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AIRCRAFT, MARITIME AND RAILWAY ACCIDENT
INVESTIGATION UNIT DIRECTORATE

(AMRAIUD)

FINAL REPORT

on

Technical investigation of serious railway accident – Derailment of fast train No 8601 occurred during ordered transit passing along fourth track of Kaloyanovets station on 12.07.2014



December 2014

With Order No ПД-08-391/17.07.2014 of the Minister of Transport, Information Technology and Communications, a Commission for technical investigation of a serious railway accident - derailment of electric locomotive No 45153.4 and five coaches of fast train No 8601 running along Sofia - Plovdiv – Varna direction, occurred on 12.07.2014 while passing transit on fourth track at Kaloyanovets station, was appointed with the task to analyse the facts and circumstances and to find the causes for the accident occurrence and to prepare a final report.

The Commission for investigation performed several inspections on the accident site and carried out confrontation with the persons involved in the accident. In order to timely ascertain and clarify the circumstances and causes that led to the accident occurrence, two independent experts were also appointed to the Commission. In the course of investigation were reviewed the report and the materials provided by the Task Force. There were additionally required materials and documents from the SE NRIC and „Holding-BDZ" EAD, which were necessary for the investigation. Additional materials and documents were required also from the “National Investigation Service” (NIS) through the supervising prosecutor of the District Prosecutor's Office – Stara Zagora.

Following the Commission for technical investigation proposal, the NIS appointed technical expertises that were to be prepared by independent experts as follows:

1. Technical expertise on decryption of the speedometer tape of locomotive No 45153.4, which serviced fast train No 8601 on 12.07.2014;
2. Complex technical expertise of the rail rolling stock;
3. Technical expertise related to the information collection from the on board device of the „Automatic locomotive signalling" (ALS) of the locomotive No 45153.4;
4. Complex technical expertise of the „Route Relay Interlocking" (RRI) equipment at Kaloyanovets station and of the signalling equipment in Mihaylovo-Kaloyanovets interstation;
5. Triple complex technical expertise on establishment of the functional workability of the registering speedometer from a speed metric installation “Hasler” and of the crane-engine driver of locomotive No 45153.4;
6. On 22.07 2014 the Technical investigation commission performed tests and experiments in Mihaylovo-Kaloyanovets interstation on track No 1 within the hour time of the accident in order to:
 - establish the visibility of the warning and entrance signals;
 - establish the conformity between the signals and position of the switches by ordering the route from the control board at the duty traffic manager;
 - check-up the road equipment of the Automatic locomotive signalling (ALS);
 - artificial unlocking the route for establishing the time for unlocking the entrance and exit routes;
 - check-up the RRI equipment status, located in the relay room;
 - check-up the conformity of the indications from the control board at the duty traffic manager and of the equipment in the relay room at Kaloyanovets station.

Discussed were the statements presented by the independent experts.

1. Facts and circumstances ascertained in the course of investigation.

On 12.07.2014 from Sofia station departed fast train (FT) No 8601 in a composition of 6 coaches, 24 axles, with a total mass of 243 tons, serviced by electric locomotive No 45153.4 and run under the Train operation timetable (TOT) in Sofia – Plovdiv -Varna direction. The locomotive and traffic crews were replaced at Plovdiv station under the approved Schedule for the locomotive and traffic crews working time. At 01:34 p.m., the train departed from Plovdiv station with a locomotive crew of one engine driver, locomotive - first person and an engine driver, locomotive - second person and a traffic crew – a train master and a train conductor. The train was run from the first command cabin by the engine driver,

locomotive - first person. The train departed from Trakia station at 01:43 p.m., as the running of the locomotive was taken by the engine driver, locomotive - second person and arrived at Mihaylovo station at 03:07 p.m.

At 03:09 p.m., the duty traffic manager at Mihaylovo station gave departure to Kaloyanovets station for the fast train No 8601, which would depart from Mihaylovo station at 03:10 p.m. towards Kaloyanovets station and would run along track No 1.

The duty traffic manager at Kaloyanovets station ordered a transit route for the train approaching along track No 1 through manipulating the securing equipment turned switches No 2/4 in a position (-) for deviation towards fourth free acceptance-departure track, opened the entrance signal (Mihaylovo station side), and then also the exit signal of the fourth track towards Stara Zagora station along railway No 2 (as the running of fast and passengers trains along railway No 1 was not allowed, due to ongoing construction-repair works at Stara Zagora station).

At 03:11 p.m. FT No 8601 departed from Mihaylovo station to Kaloyanovets station along railway No 1. After departing from Mihaylovo station, as evident from the locomotive speedometer tape encoding, the train run at a speed of 84 km/h. At 03:12 p.m., the engine driver of the locomotive undertook a fast stopping with the automatic train brake at a railway level crossing on km 85+209, by which the pressure in the main air conduit (MAC) went down from 5 bar to the environment pressure and the speed was sharply decreased to 13 km/h. Then followed a smooth acceleration of the train, firstly to 95 km/h, and after that to 109 km/h, which speed was kept for 20 sec., and then it was reduced to 106 km/h at 03:16:50 p.m. on km 91+446,52 as a follow-up from the performed duty slow down by the automatic train brake.

At 03:17:15 p.m., on km 92+144 followed a gradual detention by the automatic train brake, as a result of it the pressure in „Main air conduit" (MAC) decreased to 62,5 % from its maximum value and a subsequent partial loosening of the pneumatic train system, then the pressure in the MAC increased to 82 % of its maximum value. At that moment the locomotive was at 234,52 m after the entrance semaphore at Kaloyanovets station.

At 03:17:30 p.m. at km 92+321,52, the train speed of 104 km/h was reduced at a leap to 99 km/h. Train No 8601 passed through switch No 2 thanks to the counter rail piece and derailed at switch No 4, colliding subsequently with the metal parapet of the bridge and with the steel lattice pillar of the catenary cut it, then turned over and fell on its wheels at a 50 m. distance from the track. The point of ascension (p. 0) was at 7,48 m. from the peak of the right tongue of switch No 4. At that moment the locomotive was located at 409,52 m. after the entrance semaphore (H) of the station, and the registering nib of the speedometer for travelling time and stopping time stopped its movement.

From the decoding of the locomotive speedometer tape and the technical expertise done, it became clear that **there was not registered fast stopping by the automatic train brake.**

After the train passing at 03:17:00 p.m., the indication of the entrance signal for permission was automatically modified into non-permission, and the duty traffic manager at Kaloyanovets station went out to accept the train by the order disc for a transit passing along the fourth track. When he got out from the control room at the station, he heard strong hits and saw that the train locomotive was in the air and a cloud of dust rising behind. The duty traffic manager went back to the control room, closed the exit signal from the fourth track and sent the duty switchman/level-crossing guard to the accident site. After that he immediately informed the duty traffic manager at Mihaylovo station, the train dispatcher in Plovdiv, the Kaloyanovets station master and the operator of 112 about the accident occurred.

First medical aid was provided to the injured passengers and those who were severely injured were transported by Emergency medical aid cars for treatment to the Multi-profile hospital for active treatment in the city of Stara Zagora.

As a result of the derailment died the engine driver-locomotive - first person, and four officials were injured with a different stage of injury.

On the accident site arrived representatives of the State Investigative Authority and the Commission of technical investigation at MTITC, which carried out parallel inspections of the electric locomotive, passenger coaches, rail infrastructure elements and the status and indications of the control board in the control room at the station.

The relay room at the station was locked by two keys, which were given to the duty traffic manager for safe-keeping in a sealed condition.

After the inspections of the pre-trial and technical investigations were completed at 08:30 p.m. a permission was given to start the emergency rehabilitation works.

At 04:20 p.m. from Stara Zagora station departed a specialized automobile "IVECO", property of SE NRIC, which arrived at 05:00 p.m. on the accident site in order to lift the derailed coaches.

At 05:26 p.m. from Plovdiv station departed train No 80481, "Rehabilitation means" at RWS Plovdiv, which arrived at Mihaylovo station at 07:05 p.m. At 11:18 p.m. from Stara Zagora station departed train No 80480, "Rehabilitation means" at RWS Plovdiv, Stara Zagora district, and arrived at 11:35 p.m. at Kaloyanovets station in order to lift the derailed coaches.

Due to the derailment of locomotive No 45153.4 and 5 coaches from the composition of FT No 8601, the movement of trains between Mihaylovo and Kaloyanovets stations on track No 1 was suspended, because of damaged signalling equipment, track, catenary and broken gauge, from 03:17 p.m. on 12.07.2014 to 02:21 p.m. on 13.07.2014, as well as on track No 2 from 03:17 p.m. on 12.07.2014 (due to destroyed permanent way of track No 4 and switch No 6) for an indefinite time.

During the tests and experiments performed given in p. 6 above, the Commission for technical investigation travelled with locomotive No 46235.8 the route from Mihaylovo station to Kaloyanovets station and verified the secure equipment indications corresponding to the ordered route analogous to the route ordered for fast train No 8601.

