

Translation from Bulgarian language



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MINISTRY OF TRANSPORT,  
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**"AIRCRAFT, MARITIME AND RAILWAY ACCIDENT  
INVESTIGATION UNIT" DIRECTORATE  
(AMRAIU)**

**FINAL REPORT**

from

technical investigation of railway accident, which took place on 20.07.2011 around 17:20 hrs.  
with train № 2615, served by electrical locomotive № 44.089.1 in the stage Shunting Post (SP)  
Lesichery - Resen.



2012

**FINAL REPORT**

**Subject:** *technical investigation of railway accident, took place on 20.07.2011 around 17:20 hrs. with train № 2615, moving in direction Sofia - Varna, served by electrical locomotive № 44.089.1 in the stage Shunting Post (SP) Lesichery - Resen.*

**DEAR MR. MOSKOVSKI,**

With your order № ПД-08-356 /25.07.2011 a Technical investigation commission was appointed with chairmen - Chief inspector from “AMRAIU” Directorate of MTITC tasked to investigate and establish the facts and circumstances in which the accident occurred and to report on the inquiry.



Moments from the fire in train № 2615

Technical investigation commission immediately make a complete inspection of the burned electric locomotive and wagons from the composition of the train № 2615 and the damages caused to the rail infrastructure as a result of railway accident of 20/7/2011, took place in the stage SP Lesichery - Resen.



*Inspections of the burned locomotive and wagons*

After examined the report of the "Operational Group" with all collected materials reflecting the facts and circumstances in which the accident occurred, the members of the Commission held meetings and discussions in MTITC to clarify the reasons, led to the realization of the accident. In one of the workshops and discussions the Commission decided to make further inspections of the burned electric locomotive and wagons by Commission members.



*Inspections of the burned locomotive*



Additional materials on the case were requested and it was also proposed to make a fire and technical expertise of the electric locomotive and expert opinion on the possible technical reason for the accident. To clarify the investigated event, members of the Commission participated in an experiment conducted in the Poduyane locomotive depot to study the effective extinguishing of the experimentally lit inside rectifier cabinets with "R - C" groups in the locomotive of the same series. Various types of modern aerosol fire extinguishing generators have been tested in confined spaces. The experiment was prompted by the fact that the extinguishing agent of the extinguishing installation of the locomotive is not reaching the outbreak of fire inside the cabinets with the "R - C" groups.



*Moments from experiments carried out with different types of generators for aerosol extinguishing*

After a thorough familiarization with the submitted facts, circumstances, expertise, opinions and materials, and discussions by members of the Commission and the invited external experts we proceed with the preparation of the Final Report.

### **1. The investigation revealed the following:**

On 20.07.2011 the fast train № 2615 departs at 13:17 hours from Sofia Station in Sofia-Varna direction, composed with five passenger wagons, 20 axes, 213 tons, carried by electric locomotive № 44-089.1 and operated by locomotive crew of train driver and assistant train driver - both from Sofia locomotive depot of "BDZ Passenger Transport" Ltd. ("BDZ-PT" Ltd.), and the carriage brigade, composed of: train master passenger traffic and two ticket-collectors - all of the three from Passenger Traffic Unit (PTU) - Sofia of "BDZ-PT" Ltd. During the train trip and places with stay in the stations, locomotive brigade had external and internal view of the locomotive, in which no visible malfunctions have been noticed. The locomotive has passed technical check (TC) -2 on 15.07.2011 and needed repair on 19.07.2011 with corrected defects in it. During train movement all restrictions and speeds sections prior the event have been observed (shown by the decoded speedometer tape of the locomotive).

