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AIRCRAFT, MARITIME AND RAILWAY ACCIDENT INVESTIGATION UNIT DIRECTORATE

(AMRAIUD)

FINAL REPORT

from

Technical investigation of railway accident, occurred on 01.02.2014 at 01:25 – rise of fire in diesel locomotive No 07123.3 at Gorna Oryahovitza Locomotive depot

June 2014

APPROVE:

TO
DANAIL PAPAZOV
MINISTER OF TRANSPORT,
INFORMATION TECHNOLOGY AND COMMUNICATIONS

FINAL REPORT

Subject: *Technical investigation of railway accident, occurred on 01.02.2014 at 01:25 – rise of fire in diesel locomotive No 07123.3 at Gorna Oryahovitza Locomotive depot*

DEAR MR. PAPAZOV,

The Commission for technical investigation inspected the accident site, carried out a confrontation with all the staff on duty at Gorna Oryahovitza locomotive depot and gathered additional explanations of all the officials involved in the accident. The Commission included two external experts as well. During the course of investigation the Task Force report was analysed with the required additional documents to it, a ternary complex electrical and fire technical expertise was prepared, and statements of the external experts were discussed and adopted in order the facts and circumstances in which the accident occurred to be clarified and established.

1. Established facts and circumstances within the pace of investigation.

On 01.31.2014, the diesel locomotive No 07123.3, serviced by Plovdiv Locomotive Depot, stayed with running engine on Track 21 at Gorna Oryahovitza locomotive depot next to the refuelling point in order to be ready for immediate use due to the severe winter weather conditions. On 30-th and 31.01.2014, Repair on Necessity was made to the locomotive at the locomotive depot for defrosting of local freezing modules of the pneumatic and heating systems of the first command cabin, welding and replacement of pipes and radiators of the heating system. Within the time between 15:00 and 17:00 p.m. on 01.31.2014, shunting with the locomotive was performed in the depot area. After checking the available fuel and the cooling liquid temperature +60°C, at 07:00 p.m., the “depot master, engine driver, locomotive, Gorna Oryahovitza - passenger" with 31 years’ work experience, ordered the ”engine driver, locomotive, train work" with 25 years’ work experience, acting as depot shunting to switch off the diesel engine of the locomotive and to start it again at 22:00 p.m. The diesel engine was started at 22:08 p.m. by the engine driver, locomotive, performing depot shunting (according to the M-TEL GPS data).

Around 00:30 a.m. on 01.02.2014, the depot shunting received permission from the depot master on duty to leave the depot area for having a dinner at the station, and the locomotive was left with running diesel engine and without supervision, which violates Art. 42 PP_PLS 505/13 "Prescription for the work of engine drivers, locomotives, assistant engine drivers locomotives" at “BDZ Passenger service" Ltd.

Around 00:40 a.m., the depot master on duty checked the heating of the first command cabin and after finding that it did not work, turned it off and opened the door of the engine compartment to the corridor in order to thaw under the influence of the incoming warm air and closed the door of the command cabin. Then he returned to his office to perform pre-travel briefing to the locomotive brigade of train № 2626 at 1:02 a.m., again leaving the locomotive with running engine and without supervision.

After completing the instructions of the locomotive brigades, at 1:25 a.m. going outside, the duty depot master heard that the engine of the diesel locomotive was losing revs and went to establish the cause. Approaching the locomotive from the first cabin he noticed that the cabin full with something like steam. When he opened the cabin door, a thick suffocating smoke started to emit. The depot master on duty attempted to enter into the engine compartment of the locomotive in order to open the battery separator and to trigger the mechanical "Emergency stop", but he failed due to the rapidly invading thick and suffocating smoke.

Flame appeared above the control panel on the right side of the locomotive's first cabin, in result of which the right and left windshield were consequently burst. The staff on duty at the depot immediately took action to extinguish the burning cabin using the portable fire extinguishers available in the second cabin as well as the fire extinguishers from the depot masters on duty, and then also these from the existing ramp next to the track, breaking the left side window of the cabin with the fire extinguisher. The extinguishing of the fire failed and it extended, spreading out from the command cabin along the corridor and thence to the engine compartment. The depot master and the engine driver tried to enter into the engine compartment from the second cabin in order to open the battery separator and to activate the mechanical "Emergency stop", but failed due to massive influx of thick, suffocating smoke.

