system of the railway carrier "Bulmarket Rail Cargo" EOOD and after getting acquainted with them established the following:

Upon the examination of the technical documentation of locomotives Nr. 86003.4 and Nr. 87025.0 no violations of the applicable Rules on maintenance of electric and diesel locomotives were established or registered. Based on the submitted technical documentation on the locomotives, it was established that locomotive Nr. 86003.4 had undergone through technical examination (ТП-1) on 14.11.2016 and that locomotive Nr. 87025.0 was examined (НПР-5) on 16.11.2016.

Established were violations of the procedures from the safety management system, as well as of the organization and operation technologies.

The locomotive engine drivers, having driven the locomotives and appointed at work by the railway carrier "Bulmarket Rail Cargo" EOOD, do not conform to the requirements of Safety Procedure ПБ-07 "Instructions for work of the locomotive engine driver" from the safety management system, and namely to item 5: "The job position "Locomotive engine driver" shall be occupied by persons holding a professional training document, issued by a licensed professional training center and having acquired the professional capability of "Locomotive engine driver" for a particular type (electric, diesel) of locomotives, in accordance with the conditions and order of training of candidates for the acquisition or acceptance of capability for the job positions in the railway transport, and the order of performance of the examinations of the persons from the staff, responsible for the safety of transport." They did not provide professional qualification certificates for a part of profession for the relevant locomotive series they had driven.

The locomotive engine driver of the leading locomotive (86-003.4) has not fulfilled item 15,a) from Safety Procedure ПБ-07 "Instructions for work of the locomotive engine driver" from the safety management system of "Bulmarket Rail Cargo" EOOD: "15. The locomotive engine

driver, besides the observance of the basic normative documents, mentioned in item 2, shall be obliged to provide: a) the faultless servicing of the trains as per schedule, upon strict observance of the prescribed speeds of trafficking";

The locomotive engine driver of the leading locomotive (86-003.4) has not fulfilled item 17,д) from Safety Procedure ПБ-07 "Instructions for work of the locomotive engine driver" from the safety management system of "Bulmarket Rail Cargo" EOOD: "17. The locomotive engine driver shall be obliged: д) to fulfill unconditionally the indications of the signals, the indicators on an open way and at the stations";

The locomotive engine driver has not fulfilled item 20 from Safety Procedure ПБ-07 "Instructions for work of the locomotive engine driver" from the safety management system of "Bulmarket Rail Cargo" EOOD: "20. Upon checking of the locomotive the locomotive engine driver shall be obliged to pay special attention to the precise testing of the breaks, and during trafficking – to their correct manipulation, to the observance of the permissible speeds, as limited by the condition of the railway line and the existing breaking system's provision of the train and the locomotive, to the alertness and concentration during work of the locomotive engine driver – second person, to their knowledge in connection with the concrete provisions on safety, or to any changes having occurred in the operational work".

The locomotive engine driver of the leading locomotive (86-003.4) has not fulfilled item 32, (1), a) from Safety Procedure ПБ-07 "Instructions for work of the locomotive engine driver" from the safety management system of "Bulmarket Rail Cargo" EOOD: "32. (1) Upon the acceptance of the locomotive the locomotive engine driver shall be obliged: б) to check the availability and the condition of the seals of the apparatus, control devices and assembly units which must be sealed, and the reserve parts and materials available at hand";

The locomotive engine drivers – first persons on the two locomotives, have not fulfilled the requirements of item 13. (1) and (3) from Safety Procedure ПБ-06 from the safety management system of "Bulmarket Rail Cargo" EOOD: "13. (1) Upon each acceptance of traction rolling stock for a train, the locomotive engine driver shall check as a must the availability of faultless seals on the driving unit, the electric pneumatic valves, the connections and the control units (speedometer, couplings, boxes and stop valve). (3) In case of establishment of unsealed elements or failure of the driving unit upon the acceptance of the traction rolling stock, the locomotive engine driver shall inform thereabout an official from the "Locomotives" Department, appointed by order of the Manager of "Bulmarket Rail Cargo" EOOD".

After the performed analysis of the circumstances, facts and evidence, violations of the safety procedures were established:

- upon their appointment on duty, the locomotive brigades have attended in person at the office of the Company at Ruse-North station, where they received a pass, which is without number and without seal for capability of the personnel;
- upon filling in of the pass, no acceptance and handling over of the locomotive are recorded;
- where the locomotive travels second in the composition of the train, its alertness maintenance device is switched off;
- no information from the recording devices of the locomotives is taken and deciphered after each appointment.

From the check made at the European Virtual Register regarding the wagons, included in the composition of freight train Nr. 90570 on 10.12.2016, violations in the registration of 13 wagon-cisterns were established, as follows:

- at the date of occurrence of the accident, 11 wagons, owned by AUTOGAS IMPEX SRL, had no valid registration in the Register of vehicles, and had no enlisted person responsible for their maintenance; 7 of these wagons have derailed;
- at the date of occurrence of the accident, 2 wagons, owned by OLTCHIM SA, had valid registration in the Register of vehicles, but had no enlisted person responsible for their maintenance; 1 of these wagons has derailed.

After written request of the technical documentation on the derailed wagons from the Romanian owners and the owner of the French cistern, as at the time being only ERMEWA SAS - Succursale de Genève have provided complete set of documents for the wagon.

From the submitted technical documentation for wagon-cistern Nr. 33 87 791 5652-4, having derailed, tenth in line in the composition of the train, it was established that it was owned by ERMEWA SAS - Succursale de Genève. Reservoir Nr. 4418, mounted on the wagon, has an issued certificate for performed last examination for strength under P = 2,6 MPa and density under P = 0,68 MPa, carried out by the Notified Body BV – Romania on 30.10.2013, as well as protocol from ultrasonic NDT.

The performance of this examination shall be documented not only by issuing of certificate, but also by making of a template indication on the information panel, fixed on the reservoir, which is not done in the case.

9. Rules and norms

- The staff members on duty from the National Railway Infrastructure Company, immediately before and during the accident, have acted in conformity with the established normative regulations and internal rules regulating safety of freights in the railway transport.

- The locomotive engine drivers from "Bulmarket Rail Cargo" EOOD, carrying out transporting of the train, before and during the accident have committed mistakes which are in contradiction with the established normative regulations regulating safety of railway transport, as well as with documents from the safety management system of "Bulmarket Rail Cargo" EOOD, namely:

- isolating of the alertness maintenance device of the locomotive;

- issuing of a pass, in which there is no enlisted number and affixed seal proving capability;

- non-observance of the signals of the warning and the entrance traffic lights;

- non-observance of the speed limitation upon passing at the entrance traffic lights and the points, outlining the route to a deviation platform.

10. Functional status of the rolling stock and technical facilities of the railway infrastructure

10.1. Functional status of the railway rolling stock:

- technical status of the locomotives – no damages caused;

- technical status of the twelve derailed wagons – strongly damaged with deformed structures;

- technical status of the other 14 wagons – in technical faultless condition.

10.2. Functional status of the railway infrastructure:

Railway line and points:

- damaged 280 m of the railway line;

- damaged point Nr. 5;

- damaged elastic pavement of the level crossing and the barrier mechanisms of the level crossing at km 110^{+460} at the area of the station;

- damaged buildings, warehouses and garages of NRIC.

Safety provision equipment, communications, radio links and electric power supply:

- damaged exit traffic lights – 3 pcs.;

- damaged foundations of traffic lights – 3 pcs.;

- damaged cables of about 380 m length;

- damaged projectors and panels of the pile lighting – 8 pcs.

Status of the catenaty:

- damaged reinforced concrete poles – 6 pcs.;

- damaged reinforced grid pole – 1 pcs.;

- damaged contact conductor and bearing rope – 0,9 km.

10.3. Deciphering of the speed of locomotive Nr. 86003.4, submitted by "Bulmarket Rail Cargo" EOOD:

- “On 10.12.2016 before entering at Hitrino station freight train Nr. 90570 travelled with the speed of 80 km/h. Stopping from this speed started at a distance of 515 m away from the place where the train stopped after the derailing of the wagons and tearing apart of the train. The pressure in the main air duct of the train dropped to 1,2 bars before the final stopping of the train.”

11. Operational system documents – examinations, checks, repairs, maintenance and prophylaxis

11.1. Measures, undertaken by the staff members, for regulating of the train trafficking

The Operative Management Unit and “Management of train trafficking and station activities” - Gorna Oryahovitsa have undertaken timely operative changes in the train trafficking schedule in the section between Samuil and Kaspichan stations. Elaborated were variant schedules for changing of the traffic routes of passenger and freight trains.

11.2. Exchange of oral instructions and written notifications

By Orders Nr.Nr. 5 & 6 dt. 12.12.2016 of the train dispatcher at Regional Traffic Department – Gorna Oryahovitsa, from 08:40 h. at the section between Hitrino – Pliska stations and Hitrino – Visoka Polyana stations the traffic of all trains and vehicles is suspended, except for the traffic of the recovery equipment. The passenger trains in the section from Samuil station to Kaspichan station are annulled, and the passengers are transported by buses.

