Translation from Bulgarian.

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RAILWAY ACCIDENT INVESTIGATION UNIT
AT THE MINISTRY OF TRANSPORT, INFORMATION TECHNOLOGIES AND COMMUNICATION

FINAL REPORT

from

technical investigation of railway accident – derailing of electric locomotive Nr. 86018.9 from the composition of freight train Nr. 30690 upon entrance in Pirdop station on 04.05.2017

2017

Purpose of the Report and 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, the Railway Transport Act (RTA) of the Republic of Bulgaria and Ordinance Nr. 59 dt. 05.12.2006 on safety management in railway transport, the investigation is carried out by a national independent investigation body – the Railway Accident Investigation Unit at the Ministry of Transport, Information Technologies and Communication (MTITC) and is aimed at:

Establishing the circumstances and causes having lead to the realization of the occurrence, in view of improving safety and preventing of other accidents in the future, **without searching for anybody's guilt or responsibility.**

CONTENTS

1. Summary

On 03.05.2017 at Burgas station – Easter region a freight train is composed including three electric locomotives, two of which in non-operational condition and 23 empty wagons following them.

The train's route is: Burgas – Karlovo – Pirdop; from Burgas station to Karlovo station the train travels under Nr. 30698, and from Karlovo station to Pirdop station it travels under Nr. 30690.

During trafficking of the train in front of the entrance signal of Pirdop station at about 07:09 h. the locomotive engine driver, accompanying locomotive Nr. 86018.9, felt strong vibrations in the cabin and immediately activated the emergency breaking valve of the locomotive for stopping of the train. After stopping of the train, the crew performed examination of the locomotive and established it had derailed with its first wheel axis in the direction of movement. The locomotive with the derailed wheel axis, after being handled by specialized automobile car "UNIMOG", was loaded on recovery cart and at 11:25 h. was parked at Pirdop station, first platform.

The cause for the occurrence of the accident is breaking of the first wheel axis in the direction of movement of locomotive Nr. 86018.9 in the area of the transition to the pap back part of the axis as a result of fatigue of material and availability of multiple cracks on the external surface of the axis.

For the improvement of safety in the railway transport, three safety recommendations were rendered.

The first recommendation is addressed to the railway carrier "D. B. Cargo Bulgaria" EOOD, requesting that the staff members responsible for the non-traction rolling stock shall fulfill the requirements of the statutory acts for exact and clear filling in of the train's documents.

The second recommendation is also addressed to the railway carrier "D. B. Cargo Bulgaria" EOOD regarding the performance of training and issuing of certificates for performed professional training to the locomotive operating staff in conformity with the requirements of the national and European norms and standards.

The third recommendation is addressed to the railway company "Express Service" OOD, requesting increasing of preciseness upon the performance of ultrasonic NDT of locomotive wheel axes and axes, as well as better précising of technology for complete setting of locomotive wheel axes.

2. Circumstances and facts directly related with the accident

2.1. On 04.05.2017 upon enering of freight train Nr. 30690 in Pirdop station about 07:09 h. the locomotive driver, accompanying locomotive Nr. 86018.9 in a non-operational condition – second in the composition of the train, felt strong vibrations in the cabin and immediately activated the emergency break valve of the locomotive for stopping of the train, and after 130 m

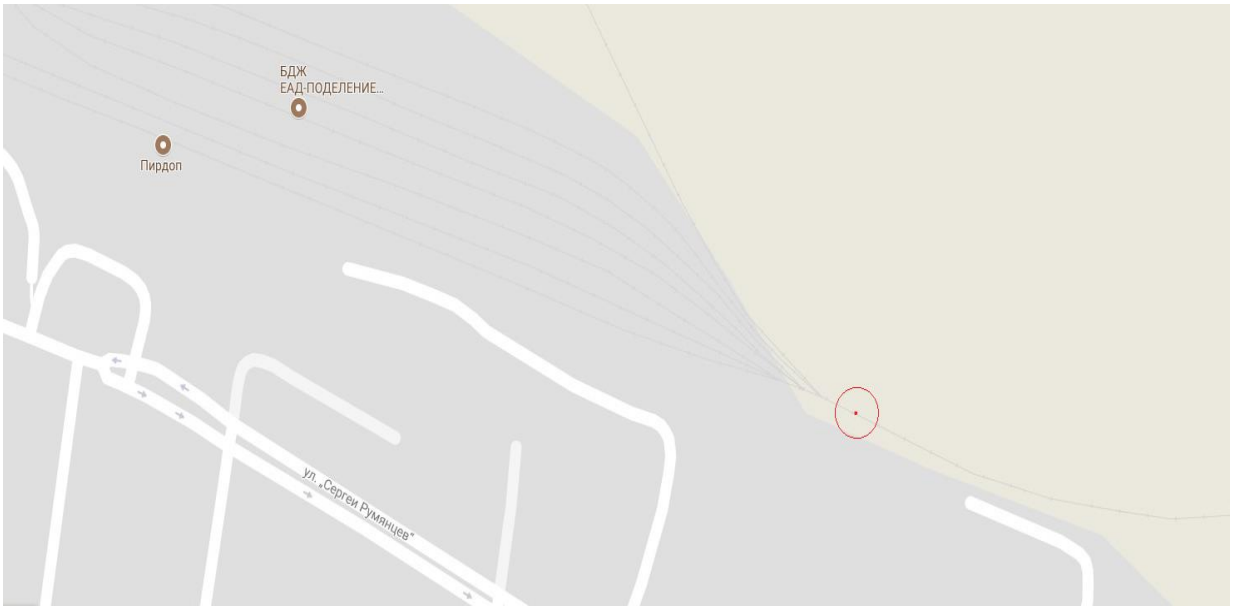

Fig. 1

of travel the train stopped at km 84^{+550} (Figure 1).

After final stopping of the train, the locomotive drivers performed examination of the running parts of the locomotive and established that the train had derailed with its first wheel axis in the direction of movement. Thereabout they informed the carrier's dispatcher on duty and waited for the relevant instructions. The locomotive was in a stay-still from 07:10 h. till 11:30 h.