At 1:30 a.m. after understanding that they were not able to extinguish the fire, the depot master on duty, electric traction, ordered the shunting switchman to send a signal for fire at phone number 112. At 1:31 p.m., two fire trucks of Regional Service "Fire Safety and Civil Protection" (RS "FSCP") – Gorna Oryahovitza headed towards the accident site. The vehicles arrived at 1:37 a.m. and at 1:39 a.m. started firefighting with extinguishing agent. At 1:41 a.m., the fire was localized and at 1:46 a.m. was liquidated. The RS FSCP provided duty service from of 1:46 a.m. to 3:25 a.m. Within the fire extinguishing 8300 litters of water were used.

The investigating officer of Transport Police at the Ministry of Interior – Gorna Oryahovitza started a pre-trial investigation on the accident scene.

2. Officials involved in the case.

2.1. Duty staff at Gorna Oryahovitza locomotive depot:

2.1.1. Depot master, engine driver, locomotive, Gorna Oryahovitza - passenger" at Gorna Oryahovitza locomotive depot, „BDZ Passenger Service" Ltd. with 31 years of work experience;

2.1.2. Depot master, engine driver, locomotive, Gorna Oryahovitza - passenger" at Gorna Oryahovitza locomotive depot, „BDZ Passenger Service" Ltd. with 31 years of work experience;

2.1.3. „Engine driver, locomotive, train work" at Gorna Oryahovitza locomotive depot, „BDZ – Passenger Service" Ltd. with 25 years of work experience;

2.1.4. „Shunting switchman" at Gorna Oryahovitza locomotive depot, „BDZ Passenger Service" Ltd. EOOD with 24 years of work experience;

3. Physical status of the officials, involved in the accidents.

The necessary duration of rest before commencement of work was provided to all officials involved in the accident accordingly to the requirements of the Labour code and Ordinance No. 50 of 12.28.2001 on the working time of the managerial and executive personnel, involved in the provision of passenger

and freight rail transport (promulgated, SG. 4 of 2002, as amended SG. 46 of 2004, amended and integrated, SG. 99 of 2006).

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 had alcohol and other drugs.

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

Alcohol test was given to the staff before commencement of work in accordance with Art. 24 and Art. 28 of Ordinance No 54 dated 02.06.2003 of the Minister of Transport and Communications (promulgated, SG. 55 dated 17.06.2003) on medical and psychological requirements for operating personnel, who service the railway transport of passengers and freights and accompanying activities on conducting of pre-travel (pre-shift) medical examinations.

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

All the officers, involved in the accident, had the necessary work and professional qualifications for the respective work position and a certificate for its execution.

5. Activities of the officers before and during the accident.

Immediately prior to the accident the duty officers did not act in accordance with the established regulations and internal rules, which regulate the safety in the performance of passenger transport by rail. The officers did not:

- adhere strictly to the requirements of health and safety at work, the adopted technical and technological rules, the rules of labour safety and fire safety, as well as all the other internal rules in force in the PTD - Gorna Oryahovitza, "BDZ - Passenger Service" Ltd.;

- respect the established in relation to the storage and operation of entrusted property, internal regulations and mandatory instructions of the employer, namely:

„Depot master, engine driver, locomotive, Gorna Oryahovitza – passenger“

- To protect locomotives and facilities at the territory of the locomotive depot, operational point. During the winter period and at an event of low temperatures to park the locomotives at the repair and equipment halls;
- In the cases of depot shunting to control its activities;
- To provide full technical and fire protection condition of the locomotives;
- the depot master is kept responsible for any accidents, incidents and cases near to incidents at the locomotive depot, operational point within rests, holidays and during the night.

„Engine driver, locomotive“

- When leaving the locomotive at the depot for a longer time, the engine driver, locomotive, is obliged to leave it on a track, defined by the depot master. The locomotive shall be brought into idle state and the driver shall:

• put the controller into neutral position;

• stop the engines;

• put the reverse (pace/gear reversal) handle and the control handle on neutral position control;

• put the handles of the train crane drivers into third position and lock them;

• switch off the rechargeable battery;

• tighten and check whether the handbrake is detained;

• lock the cabins and return the keys to the depot master.

Despite the created situation of highly smoke emission of toxic substances that threaten the human health, and the circumstances that contributed to the fire extension, the staff on duty at the Gorna Oryahovitza locomotive depot acted in accordance with the normative legislation and internal rules established and undertook the appropriate measures to suppress the fire with the available fire-extinguishing equipment in the locomotive and the area around it, and promptly informed the competent authorities on occurred fire at phone number 112.

6. Circumstances, preceding the accident in terms of track, signalling equipment, catenary, rolling stock.

The meteorological weather data having impact on the visibility of signals: in the night-time, air temperature: is - 11,8 °C, western - north-western wind with a speed of 1 m/s, cloudy 10/10, snow cover of 14 cm thickness.