After partial completion of the repair activities at 14:40 h. on 21.12.2016, the traffic of all passenger trains through Hitrino station is recovered, only with speed limitation of up to 15 km/h on First platform with electric traction.

Till complete recovery of the capacity of the railway infrastructure through Hitrino station, all freight trains from the section are re-directed on by-pass routes.

11.3. Measures, undertaken for the protection and guarding of the place of accident

From 09:30 h. on 12.12.2016 till 14:00 h. on 20.12.2016 the region of the station is surrounded and guarded by the authorities of the Ministry of Interior, upon limited access for external persons, except for the authorities and teams performing activities on the re-loading of the cisterns – “Fire Safety and Protection of Population”, the authorities of the district Prosecutor’s Office – Shumen, the National Investigative Service, the Investigation Commission at MTITC, “Civil Protection of Population”, the Bulgarian Red Cross and other partaking organizations and volunteers.

12. Health and safety of labor

- In connection with the requirements of Art.13, par.1 and Art.14, par.1 of Ordinance Nr. 50/28.12.2001, systemic violations (bad practices) were established upon reporting of the staff’s working hours in the carrier’s company.

Upon stepping in service of the locomotive brigades, working on the carrier’s trains which are not in the region of the basic depot, they appear in person at the office of the company at Ruse-North station, where they get at their disposal an official automobile by which they are transported to the place of departure of the train. The automobile provided in the disposal of the locomotive brigades is driven by them, and the hours of their travel is reported as “travelling without servicing”, though actually they are engaged with driving of the automobile for hours till their arrival at the place of departure.

- In connection with the requirements of Art. 28, par. 1 of Ordinance Nr. 54/02.06.2003, no violations have been established concerning the pre-shift medical examinations of the staff members.

- In connection with the requirements of Art. 20, par. 2 of Ordinance Nr. 54/02.06.2003, the staff members from the NRIC and the railway carrier, related with the accident, are in possession of valid certificates from psychological examination.

13. Registered previous accidents of a similar nature

- There are no committed previous accidents of a similar nature with the same rolling stock.

- The staff members, having partaken in the accident on the part of the railway carrier and the railway infrastructure, have no registered previous accidents of a similar nature.

- In the region of the railway section there are no committed accidents of a similar nature, as well as at Hitrino station.

14. Analysis and conclusions

The Investigation Commission at the MTITC collected the requested documentation and materials, analyzed all eventual circumstances, facts and evidence, which could have lead to the establishment of the technical causes for the occurrence of the railway accident. The performed detailed and profound surveys of the railway line, the safety provision equipment, the railway rolling stock, as well as the analysis of the materials and documents provided by the Operative Team, the elaborated and provided technical expertise, the opinions of the experts having partaken in the investigation, the interview carried out with the staff members, enabled the establishment of the following:

- the derailing of the wagon-cisterns from freight train Nr. 90570 occurred at 05:37 h. at point Nr. 5 upon prepared route for entrance of the freight train on Third platform at Hitrino station on 10.12.2016;

- the derailing of the sixth wagon Nr. 84 53 771 7003-8 is realized in the intermediate part of point Nr. 5, which is of radius R=300 m and is 33 m long;

- the speed of movement of the train at the moment of derailing was 78 km/h, upon permitted speed of 40 km/h;

- after the derailing, the two locomotives together with the first five wagons continued their movement and stopped in front of the reception building of Hitrino station at km 109^{+997};

- the wagons from the 6^{th} to the 17^{th} one included derailed and stopped at the section of Post Nr. 2 from km 110^{+511} (the beginning of point Nr. 5) to km 110^{+335};

- the derailed wagons, upon freeing of their catching and tearing of the composition, continued their movement uncontrolled, which caused hits in the pulling-deviation devices, as well as hits between the reservoirs, as a result of which at a particular moment the left buffer of the 9^{th} wagon cut itself in the lower part of the reservoir of the 10^{th} wagon and torn it apart;

- from the torn reservoir of the 10^{th} wagon-cistern the transported freight leaked off (propylene gas), from which, after its release in the air in concentration between 5÷15 %, an explosion occurred, followed by bursting of a large fire.

14.1. Analysis of the records from the recorders of locomotives Nr. 86003.4 and Nr. 87025.0 from Druzhba station to Hitrino station during servicing of freight train Nr. 90570

Unloading of the information from the recorders of the two locomotives was carried out in the presence of the authorities from the National Investigative Service and the Investigation Commission at the MTITC. Reading of records was performed via a program product of DEUTA WERKE ADS3. The data unloaded from the recorders of the locomotives was subjected to expert evaluation and detailed analysis in respect of trafficking of the train.

Data records, taken from the recorder of electric locomotive Nr. 86003.4, contain information on the trafficking of the train from Druzhba station to Hitrino station, as the total travelled mileage on the alignment of Druzhba – Karnobat – Sindel-razpredelitelna – Hitrino stations is 244,085 km.

Figure 10, upper part, exhibits the diagrams of changing of the speed (in green color) and the pressure in the main air duct (in red color) as function from the travelled road.

The lower part of Figure 10 exhibits the digital parameters of the movement of the

Figure 10

locomotive.

It was established that the alertness maintenance device of the locomotive was switched off from Karnobat station to Sindel-razpredelitelna station (in this section locomotive Nr. 86003.4 travelled as a second locomotive in the composition of the train, and at that time locomotive Nr. 87025.0 was positioned ahead of the train). The digital parameter with designation „H:DMA Tidsstyr Susp" (designated with blue color at the lower part of Figure 10) has "zero" value from Druzhba station to Karnobat station, thereafter an increase is registered (rectangular impulse) to Sindel-razpredelitelna station, and after that the parameter again drops down to "zero" value up to Hitrino station.

Upon the performed survey of the alertness maintenance device of the second locomotive Nr. 87025.0, it was also established that its lead seal is of violated integrity (sealing wire torn apart).

The recorded parameters of the train's trafficking were surveyed and analyzed in detail in the last 3000 meters before entering of the train at Hitrino station (point Nr. 1). Figure 10 exhibits in graphics the recorded parameters from km **200,320** to km **203,320** (provisional kilometers, the last 3000 meters before the occurrence of the derailing accident). According to the trafficking schedule of train Nr. 90570, the permitted maximum speed at the section between Pliska and Hitrino stations is 70 km/h.

On Figure 11, on the image generated by the original software base markers are superimposed with numbering, designations and distances between them (in brown color). As exhibited by the diagram of speed as a function from the travelled road V=V(S) (depicted in green color), till km 200,500 locomotive Nr. 86003.4 travelled with the permitted speed. After this moment the speed increased in an uncontrolled way and in violation of the trafficking

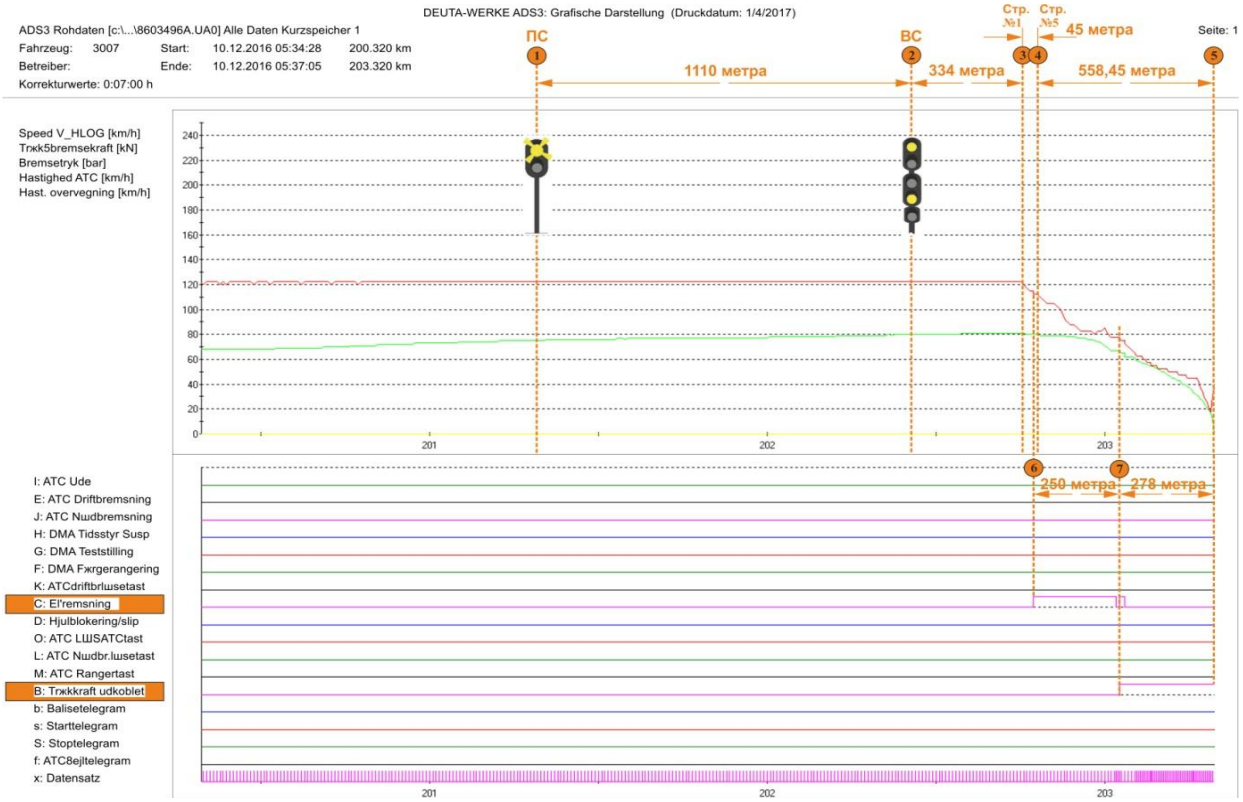


Figure 11

schedule it reached 81 km/h (marker ③ on Figure 11). At the warning traffic lights (marker ①**)** the train passed with the speed of 78 km/h, and at the entrance traffic lights (marker ②**)** – with 80 km/h.