2.2. Pirdop station is found at km 83+859 between Zlatitza and Anton stations. It is located on the Third Main Railway Line Sofia – Karlovo – Burgas. The speed of the railway line is conventional, of up to 130 km/h.

2.3. The Railway Accident Investigation Unit at the Ministry of Transport, Information Technologies and Communication (MTITC), in accordance with Art. 68, par. 1, item 2 and par. 2 of Ordinance Nr. 59, classifies the occurrence as a railway accident.

2.4. The investigation of the accident is undertaken in connection with Art. 115k, par. 1, item 3 of the Railway Transport Act (RTA), Art. 76, par. 2, item 2 of Ordinance Nr. 59 dt. 05.12.2006 and on the grounds of Order Nr. РД-08-170/11.05.2017 a Railway Accident Investigation Commission is appointed at the Ministry of Transport, Information Technologies and Communication (MTITC). Members of the Commission are also external experts possessing the relevant professional qualification and expertise.

The Investigation Commission performed several surveys on the day of the accident and interviewed the staff members having partaken in the accident, as well as the staff members related indirectly with the accident.

In the progress of investigation the Operative Team's Report and the collected documents enclosed thereat were analyzed. The Commission requested additional materials from the parties affected by the accident. The Commission analyzed the provided technical expertise on parts of the broken part of the derailed wheel axis of electric locomotive Nr. 86018.9, elaborated by the Laboratory for analysis and testing of materials and calibration of measuring devices at the Bulgarian Academy of Sciences (BAS).

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

2.5. For the performance of emergency recovery activities, at 10:00 h. at Pirdop station specialized automobile car "UNIMOG" arrived for liquidating of the accident.

At 11:08 h. locomotive Nr. 86018.9 was loaded on recovery cart and at 11:25 h. it was parked on the first platform at Pirdop station.

At 11:32 h. the composition of freight train Nr. 30690 was pulled by locomotive Nr. 88030.1 from the train on the fifth platform at Pirdop station.

3. General data established in the process of investigation

3.1. The railway carrier, having carried out the transportation of freight train Nr. 30698/Nr. 30690 from Burgas to Pirdop on 03/04.05.2017 – "D. B. Cargo Bulgaria" EOOD.

3.2. "D. B. Cargo Bulgaria" EOOD possesses:

3.2.1. License for the performance of railway transport services Nr. 206/04.05.2016;

3.2.1. Safety Certificates, Part "A": BG1120160002, and Part B: BG1220160003.

3.3. By order of "D. B. Cargo Bulgaria" EOOD, the National Railway Infrastructure Company (NRIC) developed an operative schedule for trafficking of freight train Nr. 30698 on the route of Burgas – Karlovo. From Karlovo station to Pirdop station a new operative time schedule for the same train was elaborated and the train departed under Nr. 30690 (Figure 2).

The composition of the train includes three electric locomotives - locomotive Nr. 86019.7, directing the train, and two electric locomotives in non-operational (cold) condition: Nr. 86018.9 and Nr. 88030.1, 23 empty wagons, including 12 of Eaos Series and 11 of Tamns Series, 102 axes and gross mass weight of 762 tons (as evidenced by the Nature List).

Freight train (FT) Nr. 30698 departed on 03.05.2017 from Burgas station, Eastern region, at 23:28 h. upon 13 min. delay. The train travelled without stopping to Gurkovo station. It arrived at Gurkovo station at 02:10 h. on 04.05.2017, upon 6 min. delay. After stay of 9 min. because of forthcoming scheduled meetings with freight train Nr. 30601 and freight train Nr. 30587, the train departed at 02:19 h., 12 min. earlier than the time scheduled.

From Gurkovo station to Dunavci station the train travelled without stopping. At Dunavci station the train arrived at 03:09 h. - 10 min. earlier, and after stay of 1 min. it departed at 03:10 h., 9 min. earlier. At Karlovo station the train arrived at 04:11 h., 5 min. earlier.

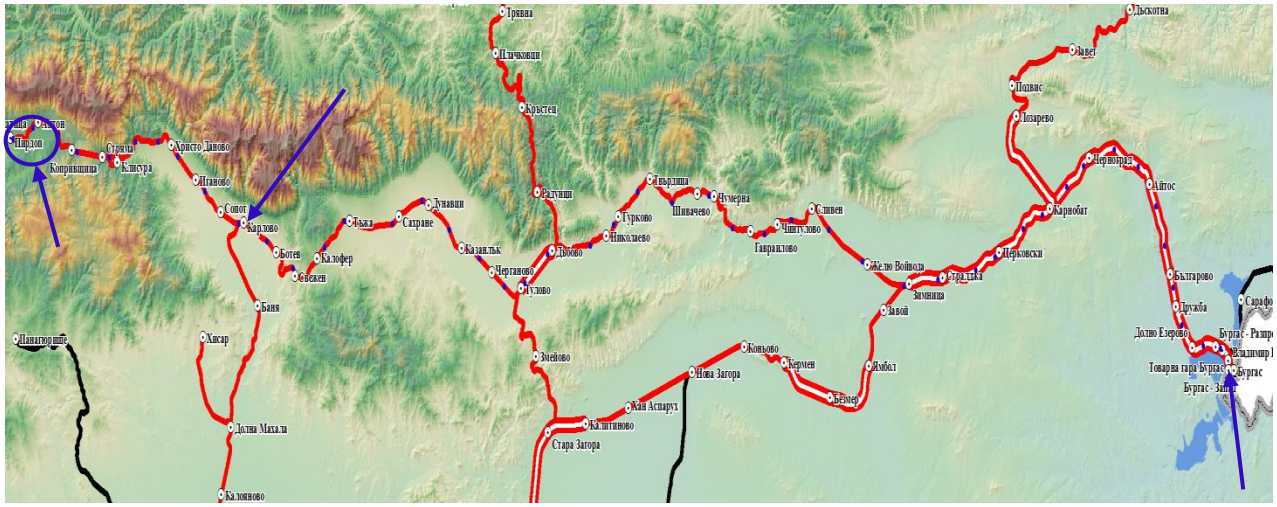

Fig. 2

At Karlovo station the train stayed from 04:11 h. till 05:25 h. for the performance of a technical examination and short testing, "D" type, of the automatic breaking system; the tests were carried out by staff members of "D. B. Cargo Bulgaria" EOOD. A new breaking mass weight certificate was issued (face side), only because the train had changed its number, and the train continued its trafficking from Karlovo station to Pirdop station under Nr. 30690.