Rail track: straight and is not related to the occurred railway accident.

Station and inter-station signalling equipment before the accident: no relation to the occurred railway accident.

Catenary: in good working order, no relation to the occurred railway accident.

Communication equipment and telecommunication connections: in good working order from technical point of view.

Profile geometry and track layout: the locomotive was stopped on Track 21 of Gorna Oryahovitza locomotive depot at level straight section with inclination of 0 ‰, in front of the refuelling facility.

Rolling stock:

Before the accident, the diesel locomotive No 07123.3 did not function well from technical point of view according to Art. 192 (1), p. 34 of Ordinance 58 on the rules of technical operation, train circulation and the railway signalling, which is evident from records of the relevant diaries, copies of which are presented in the Task Force report.

The diesel locomotive was equipped with the following fire-protection tools:

- Portable fire extinguishers type "Yatrus-12" with powder agent – 2;
- Portable fire extinguishers type "Yatrus 6" with powder agent – 2;
- Fixed firefighting installation with fire extinguishing fluid – it was not activated.

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 at Train operation and Station Activity Management Division - Gorna Oryahovitza, which is part of the SE NRIC structure, before and during the accident, as evidenced by the report of the Task Force, have been kept and these are irrelevant to the accident.

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

Diesel Locomotive No 07123.3 was secured against self-propelling/rolling and was equipped with the necessary documents. The operational staff on duty at Gorna Oryahovitza locomotive depot was equipped with business mobile phones.

The diesel locomotive № 07123.3 was produced in 1973. It was assigned to the fleet of the "Nikola Korchev" locomotive depot Varna, and was placed into service on 04.24.1973, with serial number № 07023.5. Within the implementation of "Lift repair 2" (LR 2) a Converter for train heating (CTH) was installed in the locomotive, and then by letter ref. No 27-00-V-359/21.08.2001 to SC BDZ, a modification to its serial designation was made and it was put in service on 08.27.2001 with serial number № 07123.3. With letter ref. No 03-07-46/09.12.2012 of "Holding -BDZ" PLC, the locomotive was assigned to "BDZ - Passenger Service" Ltd., Plovdiv Locomotive Depot.

The initial balance value of locomotive No 07123.3 was BGN 598 870, 60 and its residual balance value to 31.12.2013 was BGN 363 507, 80.

At the time of the accident, the runs of the diesel locomotive from the last scheduled repairs are shown in the table below:

TYPE OF THE REPAIR	FINAL DATE OF THE REPAIR	RUN FROM THE REPAIR
Overhaul (OP)	20.09.1996	1 441 115 km.
Mid repair (MR)	01.06.2004	724 000 km.
Lift repair (LR)	08.11.2013	2 314 km.
Repair in case of necessity (RN)	31.01.2014	0 km.

Within the review of the technical documentation for compliance with PP_PLS 200/11 "Prescription for inter-repair runs and cyclic recurrence of planned checks and repairs of diesel locomotives of "BDZ Passenger Service" Ltd., it was found that as a result from the Lift repair (LR) performed on 08:11.2013 to the event of the accident all checks and repairs were carried out in accordance with the approved inter-repair cycle.

Within the check of the "Technical passport of locomotive No 07123.3" (SL 005-5) and "Diary of repairs under necessity of the traction rolling stock" (Form LP - 9), there were not identified and registered any violations of the regulations in force for factory and depot repairs and for maintenance of diesel locomotives and procedures in the repair activity related to the fire occurrence.

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

It was found that the railway infrastructure before, during and after the accident was well functioning and unrelated to the accident occurred.

Before the accident, the diesel locomotive № 07123.3 was not brought pursuant to Art. 192 (1), item 34 of Ordinance № 58 on the rules of technical operation, train circulation and railway signalling *(The use of locomotives and multiple units to service the trains, isolated movement or shunting activity with faulty heating of the windscreens is forbidden).*

As a result from the accident various faults and damages to the diesel locomotive were detected as detailed in item 10 "Consequences from the accident."

10. Consequences from the accident.

10.1. Fatalities – no;

10.2. Seriously injured – no.

10.3. Faults and damages to the railway rolling stock:

Diesel locomotive:

Diesel Locomotive No 07123.3 was operated by "BDZ Passenger services" Ltd., Plovdiv Locomotive Depot. During the inspection of the investigation commission, the following was found:

- Burned and completely destroyed first cabin of the locomotive and the located in it command units and apparatus cabinets;
- In the transit lane to the engine compartment the CTH was burned;
- Burnt components and assemblies in the engine compartment;
- Fixed fire extinguishing system of the locomotive was not activated.