The designations of the markers are:

① - warning traffic lights;

② - entrance traffic lights;

③ - beginning of point Nr. 1;

④ - beginning of point Nr. 5;

⑤ - the point of stopping of locomotive Nr. 86003.4 after the derailing accident (head buffers of the locomotive);

⑥ - beginning of recuperative stopping of locomotive Nr. 86003.4;

⑦ - switching off of the traction power of locomotive Nr. 86003.4.

The digital parameter with designation „H:DMA Tidsstyr Susp" (depicted in blue color in the lower part of Figure 11) in the entire records is of "zero" value, which provides grounds to consider that the alertness maintenance device was switched on.

The digital parameter with designation „C: El-bremsning" (depicted in lilac color in the lower part of Figure 11) up to marker ⑦ is of "zero" value, after which up to marker ⑦ it is not of a "zero" value, which provides grounds to consider that recuperative (electric) stopping was applied (travelled road of 250 meters for a time of 13 seconds). It is marked by brown rectangular field on Figure 11.

The digital parameter with designation „B: Trykkraft udkoblet" (depicted in lilac color in the lower part of Figure 11) up to marker ⑦ is of "zero" value, thereafter up to marker ⑤ it is not of a "zero" value, which provides grounds to consider that "traction" was switched off, i.e. zero

traction power (travelled road of 278 meters for a time of 29 seconds). It is marked by brown rectangular field on Figure 11.

Hence, upon the established final stopping of locomotive Nr. 86003.4 after the accident at kilometer 109,99755 and at 558,45 meters after the beginning of point Nr.1, the summary travelled road is 250 meters (electric stopping) and 278 meters ("traction" switched off), or totally 528 meters; this shows that the manipulations with the controller have been late and their effect was only stopping of the two locomotives and the first 5 wagons from the composition of the train.

For establishing of the breaking efficiency of locomotive Nr. 86003.4, the Investigation Commission at the MTITC requested and carried out speed-breaking tests on 09.02.2017 at a two-way section, Poduyane – Iskar – Kazichene – Elin Pelin, as the distance was travelled twice in both directions.

The conditions, under which the tests were performed, are as follows:

- weather – cloudy;
- status of the rails – dry;
- ambient temperature - $+4^0$ C;
- the cited section of the railway infrastructure is for speed of 120 km/h.

Performed tests, measurements and checks:

- breaking tests;
- automatic break with relay valve RH-2;
- direct break with crane machine driver, Zb11 type;
- parking break;
- electric - dynamic break;
- testing of the alertness maintenance device;
- testing of the speedometer system;
- measurement of the temperature of the grease box roll bearers;
- functioning of the automatic locomotive signaling system - THERE IS NO AUTOMATIC LOCOMOTIVE SIGNALING SYSTEM MOUNTED;
- functioning of the train-dispatcher radio link.

After completion of the tests, the data records from the movement of the train was unloaded and read, as during the tests 62,89 km were travelled in total.

Figure 12, upper part, exhibits the schedules of changing of the speed (in red color) and

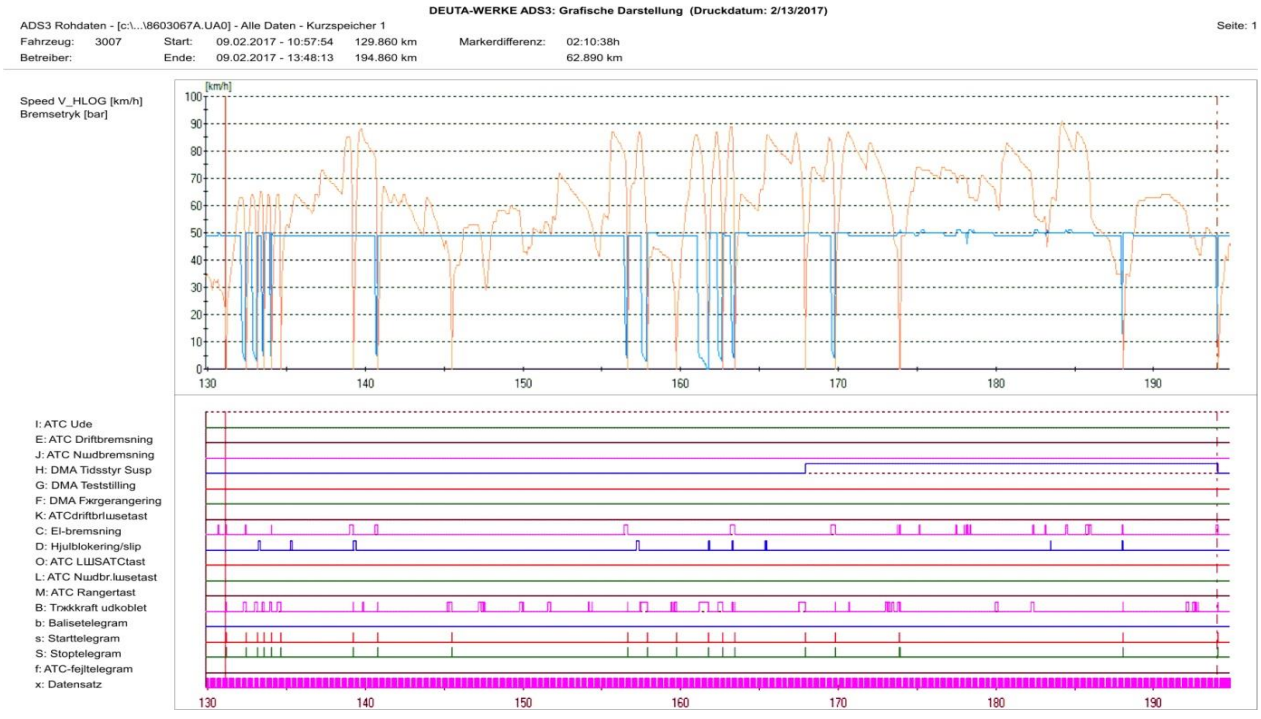


Figure 12

the pressure in the main air duct of the train (in light blue color) as a function from the travelled road.

Figure 12, lower part, exhibits the registered digital parameters of the locomotive's movement.

At km 167,900 the alertness maintenance device was switched off for carrying out of the experiment.

The digital parameter, designated with „H:DMA Tidsstyr Susp" (depicted in blue color in the lower part of Figure 12) is of "zero" value up to km 167,900, after which an increase is registered (rectangular impulse) to Poduyane-passenger station (km 194,065), where the alertness maintenance device is switched on again.

From the performed speed-breaking test of locomotive Nr. 86003.4, no irregularities or deviations in the technical norms of the locomotive were established.

Conclusively a comparative analysis was carried out of the results from the executed speed-breaking on-road test on 09.02.2017, from the last executed speed-breaking on-road test on 25.06.2014, and from the tests performed upon putting in operation of the locomotive.

No substantial differences were established in the digital values, nor were established any deviations from the permissible tolerances of variation of parameters.

In addition, compared and analyzed were the real recorded breaking trajectories (from the on-board registration systems) of the two locomotives Nr. 86003.4 and Nr. 87025.0. The result is exhibited graphically on Figure 13.

The schedule, depicting the breaking trajectory of locomotive Nr. 87025.0, is positioned on the Figure after "ahead – behind" benchmarking, i.e. from the point of stopping, upon considering of the circumstance that the sensor of the registering system of locomotive Nr. 86003.4 is mounted from a structural point of view on the first wheel axis, and of locomotive Nr. 87025.0 such is mounted on the third wheel axis, and the distance between them is 28,30 m.

The coincidence of recorded data from the registering electronic systems of the two locomotives from km 202,700 to km 202,900 confirms the conclusion that train Nr. 90570 has passed through point Nr.1 with the speed of 81 km/h, and through point Nr.5 with the speed of 78 km/h.