Thirty minutes before the acceptance of train No 8601 in Kaloyanovets station,, passenger train No 40244 was accepted on the same route on the fifth acceptance-departure track in order to meet fast train No 8602 and to allow the fast train No 8601 outrun under the orders of the train dispatcher. The engine driver, who serviced train No 40244 reported no discrepancy between the indications of the warning and entrance signals.

The duty traffic manager ordered a route for fast train No 8601 from railroad No 1 on the fourth track through switches 2/4, which was the only possible route for the train, as switch No 5 had been damaged since 19.05.2014, and on the third track could not be ordered a transit route for the train.

By order of the investigator from the DIS - Stara Zagora, the relay room was sealed on 12.07.2014. By a telephoned telegram No 85 from 13.07.2014 sent by the Supervisor of the dispatching shift, the working mode of Kaloyanovets station was changed from automatic block system (ABS) and station with switch interlocking – to a phone mode and station without switch interlocking and the station was receiving and sending the trains from and to adjacent stations by phone means till 22.07.2014.

2. Officials involved in the case.

2.1 Locomotive crew:

2.1.1. "Engine driver, locomotive", first person, of electric locomotive No 45153.4 at Plovdiv locomotive depot, "BDZ-Passenger Service" EOOD -16 years of working experience;

2.1.2. "Engine driver, locomotive", second person, of electric locomotive No 45153.4 at Plovdiv locomotive depot, "BDZ-Passenger Service" EOOD - 12 years of working experience.

2.2. Traffic crew:

2.2.1. "Train master" at PSD Plovdiv, "BDZ – Passenger Service" EOOD - 6 years of working experience;

2.2.2. "Train conductor" at PSD Plovdiv, "BDZ – Passenger Service" EOOD - 6 years of working experience.

2.3. Station staff:

2.3.1. “Duty traffic manager” at Kaloyanovets station – officer at TOSAMD -Plovdiv, SE NRIC - 6 years of working experience;

2.3.2. “Switchman/level-crossing guard” at Kaloyanovets station - officer at TOSAMD - Plovdiv, SE NRIC - 5 years of working experience.

2.4. Other employees

2.4.1. “Section master – signalling installations (SI)/Section master – signalling equipment (ST)”, SE NRIC - 40 years of working experience.

3. Physical condition of the officials involved in the accident.

The necessary duration of rest was assured to all the officials involved in the accident before starting the work shift as required by the Labour Code and Ordinance No 50 of 28.12.2001 on the working time of the management and executive personnel, involved in the provision of passenger and freight rail transport (prom. SG, issue 4 dated 2002).

Pre-travel (pre-shift) instruction was given to all the officials involved in the accident and they declared being alerted, rested and that had not used any alcohol and other drugs.

The officials, involved in the accident possessed valid certificates of psychological examination.

4. Documents, certifying work qualification and exercise of work position.

All the officials involved in the accident possessed the work and professional qualifications required for the respective work position and as well as certificates for their occupation.

Engine driver, locomotive - second person, had been working as “Engine driver assistant, locomotive” since 2004 at Plovdiv locomotive depot, as in 2011 started work at Plovdiv PSD performing on the same position. Since 2012 he had worked as “Engine driver, locomotive, train activity” - III group. On 01.07.2014 started work at Plovdiv PSD, Plovdiv locomotive depot, as „Engine driver, locomotive, train activity” III group.

By order No 18/01.07.2014 for initial training and test of the knowledge of the engine driver, locomotive - second person:

1. Pursuant to art. 20 of the Rules for Work safety and health (WSH) in electric installations of electric and heating plants and on electrical grids, it was conducted a training and exam for acquiring the qualification group on electrical safety of the engine driver, locomotive, train operation III group. The training lasted 2 training hours on 02.07.2014, and after its completion examination was conducted by a committee.

2. Pursuant to art. 13 of Ordinance No RD -07-2 dated 16.12.2009 on the conditions and procedures for conducting of periodic training and instruction of the workers and employees under the rules for ensuring healthy and safe working conditions, instruction shall be provided to him at the workplace with training and examination under the direction of an engine driver, locomotive, train operation - group II. The on the job training shall continue 20 working days effective from 07.03.2014, and after its completion he was to be examined on 30.07.2014.

3. Pursuant to art. 10 and art. 11 of Ordinance No 58/02.08.2006 the new engine driver, locomotive, train operation group III, sat an exam and on 01.07.2014 the Railway Administration Executive Agency issued a qualification certificate to him for taking the position.

4. On the basis of paragraph 5.1.5 of the Procedure on the quality from the Quality management system (QMS) PC 6.2-1 “Human Resources Management. Training“, the engine driver, locomotive, train operation gr. III, was acquainted with the structure, content and documents of the certified QMS.

5. Actions of the officials before and during the time of accident.

Immediately before and at during the time of the accident the SE NRIC officials and the traffic crew of fast train No 8601 from BDZ-PS EOOD acted in conformity with the approved regulation governing the rail transport safety.

Engine driver, locomotive - first person and engine driver, locomotive - second person, who serviced FT No 8601, did not act in accordance with the regulations governing the rail transport safety, namely:

- to ensure the fault-free operation of the train moving on schedule in strict compliance with the prescribed speeds;
- to carry out unconditionally the instructions of the signals and pointers on the outdoor track, in stations and landfills;
- to announce and after personally persuade themselves to confirm the directions of the input, warning and Level crossing semaphores and alerts for speed reduction;
- after personally persuade themselves to reaffirm the switches' positions and to announce: "the entrance switches are for the main (or diverted) track, "the track is unoccupied", or "the exit switches are for exiting from the main (or diverted) track";
- on the road to pay particular attention to the proper handling of the brakes, the observance of permitted speeds and to alertness and focus on the work of the Assistant engine driver (second person).

After the locomotive crew was aware that they would depart from Mihaylovo station on track No 1 and that the train will be accepted on diverted track at Kaloyanovets station, they were obliged to pay attention to the indications of:

- The warning semaphore: "one yellow flashing light – indicating that the entrance semaphore is opened and the movement is allowed with a speed specified for the train, but with a readiness for reducing it at the entrance semaphore to 40 km/h" and
- The entrance semaphore: „one green light and a yellow light below it - meaning "Entrance, permitted with a speed up to 40 km/h from the entrance semaphore to after passing along the entry switches" and immediately, punctually and unconditionally to undertake speed reducing of the train by the automatic train brake to the safe speed indicated."

6. Circumstances, preceding the accident in regards to track, signalling equipment, catenary, rolling stock, etc.

Meteorological weather data with an impact on the visibility of signals:

- air temperature: 29 °C;
- light breeze;
- daylight hours;
- good visibility.

Was the plan for acceptance of the train at the station observed: it was observed – due to delay of FT No 8602 by 28 minutes the meeting place was changed from Svoboda station to the Kaloyanovets-Mihaylovo interstation section.

Profile, geometry and situation of the track at the accident site:

The distance from the entrance semaphore (ES) on km 91+912 at Kaloyanovets station to the beginning of switch No 2 (BS 2) on km 92+201 is 289 m in a straight line section;

The distance between the warning semaphore (WS) on km 90+397 and the entrance semaphore on km 91+912 is 1515 m;

Switches No 2 and No 4 are with radius $R=300$ m;

Rehabilitation and renewal works of track No 1 and No 2 were implemented from Kaloyanovets station to Stara Zagora station and of their adjacent switches of S49 type to S60 type.

Railway: regular.

Condition of the station and interstation signalling equipment and its status before the accident: RRI - H68Y, automatic blocking system (ABS) with axle counters in the Mihaylovo-Kaloyanovets interstation on track No 1 and No 2 - regular; Warning and entrance semaphores on track No 1 – regular and regularly activated; A route for transit passing of train No 8601 in deviation through switches No 2 and No 4 on fourth acceptance-deviation track at Kaloyanovets station towards track No 2 in the Kaloyanovets-Stara Zagora interstation – ordered, outlined and locked;

ALS track equipment (balises) of the warning and entrance signals: regular;

Cleanness of the switches, signals and equipment before the accident: regular;

Catenary: regular, irrelevant to the rail accident occurred;

Train composition station: Sofia;

Communication equipment and telecommunication connections: technically regular.

The electric locomotive No 45153.4 was technically regular, with technically in order running gear and brake system, and light and sound signalling means working in conformity with the technical norms and requirements, which was evident from the records in the respective log-books represented in the Task Force report. The electric locomotive No 45153.4 was equipped with Automatic locomotive signalling (ALS) system “ALTRAKS – BDZ”, but it was not switched on due to the non-qualification of the locomotive crew to work with;

The passenger coaches of FT No 8601 composition with numbers: No 51 52 9257 038-6, No 50 52 2974 079-8, No 50 52 2974 156-4, No 51 52 1940 121-0 and No 50 52 974 231-5 were technically in order, with technically regular running gear, brake system, and light and sound signalling means working in conformity with the technical norms and requirements, which was evident from the records in the respective log-books, represented in the Task Force report.