As the train passed through the shunting post (SP) Lesichery at 17:18 hours the duty traffic manager of the post does not notice any signs of ignition on the el. locomotive servicing the train moving on the road № 1 with first cabin at the head. At 17:20 hrs. the assistant locomotive driver peers through the window of the locomotive, looks back and notices that in the middle of the locomotive, below - where the horizontal ventilators are - flames and smoke are coming out. He immediately informs the driver, who, having heard from his assistant "we are burning" looks through the window on his side (right in the direction of motion) back and sees that in the middle, where the horizontal fans are located, smoke and flames are coming out. Train driver immediately activates automatic braking of the train in a "quick stop" mode. At a speed of 118 km / h, after about 200 m the train stops at kilometer 271 +150 near the pillar № 281 of the contact network. After the train stopped, the driver and his assistant enter the engine room of the locomotive, where they found out that there was nothing burning, but only smoke coming from below. They take the fire extinguishers from the locomotive, get down and start fighting the flames coming from the horizontal fans, the driver at the right side in the direction of travel, while the assistant - from left in the direction of movement. While the locomotive crew endeavor to suppress the fire, the carriage brigade members at the same time organize safe evacuation of passengers and their luggage from the cars by leading them to a safety distance.

Locomotive crew, though spending all four fire extinguishers from the electric locomotive (2 pcs. powder extinguishers of 12 kg and 2 pcs. CO<sub>2</sub> of 6 kg) fails to extinguish the fire, which begins to grow and enters the engine room of the locomotive. Then the train driver activates powder fire-fighting installation of the locomotive but that also did not quell the fire. The carriage brigade brings four additional 6 kg dry powder extinguishers from the wagons, but even with them doesn't manage to extinguish the fire. Assistant-locomotive driver disconnects the cable of the train heating and Knorr links between the locomotive and first wagon. As the screw coupling between the locomotive and the first wagon has been very overcharged, assistant locomotive driver failed to separate the burning locomotive from the cars. At this point an explosion from the left side of the locomotive is heard. The driver and his assistant found that a battery have been exploded, leading to disruption of the operational chain of the locomotive and it becomes uncontrollable. Because of the wind from the southeast with speed of 3-4 m / sec and high air temperature, which at 15:20 hrs. is 34,9° C and at 18:00 is 31,8° C, the fire has engulfed the entire machine and spreads to the first wagon № 505229741390 from the composition of the train. The fire spread very quickly and despite the started disconnection of the second from the first wagon by the train master and passenger from the train, the fire further engulfed the second wagon № 505229742984, but they fail to disconnect it. Then the carriage brigade staff with the assistance of passengers separated composition between the second and third car, make a manual maneuver and push the other three carriages of the train at a safe distance of about 30 meters from the burning locomotive and two passenger cars. Necessary measures against self-movement of the pushed wagons have been taken.

The first message for the fire was submitted to tel. 112 at 17:24 hrs. by the phone of the train master. The signal for the fire was received by Regional Fire Safety and Protection of Population Service (RFSPPS) town of Veliko Tarnovo at 17:26 hrs. For the liquidation of the fire in 17:27 hours originally two fire vehicles have been dispatched, and subsequently at 18:46 hrs. and 18:59 hrs. another two fire vehicles were sent to help. Due to the collapse of a bridge the fire vehicles have to be rerouted on a lengthy and extremely difficult to pass road. Fire vehicles arrived at the site of the fire at 18:30 hrs. and immediately started extinguishing the fire. The fire was localized at 19:00 hrs. and report of its cessation is made at 19:30 hrs. Clearing lasted from 19:30 until 23:20 hrs., when the fire is completely eradicated.

As a result of the fire the electric locomotive № 44-089.1 and the first two wagons № 505229741390 and № 505229742984 from the composition of the train are destroyed. No injuries and fatalities.