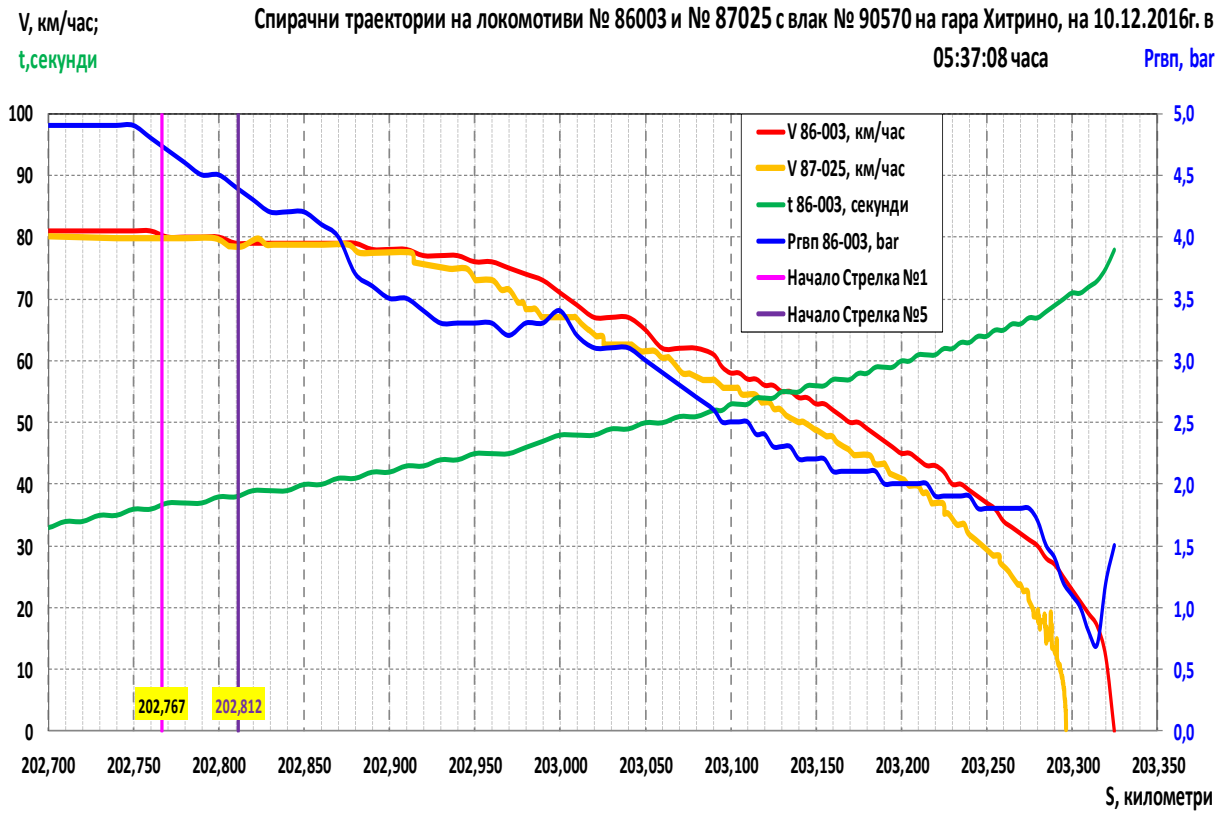


Figure 13

Breaking trajectories of locomotives Nr. 86003 and Nr. 87025 with train Nr. 90570 at Hitrino station on 10.12.2016 at 05:37:08 h

Clarifications of Figure 13:

- depicted in **red color** is the breaking trajectory of locomotive Nr. 86003.4, schedule V=V(S) – the speed as a function of travelled road;

- depicted in **orange color** is the breaking trajectory of locomotive Nr. 87025.0, schedule V=V(S) – the speed as a function of travelled road;

- depicted in **green color** is the time in seconds, having passed after km 202,000, as a function of travelled road;

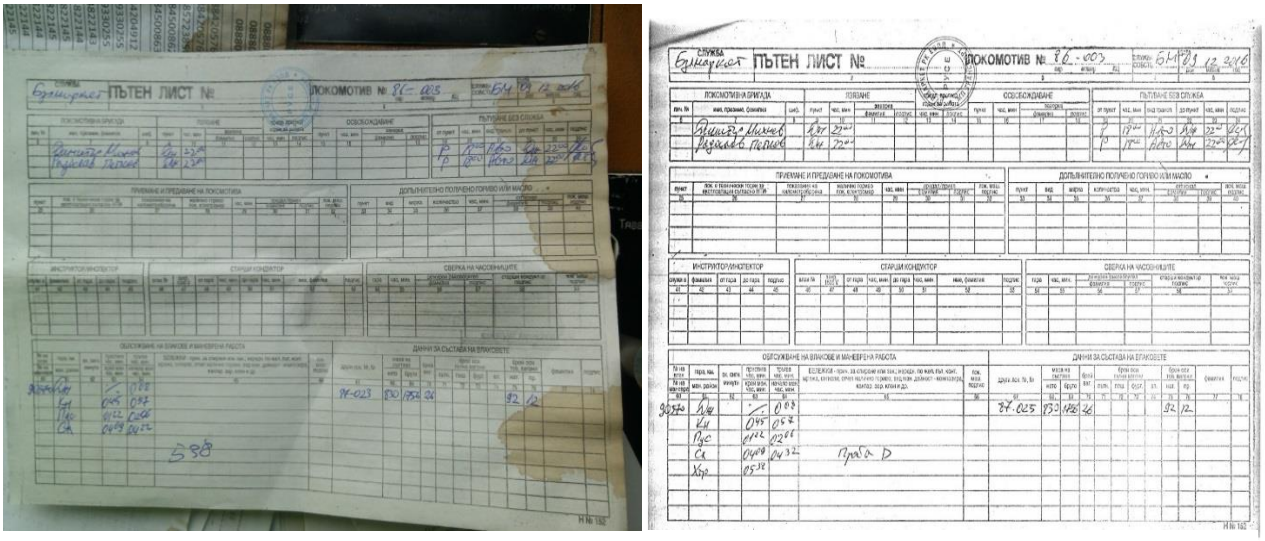
- depicted in **blue color** is the variation of pressure in the main air duct of the train as a function of travelled road (with command function for the breaking system). The breaking system of the trains is of indirect action. Upon pressure of $P_{ГВП} = 5^{\pm 0,1}$ bar, the break is in a loosened state (there is no breaking power), and as lower is the value of pressure $P_{ГВП}$, as bigger is the breaking force of the train;

- the vertical line, depicted in **lilac color**, designates the location of point Nr. 1 (entrance point for the station), and in **dark lilac color** – the location of point Nr. 5;

The yellow field shows the location of point Nr.1 (km 202,767) and of point Nr.5 (km 202,812), benchmarked in the schedule.

14.2. Analysis of the organization of the operational activity:

Upon their steeping in shift, the locomotive engine drivers who will service train Nr. 90570 appear in person at the office of the company carrier at Ruse-North station, where they are provided with a pass, an automobile for official use, which is driven by them in person to the station where the locomotive, which will be serviced by them, is parked. The pass, which the locomotive engine drivers receive upon their appearance at the office, has no number, verification or seal for capability of the staff members, affixed by the official issuing the pass, and this is a pre-condition for its replacement with another pass, which in reality was established in the process of investigation, namely: in the cabin of locomotive Nr. 86003.4 two passes were



Фиг. 14

found with different data filled in (Figure 14).

The time during which the locomotive brigades travel with the official automobile is reported as “time without service”. Actually, the brigade travelled for more than 4 hours, at that time being engaged with driving of the automobile to the place of destination. Upon arriving at Drurzhba station, a staff member from the company carrier, possessing professional capability for “revision of wagons”, rendered instructions (performing this activity as a second job) to them. Freight train Nr. 90570 travelled from Druzhba station to Hitrino station, changing its direction twice at the stations of Karnobat and Sindel-razpredelitelna, and respectively the locomotives changed their places:

- initially ahead of the train was locomotive Nr. 86003.4, and train one was locomotive Nr. 87025.0 in the section from Druzhba station to Karnobat station;

- after changing of the direction of trafficking, from Karnobat station to Sindel-razpredelitelna station ahead of the train was locomotive Nr. 87025.0, and second was locomotive Nr. 86003.4;

- from Sindel-rapredelitelna station to Hitrino station again ahead of the train was locomotive Nr. 86003.4, and second was locomotive Nr. № 87025.0.

Based on the performed analysis of the records from the recorders of the locomotives it was proven that the alertness maintenance device of both locomotives was switched off in the cases where the locomotive was second in the composition of the train, namely of locomotive Nr. 87025.0 from Druzhba station to Karnobat station and from Sindel-rapredelitelna station to Hitrino station, and of locomotive Nr. 86003.4 from Karnobat station to Sindel-razpredelitelna station.