From Karlovo station freight train Nr. 30690 departed at 05:25 h. and travelled to Stryama station without stopping. The train arrived at Stryama station at 06:18 h., after a stay of 15 min., because of forthcoming scheduled meeting with passenger train Nr. 30211. The train departed at 06:33 h. and travelled to Pirdop station without stopping. During movement, no irregularities had been observed by the locomotive engine driver accompanying locomotive Nr. 86018.9 (as evidenced by the written explanations and the performed interview).

3.4. Railway line with joints – "PANDROL" type;

3.5. Safety equipment at stations and between stations:

- The section between Anton and Pirdop stations is equipped with Automatic Blocking System without pass signals with axle counters. The Automatic Blocking System is isolated because of reconstruction of the safety equipment at Anton station. Trafficking of trains is ensured by phone – it is of no relevance to the permitted railway accident;

- Pirdop station is provided with Route Relay Centralization System (RRCS – for small stations); it is of no relevance to the permitted railway accident;

3.6. Catenary – in the proper operational condition;

3.7. Train composition station – Burgas;

3.8. Communication equipment and telecommunication links – of the proper operational condition;

3.9. Profile, geometry and layout of the railway line in the area of derailing:

- The place of derailing between the stations of Anton and Pirdop is at km $84^{+790,7}$, in a right bend in the direction of movement, with inclination of 13,4 ‰ upon descending derails the second locomotive from the composition of the train;

3.10. Traction rolling stock:

- Electric locomotive Nr. 86019.7 has serviced freight train Nr. 30690;

- Electric locomotives in non-operational (cold) condition – 2 pcs. – Nr. 86018.9 and Nr. 88030.1;

- The locomotives have had properly operating running parts, breaking systems, light and audible signaling systems, in conformity with the requirements of the technical norms and standards, as evidenced by the records kept in the relevant logbooks, copies of which were provided together with the Report of the Operative Team.

As a result from the derailing accident, locomotives Nr. 86019.7. and Nr. 88030.1 – are of no failures;

As a result from the derailing of locomotive Nr. 86018.9, there are damages caused on the running parts of the derailed cart;

3.11. Non-traction rolling stock:

Totally 23 wagons were included in the composition of the train:

- Wagons, Eaos Series, 12 empty ones – of no failures;
- Wagons, Tamns Series, 11 empty ones – of no failures;

3.12. At the moment of realization of the accident no construction works on the railway infrastructure were performed at or near the place of derailing.

3.13. After the surveys, executed jointly by the Regional Police Department of Pirdop and the Investigation Commission at the Ministry of Transport, Information Technologies and Communication, the train was released for starting of the technical investigation.

3.14. Actions were undertaken for clearing of the railway section between Pirdop and Anton stations. Emergency repairing works were commenced for the fast recovery of the railway line's capacity. After the completion of the partial repairing works on the railway line, trains' trafficking on the railway section between Anton and Pirdop stations was recovered at 12:10 h. on 04.05.2017.

The traffic speed from km 84^{+550} to km 84^{+800} = 250 m is limited up to 40 km/h.

4. Death cases, injuries and property damages

4.1. Death cases – none;

4.2. Injured persons with traumas – none;

4.3. Property damages:

4.3.1. Damages on the derailed locomotive Nr. 86018.9:

4.3.1.1. Repair of cart – BGN 15,235, VAT excluded;

4.3.1.2. Price of input locomotive axis – BGN 5 867,49, VAT excluded;

4.3.2. Damages of the railway infrastructure:

4.3.2.1. Railway line and facilities:

- Damaged are 98 complete sets of reinforced concrete sleepers with joints of "PANDROL" type;

The damages and expenses for recovery of the railway line amount to BGN 8 266,30, VAT included.

4.3.2.2. Safety equipment and communications, radio links and electric power supply.

- Damaged is 1 complete set of counter point;

The damages and expenses for recovery of safety equipment amount to BGN 8 906,88, VAT included.

4.3.3. Expenses for changing of the Train Trafficking Schedule – none;

4.4. Expenses for recovery equipment:

Expenses for specialized automobile car "UNIMOG" – BGN 925,00, VAT included.

4.5. The total damages and expenses incurred from the accident amount to: BGN 39200,64.

5. External circumstances – climatic and geographic conditions

Meteorological data on the weather conditions exercising influence over the visibility:

- in the light hours of the day;
- ambient temperature about + 10° C;
- weather – clear.

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

6.1 Locomotive brigades:

6.1.1. "Locomotive engine driver" of electric locomotive Nr. 86019.7, an employee of "D. B. Cargo Bulgaria" EOOD – 20 years, 1 month of service;

6.1.2. “Locomotive engine driver” of electric locomotive Nr. 86019.7, an employee of “D. B. Cargo Bulgaria” EOOD – 30 years, 7 months of service;

6.1.3. “Locomotive engine driver” of electric locomotive Nr. 86018.9, an employee of “D. B. Cargo Bulgaria” EOOD – 26 years, 11 months of service;

6.1.4. “Locomotive engine driver” of electric locomotive Nr. 88030.1, an employee of “D. B. Cargo Bulgaria” EOOD – 12 years, 1 month of service;

6.1.5. Locomotive engine driver” of electric locomotive Nr. 88030.1, an employee of “D. B. Cargo Bulgaria” EOOD – 18 years, 2 months of service;

6.2. Station staff:

6.2.1. “Traffic controller” – at Pirdop station – employee at “Management of train trafficking and station activities”, Sofia, the National Railway Infrastructure Company – 1 year of service (night shift);

6.2.2. “Traffic controller” – at Pirdop station – employee at “Management of train trafficking and station activities”, Sofia, the National Railway Infrastructure Company – 6 months of service (day shift);

6.3. Professional capability documents:

6.3.1. The staff members from the National Railway Infrastructure Company (NRIC) possess:

- Certificate for occupying of the relevant job position;
- Professional capability certificate;
- Professional qualification document;
- Certificates for successfully passed examination in accordance with Ordinance Nr. 56 dt. 2003.