7. Fulfilment of the working procedures and technologies within the system of the SE National Railway Infrastructure Company before and during the accident.

The working procedures and technologies before and during the accident at the Train Operation and Station Activity Management Division – Plovdiv, part of the SE NRIC structure, were obeyed. That was evident from the Task Force report and its appendixes, the conducted experiments and the additionally required materials as well as the performed confrontations on-site of the staff involved in the accident.

8. Fulfilment of the procedures and technologies for rolling stock service by the railway undertaking before and during the accident.

Fast train No 8601 was provided with the necessary brake mass and train documents. The locomotive and the traffic crews were provided with business mobile phone.

Within the review of the technical documentation, there were not ascertained and recorded any infringements of the effective Rules for factory and depot repairs and maintenance of electric locomotives and passenger coaches, as well as of the procedures and technologies of the repair activities related to the accident.

9. Railway infrastructure and rolling stock status before, during and after the accident.

It was found that the railway infrastructure was regular before and during the accident.

As a result from the accident there were found failures and damages caused to the railway infrastructure, described in details in point 10.4.

Before the accident, the electric locomotive No45153.4 and the coaches of the FT No 8601 composition were regular.

As a result from the accident were found failures and damages, described in details in point 10.3.

10. Consequences from the accident.

10.1. Fatalities – 1, engine driver, locomotive, first person;

10.2. Seriously injured – 8 persons:

- Four passengers – hospitalized at MPHAT – Stara Zagora;

- Four officials - hospitalized at MPHAT – Stara Zagora:

- Engine driver, locomotive, second person including:
- Train master;
- Train conductor;
- Train master, who was travelling not on duty on train No 8601.

10.3. Failures and damages caused to the railway rolling stock:

10.3.1. Electric locomotive:

The damages caused to electric locomotive No 45153.4 – property of “BDZ-Passenger Services” EOOD, Plovdiv PSD, Plovdiv locomotive depot, amounted to a balance value of 287 615,16 BGN.

10.3.2. Coaches:

10.3.2.1. Passenger coach No 51 52 9257 038-6, Bm-van, property of “BDZ-Passenger Services” EOOD -

- Strongly deformed frame of the coach;
- Deformations and tearing of the coach body shell;
- Deformed and twisted bogie frames;
- Deformed shafts of the lever-brake system;
- Torn and missing draw gears;
- Dents and breaks on the rolling surface of the wheel-sets.

The caused damages to the coach amounted to 51 720,87 BGN.

10.3.2.2. Passenger coach No 50 52 2974 079-8, B4-second class, property of “BDZ-Passenger Services” EOOD,

- Strongly deformed frame of the coach;
- Deformations and tearing of the coach body shell;
- Deformed and twisted bogie frames;
- Deformed shafts of the lever-brake system;
- Torn and missing draw gears;
- Dents and breaks on the rolling surface of the wheel-sets;
- The coach is non-recoverable.

The caused damages to the coach amounted to 248 208,21 BGN.

10.3.2.3. Passenger coach No 50 52 2974 156-4, B4-second class, property of “BDZ-Passenger Services” EOOD,

- Strongly deformed frame of the coach;
- Deformations and tearing of the coach body shell;
- Deformed and twisted bogie frames;
- Deformed shafts of the lever-brake system;
- Torn and missing draw gears;
- Dents and breaks on the rolling surface of the wheel-sets;
- The coach is non-recoverable.

The caused damages to the coach amounted to 256 060,00 BGN.

10.3.2.4. Passenger coach No 51 52 1940 121-0, A4-first class, property of “BDZ-Passenger Services” EOOD,

- Strongly deformed frame of the coach;
- Deformations and tearing of the coach body shell;
- Deformed and twisted bogie frames;
- Deformed shafts of the lever-brake system;
- Torn and missing draw gears;
- Dents and breaks on the rolling surface of the wheel-sets;
- The coach is non-recoverable..

The caused damages to the coach amounted to 225 090,77 BGN.

10.3.2.5. Passenger coach No 50 52 2974 231-5, B4- second class, property of “BDZ-Passenger Services” EOOD,

- deformed front beams and columns;
- Dents on the rolling surface of the wheel-sets;
- The coach could be repaired.

The caused damages to the coach amounted to 10 434,54 BGN.

10.4. Failures and damages to the rail infrastructure:

10.4.1. Permanent way and structures:

In result of the derailment, damages were caused to the permanent way and structures and to the components of rail switches as follows:

- Permanent way between switches, destroyed and unavailable for operation – 50 m;

- Switch No 2 R-300, T 60, L – crossing – hit in the frog pointer;
- Switch No 4 R-300, T 60, L – right tongue - deformed;
- Normal sleepers ST 6, T 60 before switch No 4 (2 units) – with broken integrity;
- Switch No 6 R-300, T 60, R (set) - with broken integrity;
- Switch sleepers after switch No 8 R-300, T 60, R (2 units) - with broken integrity;
- Switch No 8 R-300, T 60, R – right guard rail - deformed;
- Switch No 10 R-300, T 60, L – right tongue - deformed;
- Switch No 10 R-300, T 60, L – point machine - broken;
- Switch No 10 R-300, T 60, L – auxiliary apparatus - broken;
- Switch No 10 R-300, T 60, L – sleepers in the tongue and interim parts (20 units) – with broken integrity;
- Bridge railing at on km 92+255 (50 meters) - broken.

The expenditures for restoring the train operation in Mihaylovo-Kaloyanovets interstation along track No 1 for SE NRIC amounted to 12 279,22 BGN, without VAT.

The damages to the permanent way and structures amounted to 345 363,58 BGN, without VAT.

10.4.2. Signalling and communications, radio connections, power supply:

As a result from the derailment, failures and damages were caused to the following structures of the ST:

- ESPM of switch No 6 type Siemens S 700K;
- ESPM of switch No 10 type Siemens S 700K;
- Counter points (CP) set;
- Heating of switch No 6 set.

The damages caused to the signalling equipment of the ST-Plovdiv amounted to 31 400,00 BGN, without VAT.

10.4.3. Catenary:

As a result from the derailment, failures and damages were caused to the following structures of the catenary:

- Pillar MA-1 - 1 unit;
- Pillar BMK - 2 units;
- Foundation of pillar MA-1 - 1 unit;
- Foundation C of BMK pillar - 2 units;
- Single-track console C - 5 for BMK – delivery and installation - 1 unit;
- Single-track console M for BMK - delivery and installation - 1 unit;
- Single-track console M for MK-1 - delivery and installation - 1 unit;
- Contact wire Cu 80 mm² – delivery, assembling and installation - 120 m;
- Messenger (carrying cable) Bz 50 mm² - delivery, assembling and installation - 120 m;
- Solid anchoring for MA-1 - 1 unit;
- Semi-compensating anchoring for MA-1 - 1 unit;
- Droppers and terminals set (for 120 m - 15 k-t) - 0,120 km;
- C regulation of the fourth track - 0,880 km;
- C regulation of the fifth track - 1,118 km;
- Placing and regulation of C at S-tie over switches No 2, 4, 6, 8 - 2 units;
- Earthing – delivery and installation with fastening - 3 units

The damages caused to the catenary and facilities (structures), property of SE NRIC Energy Section – Plovdiv amounted to 46 149,42 BGN, without V.A.T.

10.4.4. Other failures and damages: none.

10.5 Damages and spill of freights, baggage and parcels: none.

10.6. Train movement interruption:

Due to the derailment of electric locomotive No 45153.4 and five coaches from the composition of FT No 8601, the train movement between Mihaylovo-Kaloyanovets stations was interrupted on track No 1 from 03:17 p.m. on 12.07.2014 to 02:21 p.m. on 13.07.2014, and on track No 2 from 03:17 p.m. on 12.07.2014 for indefinite time.