These findings suggest that the locomotive engine drivers of "Bulmarket Rail Cargo" EOOD have established the harmful practice to switch off the alertness maintenance device of the locomotive when it travels second in the composition of the train. This was also confirmed by the performed surveys of the two locomotives, on (Figure 15) locomotive Nr. 86003.4 and on (Figure Nr. 16) locomotive Nr. 87025.0, whose alertness maintenance devices were found with interrupted seals, disguised as intact and regular ones, which constitutes a rough violation of the normative acts on safety and of the safety management system of the company.

Фиг. 15

Фиг. 16

14.3. Analysis of the train's trafficking

Based on the information provided from the recorders of the two locomotives it was established that in the section between Druzhba station and Pliska station the train travelled normally, observing the speed limitations in accordance with the Schedule book.

The train passed through Pliska station without stopping with a speed of 54 – 56 km/h, thereafter it started accelerating and after about 2,2 km the speed increased gradually and smoothly up to 66 - 67 km/h, as the train travelled with such speed for about 1,2 km. It worth mentioning that in this interval the road profile is variable (initially comparatively large inclination of ascending between 11 ‰, 16,7 ‰ and 12 ‰, thereafter followed by an almost plain interval from 0 to 5,9 ‰), and in order to maintain this permanent speed the locomotive engine driver must perform the relevant driving control manipulations, which leads to the conclusion that the locomotive engine driver has actively controlled the trafficking of the train. From this moment on the train's speed increased rapidly, as for about 100 m it grew up to 70 km/h, which is the permissible speed of the train's movement in this section of the railroad between the stations. The train continued to increase its speed, not known why, and it reached 75 km/h at km 123^{+800}, i.e. at about 7 km after Pliska station, regardless of the fact that the road's profile is ascending. For the next 1,5 km or so the speed was gradually and smoothly decreased

to 67 km/h, thereafter it was rapidly increased again to 72 km/h, again in an interval of a large inclination, followed again by travelling at this constant speed for 250 m, thereafter the speed was decreased to 68 km/h and after 3,6 km it was smoothly decreased to 58 km/h. Again rapid increase of speed to 69 km/h followed and it was maintained almost at a constant level for 4,5 km in an interval of a large ascending inclination. From km 112^{+300} at a distance of about 40 m the speed was again increased sharply to 72 km/h and after 2 km the speed started to increase smoothly and reached 81 km/h in front of point Nr. 1. All described events are unexplainable by the normal and professional logic and can be summarized as inadequate. The locomotive engine driver of the leading locomotive remained impartial in respect of the train's movement for many kilometers of travelled road, thereafter he corrected his mistake, followed again by passiveness and lack of reaction in spite of the altered conditions of train's trafficking. The other two locomotive engine drivers – professionals with large experience in the specialty, also remained impartial towards the happening events. Finally the shaking of the locomotive upon its passing through point Nr. 1 a – an on-road point in respect of the train's movement, provided a signal to the locomotive engine driver, first person on the leading locomotive, that the speed of the train composition, lead by him, was higher than the permitted one and he undertook actions by the train's break for decreasing of speed. Anyway, there again followed an inadequate action on his part: instead of undertaking fast stopping (extreme hold-up) by the train's automatic break, which would have decreased the speed of trafficking and would have stopped the train not later than at the throttle place of the points, and in such way would have prevented the possibility for derailing of the train, he performed a short hold-up on a stage basis, which was not sufficient to decrease the speed of the train under the permissible one for passing through the deviation element of the points, and there followed the derailing accident.

Further decrease of the pressure in the main air duct of the train is due to the derailing of the wagons and tearing apart of the train between the 6th and the 7th wagon. Passing of the two locomotives and the first six wagons through the two points was possible thanks to the strength of the railway line in the area of point Nr. 5. As a result from the occurrence of big crosswise forces, the rail- sleepers' grid shifted initially on the right in the direction of the centrifugal force acting on the part of the locomotives and wagons, later the right rail twisted on the right, which lead to the derailing of 12 wagons from the composition of the train.

14.4. Analysis of the safety provision equipment

Hitrino station is provided with Relay Key Dependence System with Control unit found in the premises of the traffic controller at the reception building of the station, and Executive units found at the points' Posts Nr.1 and Nr. 2 in the two throttle places of Hitrino station. On 14.12.2016 the Investigation Commission at the MTITC performed survey of the external and

Figure 17

internal equipment in the presence of a mechanic - "safety provision equipment", to register the condition of the prepared route with the installation in the station and at Post Nr. 2, of the partaking in the route entrance points Nr. 1 and Nr. 5, and the position of the switch rails locked with locks of "Kolben-Danek"" type. As evidenced by the control panel of the Control unit in the station (Figure 17) and the position of the keys inserted in the sockets of the Executive unit at Post Nr. 2 (Figure 18) and the dropped barriers of the railway level crossing, the Commission found that the route was properly aligned and the installation was in a faultless state at the moment of the accident.

The seals of the Control unit and the Executive units were of a regular state (Figure 19).

Figure 18

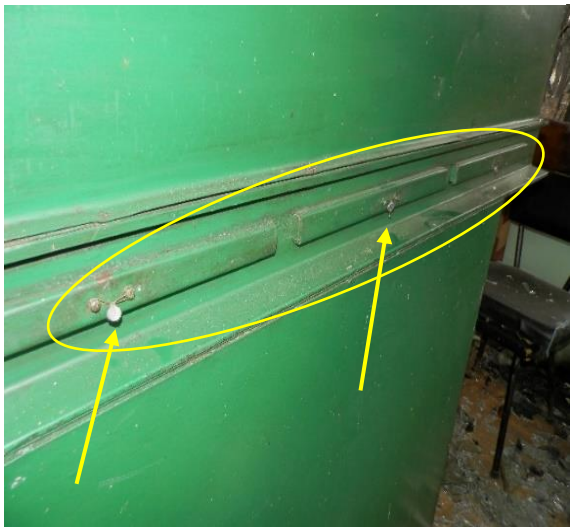


Figure 19

Provided were two Protocols of Findings on the condition of the safety provision equipment and the devices of the Control unit and the Executive units at Hitrino station dt. 10.12.2016. As evidenced by the above Protocols, at the moment of the accident the installation was in a faultless state, which provides confirmation of the route, prepared for deviation with the light indications of the warning and the entrance traffic lights.

The failures enlisted in the Records of the safety provision equipment, Model Form VII-51, found at Post Nr. 2 and the station had been rectified on a timely basis, as at the moment of the accident there weren't any failures enlisted in the above Records. The traffic controller on duty has instructed in writing and via the Control unit of the Relay Key Dependence System the post switchman at Post Nr. 2 to prepare a route for acceptance of the train on the Third acceptance-departure deviation platform, with stopping at the station. Points Nr. 1 and Nr. 5 were prepared correctly by the post switchman at Post Nr. 2 for entrance of the train on the Third platform.

The manual point locks, "Kolben-Danek" type, have locked correctly the switch rails at point Nr. 1 in (+) position (on Figure 20) and point Nr. 5 in (+) position

Figure 20

(on Figure 21) for acceptance of the train on the Third platform. The keys from the manual point locks are placed in the sockets of the Executive unit at Post Nr. 2 for the prepared route, and the platform's lever is turned on correctly for entrance of the train on the Third platform.

Figure. 21

Upon prepared route, opening of the entrance signal for acceptance of the train in the station was commenced. The conforming indications of the warning and the entrance traffic lights are in accordance with the requirements of Art. 317, item 3 and Art. 324, par. 3, item 5 of Ordinance Nr. 58, and the Table on route dependences of Hitrino station, submitted by "ST Section" – Gorna Oryahovitsa.

After the actions, undertaken and performed on the part of the traffic controller on duty via the Control unit at the station and on the part of the post switchman via the Executive unit at Post Nr. 2, the indications of the entrance signal are two yellow lights – one up and one down, of permanent lighting, obliging the locomotive engine driver of the train, entering into a deviation on the Third platform, to limit the speed of trafficking to 40 km/h upon passing through points Nr. 1 and Nr. 5. On the warning traffic lights, located at 1110 m in front of the entrance traffic lights, the indication is one yellow flashing light of sixty flashings per minute, obliging the locomotive engine driver to reduce the speed of trafficking of the train before the entrance traffic lights to 40 km/h.

On 18.01.2017 independent external experts, appointed by the National Investigative Service, performed a survey and examination of the safety provision equipment at Hitrino station in connection with the elaboration of Complex Technical Expertise.

14.5. Analysis of the railway line

For the acceptance of trains and other railway vehicles upon an arranged route for deviation including points of radiuses R=190 m and R=300 m, the maximum permissible speed for passing through the points is 40 km/h. The speed is related with the indications of the signaling system. Stations, provided with safety provision equipment of Relay Key Dependence System type on both sides, are signaled by signals limiting the speed of trafficking on the main platform to 60 km/h through the points. Upon the entrance of freight train Nr. 90570 in the right deviation of point Nr. 1 (Figure 22, the point designated in yellow color), consequentially from the high speed of 81 km/h and the movement in a bend of R=300 m without (surpass) height, where the side accelerations are not cancelled, strong hits were caused by the ledges of the

wheels on the external left guide rail of the point, but due to the one-directional movement no derailing of the rolling stock has occurred thereupon.