6.3.2. The locomotive servicing staff members from “D. B. Cargo Bulgaria” EOOD, having driven electric locomotives Nr. 86019.7, Nr. 86018.9 and Nr. 88030.1, possess:

- Certificate for occupying of the relevant job position;
- Professional capability certificate;
- Certificates for successfully passed examination in accordance with Ordinance Nr. 56 dt. 2003;
- Professional capability certificates for driving of locomotives from the relevant Series, issued to the locomotive engine drivers, which are in contradiction with the requirements of Art. 9, par. 1 and Art. 38, par. 3 of the Law on the professional education and training and Art. 44, par. 1, item 1 of Ordinance Nr. 56/2003.

6.4. 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.

6.4.1. “Locomotive engine driver”, first person on electric locomotive Nr. 86019.7, rested from 00:05 h. on 29.04.2017 till 20:30 h. on 03.05.2017, with an interruption at Burgas station from 10:00 h. till 20:30 h. on 03.05.2017;

6.4.2. “Locomotive engine driver”, second person on electric locomotive Nr. 86019.7, rested from 23:45 h. on 30.04.2017 till 23:40 h. on 02.05.2017, with an interruption at Burgas station from 10:00 h. till 20:30 h. on 03.05.2017;

6.4.3. “Locomotive engine driver”, first person on electric locomotive Nr. 86018.9, rested from 23:30 h. on 01.05.2017 till 23:40 h. on 02.05.2017, with an interruption at Burgas station from 10:00 h. till 20:30 h. on 03.05.2017;

6.4.4. “Locomotive engine driver”, first person on electric locomotive Nr. 88030.1, rested from 02:00 h. on 03.05.2017 till 20:30 h. on 03.05.2017;

6.4.5. “Locomotive engine driver”, second person on electric locomotive Nr. 88030.1, rested from 02:00 h. on 03.05.2017 till 20:30 h. on 03.05.2017.

6.5. Pre-shift instructions:

The locomotive brigades, having serviced freight train Nr. 30698/Nr. 30690, have undergone through rendering of pre-shift instructions at Burgas station. They have decaled by their 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 at Pirdop station have undergone through pre-shift instructions. They have decaled by their 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 investigations of any other occurrences of a similar nature have not been carried out. The Investigation Commission does not dispose of any witnessed evidence on the occurrence under investigation.

8. Safety management system (SMS) of the National Railway Infrastructure Company and "D. B. Cargo Bulgaria" EOOD.

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

The Investigation Commission got acquainted with the procedures provided by the safety management system and established that they had been fulfilled by the staff members of Sub-division "Management of train trafficking and station activities", Sofia, operating within the structure of the National Railway Infrastructure Company. This is evident from the Report of the Operative Team and the additionally requested materials, as well as from the interview carried out with the station staff members.

8.2. Observance of the procedures from the safety management system of "D. B. Cargo Bulgaria" EOOD:

The Investigation Commission got acquainted with the procedures included in the safety management system of the railway carrier "D. B. Cargo Bulgaria" EOOD, which are in conformity with the requirements of the national legislation.

Upon the examination of the technical documentation of locomotive Nr. 86018.9 no violations of the applicable Rules on plant and depot repair and maintenance of electric locomotives were established or registered, as well as of the organization and operation technologies.

Based on the provided technical documentation of locomotive Nr. 86018.9, it was established that revision under operational conditions (PE-2) was performed on 10.04.2017, and that the last ultrasonic NDT of the axis of the wheel axis was carried out by "Express Service" OOD on 20.10. 2016, which was within the prescribed time term till the next ultrasonic NDT.

The examination of the transport documents of freight train Nr. 30690 proved non-fulfillment of the requirements of Ordinance Nr. 58 on the elaboration of breaking mass weight certificate, namely:

- Not registered in the certificate are the two electric locomotives which have been transported in non-operational (cold) condition, in violation of Art. 89, par. 4 of the Rules on train's trafficking and maneuvering work in the railway transport.
- Not enlisted in the breaking mass weight certificate are the complete numbers of the wagons from the train's composition, in violation of Art. 309, par. 3 of the Rules on train's trafficking and maneuvering work in the railway transport.
- The breaking mass weight certificate, issued at Burgas station, contains corrections, in violation of Art. 309, par. 1 of the Rules on train's trafficking and maneuvering work in the railway transport.

The issued Nature List of the train is not signed by the traffic controller on duty at Burgas station.

The locomotive brigades, having serviced the three locomotives, were provided with mobile phones for official use.

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 staff members on duty, providing the train with the relevant train trafficking documents from "D. B. Cargo Bulgaria" EOOD, have committed mistakes before the accident, being in non-conformity with the established normative regulations on the safety of railway freights (filling in of the train transport documents).

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

10.1. Technical condition of the locomotives:

- locomotive Nr. 86019.7 – of no damages caused;
- locomotive Nr. 88030.1 – of no damages caused;
- broken axis Nr. 5206 on the fourth wheel axis of locomotive Nr. 86018.9 in the area of the transition to the pap back part of the axis;

10.2. Status of wagons – no damages caused;

10.3. Status of the railway infrastructure:

10.4. Railway line:

- damaged are 98 pcs. of reinforced concrete sleepers, complete with "PANDROL" fixings from km 84^{+550} to km 84^{+790} before Pirdop station.