After the accident, pursuant to § 18 and Annex № 3 of the "Regulation for depot repair and maintenance of diesel-electric locomotives of BDZ" series 07 - Signature No ЛС 0107 a Protocol No 187/07 of findings was prepared dated 14.03.2014 on the evaluation of the material damages amounting to 13 641, 95 leva.

10.4. Faults and damages to the railway infrastructure:

10.4.1. Permanent way and structures: no.

10.4.1. Signalling equipment and communications, radio connections, power supply: no.

10.4.2. Catenary: no

10.4.3. Other faults and damages: no.

10.5. Damage and spillage of cargo, luggage and parcels: no.

10.6. Train circulation interruption: no.

10.7. Trains delay: no

10.8. Rehabilitation vehicles circulation:

10.8.1. Rehabilitation train: no.

10.8.2. Other rehabilitation tools: no.

11. Analysis of the causes for the railway accident.

After analysing the nature of the damages and established evidences of the fire action in the fire area, the zone of thermal effect and the smoke area, the place of fire occurrence was found. Due to the prolonged burning, maximum depth of burning, charring, and significant damages were observed at the place of fire occurrence and evidences of strong temperature effects on composite materials were generated - complete burn and thermal deformation of the metal elements and structures. Depending on their type, the flammable materials were charring, destroyed or deformed in the centre of the fire. Thereon may be determined the achieved temperature in certain areas of the fire. The products formed in the combustion zone constituted a multicomponent mixture, which in the process of burning created a higher pressure. Under the impact of this pressure, the combustion products were spreading outside the combustion zone. As a result from the temperature differences in height in this zone and in the space at a certain distance beyond, the heated particles of hydrocarbon cooled down and postponed on the vertical and horizontal structures, forming coating, which stained the surfaces in black and dark brown. This coating was retained on the surfaces only at a certain critical temperature within the range

of 600-630°C. At the locations of the combustion zone, where the temperature was higher, the deposited solid particles of hydrocarbon were burned and white spots and areas were formed, and around them where the temperature was lower than 600°C, the surfaces remained black or dark brown.

Below the control panel of the locomotive 13 conductors were hanging towards the floor, on the edges of which melting spot thaws were observed. The electrical short circuits are random events resulting from defects in the insulation of the current-carrying cables and conductors. The cables could be damaged when affected by aging, moisture and chemical substances, excessive mechanical stretching or loss of insulating characteristics.

The short circuit occurs when conditions for electrical contact are created by a touch between electrical wires of different polarity, which are under electrical tension and when contact occurs over a very small resistance, which has not been foreseen for the conditions of the normal operation of the electrical circuits of the locomotive. A characteristic sign of the electrical short circuits represent the melting of the wires from the electric arc, whose temperature could reach 1500 ° to 4000 ° C and within which typical "frozen drop pearls" of molten metal are observed.

X-ray analysis with X-ray apparatus URS 2.0 for determination of the short circuit type was made to the pieces of conductor with melts at the edges seized from the lower part of the control panel in the burned cabin of the diesel locomotive. The conclusion from the analysis made by the "Centre for Research and Expertise" of the General Directorate "Fire Safety and Civil Protection" at the Ministry of Interior, unambiguously found that the short circuit in wiring pieces seized was "secondary", i.e. it was caused by the fire.

From the initial and additional inspections completed, typical signs of a fire outbreak were found and clearly identified in the right front part of the floor of the diesel locomotive's first cabin in the area around the technological hole with a diameter of about 40 mm, very close to the "crane driver". During the additional site visits, there were detected traces of deep charring of the floor panels in the first cabin on their lower side, and the floor panels in the front right side were completely charred.

While carrying out the inspections traces of prolonged heating and burns were found, as well as swelling and separation of the paint of the starting and shut-off lever of the crane for condensation drainage as well as at the bottom of the 5 Bar condense pressure pot. As a result from the long lasting exploitation of the locomotive, accumulation of deposits of dust, oils and other combustible materials happened in the area around this technological hole. Under the influence of imported open fire source around the front 5 Bar condense pressure pot, the layering of dust, oils and other combustible materials were ignited and started to smoulder or burn (incomplete combustion) under the influence of convective flows and hot flue gases spreading vertically. The fire was growing and spreading at a slow rate, suggesting the presence of an ignition source with low power.