*Burned locomotive and wagons*

Due to the high temperature developed by the fire and the wind direction from road № 1 towards road № 2 the contact network (CN) over road № 2 is melted, and in the area of the burned wagons and electric locomotive on road № 1 and road № 2 the elements of the railroad superstructure are damaged. The movement of trains on the road № 1 in stage SP Lesichery - Resen is suspended by 18:03 hrs. For transportation of passengers and three other cars by train № 2615 from Gorna Oryahovitsa station a train № 20994 was sent (isolated diesel locomotive № 55-115), who arrived in Pavlikeni station at 18:45 hrs. The isolated locomotive departs from Pavlikeni station to SP Lesichery on road № 1 at 18:46 hrs. as train № 20995. The locomotive and three wagons with passengers from train № 2615 are appointed as train № 20398, who arrives in Pavlikeni station at 19:55 hrs. Due to the deflection of CN over road № 2 and impaired gauge of road № 2 in the stage in SP Lesichery FP - Resen the movement of trains on the same is stopped from 19:06 hrs. Have been sent Construction Machine (CM) -054 by Sub region / power distribution - Gorna Oryahovitsa, which departed Resen station by road № 2 to the point of deflection at 19:38 hours and Construction measuring machine (CMS) -051 by Sub region / power distribution - Levski, which departed SP Lesichery by road № 2 to the point of deflection at 19:25 hours. Canceled and appointed trains are listed in the enclosed reference № II GO 249/25.07.2011. For evacuation of locomotive № 44-089.1 and wagons № 505229742984 and № 505229741390 and to clear the road № 1 in the stage SP Lesichery - Resen was appointed train № 20960 (isolated diesel locomotive № 07-066) by station of Gorna Oryahovitsa, which arrived in Resen station at 20:40 and departed at 21:00 hrs. to km 277<sup>+850</sup> on road № 1 of the stage SP Lesichery - Resen. After completion of the investigation at 23:00 hours a permission is granted to start work on restoring the railway infrastructure. Road № 1 of the stage SP Lesichery - Resen is cleared from the burned rolling stock (RS) at 23:39 hrs. Labor train (LT) - № 20395 along Resen - Gorna Oryahovitsa direction is appointed for evacuation of the burned rolling stock. It arrived in Gorna Oryahovitsa station at 0:22 hrs. For repairing of the damages on railroad to the site of the accident from SP Lesichery on road № 1 departed a motor tractor (MT) -4 at 2:28 hrs. After finishing of the restoration work starts the return of SM-054 to Resen station at 5:27 hrs., of MT-4 at 5:39 hrs. to Resen station and of CMS-051 to SP Lesichery at 5:44 hrs. The voltage of CN is off at 17:34 hrs. on road № 1 (GO - Rs - SP Lch) and at 17:47 hrs. the voltage of Resen station and the stage Resen - SP Lesichery on the road № 2 is shut-down. After the performed restoration works the voltage is switched-on at 05:53 hrs. and at 05:55 hrs. the train movement is restored on road № 1 and № 2 of

stage SP Lesichery - Resen, from kilometer 277<sup>+790</sup> to kilometer 277<sup>+850</sup> and a limit of the speed - 25 km / h is imposed on both roads.

For the accident a pre-trial proceedings № 149/2011 on the inventory of RU "Transport Police" of Gorna Oriahovitsa is initiated.

## **2. Officials involved in the case.**

2.1. Locomotive crew of train № 2615 served by electric locomotive № 44-089.1:

- "locomotive driver", place of employment Passenger traffic division (PTD) - Sofia of "BDZ PT" Ltd. with work experience of this position - 30 years;
- "assistant-locomotive driver", place of employment PTD - Sofia of "BDZ PT" Ltd. with work experience of this position - 15 years;

2.2. Carriage brigade of train № 2615:

- "Train-master, passenger movement," place of employment - PTD - Sofia "BDZ-PT" Ltd. with work experience of this position - 2 years and 3 months;
- "ticket-collector", place of employment PTD - Sofia of "BDZ PT" Ltd. with work experience of this position - 16 years;
- "ticket-collector", place of employment PTD - Sofia of "BDZ PT" Ltd. with work experience of this position - 2 years;

2.3. Station workers and employees:

- "ticket-collector", place of employment UDVGD-GO (SP Lesichery) with work experience of this position - 5 years;

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

3.1. All officials involved in the accident were provided with the necessary rest period before starting work as required by the Labor Code and Ordinance № 50 of 28.12.2001 on working time of the management and executive personnel, engaged with passengers and freight railway transportation of the Minister of Transport (promulgated, SG. issue 4 of 2002, amended. SG. iss. 46 of 2004, amended. and suppl. SG. iss. 99 of 2006).

3.2. All officials involved in the accident passed pre- travel (pre- shift) instruction at which has been found that they didn't consumed alcohol or drugs and are fit for work.

3.3. These officials have a valid certificate of psychological check which is not expired.

## **4. Qualification and appointment documents.**

All officials involved in the accident, have the necessary certificates and professional qualifications for the occupied position and possess certificate of its occupation.

## **5. Actions of the officials before and during the accident.**

All officials immediately before and during the accident acted in accordance with the approved regulations and internal rules governing the safety performance of transport by rail.