10.5. Communication equipment, communications, radio links and electric power supply:

- damaged one counting point – 1 complete set;

10.6. Status of the catenary – no damages caused.

10.7. Speed analysis of locomotive Nr. 86019.7 provided by "D. B. Cargo Bulgaria" EOOD:

- At 07:09 h. upon movement of the train with speed of 51-52 km/h, smooth stopping of the train by its electric break was exercised and the speed of movement was decreased up to 50 km/h, followed by an abrupt pressure drop in the main air duct] thereafter the train stopped.

The records' analysis is made based on the registered provisional mileage, obtained from the speedometer installation of the leading locomotive Nr. 86019.7.

From the moment of derailing of locomotive Nr. 86018.9 till its final stopping, the train passed 250 m. Locomotive Nr. 86019.7 stopped at provisional kilometer 3395,130, and the derailing accident occurred at provisional kilometer 3394,880, i.e. 250 m before the final stopping of the train at 07:09:13 h., upon a speed of 52 km/h and activating of the electric break.

The emergency break was activated at 07:09:21 h. at provisional kilometer 3394,995 upon a speed of 50 km/h, or 8 seconds after the derailing accident. From the moment of derailing till activating of the emergency break the locomotive traveled 115 m.

After the activation of the emergency break, the locomotive traveled 135 m till its final stopping at km 3395,130.

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

For preventing of any consequences from the accident, suspended was trains' trafficking in the section between Anton and Pirdop stations till 12:10 h. on 04.05.2017. As a result thereof the following trains were delayed, cancelled, deviated or scheduled:

11.1. Delayed trains:

- train Nr. 30121 of the railway carrier BDZ – Passenger Transport EOOD: + 15 min. at Zlatica station;
- train Nr. 30194 of the railway carrier BDZ – Passenger Transport EOOD: + 16 min. at Sofia station;
- train Nr. 30602 of the railway carrier BDZ – Passenger Transport EOOD: + 321 min. at Iliyanci station;

11.2. Cancelled trains:

- train Nr. 3621 of the railway carrier BDZ – Passenger Transport EOOD: cancelled at the section from Kazichene station to Karlovo station;

- train Nr. 30111 of the railway carrier BDZ – Passenger Transport EOOD: cancelled at the section from Zlatica station to Karlovo station;

- train Nr. 30114 of the railway carrier BDZ – Passenger Transport EOOD: cancelled at the section from Koprivshtica station to Sofia station;

- train Nr. 30121 of the railway carrier BDZ – Passenger Transport EOOD: cancelled at the section from Pirdop station to Koprivshtica station;

- train Nr. 30122 of the railway carrier BDZ – Passenger Transport EOOD: cancelled at the section from Koprivshtica station to Pirdop station;

11.3. Deviated trains:

- train Nr. 3621 of the railway carrier BDZ – Passenger Transport EOOD: deviated at a by-pass route from Kazichene station – Plovdiv station – Karlovo station;

11.4. Scheduled trains:

- train Nr. 30191 of the railway carrier BDZ – Passenger Transport EOOD: scheduled on the route of Koprivshtica station – Karlovo station;

- train Nr. 30194 of the railway carrier BDZ – Passenger Transport EOOD: scheduled on the route of Zlatica station – Sofia station.

12. Health and safety of labor

12.1. In connection with the requirements of Art. 13, par. 1 and Art. 14, par 1 of Ordinance Nr. 50/28.12.2001, no violations have been established concerning the working hours of the staff members.

12.2. 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.

12.3. In connection with the requirements of Art. 20, Par. 2 of Ordinance Nr. 54/02.06.2003, the staff members related with the accident are in possession of valid certificates from psychological examination.

13. Registered previous accidents of a similar nature

13.1. In the period 2012 – 2017 there were 4 (four) registered accidents of a similar nature, namely:

13.1.1. Railway carrier "D. B. Cargo Bulgaria" EOOD:

1. On 06.11.2012 upon servicing of freight train Nr. 30562 between Chernograd and Karnobat stations on road Nr. 2, locomotive Nr. 86013 breaks an axis and derails;

2. On 13.07.2014, upon servicing of freight train Nr. 90692 between Chumerna and Gavrilovo stations, locomotive Nr. 86012 breaks an axis and derails;

13.1.2. Railway carrier "Bulmarket Real Cargo" EOOD:

1. On 17.04.2012, upon servicing of freight train Nr. 90571 between Velishkovo and Dalgopol stations, locomotive Nr. 86003.4 breaks an axis and derails;

2. On 18.10.2012, upon servicing of freight train Nr. 90571 between RP Dunav and Ruse-North stations, locomotive Nr. 86005.9 breaks an axis and derails;

13.2. The staff members, directly related with the accident, have not partaken in previous accidents of a similar nature.

13.3. In the investigated railway section there are no registered accidents of a similar nature.

14. Analysis and conclusions

14.1. Based on the performed examinations, the additionally requested materials, as well as the additional measurements of the railway line and of electric locomotive Nr. 86018.9, the Technical Investigation Commission established the following facts:

- the derailing of electric locomotive Nr. 86018.9, second, of non-operational condition, in the composition of freight train Nr. 30690, has occurred between Anton and Pirdop stations upon the train's entrance in Pirdop station at 07:10 h. at km 84^{+790} on 04.05.2017;

- the derailing of electric locomotive Nr. 86018.9 is realized in the right bend in the direction of movement of the train with radius R=500 m and length 523 m in a railway line section with inclination of 13,4 ‰ upon descending;

- the speed of the train at the time of derailing is 50-52 km/h, as the permissible speed for this railway line section is 60 km/h.

- the locomotive derails at km 84^{+790}, the train continues travelling and stops at km 84^{+550} = 240 m and at (10 m after the entrance signal).

14.2. Analysis of the railway line

For establishing of the causes having lead to the derailing accident, the railway line was subjected to detailed survey and measurement of its parameters in the area of derailing.