10.7. Caused delay of trains:

10.7.1. Delayed trains:

- Train No 8613 - 12.07.2014 - „BDZ PS“ EOOD - 21 min.;
- Train No 8671 - 12.07.2014 - „BDZ PS“ EOOD - 26 min.;
- Train No 8674 - 12.07.2014 - „BDZ PS“ EOOD - 62 min.;
- Train No 10243 - 13.07.2014 - „BDZ PS“ EOOD - 24 min.;
- Train No 40292 - 13.07.2014- „BDZ PS“ EOOD - 13 min.;
- Train No 82204 - 13.07.2014- „BDZ PS“ EOOD - 30 min.;
- Train No 82206 - 13.07.2014- „BDZ PS“ EOOD - 12 min.;
- Train No 80190 - 13.07.2014- „BDZ PS“ EOOD - 128 min.;
- Train No 80192 - 13.07.2014- „BDZ PS“ EOOD - 89 min.;
- Train No 8627 - 13.07.2014- „BDZ PS“ EOOD – 23 min.;
- Train No 3621 - 13.07.2014- „BDZ PS“ EOOD - 6 min.;
- Train No 80194 - 13.07.2014- „BDZ PS“ EOOD - 78 min.;
- Train No 8684 - 13.07.2014- „BDZ PS“ EOOD – 26 min.;
- Train No 8689 - 13.07.2014- „BDZ PS“ EOOD - 15 min.;
- Train No 80195 - 13.07.2014- „BDZ PS“ EOOD - 14 min.;
- Train No 8688 - 13.07.2014- „BDZ PS“ EOOD - 15 min.;
- Train No 80145 - 13.07.2014- „BDZ PS“ EOOD - 6 min.;
- Train No 8612 - 13.07.2014- „BDZ PS“ EOOD - 5 min.;
- Train No 80107 - 13.07.2014- „BDZ PS“ EOOD - 34 min.;
- Train No 80106 - 13.07.2014- „BDZ PS“ EOOD - 70 min.;
- Train No 8641 - 13.07.2014- „BDZ PS“ EOOD - 18 min.;
- Train No 8699 - 13.07.2014- „BDZ PS“ EOOD – 12 min.;
- Train No 3693 - 13.07.2014- „BDZ PS“ EOOD - 74 min.;
- Train No 8613 - 13.07.2014- „BDZ PS“ EOOD - 119 min.;
- Train No 3625 - 13.07.2014- „BDZ PS“ EOOD – 126 min.;
- Train No 8632 - 13.07.2014- „BDZ PS“ EOOD - 61 min.;
- Train No 8693 - 13.07.2014- „BDZ PS“ EOOD - 4 min.;
- Train No 8636 - 13.07.2014- „BDZ PS“ EOOD - 27 min.;
- Train No 8612 - 12.07.2014- „BDZ PS“ EOOD - 45 min.;
- Train No 8626 - 13.07.2014- „BDZ PS“ EOOD - 53 min.;
- Train No 8640 - 13.07.2014- „BDZ PS“ EOOD - 10 min.;
- Train No 5621 - 13.07.2014- „BDZ PS“ EOOD - 31 min.;
- Train No 50273 - 12.07.2014- „BDZ PS“ EOOD - 10 min.;
- Train No 50241 - 13.07.2014- „BDZ PS“ EOOD - 20 min.;
- Train No 50251 - 13.07.2014- „BDZ PS“ EOOD - 15 min.;
- Train No 5610 - 13.07.2014- „BDZ PS“ EOOD - 10 min.;
- Train No 5623 - 13.07.2014- „BDZ PS“ EOOD - 13 min.;
- Train No 5670 - 13.07.2014- „BDZ PS“ EOOD - 41 min.;

10.7.2. Appointed trains and vehicles

- Train No 8674 - 12.07.2014 – from Sa to Po - „BDZ PS“ EOOD;
- Train No 8671 - 12.07.2014 – from Po to Sa - „BDZ PS“ EOOD;
- Train No 8692 - 12.07.2014 – from Sa to Po - „BDZ PS“ EOOD;
- Train No 8673 - 12.07.2014 - from Po to Sa - „BDZ PS“ EOOD;
- Train No 8672 - 12.07.2014 – from Sa to Po - „BDZ PS“ EOOD;
- Train No 8688 - 12.07.2014 – from Sa to Po - „BDZ PS“ EOOD;
- Train No 8689 - 12.07.2014 – from Po to Sa - „BDZ PS“ EOOD;
- Train No 8684 - 12.07.2014 – from Sa to Po - „BDZ PS“ EOOD;

- Train No 8671 - 12.07.2014 – from Sz-Tl to Kn - „BDZ PS“ EOOD;
- Train No 8670 - 12.07.2014 – from Sp to Sf - „BDZ PS“ EOOD;
- Train No 82692 - 12.07.2014 – from Por to Svi- „BDZ PS“ EOOD;
- Train No 40770 - 12.07.2014 – from Sz to Po- „BDZ Cargo“ EOOD;
- Train No 82693 - 13.07.2014 – from Tl to Bz- „BDZ Cargo“ EOOD;
- Train No 82694 - 13.07.2014 – from Por to Svi- „BDZ Cargo“ EOOD;
- Train No 44998 - 13.07.2014 – from Sz to Tl- „BDZ Cargo“ EOOD;
- Train No 44999 - 13.07.2014 – from Mh to Dg- „BDZ Cargo“ EOOD;
- Train No 44994 - 13.07.2014 – from Dgs to Mh- „BDZ Cargo“ EOOD;
- Train No 44995 - 13.07.2014 – from Sz to Klc- „BDZ Cargo“ EOOD;
- Train No 40989 - 13.07.2014 – from Mh to Dgs- „BDZ Cargo“ EOOD;

10.7.3. Deviated trains

- Train No 8627 – 12.07.2014 – from Po-Kv to Tl - „BDZ Cargo“ EOOD;
- Train No 8637 – 12.07.2014 – from Po-Kv to Tl - „BDZ Cargo“ EOOD;
- Train No 8632 – 12.07.2014 – from Tl-Kv to Po - „BDZ Cargo“ EOOD;
- Train No 8636 – 12.07.2014 – from Tl-Kv to Po - „BDZ Cargo“ EOOD;
- Train No 8626 – 12.07.2014 – from Tl-Kv to Po - „BDZ Cargo“ EOOD;
- Train No 8631 – 12.07.2014 – from Po-Kv to Tl - „BDZ Cargo“ EOOD;
- Train No 8611 – 12.07.2014 – from Po-Kv to Tl - „BDZ Cargo“ EOOD;
- Train No 8601 – 12.07.2014 – from Po-Kv to Tl - „BDZ Cargo“ EOOD;
- Train No 8610 – 12.07.2014 – from Tl-Kv to Po - „BDZ Cargo“ EOOD;
- Train No 8602 – 12.07.2014 – from Tl-Kv to Po - „BDZ Cargo“ EOOD;

10.7.4. Non used capacity from “BDZ PS” EOOD on the main railway lines

- Train No 8601 - 12.07.2014 – from Klc to Kn - „BDZ PS“ EOOD;
- Train No 8641 - 12.07.2014 – from Sa to Sz - „BDZ PS“ EOOD;
- Train No 8697 - 12.07.2014 – from Sz to Nz - „BDZ PS“ EOOD;
- Train No 8698 - 12.07.2014 - from Nz to Sz - „BDZ PS“ EOOD;
- Train No 8699 - 12.07.2014 – from Sz to Nz - „BDZ PS“ EOOD;
- Train No 8640 - 12.07.2014 – from Sz to Po - „BDZ PS“ EOOD;
- Train No 8694 - 12.07.2014 – from Nz to Sz - „BDZ PS“ EOOD;
- Train No 40294 - 12.07.2014 – from Dbv to Kzn - „BDZ PS“ EOOD;
- Train No 30147 - 12.07.2014 – from Tl to Sz - „BDZ PS“ EOOD;
- Train No 80109 - 12.07.2014 – from Sa to Nz - „BDZ PS“ EOOD;
- Train No 80294 - 12.07.2014 – from Nz to Sz- „BDZ PS“ EOOD;
- Train No 30235 - 12.07.2014 – from Kzn to Sl - „BDZ PS“ EOOD;
- Train No 40244 - 12.07.2014 – from Klc to Dbv - „BDZ PS“ EOOD;
- Train No 80107 - 12.07.2014 – from Sa to Nz - „BDZ PS“ EOOD;
- Train No 80106 - 12.07.2014 – from Nz to Sz - „BDZ PS“ EOOD;
- Train No 80390 - 12.07.2014 – from Nz to Sz- „BDZ PS“ EOOD;
- Train No 80100 - 12.07.2014 – from Sz to Po - „BDZ PS“ EOOD;
- Train No 80110 - 12.07.2014 – from Sz to Po - „BDZ PS“ EOOD;
- Train No 40244 - 12.07.2014 – from Dgs-Tl to Kzn - „BDZ PS“ EOOD;
- Train No 40243 - 12.07.2014 – from Sa to Sz - „BDZ PS“ EOOD;
- Train No 80112 - 12.07.2014 – from Sz to Sa - „BDZ PS“ EOOD;
- Train No 80195 - 12.07.2014 – from Sa to Sz - „BDZ PS“ EOOD;
- Train No 80194 - 12.07.2014 – from Sz to Sa - „BDZ PS“ EOOD;
- Train No 80292 - 12.07.2014 – from Nz to Sz - „BDZ PS“ EOOD;
- Train No 40294 - 12.07.2014 – from Tl to Kzn - „BDZ PS“ EOOD;
- Train No 30135 - 12.07.2014 – from Kzn to Slv - „BDZ PS“ EOOD;
- Train No 8602 - 12.07.2014 – from Sp to Sf - „BDZ PS“ EOOD;