## **6. Circumstances preceding the accident in respect of railways, auxiliary equipment, contact network, rolling stock and others.**

6.1. The railway track does not relate to the admitted railway accident.

6.2. Station and stage auxiliary equipment before and during the accident was in working condition. SP Lesichery and Resen station equipped with MRC MN-70 - in working condition. Road № 1 and road № 2 of stage SP Lesichery - Resen equipped with a AB - BO - operational.

6.3. Signals and equipment before the accident have been in working order and correctly activated.

6.4. The locomotive № 44-089.1 servicing the train has been in good technical condition - with good working running gear, braking system, light and sound signaling equipment.

6.5. The contact network does not relate to the admitted railway accident.

6.6. Wagons in the composition of the train before the accident have been in working order and not related to the admitted railway accident.

## **7. Compliance with the procedures and working technologies in the system of State Enterprise "National Company Railway Infrastructure" (SE, "NCRI") before and during the accident.**

Complied with the procedures and working technologies in the system of SE "NCRI" before and during the accident, as evidenced by the report of the Operational grope.

## **8. Compliance with the procedures and technology for servicing of rolling stock in the carrier system before and during the accident.**

All requirements, procedures and technologies for servicing of rolling stock in the system of "BDZ - Passenger Transport" LTD are complied.

Train № 2615 has been provided with the necessary brake mass and was equipped with the necessary train documents, train dispatcher radio communication, and locomotive and carrying crews - with service GSM mobile phones. In its motion in the stage SP Lesichery - Resen train did not exceed the maximum allowed speed of  $V = 125 \text{ km / h}$  for this stage.

As a result of the analysis of the collected documents proving the technical state of locomotive № 44-089.1, made repairs and scheduled examinations and collected explanations of official staff involved in the case violations of the organization, procedures and technologies were not established.

Locomotive № 44-089.1 was manufactured in 1976 and was delivered in 1977. Its balance value at 30.06.2011 is 555 911, 95 BGN. At the time of the accident the locomotive runs from the last planned repairs and inspections are as follows:

Type of repair	Date of discharge from the repair	Run from the corresponding repair
Capital repair (CR)	24.01.1998	1 651 880 km
Middle repair (MR)	23.11.2008	502 302 km
Lifting repair (LR)		
Large periodic repair (LPR)	15.01.2011	117 315 km
Small periodic repair (SPR)	23.05.2011	33 993 km
Technical inspection (TI)	15.07.2011	1 942 km
Exploitation inspection (EI)	20.07.2011	

The last exploitation inspection of the locomotive was made in locomotive depot of Sofia on 20.07.2011, from 08:00 am to 9:40 am.

All repairs of the locomotive were made according to the approved inter-repair cycle and in accordance with the regulations.

The locomotive five-year safety certificate № 25 of 01.07.2004 has expired on 01.07.2009.



Verification of entries in the logbook and repair inventories show that indicated in the act-orders failures are removed promptly. The passport of the locomotive does not reveal recorded damages on electrical equipment of the locomotive, which may be a possible cause of fire.

## **9. Condition of the railway infrastructure and rolling stock before, during and after the accident.**

The railway infrastructure was in working condition before the accident. The section of railway track at km 271<sup>+150</sup> is straight with a slope of 0‰, continuous welded rail track, rails are type 60, sleepers ST-6 and railway clip SKL-14.

After the accident on the elements of the railway infrastructure damages are detected .

Rolling stock was in working condition before the accident.

As a result of the accident damages have been caused of electric locomotive № 44-089.1 and two wagons № 505229741390 and № 505229742984.

## **10. Consequences of the accident.**

### **10.1. Injured and / or killed**

- none

### **10.2. Material damages.**

Damages have been caused to the rolling stock and rail infrastructure, as follows:

- rolling-stock:

- electric locomotive № 44-089.1 - produced in 1977, owned by "BDZ PT" Ltd., Sofia locomotive depot - the damage is about 80% of balanced value to 06.30.2011. - 555 911.95 x 80% = damage of 444 729.56 BGN;
- wagons - damages of the burned two passenger wagons № 505229741390 and № 505229742984 are not provided until the completion of the report. The value of the damages will be further provided.