The place of derailing is found in a transitional bend with radius R=500 m and length L=523 m, including two transitional bends of length 120 m each and a circular bend 283 m (Figure 3). The surpass height in the circular bend is H=40 mm, with transitions of surpass height 1:3000 in the two transitional bends. The railway line profile in the section between the stations in the direction to the station is of 12.73 ‰ inclination from km 84^{+256} to km 84^{+415} and 13,40 ‰ from km 84^{+415} to km 84^{+905} upon descending. Per type of structure, the railway line is jointless, made of rails of UIC 60 type clad on reinforced concrete sleepers, complete with fixing units, "PANDROL" type. The point of derailing of locomotive Nr. 86018.9 is at km 84^{+790}, located at 230 m before the entrance signal of Pirdop station, at the side of Anton station.

Based on the performed technical measurements of the railway line in the area of derailing it was established that the condition of the rail and sleeper's grid and the ballast prism is in conformity with the technical norms and standards. In respect of distance between rails, cross-wise and longitudinal level, as well as per its central line, the railway line is within the prescribed norms. There are no absent or loosened fixing units. The railway line is in conformity with the requirements of the Instructions on the arrangement and maintenance of the upper structure of the railway line and the railway points. This is also confirmed by the measurements registered in the Protocol of Findings on the status of the railway line, submitted by the representatives of the Operative Team.

Fig. 3

14.3. Analysis of the rolling stock

The Investigation Commission got acquainted with the circumstances related with the derailing accident, as well as with the actions of the locomotive engine drivers having serviced the locomotives during trafficking of the train till the derailing occurrence in front of Pirdop station.

After dismantling and survey of the axis at "Express Service" OOD, it was established that the surfaces of its two parts are not in a good state. Visible on the surfaces are crashings obtained during trafficking from the moment of breaking of the axis till the moment of stopping of the locomotive. Nevertheless it can be definitely stated that breaking of the axis has resulted from fatigue of material. This is proven by the presence of clearly expressed areas of wear and

tear, comprising about 60 – 70% from the cross sectional area of the axis, obtained from the development of the crash in the axis, and an area of a granular crash obtained from the sudden destruction, which is the last stage of destruction of the structure (Figure 4).

Fig. 4

The Investigation Commission visited "Express Service" EOOD plant in Ruse where the wheel axis was manufactured. The Management of the plant provided thorough assistance to the investigation and submitted the complete documentation on the wheel axes of locomotive Nr. 86018.9. The check proved that the technology of manufacture of the wheel axis is fully and exactly compliant and is in conformity with the applicable standards, as well as that ultrasonic NDT of wheel axes had been performed. The results from the NDT exhibit lack of cracks in the surveyed areas of the axes. The crack on the broken axis shows that as the breaking is realized at the transition from the pap bottom part of the axis to the pap back part of the axis, there is enough grounds to consider that the crack has originated at the point of transition between these two vulnerable to such damages areas of the locomotive axis. It may be asserted that the material and the technology of formation of the wheel axis do not have any relevance to the admitted accident.

One of the most probable explanations may be, that the conditions and period of operation of the locomotive constitute the basis for the permitted failure of the locomotive axis. Considered shall be the fact that in Denmark these locomotives have pulled passenger trains at high speeds (the maximum permissible speed for these locomotives is 170 km/h) and with small mass weight at horizontal sections (i.e. with small traction forces). Within the meaning of the above stated it may be concluded that they have travelled for long at a high speed. This has lead to the accumulation of fatigue in the material, which anyway has not been sufficient for the destruction of the axis (or the axes, upon taking in consideration of other occurrences with these locomotives). After being imported in Bulgaria, these locomotives start pulling freight trains of big mass weights (i.e. realizing big traction efforts) on heavy railway sections with aggressive slopes. The accumulated fatigue of material obtains the necessary additional push, which leads to destruction of the structure upon incomparably smaller mileage of the locomotive in general, and of the axis in particular.

The examination also proved that some of the operational staff members of "D. B. Cargo Bulgaria" EOOD, responsible for the technical status of the non-traction rolling stock, have not fulfilled with good quality their obligations upon the performance of the complete testing and provision of the train with breaking mass weight.

The analysis of the certificates on breaking mass weight, with which the train has travelled from Burgas station to Pirdop station, proves the commitment of several mistakes:

- The breaking mass weight certificate of train Nr. 30698, issued at Burgas station, contains corrections made in the train's number which makes it illegible, and respectively invalid (figure 5, pos.1). According to the requirements of Art. 243, par. 4 of Ordinance Nr. 58 and Art. 309, par. 1 of the Rules on train's trafficking, the breaking mass weight certificate shall be issued in a clear, readable and non-corrected form.
- The certificate, issued at Burgas station, lists the numbers of wagons only by a portion of the number – only 8 digits are enlisted (Figure 5, pos. 2). According to the requirements of Art. 309, par. 3 of the Rules on train's trafficking, the breaking mass weight certificate shall include enlisting of the complete (12 digital) number of the wagon;
- The train's composition includes for transport purposes two electric locomotives in a non-operational condition whose numbers are not enlisted in the certificate, and respectively their breaking mass weights are not included in the calculation of the available breaking mass weight of the train. According to the requirements of Art. 89, par. 4 of the Rules on train's trafficking, upon the calculation of the available breaking mass weight there shall be taken in consideration also the breaking mass weight of the locomotives in a non-operational condition.