This was not the situation upon passing of the train through point Nr. 5 (Figure 22, the

Figure 22

point designated in red color). Because of the high speed of 78 km/h upon the entrance of the train in the point, the train changed its trajectory of movement depending on the position of the switch rails, and passed from right bent to left bend, as a result of which the horizontal crosswise forces had gained multiple increase. The locked right switch rail, densely affixed to the rail shoulder, and its strong fastening to the sleeper's grid, assisted the switch rail of the point to counteract at the forces generated from the wheels of the two locomotives and of the first five wagons.

After passing of the two locomotives and the first five wagons through the point, there started a process of losing stability of the rail-sleeper's grid of the point, which caused its shifting aside as follows:

- in the area of the switch rail from the 1st to the 6th slide, it shifted 9 cm on the left;
- at the 9th slide, it shifted 40 cm on the right;
- at the end of the switch rail, it shifted 95 cm on the right;
- in the intermediate part, the point shifted 134 cm on the right.

The intermediate part of the point is its geometric center, positioned at km 110^{+494}, which proves to be also the point of derailing of the 6th wagon. Consequentially from the great shifting on the right of the rail-sleeper's grid in the section of the switch rail and the intermediate part of point Nr. 5, the design radius of point Nr. 5 changed; changed was also the central line of the deviation platform, on which the train was trafficking.

Because of the reliable locking of the right deviation switch rail to the rail shoulder and their joint counteraction against the big dynamic, vertical and horizontal forces, generated by the high speed, the two locomotives and the first five wagons were able to pass unobstructed through the point. This is not the situation with the intermediate right guide rail of point Nr. 5, there the largest shifting and changing of the design radius and the central line of the deviation platform occurred. On such causes, after the joint at the end of the switch rail there started pulling out of

the sleeper's screws, connecting the rib pads to the sleepers on the internal side of the rail. On the first sleeper after the double sleeper, the sleeper screws are pulled out with about 25 mm, and on the 2nd, 3rd and 5th sleepers (Figure 23) the sleeper screws are completely pulled out. On the 4th

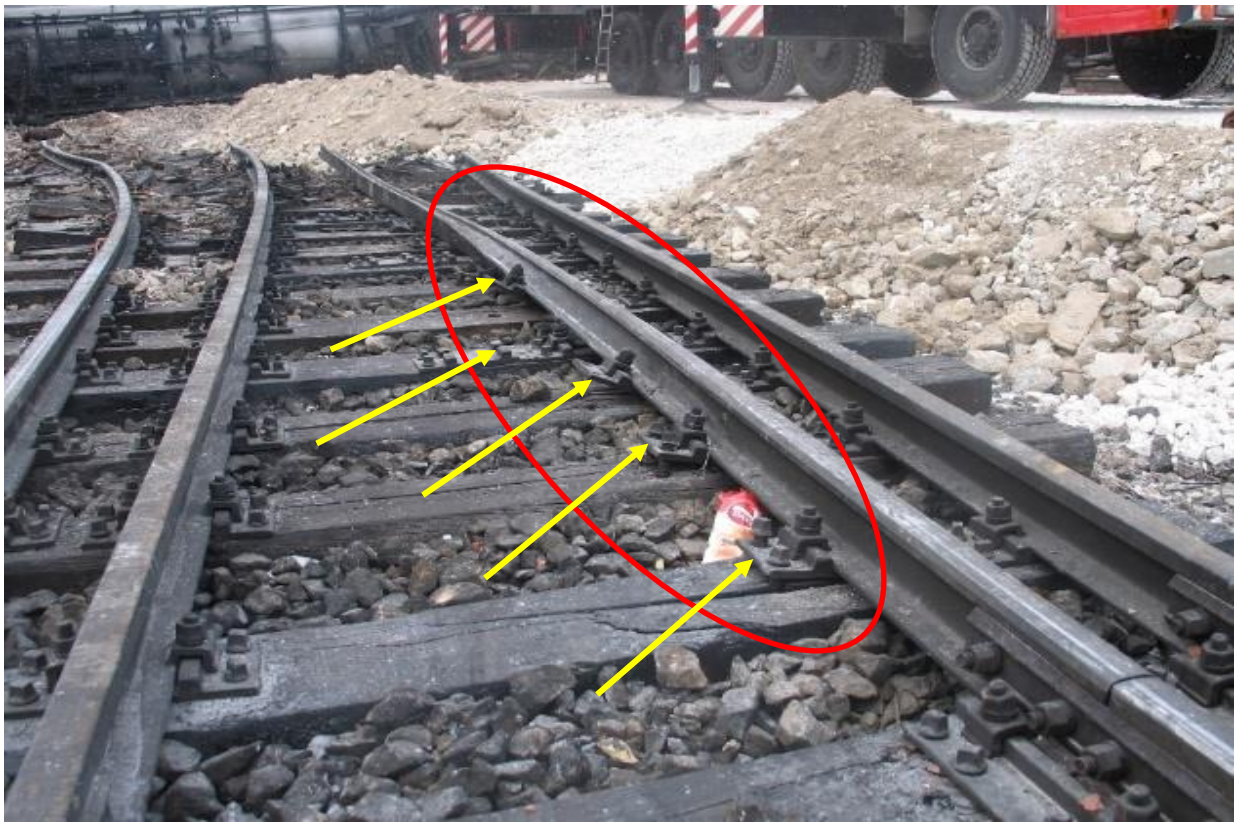


Figure 23

sleeper, where there is a strengthened rib pad, the sleeper screws are not pulled out but the heel of the rail is pushed aside from the internal and external fastening sets. All this has contributed for twisting of the intermediate rail of point Nr. 5 along its longitudinal axis on the right. The crosshead of point Nr. 5 is totally destructed. This occurred after passing of the two locomotives with the first five wagons and after the derailing of the second cart of the 6th wagon. Driven by the centrifugal force, the following eleven wagons jumped over the twisted intermediate rail on the right in the direction of trafficking and started derailing. Consequentially from the inert pressure generated from the remaining non-derailed part of the train, the 6th wagon was lifted and its buffers caught the buffers of the 6th wagon, in this moment the train got torn apart between the 6th and the 7th wagon. The 6th wagon, affixed to the 5th wagon, continued together with the first part of the train to move on the Third platform. The second derailed cart of the 6th wagon managed in the area of the right counter rail and the core of point Nr. 5 to climb on the railway line and continued its movement on the Fourth platform. With the train's first part moving on the Third platform, after 150 m the back side of the 6th wagon hit a pole of the catenary and pushed it down, the pole being located on the right on the Fourth platform. Upon meeting the resistance from the hit, the wagon disconnected its catch to the 5th wagon and after tearing apart the traction device, flew on the right over the Fourth platform and laid aside on the balloon (cylindrical part) of its reservoir. The two locomotives, together with the five wagons, continued to move and stopped a little after the reception building of the station. After the derailing of the 6th wagon and upon an already interrupted railway line, there followed the derailing of other eleven full wagon-cisterns, as the 17th wagon-cistern derailed only with its first cart at point Nr. 5. The second non-derailed cart of the wagon-cistern stopped in the switch rail part of the point. After the 17th wagon, there stopped the remaining non-derailed nine wagon-cisterns from the train's composition.

14.6. Chemical composition, metallographic analysis and strength of material – the test is performed on a model sample taken from a cut part from the intermediate rail of point Nr. 5 at Hitrino station.

- Chemical composition of material – the spectral analysis, performed on the model sample, pproves that its chemical composition is within the limits of steel R260, according to the Technical Specification (ТС-ЖИ 023-2011), "Railway rails" – NRIC.

- Metallographic analysis – the microstructure of the model sample in the core of the material is almost entirely pearlite. The pearlite, in its grater area, is sorbitol-like and lamellar with dispersion (distance between lamellas) under 0,3 μm, as at some individual sections the pearlite dispersion increases, reaching values of 1,6 μm. On the surface of the model sample ferrite network is observed, as well as entire grains, as the ferrite network on the boundaries of the grains reaches depth of about 800 μm. In the area of contact with the wheels, registered are also plastically deformed grains.

- Definition of strength – the result from the performed tests at three points next to the central line on the surface of rolling prove strength (HWB) 278,4±3,68.

On the basis of the performed tests and comparisons it may be determined that the material from which the rail is manufactured is in conformity with the Technical Specification – "Railway lines", applicable at NRIC.

14.7. Measuring the thickness of reservoir Nr. 4418, volume 112440 l, mounted on wagon-cistern Nr. 33 87 791 5652-4 (Figure 24).