After the ignition of the layered dust, oils and other flammable materials in the technological hole of the cabin floor, under the effect of the convection flows, flame spread along the lower surface of the wooden floor panels. The released fumes mainly under the influence of the convection began to spread through leaks on the floor, up to the electrical wiring of the control panel of the locomotive. Following the opening of the door of the driver's cabin, an incomplete combustion turned into full and spread along the flammable insulation of the wires on the control panel and onto the other combustible materials in the cabin. After covering the cabin volume, burning begun to spread out through the holes of the broken from the fire temperature front windshields and backwards to the corridor and engine compartment under the action of convective, conductive and radiation fluxes.

Circumstances featured the fire occurrence and spreading:

- Use of open fire source (paraffin torch) to defrost separate nodes and aggregates of diesel locomotives;
- The diesel locomotive was left with running diesel engine without supervision;
- Lack of direct visibility from the office of the depot master to the locomotive;

- Presence of big quantity of combustible materials in the diesel locomotive - combustible insulation of electric wires and cables, wooden elements, layering of powders, oils, plastics, etc.;

- Non duly start of the fire extinguishing system of the diesel locomotive by the staff on duty;

- Not good cooling effect of the extinguishing agent of the hand powder extinguishers used in the initial extinguishing;

- Bad weather conditions (wind, snowing, and low temperatures).

Close to the place where the locomotive was stopped, fuel distribution column for diesel and warehouses № 211 and № 212 with combustible roof structures were located. There was a real danger of the fire spreading to the fuel distribution column and the roof structures of the warehouses. There was a hazard of spreading the fire occurred to other objects and it endangered the life and health of the personnel on duty at the locomotive depot.

The spread of fire was prevented due to incomplete combustion developed with low speed in the volume of the command cabin of the locomotive, the timely informing of the fire at phone number 112, the proximity of the RS "FSCP" – Gorna Oryahovitza and the quick and correct actions of the employees.

12. Cause for the accident.

In result of repeated inspections of the Commission for investigation on the site of the rail accident at Gorna Oryahovitza locomotive depot, becoming familiar with and discussion of the data and information from collected protocols on the Scheduled repairs and checks, measurements and other technical documentation on the case, considering the facts cited in the Task Force report, the written and oral explanations taken additionally from the duty staff involved in the accident , the results of the ternary complex electrical and fire technical expertise required by the Commission, the opinions of the independent external experts and after a thorough analysis, the Commission considers that:

The immediate technical cause of the occurred accident – fire ignition in the diesel locomotive No 07123.3 at Gorna Oryahovitza locomotive depot, was the use of open fire source (paraffin torch) for defreezing the water separators (condense pots) with pressure of 5 and 10 Bar from the pneumatic installation located under the floor of the locomotive first cabin. Leaving unattended the locomotive with operating diesel engine led acceleration and expansion of the fire.

13. Recommendations and suggestions for events and activities to prevent other accidents of a similar nature

In order to prevent future accidents of similar nature and in connection with Art. 94, par. 1 of Ordinance 59 dated 5.12.2006 on management of railway safety of the Minister of Transport, the Railway Administration Executive Agency shall order ,,Holding – BDZ" PLC to implement the following safety recommendations:

1. ,,Holding BDZ" PLC to prepare an Instruction on maintaining of diesel locomotives in warm state when working in winter conditions;
2. ,,Holding BDZ" PLC to establish the necessary organization and preventive control in order to guarantee that open sources of ignition (flame from gasoline lamps, gas burners, paraffin torches, etc.) will not be used for thawing of frozen elements of pneumatic and heating installations of the locomotives and multiple unit motorcars.
3. To be implemented a single check of the fire alarm and fire suppression systems functionality in all series of diesel locomotives operated by "Holding BDZ".

4. “Holding BDZ” to study the possibility and install extra temperature sensors or optical smoke detectors for fire alarm installation in the command cabins, which shall be connected to the existing Fire Alarm installation in diesel locomotives of 06000 and 07000 series.

With reference to Art. 94, par. 3 of Ordinance 59 dated 5.12.2006 on the management of railway safety of the Minister of Transport, Information Technology and Communications within the deadline up to 28.11.2014, the Railway Administration Executive Agency and "Holding BDZ" shall notify in writing the AMRAIUD Directorate at MTITC on the appropriate actions undertaken for the implementation of the abovementioned recommendations.

Appendix*:* *1. Photos – 6.*

2. CD with photos from the accident.

Chairperson:

……..... (Boyko Stoilov)

Chief Inspector at AMRAIUD, MTITC

Members:

1. ……..... (Dimitar Iotov)

Inspector at AMRAIUD, MTITC

2. ……..... (Ivan Petrov)

Independent external expert RRS

3. ……..…..… (Petyo Piskulev)

Independent external expert RRS