10.7.5. Non used capacity from “BDZ PS” EOOD on the secondary railway lines

- Train No 46870 - 12.07.2014 – from Kk to Por - „BDZ PS“ EOOD;
- Train No 44155 - 12.07.2014 – from Por to Kk - „BDZ PS“ EOOD;
- Train No 10601 - 12.07.2014 – from Por to Svi - „BDZ PS“ EOOD;

- Train No 10534 - 12.07.2014 - from Sz to Sp - „BDZ PS“ EOOD;
- Train No 10604 - 12.07.2014 – from Svi to Por - „BDZ PS“ EOOD;
- Train No 40642 - 12.07.2014 – from Dgs to Sz - „BDZ PS“ EOOD;
- Train No 40643 - 12.07.2014 – from Sz to Dgs - „BDZ PS“ EOOD;
- Train No 80604 - 12.07.2014 – from Sz to Por - „BDZ PS“ EOOD;
- Train No 83504 - 12.07.2014 – from Sz to Ln - „BDZ PS“ EOOD;
- Train No 83505 - 12.07.2014 – from Dg to Ln - „BDZ PS“ EOOD;
- Train No 40640 - 13.07.2014 – from Dgs to Sz- „BDZ PS“ EOOD;
- Train No 40642 - 13.07.2014 – from Dgs to Sz- „BDZ PS“ EOOD;
- Train No 40643 - 13.07.2014 – from Sz to Dgs- „BDZ PS“ EOOD;
- Train No 80601 - 13.07.2014 – from Por to Sz - „BDZ PS“ EOOD;
- Train No 80602 - 13.07.2014 – from Sz to Por - „BDZ PS“ EOOD;
- Train No 80603 - 13.07.2014 – from Por to Sz - „BDZ PS“ EOOD;
- Train No 80604 - 13.07.2014 – from Sz to Por - „BDZ PS“ EOOD;
- Train No 80612 - 13.07.2014 – from Tl to Sz - „BDZ PS“ EOOD;
- Train No 83504 - 13.07.2014 – from Dg to Ln - „BDZ PS“ EOOD;
- Train No 83505 - 13.07.2014 – from Ln to Dg - „BDZ PS“ EOOD;
- Train No 83506 - 13.07.2014 – from Dg to Ln - „BDZ PS“ EOOD;
- Train No 83507 - 13.07.2014 – from Ln to Dg - „BDZ PS“ EOOD;

10.7.6. Costs of modifying the Train movement schedule:

10.7.6.1 „BDZ – Passenger Services“ EOOD – 36 102,31 BGN, without VAT.

- Returned back tickets and locomotive and traffic crews salaries - 916, 61 BGN;

- Passengers transport by buses (trans-boarding) - 9 106, 56 BGN;

10.7.6.2 „BDZ – Cargo“ EOOD – 32 365,65 BGN, without VAT.

10.8. Movement of rehabilitation vehicles:

10.8.1. Rehabilitation train:

At 11:18 p.m. on 12.07.2014, from Stara Zagora station departed train No 80480, “Rehabilitation means” at RWS - Plovdiv, Stara Zagora district of SE NRIC, which arrived at 11:35 p.m. at Kaloyanovets station for lifting the derailed coaches.

At 05:26 p.m. on 12.07.2014, train No 80481 of “Rehabilitation means” at RWS - Plovdiv SE NRIC departed from Plovdiv station and arrived at Mihaylovo station at 07:05 p.m.

10.8.2. Other rehabilitation means:

At 04:20 p.m. on 12.07.2014, from Stara Zagora station departed specialized vehicle “IVECO”, property of SE NRIC and arrived at 05:00 p.m. on the accident site to lift the derailed coaches.

11. Analysis of the causes leading to the railway accident.

From additional viewings and measurements on site and from the additional inspections and measurements on site and from materials submitted by the task force it was found that the investigated serious railway accident – derailment of fast train No 8601, moving in direction Sofia - Plovdiv - Varna occurred on 12.07.2014, at 03:17:30 p.m. along ordered transit route on the fourth track of Kaloyanovets station.

In accordance with the technical specification and technology of Kaloyanovets station (with initials Klts), located on km 92 + 869 on the main railway line No 8 between stations Mihaylovo (Mh) and Stara Zagora (SZ) it is opened for “Operation” and passenger transportation serving four settlements in the area – villages of Kaloyanovets, Rakitnitsa, Lovets and Borovo.

Approaches and profiles of the rail track towards Kaloyanovets station:

| From/to station | From the warning (WS) to the entrance signal | I m. | From the entrance signal (ES) to the first entrance switch | I m. |
|----------------------|---|---------|--|-----------|
| Mihaylovo track No 1 | From WS km 90+397 to 90+920 -523 m 3,0 % downwards; from km 90+920 to 91+795 - 875 m 8,0 % downwards; from 91+975 to ES km 91+912 - 117 m 2,8% downwards; | 6% down | From ES km 91+912 to BS No 2 km 92+201 - 289 m 2,8 % downwards | 2.8% down |

| | | | | |
|--------------------------------|--|---------------------|---|---------------------|
| Mihaylovo track No 2 | From WS km 90+398 to 90+920 -532 m 3,0 ‰ downwards; from km 90+920 to 91+795 - 875 m 8,0 ‰ downwards; from 91+975 to ES km 91+898 - 103 m 2,8‰ downwards; | 6‰ down | From ES to BS km 91+898 to ES No 4 km 92163 - 265 m 2,8 ‰ downwards | 2.8‰ down |
| Stara Zagora track No 1 | From WS km 94+980 to 94+417 -563 m 3,1 ‰ upwards; from km 94+417 to ES 93+836 - 581 m 4,7 ‰ upwards | 4,3‰ upwards | From ES km 93+836 to 93+637 -199 m 4,7 ‰ upwards; from km 93+637 to BS No 1 km 93582 - 55 m 0 ‰ horizontal | 3,6‰ upwards |
| Stara Zagora track No 2 | From WS km 94+980 to 94+417 -563 m 3,1 ‰ upwards; from km 94+417 to ES 93+836 - 581 m 4,7 ‰ upwards | 4,3‰ upwards | From ES km 93+836 to 93+637 -199 m 4,7 ‰ upwards; from km 93+637 to ES No 3 km 93539 - 98 m 0 ‰ horizontal | 3,1‰ upwards |

Profile and actual track inclinations (in the interstation sections) to the neighbouring stations, as follows:

| To neighbouring station | Prevailing actual inclination | Actual inclination for the locomotive norms | Actual inclination for the brake mass |
|-------------------------|-------------------------------|---|---------------------------------------|
| Mihaylovo | Upwards 9,5 ‰ | 7‰. | -10 ‰ |
| Stara Zagora | Upwards 6,8 ‰ | 3‰ | - 5 ‰ |

In relation to the performance of Contract No 3619/08.02.2011 of the project “Rehabilitation of railway infrastructure along sections of Plovdiv – Burgas railway line” and approved minutes dated 07.03.2014 on the reconstruction and rehabilitation of Stara Zagora station, by telegram No 524/25.03.2014, the Director General of SE NRIC made changes in the TOT, as follows:

“9. The trains from Kaloyanovets station will be accepted in Stara Zagora station as follows: the passenger trains shall run only on track No 2 and shall be accepted on the 1-st, 2-nd and 3-rd track, as for the acceptance on the third track shall be used the individual button welcoming signal “CHMZA” under the established order;

The freight trains shall run on track No 1 and No 2 and shall be accepted with regularly opened input entrance signal on the 1-st, 2-nd, 10-nth, 11-nth, 12-th, 13-nth ,14-nth and 16-nth track.

10. Trains No No 8637, 8627, 80 111, 464, 8631, 80103, 8611, 80195, 30144, 8601, 80107, 8613, 80109 and 8641 shall run along Kaloyanovets - Stara Zagora interstation on track No 2”.

To the moment of the railway event, the track in the railway section was reconstructed under the project "Reconstruction (Mechanized renewal) of the track in section Mihaylovo-Kaloyanovets on the eight railway line from km 82 + 883 to 93 + 539 – track No 1 and No 2 with total length of 21 309 m. and put into operation with Protocol Form 16 dated 14.04.2014 laying down the suitability for use of the construction site and Permission for use No CT-05-556 dated 14.04.2014.

From the submitted technical specifications and technology of Kaloyanovets station was evident that:

- The track superstructure was continuously welded track, with rails of UIC 60 type, pre-stressed reinforced concrete sleepers type B91S, 1640 pc/km and elastic and without pads fastening SKL 14. The rails are welded by electro-contact mode at each 108 m. After the neutralization performed to the track, aluminium –thermal welds were made in every 500 to 1000 meters-;

- Switches No 2 and No 4 were of CO UIC 60 1:9 type with radius R-300 EERP, of pre-stressed reinforced concrete sleepers and elastic fastenings SKL 14. The switches were welded.