Scheme of performed NDT on reservoirs of wagon-cistern transporting hazardous freights

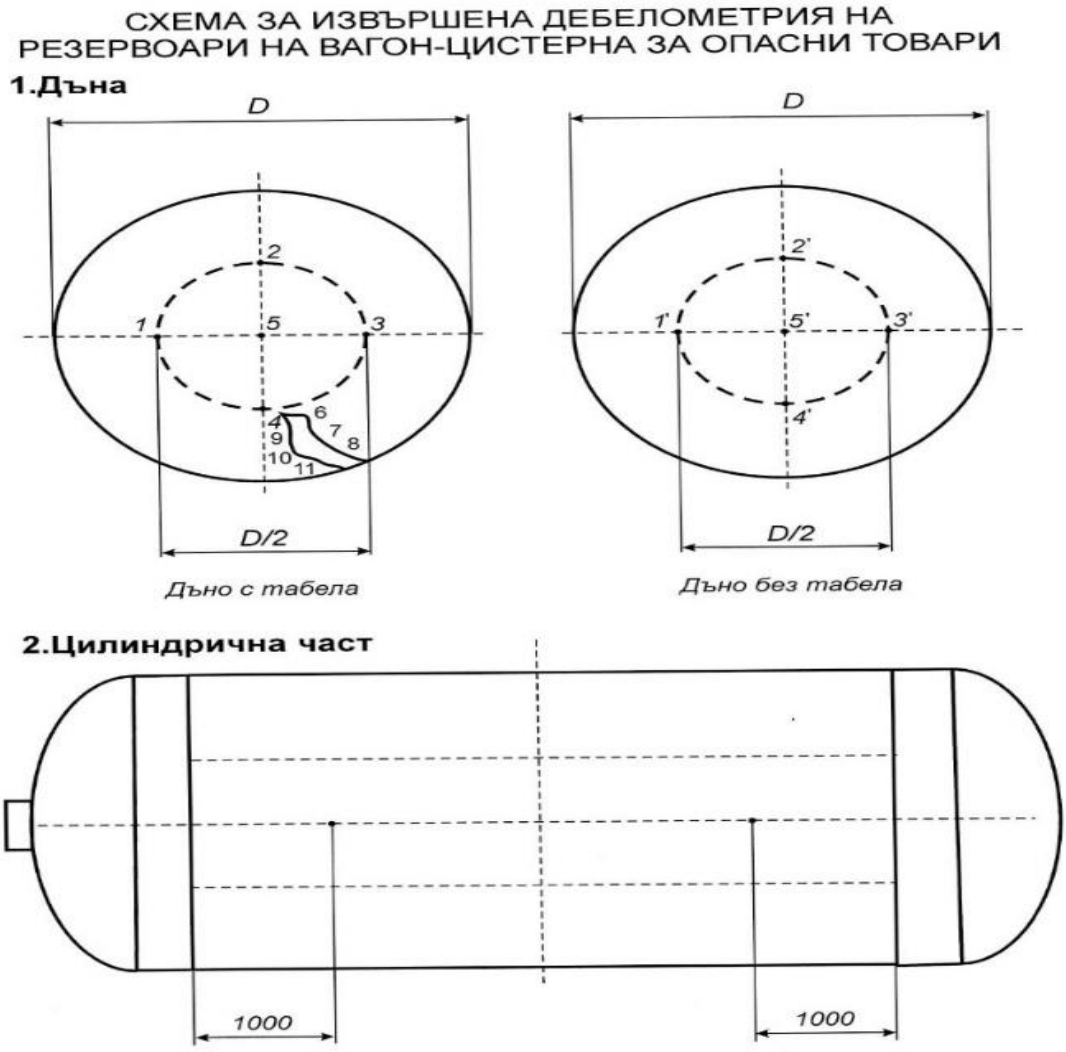


Figure 24

- measured values of the bottom thickness with a board – measurements are carried out at eleven points in total, from which the lowest measured value is at p. 8 of 7,8 mm, and the highest measured value is at p. 4 of 9,2 mm;

- measured values of the bottom thickness without a board - measurements are carried out at five points in total, from which the lowest measured value is at p. 5 of 8,7 mm, and the highest measured value is at p. 4 of 9,3 mm;

- measured values of the upper level of the balloon (cylindrical part) of the reservoir - measurements are carried out at twenty eight points in total, as the measured values are within the range from 15,6 mm to 16,3 mm;

- measured values at the middle level of the balloon of the reservoir – measurements are carried out at twenty eight points in total, as the measured values are within the range from 15,3 mm to 16,5 mm;

- measured values at the lower level of the balloon of the reservoir - measurements are carried out at twenty eight points in total, as the measured values are within the range from 15,4 mm to 16,1 mm.

14.8. Analysis of the wagons in a mode of exchange

After the survey of the wagons and analysis of the infromation from the documents, accompanying the train, it was established that the wagons from the composition of freight train Nr. 90570 have serial numbers with the following modes of exchange: from totally 26 wagons, 16 ones start with serial Nr. 84 …., 2 ones with Nr. 83 …. and 8 ones with Nr. 33 …

Wagon-cisterns, whose serial numbers start with 84, are designated for trafficking only inside the railway administration of their registration. To be permitted to travel to another railway administration, they must possess additional permission (concurrence). To that end the cylindrical part of the reservoir must be marked with CFR/БДЖ, and the mode of exchange must change from series 84 … to series 83 …. according to the requirements of Form UIC 438/2 dt. 2004. In this case, the train's composition includes only two wagons upon such mode of exchange. The serial numbers of the other eight wagons start with 33…., which means that the wagons from a technical point of view are in conformity with all international transport requirements.

From the performed check on the degree of loading of wagon-cistern Nr. 33 87 791 5652-4 and from the elaborated comparative table on its volume – 112 440 l, it was established that with the transported load – propylene with UN code 1077, upon coefficient for this carbonic gas per volume unit 0,43, the wagon can transport 48 349 kg. On the wagon's designation plate the producer has marked 48 343 kg. На табелата на вагона производителят е записал 48 343 кг. The specification on the dispatched quantity from Lukoil Neftochim – Burgas specifies 45 350 kg, which shows that this wagon was not overloaded.

Based on the performed measurements of the thicknesses of the bottoms and the cylindrical part of the wagon's reservoir, the following was established:

Flow limit - 0,2%	Re	400	N/mm2
Tensile strength	Rm	580	N/mm2
Test pressure	P_T	2,6	Mpa
Internal diameter	D	3000	mm
Coefficient of welded seam		0,9	
Maximum permissible tension		290,0	N/mm^2
Minimum thickness of cylindrical part	e	14,94	mm
Minimum thickness of hemispherical part	e_{hsph}	7,47	mm

Upon comparing of data with the data from the performed ultrasonic NDT of the entire reservoir at the Wagons' manufacturing plant of "Trakcia" AD – Samuil, it was established that it is in conformity with the structural norms and there are no measured values, which are under the standard thickness values, of the cylindrical part and the bottoms of the reservoir.

The performance of this test must be reflected not only in the certificate, but on the information plate at the bottom of the reservoir, which anyway was not done (Figure 25).

Figure 25

14.9. Circumstances preceding the accident

From the performed tests, analyses and samplings on the train's trafficking, the Technical Investigation Commission at MTITC draw the conclusion that about 3000 meters before the derailing of the train at Hitrino station to km 112+633 locomotive Nr. 86003.4 has travelled with the speed permitted for the train.

According to the time schedule of train Nr. 90570, the permitted maximum speed at the section between Pliska and Hitrino stations is 70 km/h. After this moment the speed grew uncontrolled in violation of the time schedule: at the warning traffic lights at km 112+000 the train passed with the speed of 78 km/h, at the entrance traffic lights at km 110+890 – with 80 km/h, and at point Nr. 1 at km 110+556 with 81 km/h, instead of the permitted speed of up to 40 km/h.

After comparing the trafficking speeds of the two locomotives Nr. 86003.4 and Nr. 87025.0, established was complete coincidence of the recorded data from the registering electronic systems, which provides confirmation of the facts that train Nr. 90570 passed through point Nr.1 with speed of 81 km/h, and through point Nr. 5 – with 78 km/h.

Upon the performed survey of the condition of the alertness maintenance devices of both locomotives of the train, it was established that the integrity of the lead seals was violated, which could be a hypothetic cause for the uncontrolled increase of speed before the derailing accident.

The mileage indications of locomotive Nr. 86003.4 are comparable with the mileage of the railway line in the section between Pliska and Hitrino stations.

14.10. Major cause for the occurrence of the accident

Non-observance of the speed of trafficking upon prepared route for entering of freight train Nr. 90570 on the Third platform at Hitrino station.

Through point Nr.1 the train passes with the speed of 81 km/h, and through point Nr. 5 – with 78 km/h, upon permitted speed of up to 40 km/h for entering into a deviation on the Third acceptance-departure platform, with stopping.