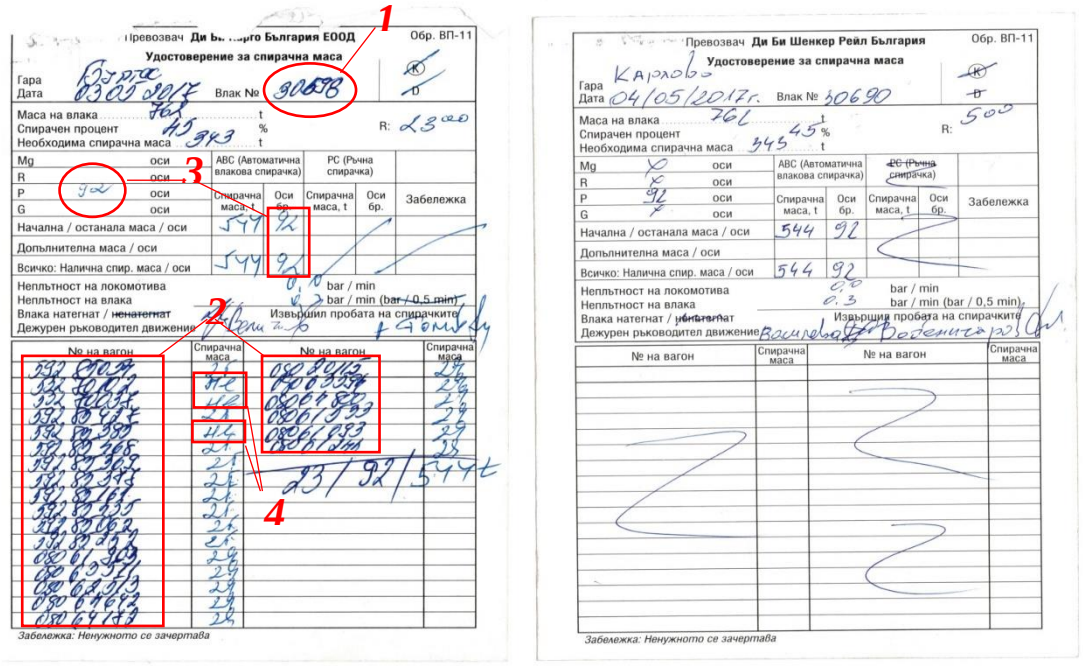

Fig. 5

- In the two breaking mass weight certificates, the number of axes of all vehicles included in the composition of the train and the number of wagons with included breaking system is one and the same (figure 5, pos. 3), upon the condition that it is obvious that the train's composition includes wagons with isolated breaking systems (Figure 5, pos. 4);
- At Burgas station on 03.05.2017, where Nature List of train Nr. 30698/30690 was issued, the latter ws not submitted to the traffic controller on duty for signature.

The afore stated comments are of no direct relevance to the realized accident but prove omissions in the work of the operational staff of the company, as well as absence of efficient control over the job places on the part of the direct managers.

The Investigation Commission requested the data from the speedometer installation of the leading locomotive Nr. 86019.7 and executed deciphering of the train's trafficking at the sections between Anton and Pirdop stations:

Freight train Nr. 30690 is composed as follows:

- locomotive 86-019.7 ahead of the composition, in operational condition;
- locomotive 86-018.9, second in the composition, in non-operational condition;
- locomotive 88-030.1, third in the composition, in non-operational condition;
- wagons, 23 pcs., empty, non-covered (12 of Eaos Series and 11 of Tamns Series).

The train moves in the section between Anton and Pirdop stations with speed of 50 – 52 km/h, and the locomotive operates with activated electric break. At the same time the pressure in the main air duct is lowered to 4,42 bar, which evidences that the automatic train break is activated as well. All this is made because the road's profile is 13,4 ‰ with descending inclination and forthcoming is entrance on a deviation track at Pirdop station, hence the speed is smoothly decreased.

At km 84^{+790} locomotive 86018.9 derails with its fourth wheel axis (first in the direction of movement).

At km 84^{+591}, i.e. 199 m after the derailing accident, the locomotive engine driver of locomotive 86018.9 activates the breaking emergency valve.

As a result from the extreme hold up, at km 84^{+550} the train stops finally.

The locomotive engine driver has carefully followed the trafficking situation and the status of the train, has timely reacted and has acted correctly according to the existing situation (Figure 6).

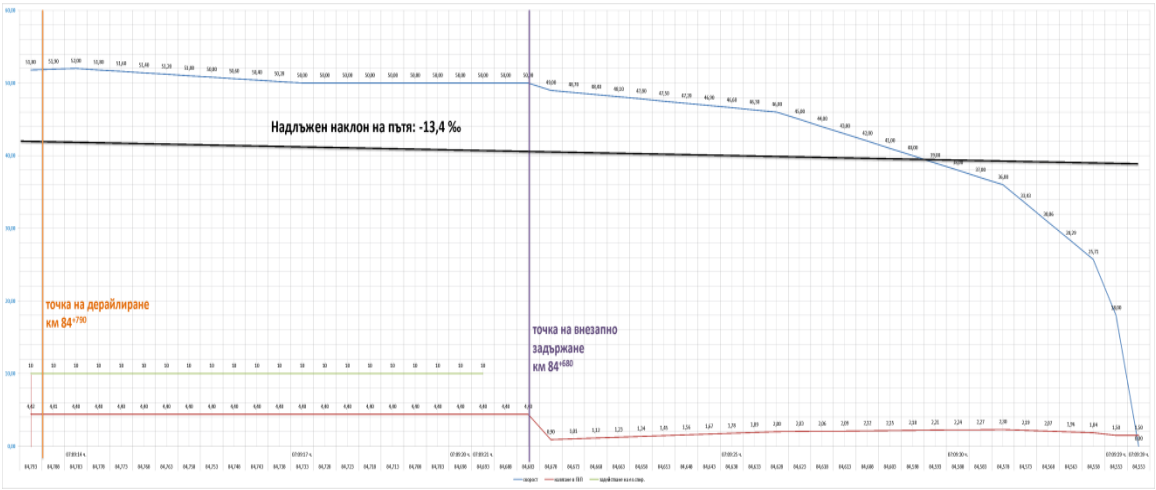

Figure 6

14.4. Chemical, metallographic, fraction-graphic analysis and non-destructive testing of the axis – the investigation is carried out on test samples, cut two-sidedly from the place of the broken locomotive axis.

- Chemical composition of material – the spectral analysis performed on the test sample exhibits that its chemical composition is within the limits for steel 25CrMo4 – EN 10083.