- The warning and entrance semaphores were installed to implement the speed signalling in pursuance of art. 317 and art. 324 of Ordinance No 58 on the rules for technical operation, movement of trains and railway signalling;

- The warning semaphore is located at km 90+ 397 and the entrance one - at km 91 + 912. The distance between them is 1515 m, according to art. 312 (1) of Regulation No 58 for train running speed of up to 160 km/h;

- The entrance semaphore on track 1 at station Kaloyanovets, Mihaylovo station side, is located at a distance of 289 m. from the first entrance switch No 2, which is located at km 92 + 201 (according to art. 71 (1) of Ordinance No 58).

Therefore, the visibility of the installed warning and entrance signals on the track is in accordance with the requirements of Ordinance No 58. When approaching the warning and entrance semaphores there are no any obstacles these to be seen.

On 22.07.2014, at Kaloyanovets station the Commission for investigation from MTITC together with investigators from the District Investigation Service (DIS) - Stara Zagora and experts from SE NRIC and "Holding –BDZ" EAD performed tests and experiments with the tasks to:

- check the route-relay interlocking (RRI) and signalling equipment (SE) in the station;
- test for the conformity of the RRI equipment with the indications of the warning and entrance signals;

- test the ordering of route from track No 1 through switches No 2, 4 and 6 on the fourth acceptance-departure track on rail road No 2 towards Stara Zagora;

- check for the visibility of the warning (WS) and entrance (ES) station semaphores from Mihaylovo side on track No 1;

- check the track equipment of the automatic locomotive signalling (ALS) for regular functionality between Mihaylovo and Kaloyanovets stations on track No 1.

During the initial inspection on the accident site, the apparatus of switch No 6 and counting point No 20 before switch No 10 were found damaged by the derailed locomotive.

After authorization by the investigator from Stara Zagora DIS and a record in Book VII-51 for damages to the safety equipment made, the relay room was opened for inspection and following was found:

- There were no visible signs that the relay equipment was discredited;
- The attention was focused on the equipment involved in the arrangement of the route for train No 8601.

- Switches No 2 and No 4 were set to "+". The control relays were respectively PCR 2 (Plus control relay) - activated, and the MCR 2 (Minus control relay) - not activated and control relays SIC 4 - activated and MCR 4 - not activated. These were in conformity with the real position of the switch tongues on the spot and the control-board of the duty traffic manager;

- By arranging the route from track No 1 towards the third track by the duty traffic manager in the part of it not affected by the accident, the relays involved were in position - PCR 2 (Plus control relay) was activated, MCR 2 (Minus control relay) - not activated in accordance with the tables for route mutual dependencies (TRD) (line 03 entrance by entrance signal (Tch) on track No 1 from Mihaylovo station on third track) and schematic documentation RRI at Kaloyanovets station.

From the findings it was evident that the devices of the station centralization in Kaloyanovets did not allow:

- Opening of signal on a given route before the switches on the route get electrical control for the necessary position and been locked;

- Reversing of the switches, locked individually or in route;

The devices of the station centralization system provide verification of the safety conditions and interdependence between the switches and the signals electrically.

After performed inspection and re-entry into the relay room of the station, the following activities were carried out:

- Reset the controlled track sections within the station area, which had remained busy since the day of the accident;
- Recovery of the switch No 6 functionality;
- Insertion of the working fuses of switches No 2, No 4, No 6, No 8 and No 10.

With the purpose to check the visibility of the semaphores, their signal indications and the functionality of the ALS, at 00:34 p.m. members of the Commission for investigation and investigators from DIS - Stara Zagora departed from sixth track in Mihaylovo station with electric locomotive No 46235.8 towards station Kaloyanovets on railway No 1, serviced by engine driver, locomotive - senior instructor of locomotive depot Plovdiv, with regular exit signal and ALS activated with indication on the panel "no information" (NI). The locomotive was equipped with ALS of "ALTRAKS-BDZ" model. The movement of the locomotive was secured by the duty traffic manager at Mihaylovo station and the duty traffic manager at Kaloyanovets station through manipulations of the signalling equipment - entrance in deviation and exit from a straight track, analogical to the route prepared for train No 8601 (entrance on entry signal R from track No 1 from station Mihaylovo on fourth track, in accordance with line 04 of TRD and the scheme documentation of RRI-N68U at Kaloyanovets station).

After the locomotive entered Kaloyanovets station, it stopped in front of switch No 2 and received permission from the train dispatcher for unsealing of button "Artificial route unlocking" (ARU). The time for unlocking the route was checked measuring with a chronometer separately for the entrance and exit route and it was found that:

- The time for unlocking the entry route was 4 minutes and 23 seconds;
- The time for unlocking the exit route was 4 minutes and 50 seconds and both the time delays were in accordance (with art. 80-3 minutes) with the "Rules for technical operation of the railway infrastructure" (RTO) of NRIC.

After the locomotive passed over the balises of the Automatic level-crossing device (ALCD) on km 92+598, the on-board equipment of the ALCD received information and indicated „full control" (FC) on the control board. While passing the warning signal (WSR) at Kaloyanovets station the ALC did not receive a valid functional telegram, in which the engine driver reduced the speed under 25 km/h and the system went into „no information" (NI) regime. This is a protective status, to which the ALS normally switches upon reception of a wrong telegram. When passing over the balise of the entrance signal (ESR) at Kaloyanovets station, the ALS receives a regular functional telegram from it.

After passing of the locomotive beyond the entrance signal, the allowing indication for it switched to prohibitive one (red light illuminated). Tests were performed with a tester to the track equipment of ALS of WRSR and ERS at Kaloyanovets station. At the WS the tester showed damage of the active inductor and at the ES showed correctly functioning track equipment.

Upon completion of the work of the Commission, pursuant to telephoned telegrams No 164 and No 163 from 22.07.2014 of the dispatching shift supervisor, the mode of operation of Kaloyanovets station was restored (from station without switch centralisation to station with switch centralisation and automatic blocking). Based on the results from the performed experiment the following conclusions were made:

- All devices involved in preparation of the route of train No 8601 (switches and warning and entrance semaphores) were in good working conditions as required by Ordinance No 58;
- The indications of the warning and entrance semaphore at the station matched the switches position in the route preparation;
- The relay room was sealed and the state of the equipment in it complied with the requirements;
- The ALC balises were functioning except the one next to the warning semaphore.

The electric locomotive No 45153.4 was equipped with a speedometer installation type "Hasler" for recording the running speed. The installation registers speeds ranging from 0 to 150 km/h. In the first cab of the locomotive was installed wall band tachometer and in the

second locomotive cabin - wall tachometer of A 16 type. The speedometer installation performed on waxed speedometer band the following registrations:

Basic registrations:

- Speed - in km/h;
- Astronomic time - 24 digital scale;
- Travelling and stopping time - in minutes;
- Travelled road.

Additional registrations:

- Registration of the rheostat brake activation;
- Air pressure in the main air conduit (activation of the pneumatic brake).

On 15.09.2014 the registration speedometer was dismantled from the first cabin as well as the body of the angular reduction gear with the tachometer transducer from the first locomotive wheel-set for performing of a Triple technical expertise by independent experts. During the external inspection performed, it was found:

- The speedometer was of RT 9 type with manufacturing No 34370;
- Found damages - broken glass of the speedometer; damaged in several pieces connection cable connecting the tachometer transducer with the speedometer;
- The shell of the angular reduction gear and the tacho-transformer was lead sealed with No 2.

The registration speedometer was put to control tests as a result of which it was established that:

- The speedometer operated normally with the stand tacho-transformer within the range of 0-120 km/h, as the permissible error was 0.3%;
- The speedometer operated normally with the electric locomotive No 451534 tachometer transducer within the range of 0-120 km/h, as the permissible error was 0.3%;
- The speedometer performed accurate registration: speed, air pressure in the pneumatic membrane, astronomic time, travelling and stopping time.

Based on the findings and on the triple complex technical expertise, it was concluded that the registering speedometer with factory No 34370 and its tachometer transducer were regular and in good functional condition". This leads to the conclusion that the data on the speed of FT No 8601 for travelled distance, time, and pressure of the compressed air in the main air conduit of the train braking system were reliable.

The electric locomotive No 45153.4 was equipped with a crane driver installation Knorr D 2 (factory No 9997) to work with the automatic train brake. In both loco cabins were installed crane drivers. The handling of the automatic train brake was performed only with one of the two, depending on which cabin the locomotive was operated from (the other should be locked in "insulated" position).

The crane driver was with the ability to work in common with the RGV3 valve system for ALS.

The Basic rules, technical standards, tolerances and requirements for repair and testing of pneumatic equipment for railway rolling stock (RRS) of BDZ are given by the "Rules for repair and testing of brake systems for rolling stock of BDZ"

As a result from the tests performed it was found that for all the test modes of the train crane driver of locomotive No 45153.4 with factory No 9997 the received diagrams satisfied the requirements laid down in the regulations.

Based on the multiple complex expertise it was concluded that the "Crane driver" of locomotive No 45153.4 with factory No 9997 was regular and functionally workable".