Upon the entrance of the train at Hitrino station, not fulfilled are the permission indications of the warning and the entrance traffic lights, limiting the speed of trafficking up to 40 km/h in accordance with Art. 317, item 3 and Art. 324, par. 2 and par. 3, item 5 of Ordinance Nr. 58 (Figure 26).

Not fulfilled is also the signal for limiting of the speed up to 60 km/h through the entrance points for entering on the Main platform, necessitated by the type of locking of the points at Hitrino station in accordance with Art. 384, par. 1 and par. 2 of Ordinance Nr. 58

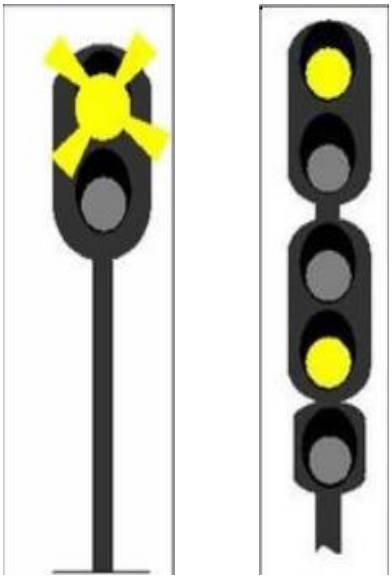


Figure 26

Figure 27

(Figure 27).

15. Description of already undertaken measures or measures in consequence of the accident

After the realized heavy railway accident, the railway carrier "Bulmarket Rail Cargo" EOOD has undertaken measures for amendment of the procedures from the safety management system, aimed at improving safety and preventing other accidents in the future:

- an Order is issued by which the locomotive engine drivers, first and second person, are designated in person by name;
- new position descriptions are elaborated of a locomotive engine driver, first and second person;

- in the period 08 ÷ 13.01.2017 additional out-of-schedule instructions are rendered to the entire staff of the carrier "Bulmarket Rail Cargo" EOOD in connection with the permitted heavy railway accident;

- an Order is issued, which designates by name the officials who will perform sealing of the devices and apparatus in the locomotives, as well as the numbers of the sealing pliers by which such seals will be affixed. On the grounds of the issued Order the relevant staff members have undergone training on checking the integrity of the seals and the manner of sealing, aimed at preventing any manipulations on the part of the locomotive driving staff;

- an Order is issued regulating the order of issuing and numbering of the passes;

- a new procedure "Rules on rendering of instructions" is elaborated. The officials who will render the instructions are determined by an Order;

- actions are undertaken for the organization and carrying out of training for re-qualification of the locomotive engine drivers for driving of electric locomotives, series 86 and series 87, at a licensed training center;

- procedures on internal audits are elaborated, within the safety management system and the quality management system of the company.

16. Rendered recommendations for preventing of accidents of a similar nature

In connection with the requirements of Art. 94, par.1 and par. 3 of Ordinance Nr. 59 dt. 05.12.2006 on the management of safety in the railway transport, in view of improving safety in the railway transport, the "Railway Administration" Executive Agency in its capacity of National Safety Authority shall order to "Bulmarket Rail Cargo" EOOD and the National Railway Infrastructure Company (NRIC) to provide the fulfillment of the rendered safety recommendations.

1. The "Railway Administration" Executive Agency shall recommend to the managers of railway carries and the General Director of the National Railway Infrastructure Company (NRIC) to carry out discussions with the staff members, connected with safety of transport, acquainting them with the contents of the Final Report from the performed investigation.

2. The wagon-cisterns, transporting liquefied hydro-carbonic gases, shall be equipped with pulling-deviating devices with crash elements, according to the requirements of BSS EN 15227:2008+A1:2010, and shall possess safety certificates.

3. The "Railway Administration" Executive Agency shall order eliminating the possibility for the owners of wagons transporting hazardous freights to decide by themselves on the period of repair of the running parts, the frame and the pulling-deviating devices, which at the time being could be 4 or 6 years. The period of repair shall be fixed only to 4 years, as is stipulated by the requirements to the reservoirs transporting hazardous freights according to RID Rules.

4. Permitted at the border stations shall be the acceptance in the country of wagons for transport of hazardous freights on the railway structure only in a faultless state, as per documents and technical condition, from the relevant railway carrier.

5. The "Railway Administration" Executive Agency shall organize the performance of check examinations of the operative staff members, connected with safety of transport, in connection with the requirements of Art. 6, par. 1 of Ordinance Nr. 56 dt. 2003 on a permanent, and not campaign basis. These shall be preceded as a must by periodic training and shall be related with checking of the theoretical knowledge, as well as the practical skills of the locomotive engine drivers through simulators, enabling checking of their reactions in emergency and stress situations.

6. The "Railway Administration" Executive Agency shall elaborate technical conditions for the provision of a recording device from a confirmed type and shall oblige all railway carriers, the Manager of the railway infrastructure and the owners of traction rolling stock to mount such a device on their traction vehicles. The device shall be designed in a way, providing its capability to record the most important parameters of trafficking of the relevant vehicle:

- ✓ Traffic speed;

- ✓ Travelled road;
- ✓ Astronomic time;
- ✓ Time of travel and time of stay;
- ✓ Activating of the automatic train break and whether this is performed by the crane machine driver or from another place in the train;
- ✓ Activating of the additional (direct) break;
- ✓ Activating of another type of break, mounted on the vehicle, and values of the realized breaking force;
- ✓ Position of the controller (value of the traction force);
- ✓ El. current in the traction engines;
- ✓ Voltage in the catenary;
- ✓ Revolutions per minute of diesel (or another type of) engine;
- ✓ Maintaining of the alertness maintenance device in readiness by the locomotive engine driver;
- ✓ Condition of the alertness maintenance device (switched on – switched off position);
- ✓ Rendering of audible signal by the horn of the traction vehicle;
- ✓ Personification of driving of the relevant vehicle by a chip, magnet card, or in another appropriate manner, and respectively blocking of its movement upon the absence of personification and identification on the part of the operative staff members;
- ✓ The devices shall be structured in a manner providing possibility for immediate unloading of the requested information by the safety authorities (the National Safety Authority and the administrative safety authorities), without the necessity of transforming or processing of such information.

7. Upon each going out of rolling stock for travel on the railway infrastructure, its technical condition shall be checked by mechanic, "revision of wagons" – a staff member of the railway infrastructure, which shall be verified in a relevant manner in the train's trafficking documents.

8. The "Railway Administration" Executive Agency shall oblige all carries to mount in their traction rolling stock alertness maintenance devices with variable time of activation, which shall prevent monotonous work of the operational staff.

9. The Management of "Bulmarket Rail Cargo" EOOD shall organize the performance of training for the acquisition of professional qualification on a part of profession at a licensed organization in accordance with Art. 9, par. 5 of the Law on professional education and training.

10. "Bulmarket Rail Cargo" EOOD shall increase the control upon issuing of passes of locomotives and rendering of pre-shift instructions to the locomotive brigades and upon ensuring rests in accordance with the requirements of the normative base.

11. "Bulmarket Rail Cargo" EOOD shall increase the control upon the performance of checks by the control authorities in respect of the technical condition of the railway rolling stock and the staff members connected with safety of transport.

12. "Bulmarket Rail Cargo" EOOD shall precise the requirements for the appointment of locomotive engine drivers for working in the company, who have acquired right of pension, have gained years of experience and age for social security, in accordance with their category of labor.

13. The National Railway Infrastructure Company (NRIC) shall organize and carry out training of staff at all stations on their actions upon the occurrence of railway accidents.

14. Corrected shall be the time schedule for trafficking of freight trains transporting hazardous freights, where possible, transit on the main platforms of the stations, moving with a speed close to the permissible one for the relevant railway sections, providing reserve in the time of traveling.

15. The National Railway Infrastructure Company (NRIC) shall organize urgent building and implementation of control system for the railway rolling stock upon trafficking ("Check Point") on the railway network of the Republic of Bulgaria.

16. The National Railway Infrastructure Company (NRIC), together with the railway enterprises, performing transports by their own traction rolling stock, shall organize urgent building and implementation of automatic locomotive signaling system – road equipment on the major railway network of the Republic of Bulgaria and on-board equipment of the locomotives and the rail motor trains.

In connection with the requirements of Art. 94, par. 4 of Ordinance Nr. 59 dt. 05.12.2006 on the management of safety in the railway transport, till 31.10.2017 the "Railway Administration" Executive Agency, "Bulmarket Rail Cargo" EOOD and the National Railway Infrastructure Company shall inform in writing the Chairman of the Investigation Commission at the Ministry of Transport, Information Technology and Communications on the undertaken actions for the fulfillment of the rendered safety recommendations.

Sofia
September 29th, 2017

Chairman:

D-r Eng. Boycho Skrobanski
State investigation inspector at MTITC

I, the undersigned, Ventseslava Mihailova Mishlyakova certify the truthfulness of the translation made by me from Bulgarian into English of the enclosed document. The translation consists of 40 pages.

Sworn translator:
Ventseslava Mihailova Mishlyakova