- Metallographic analysis of material – the microstructure of material, from which the wheel axis is made, is dot-shaped pearlite and sorbite, as at the area of destruction some adiabatic strips of sliding and plastically deformed structure are present.

- Fraction-graphic analysis – the axis is broken crosswise of the longitudinal axis, as the destructed surface is thoroughly polluted and rubbed through. The destructed surface is comparatively plain and is covered by an oxide layer. After removal of the oxide layer, the material reveals its plasticity, visible becomes also a network of cracks entering the side surface of the axis.

- Non-destructive testing – over the side surface in the area of the axis registered are surface imperfections of sizes over 200 microns, in the crosswise direction of the destructed surface.

- Analysis of results – the material from which the wheel axis is made is low alloyed carbon steel 25CrMo4. The performed fraction graphic tests clearly prove fatigue of material of the axis.

The observed cracks and their development result from external impacts and deterioration of the physical characteristics of the detail in the process of undergoing permanent operational impacts.

14.5. Other conclusions and violations of the normative regulations, established upon the investigation.

After the performed investigation of the railway accident – derailing of locomotives Nr. 92034 and Nr. 92027 having serviced freight train Nr. 30561 at point Nr. 11 at Zimnica station on 23.12.2014, two safety recommendations were rendered. The one of them was addressed to the railway carrier "D. B. Schenker Rail Bulgaria" EOOD regarding the organization and carrying out of training and issuing of new professional qualification certificates to the locomotive engine drivers operating the relevant locomotive series by a licensed educational institution.

After the commenced investigation of the railway accident – derailing of electric locomotive Nr. 86018.9 from freight train Nr. 30690 upon entrance at Pirdop station on 04.05.2017, the Operative Team submitted documents and materials of the staff members having partaken in the accident. Based the submitted materials and documents, it was established that no training had been performed and the documents of the locomotive drivers had not been re-issued in conformity with the requirements of Art. 18, item 6 of the Law on professional education and training and Art. 44, par. 1, item 1 of Ordinance Nr. 56 dt. 14.02.2003.

By letter Nr. 235/07.07.2015 of "D. B. Schenker Rail Bulgaria" EOOD, in its written response to the National Safety Body, the "Railway Administration" Executive Agency in connection with the rendered recommendation have declared that the professional qualification certificates are issued by an educational institution in accordance with Art. 18, item 6 of the Law on professional education and training. As evidenced by the submitted professional capability certificates, issued for the relevant locomotive series by the Manager of "D. B. Schenker Rail Bulgaria" EOOD, it was proven that the later do not conform with the normative acts cited here above.

The existing professional capability certificates have been re-issued with the new registration of "D. B. Cargo Bulgaria" EOOD.

In the response, delivered to the National Safety Body, it is stated that the training and the professional qualification examination for driving of the relevant series of electric locomotives are carried out by specially trained locomotive instructors in England for the relevant locomotive series, which is in contradiction with the requirements of the normative base regarding professional training performed at a licensed educational institution for acquiring of professional capability for the relevant locomotive series.

14.6. Causes for the occurrence of the accident.

After the performed field surveys, measuring of the railway line parameters and parameters of the derailed locomotive Nr. 86018.9, the performed interview with the staff members having partaken in the accident, the elaborated technical expertise and the submitted opinions of the external experts, the Technical Investigation Commission concluded that the cause having lead to the occurrence is: **breaking of the axis of the first wheel axis in the direction of movement of locomotive Nr. 86018.9 in the area of transition to the pap back part of the axis, resulting from fatigue of material and availability of multiple cracks on the external surface of the axis (as evidenced by the technical expertise).**

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

After the above cited previous accidents at "D. B. Cargo Bulgaria" EOOD and "Bulmarket Real Cargo" EOOD, described in p. 13, the company has undertaken measures for introduction of changes in the safety management system for shortening of the periods of ultrasonic diagnostics of the locomotive wheel axes and axes, aimed at mitigating the risk from the occurrence of other accidents of a similar nature.

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

For prevention of other accidents of a similar nature, in connection with the requirements of Art. 94, par. 1 of Ordinance of the Minister of Transport Nr. 59 dt. 05.12.2006 on the safety management in railway transport, the "Railway Administration" Executive Agency shall order to "D. B. Cargo Bulgaria" EOOD and "Express Service" OOD the fulfillment of the rendered safety recommendations, as follows:

1. The technical staff of “D. B. Cargo Bulgaria” EOOD, related with safety of railway transport of non-traction rolling stock, shall comply strictly and exactly with the requirements, stipulated by Art. 243, par. 4 of Ordinance Nr. 58/2006, Art. 89, par. 4 and Art. 309, par. 1 and par. 3 of the Rules on train’s trafficking and maneuvering work in the railway transport, as well as by the safety management system.

2. The railway carrier “D. B. Cargo Bulgaria” EOOD shall organize the training of the locomotive staff members, operating the relevant locomotive series, at a licensed educational institution in conformity with the requirements of Art. 18, item 6 of the Law on professional education and training and in conformity with Art. 44, par. 1, item 1 of Ordinance Nr. 56/2003 the staff members shall be provided with new professional training certificates.

3. The management of “Express Service” OOD shall undertake measures for comprehensive performance of ultrasonic NDT of the locomotive wheel axes and axes, and strict application of the technology for complete setting of locomotive wheel axes.

In connection with the requirements of Art. 94, par. 3 of Ordinance Nr. 59 dt. 05.12.2006 on the safety management in railway transport, within the deadline till 30.11.2017 the ”Railway Administration” Executive Agency, “D. B. Cargo Bulgaria” EOOD and “Express Service” OOD shall inform in writing the Chairman of the Investigation Commission at the Ministry of Transport, Information Technologies and Communication on the actions undertaken in fulfillment of the rendered safety recommendations.

Sofia
30 August 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 17 pages.

Sworn translator:
Ventseslava Mihailova Mishlyakova