The electric locomotive No 45153.4 was equipped with on-board equipment of European system for monitoring the movement of the train – of point type (ETCS - Level 1) v. 1.2.0, trademark name "ALTRAKS – BDZ". The system for ALS "ALTRAKS – BDZ" was a microprocessor system with inserted build in specific transmission module, carrying out continuous control of the train movement based on the transmission of information from the road signals to the locomotive, by which compulsory compliance with the signalled or established allowed speed of the train is performed.

The ALS system “ALTRAKS – BDZ” assures at least:

- Information to the driver about the admissible traffic speed;
- Provision of light and sound signals on exceeding of the admissible traffic speed and command on duty or immediate stop when the safety conditions are breached;
- A ban on passing on prohibitive signal without stopping;
- Passing on prohibitive signal after receiving permission for further movement;
- Registration of the events.

From the locomotive were dismantled the box of the board unit of the ALS (i.e. European safe computer (ESC)) and packet switch serving to supply and interrupt the electrical power to the on-board ALS equipment. During the inspection performed and the relevant measurements of the technical expertise regarding the data collection from the on-board ALS unit of the locomotive, it was found as follows:

Box board unit of ALS:

- Highly deformed and mechanically broken tracks on the motherboard;
- Mechanically destroyed 5 integral schemes and the connecting slot nearby;
- Destroyed accumulation battery.

Packet switch:

- Missing plastic handle;
- Cut connecting cables;
- Deformed blade terminals;
- The packet switch was set to “Off”.

From the performed technical expertise regarding the information collection from the on-board unit of ALS was concluded that the information on the work of the locomotive board equipment of the ETCS “ALTRAKS” system was missing and cannot be taken (any interruption of the power supply from the battery causes memory reset) and the packet switch during the accident was set to “Off”, i.e. the board locomotive equipment of ALS was switched off. The board equipment was properly sealed with lead seal and legible number, which excludes the possibility of unauthorized intervention in its regime of work.

The locomotive equipment ALS of train No 45153.4, running in section equipped with ALS was switched off because the locomotive crew had no license to work with ALS. When the Investigation Commission requested information on the employees of the Plovdiv locomotive depot “Engine driver, locomotive”, “Assistant engine driver, locomotive”, “Depot-master, engine driver, locomotive” that qualified as “Operator of electric locomotives” and “Assistant engine driver of electric locomotives”, it became clear that out of a total of 157, with the required qualification for work with ALS were 48 persons.

However, despite the existence of a system of ALS in the locomotive, the train driver was obliged to monitor the signal means installed next to the railway line and in case of discrepancy between the signals and the information from it, he shall respect the signals indications (art. 109, para. 2 of Ordinance No 58).

In the RLD 701-2/2004 “Temporary Instruction for operations and maintenance of Automatic locomotive signalling “ALTRAKS – BDZ” subsystem “locomotive equipment””, effective from 20.04.2004, the art. 28, p. 4.5. and p. 4.6 there are ordered the obligations of the heads of departments for management of locomotives, possessing locomotives and EMU equipped with ALS:

“4.5. To provide training and increase of qualification to the locomotive drivers, operational and maintenance workers in the use and maintenance of the system for ALS”;

“4.6. To timely submit for solution to the BDZ Central Office all issues that violate the correct and complete operation of the ALS system”;

At 03:17:30 p.m. at a speed of 104 km/h, the speed of the train jumped down to 99 km/h. At that moment after the derailment, the locomotive struck for the first time. The further movement of the train according to the encoding of the speedometer tape of the locomotive was as follows:

- Train running at a constant speed of 99 km/h for 450 meters;

- New speed lowering per saltum to 86 km/h. At that moment the locomotive struck for the second time;
- Train running at a constant speed of 86 km/hour for 800 meters. At that point the locomotive struck for the third time;
- Speed lowering at a leap to 61 km/h and running at that speed for 850 meters. At that point the locomotive struck for the fourth time;
- Per saltum lowering of the speed to 0 km/h.

It should be noted that after 03:17:30 p.m. (after the first supposed hit of the locomotive), the registration of the covered distance from the locomotive, reflected on the speedometer tape was real only if the wheels of registering wheel-set were in constant contact with the track. In case when this condition was not met, the registration for passed track would be done (as the wheels rotate freely) but it would not correspond to the real track travelled by the locomotive.

All the trains were provided with the required braking mass, which in case of activation of the automatic train brake assures the train stopping at a determined braking distance from the departure to the destination station. Train No 8601 was provided with the required braking mass. According to the requirements of applicable regulations and timetable booklet, the required braking rate for that category of trains was 115%. According to slip 544-1 of UIC/2004, if a train with such a braking rate would implement quick stop at a speed of 100 km/h on a straight horizontal section of the track, there would be a stopping distance of about 500 m.

According to the Certificate for brake mass (IR-11) of train No 8601 dated 12.07.2014, the available braking power was 307 tons, and 280 tons were required for braking percentage of 115%, i.e. the train was provided with greater braking rate of 126% and its braking distance would be even shorter. Based on that the following conclusions could be made:

- If at the time of visibility of the entrance semaphore at Kaloyanovets station was undertaken a quick stop by the automatic train brake the train would obtain the following results:

- Psychological reaction time of the engine driver - 0.1 seconds;
- The train moving at approximately 104 km/h would pass for that time approximately 3 meters;
- In case of a braking distance of 500 meters, the train would stop eventually at 133 meters distance after the entrance semaphore, i.e. before the first entrance switch at Kaloyanovets station.
- In case where a quick stop was undertaken by using the automatic train brake at the entrance semaphore, the train would stop finally at 211 meters after the first switch, i.e. the entrance switches at the station would be passed with a speed not causing a derailment. In the formulation of the above findings it was not explicitly reported the slope (inclination) of 2.8‰, which was next to the entrance switches, but bearing in mind that the train was actually with higher braking percentage, the results would not be significantly changed.

In accordance with art. 219, para. 3 of Ordinance No 58, the composition of the locomotive crew for the different train categories depending on the running sections is to be determined by the railway undertaking (the managers of "BDZ - Passenger Services" EOOD), which is agreed with the Railway Administration Executive Agency and the manager of the railway infrastructure is to be informed about. When the railway undertaking has enough locomotive drivers, the locomotive crew could be consisted of two train drivers - first person and second person. In this case, the locomotive crew consisted of two certified and qualified for the particular train and locomotive series drivers, as for the second person was considered the locomotive driver appointed at second place in the daily schedule (timetable). The head of the locomotive depot regulated by a written order the service of the locomotive by the first and second person engine drivers, locomotive, determining who of the two designated drivers would be the first person and the second person in alternative in each section. By appointing two qualified drivers, the locomotive driver - second person, performs the duties of the

assistant locomotive driver. Changes in the statutory order are allowed only when the engine driver who should operate the locomotive temporarily or permanently loses the ability to do so (illness, stress, etc.) and only to the first station, where replacement is possible and necessary. The superior of the locomotive crew is the locomotive driver registered first in the travel documents, no matter if he operates or not the locomotive at the moment.

By Order No 76/06.19.2013 of the Head of the locomotive depot Plovdiv, pursuant to article 14 of PS_RLS 505/13 and in compliance with the Order No 243/13.11.2011 of the managers of "BDZ-PS" EOOD it was ordered:

"3. I determine the following order of train service on the long traction arm Plovdiv-Varna:

- In the railway sections from Plovdiv station to Karnobat station, the train is run by the designated *engine driver, locomotive second person*;
- In the railway sections from Karnobat station to Varna station the train is run by the appointed *engine driver, locomotive 1-st person*."

Engine drivers, locomotive, and assistant engine drivers locomotive should be familiar with and be guided in their practical activity from the main regulations in the railway transport, brought to their knowledge against signature in the order books.

In his written explanations on the occurred railway event, the engine driver, locomotive - second person, states that from Plovdiv station to Trakia station, the train was operated by the driver, locomotive - first person, and he took the control from Trakia station to Kaloyanovets station. He stated explicitly that the locomotive and the coaches were regularly functioning – during running and stopping. On the departure of the train from Mihaylovo the locomotive crew knew that the train would be accepted in Kaloyanovets station in deviation from the current track and the speed should be reduced to 40 km/h. The locomotive driver stated that the warning signal "was illuminated in green light and was given for the main track", but after approaching the entrance semaphore, it was found that it was illuminated in green and yellow, given for deviation.

On 10.12.2014, the Commission for investigation at MTITC initiated a working meeting with the management of the National Transport Hospital "Tsar Boris III" - Sofia and the Head of Sector "Expertise in Rail, Water and Road Transport". There were discussed issues concerning the psychological status and medical certification of the train drivers in relation to the occurring significant railway accidents, which were of essential importance to the level of safety of the passenger and freight transport. During the meeting it was come to an unanimous conclusion on the need of performing mental fitness check. Such a check shall be done upon a proposal from the Chairman of the Commission for investigation at the MTITC in order to clarify the technical causes for occurring accidents. With the aim of prevention in the field of safety, the officials carrying out rail transport of passengers and freights shall be regularly checked for stability and suitability in accordance with the requirements of Regulation No 54 dated 2.06.2003. In art. 18, para. 1, p. 1 and 2 of the Ordinance are stated the officials (locomotive driver and assistant driver), who are directly related to the traffic safety. As participants in different railway events, they suffer personally-emotional changes and stress in varying degree and direction.

By letter No 10-60-276 from 11.12.2014, the National Multi-profile Transport Hospital "Tsar Boris III" supported the proposed by the Chairman of the Commission for the technical investigation at the MTITC amendment of art. 23 of Ordinance No 54, creating a new paragraph 2 with the following text: "At a proposal of the Chairman of the Commission for the technical investigation at the MTITC there shall be performed psychological examinations of the officials referred to in art. 18, para. 1, p. 1 and 2 of the Ordinance committed and caused railway accidents".

12. Causes for the accident.

In result of the inspections carried out on site, acquaintance with the report and collected to it statements and supporting documents of the Task Force, the results of the checks performed and appointed technical expertise and other technical documents and the analysis of the causes presented, the Commission for Investigation finds that:

The immediate reason for the serious railway accident - derailment of electric locomotive No. 45153.4 and five wagons from the train composition no. 8601 that occurred on 12.07.2014 in an ordered route from the duty manager for a transit movement on the fourth track of Kaloianovets station, is the passing the input signal by the train at a speed of 106 km/h and entering the input switches no 2/4 at a speed of 104 km/h in permitted speed for movement of up to 40 km/h. The speed limit of 40 km/h is due to the passage of the train through the switches in deviation with radius of R 300 m.

The signal is a direct commandment expressed by a certain shape, position, colour, light, sound or movement that shall be executed IMMEDIATELY, ACCURATELY and UNCONDITIONALLY and any questionable situation or indication of the main semaphores, including their non-illumination, any unclear or incorrect giving of signal and any questionable perception of a signal is a STOPPING ORDER.

In serving the fast train No 8601 and its entering in the entrance switches area at Kaloyanovets station the following basic requirements of the regulations for the operation of railway infrastructure regulating the safe movement of trains were not kept:

1. Engine driver, locomotive - first person and engine driver, locomotive - second person did not respect:

1.1. Art. 109, para. 2 of Ordinance No 58 dated 2 August 2006 on the rules of technical operation, the movement of trains and railway signalling:

“Art. 109. (2) notwithstanding the existence of ALS in the locomotive, the locomotive driver is obliged to monitor the signal means next to the railway line. In case of discrepancy between the signals and information from the ALS, the locomotive driver performs following the signals. “

1.2. Art. 324, para. 2 and par. 3 pt. 6 of Ordinance No 58 on the rules of technical operation, movement of trains and railway signalling in the rail transport:

“Art. 324. (2) In case of two lights on of the semaphore under par. 1 the upper light permits entering of the train in the station and gives indications for the situation of the exit semaphore, and the down light indicates the speed of 40 km/h from the entrance semaphore to the passing through the entry switches”

“(3) The semaphore under par. 1 gives the following thirteen signals round-the-clock:

...

6. a green light and a yellow light below - meaning “Entering is permitted at speed of up to 40 km/h at the entrance semaphore! Exit semaphore is opened for exiting with the designated train speed!”

...

1.3. Art. 324 para. 2 pt. 2, letter a) and Art. 507, para. 1, p. 8 of the “Rules for technical operation of the railway infrastructure” (RTORI) of SE NRIC:

1.3.1 “Art. 324. (2) The movement of rolling stock and vehicles at the stations is carried out with the following maximum speeds:

...

2. in track, which is a deviation of the current track: a) up to 40 km/h - railway lines with standard gauge of 1435 mm.

1.3.2. “Art. 507 (1) The locomotive driver shall:

...

8. In section equipped with ALS, serve the train with the locomotive ahead and proper on-board equipment; in case of malfunction of the on-board ALS equipment during the service of the train immediately notify the train dispatcher and ask for a permission to continue to move, which is entered in the logbook. “

1.4. Art. 25, point (a), art. 26., letters (f) and (g) art. 28. para. 1 and art. 29 PPRLS 505/13 “Instruction for engine drivers, locomotive and assistant engine drivers, locomotive at “BDZ - Passenger Service” EOOD, effective from 15.03.2013:

1.4.1. “art. 25. The Engine driver, locomotive, in addition to the compliance with the basic regulations indicated in article 2 of this instruction, shall provide:

a) Flawless train service on schedule in strict compliance with the prescribed speeds; “

1.4.2. “art. 26. The engine driver, locomotive shall:

...

f) Perform unconditionally instructions of the signals and indicators in open line, stations and depots;

g) Require the assistant engine driver, locomotive, to declare, and the engine driver, locomotive, after being personally convinced, to confirm the positions of the switches, clearness of the tracks in the station, the indications of entry, exit, passage, fencing, pre-level-crossing and at the level-crossing semaphores, signals on the speed reduction and signals requiring a signal with horn. In authorizing position or indication of the semaphore, first it shall be pronounced: “GIVEN” and then shall be said the indication, while in case of prohibitive position or indication it shall be said “CLOSED”. In case of closed reverse entrance or warning signal, it is said “THE REVERSE ENTRANCE (WARNING) SIGNAL NORMAL”. In case of open reverse signal, it is said “...OPEN STOP”. The position of the switches shall be announced “the entrance switches are for the main (deviation) track; “The track is free”, or “exit switches are for exiting from the main (diversion) track.”

1.4.3. “art. 28. The engine driver - locomotive shall:

(1). Exercise control over the work of the assistant engine driver (second driver), theoretically and practically to train him on the proper management of the locomotive, its maintaining in proper technical and fire safety condition, on internal and external cleanness required, completeness of equipment and materials, timely and qualified review of all the stopping times, taking over and handing over of the locomotive, compliance with the regulations and instructions on traffic safety and safety at work.”

1.4.4. “Art. 29. The locomotive driver is obliged while performing a check of the locomotive, to pay particular attention to the precise testing of the brakes and while travelling, to their proper handling with respect to the permissible speeds limited to the condition of the track and available train and locomotive braking provision , to the alertness and mental focus of the assistant engine driver (second engine driver, trainee) during the work and his knowledge in relation to specific safety provisions or any changes in the operational work”.

2. The Head of Passenger Services Plovdiv Division (PSPD), did not fulfil art. 28, pt. 4, point 4.5 and point 4.6 of RLS 701-2/2004 “Temporary Instruction on operation and maintenance of the Automatic locomotive signalling ”ALTRAKS – BDZ” subsystem ”locomotive equipment”, effective from 20.04.2004:

“4. Duties of the directors of divisions for management of locomotives, possessing locomotives and EMU equipped with ALS

...

4.5. To assure the education and training of the locomotive drivers and operational and maintenance workers on the ALS system use and maintenance;

4.6. To submit in a timely manner all questions that violate the proper and complete operation of the ALS system to the Central Administration at BDZ EAD for solution.

13. Recommendations and proposals for activities to prevent other incidents of a similar nature.

With the purpose of preventing other accidents of similar nature in the future and with reference to the requirements of art. 94, par. 1 of Ordinance №59 dated 5.12.2006 on the management of railway safety, the Railway Administration Executive Agency to order and put into execution the following safety recommendations:

1. Licensed railway undertakings, which carry out railway transport of passengers and goods in sections, equipped with “Automatic locomotive signalling” (ALS), not to allow the locomotive personnel not qualified to work with ALS to enter in a working shift;

2. Licensed railway undertakings that carry out railway transport of passengers and goods in sections equipped with ALS, shall prevent from operation the traction rolling stock (TRRS), which is not equipped with ALS or the ALS equipment is not functional or turned off;

3. RAEA to amend and add to the text of art. 192, para. 1 of Ordinance No 58 dated 2.06.2006 on the rules of technical operation, movement of trains and signalling in the rail transport a new item with the following text: “not equipped with on-board ALS equipment and with inoperative one in sections, equipped with ALS”;

4. RAEA to amend and integrate art. 23 of the Ordinance No 54 dated 2.06.2003 on the medical and psychological requirements for the operating personnel, that provide railway transport of passengers and freights and perform associated activities, and for conducting of pre-travel (pre-shift) medical examinations, as the text in art. 23 shall be separated in paragraph 1 and a new paragraph 2 shall be created with the text: "On proposal of the chairman of the Commission for accident investigation appointed by MTITC, psychological tests and examinations to be carried out to the staff referred to in art. 18, para. 1, p. 1 and. 2, that admitted and caused railway accidents.”

With reference to the requirements of art. 94, par. 3 of Ordinance No 59 dated 5.12.2006 on the management of railway safety, the Railway Administration Executive Agency shall notify in writing the AMRAIU Directorate at MTITC on the appropriate actions undertaken for the implementation of the recommendation not later than 30.04.2015.