- railway infrastructure;

- expenditure for labor, materials and fuel for machinery for restoration of railways - all total - 10 945.21 BGN - according analysis data of ZPS - GO;
- costs of restoring the damage to overhead lines (used materials and machinery) - total - 9 838.58 BGN - according the data of value account of RP "Energy section" - Gorna Oryahovitsa.

- expenditure on account of PTP - Gorna Oryahovitsa - 718.13 BGN, excluding VAT;

- losses incurred by CTMSA - Gorna Oryahovitsa - 117.47 BGN;

### **10.3. Interruption of the movement:**

- on current road № 1 in the stage SP Lesichery - Resen from 18:03 hrs. on 20.7.2011 until 5:55 hrs. on 21.07.2011;

- on current road № 2 in the stage SP Lesichery - Resen from 18:03 hrs. on 20.7.2011 until 5:55 hrs. on 21.07.2011;

10.4. Caused delays of trains on 20.07.2011 by reference № II-GO - 249/25.07.2011, of Management of train movements and capacity - Unit "Operational Dispatching" - Gorna Oryahovitsa:

- delayed - 32 trains;

- canceled - 16 trains;

- trans-boarded passengers from 9 trains;

- appointed trains - 13.

## 11. Cause of the accident.

As a result of inspections conducted of the burnt electric locomotive and two passenger coaches of train № 2515, the collected protocols for planned repairs and inspections of the electric locomotive, protocols for electrical measurements and other documentation of the case and explanations taken from the locomotive and carriage brigades and staff in connection with the event occurred, the made fire-technical expertise and opinions in relation to the fire in the electric locomotive, the Commission for the technical investigation considers:

- according the requirements of the national safety rules (Article 19, para. 3 of Ordinance № 58 of 02.08.2006 laying down rules for the technical operation, train movement and signaling in railways) employees of railways in case of emergency shall immediately take measures for securing passengers and employees, present at the scene, to assist the victims, if any, and take measures to avoid the consequences.

**After thorough analysis and detailed review of the submitted and additionally requested documentation, explanations and behavior during the execution of the duties of locomotive and freight brigades and other officials before and during the fire was found that they complied with traffic rules, thus are not cause for the property damage occurring from fire.**

- on the name of Locomotive depot Sofia certificate № TRBA 100 0164 is issued by TUV Rheinland Bulgaria - Ltd. valid from 17.02.2011 until 16.02.2013, with the following area of application: Repair and maintenance of diesel and electric locomotives, train buses. This means that "BDZ - PT" Ltd. owns and has the facilities, technology and personnel to carry out repair and maintenance of electric locomotives.

**This imposes the conclusion that electric locomotive № 44.089.1 is served, both in repair and in operation by trained and competent personnel.**

- the electric locomotive № 44 -089.1 between 08.12.2010 and 15.01.2011 passed large periodic repair (LPR) in the locomotive depot in Sofia. Parameters of electrical equipment envisaged for repair according the LPR rules are brought into an acceptable range.

- on 15.07.2011 the locomotive passed technical inspection (TI-2), at which the parameters of the traction rectifiers and rectifiers of the auxiliary machines were measured, also were measured the parameters of the traction reactors, roof equipment, power circuits, relay rack and over-current relays. According to documents the parameters are within the permissible limits.

- in a period of two months (from 20.05.2011 until 20.07.2011) from the log of the current checks and repairs is found that repairs on the electrical part of the locomotive have not been made. It is noted however large oil consumption of the compressors. For the above mentioned period the two compressors are refilled with 20 liters of oil, three quarters of it is for the second compressor, which leads to the conclusion that a second compressor is significantly worn.

- on 27.06.2011, 15.07.2011, and 17.07.2011, in the logbook as an irregularity is indicated "Level of traction transformer oil under the fourth pin"; this anomaly suggests that during operation of the locomotive level of the oil decreases due to leaks in flanges, cracked oil conduit , leaking from the pipes of radiator bodies or overloading of the traction transformer (in which gases are evolving with low-intensity). When reviewing the documentation it is found that nowhere is noted repair of oil conduit, radiator body or adding oil, which leads to the conclusion that oil was above the permissible minimum level.

- on 20.07.2011 Exploitation inspection (EI) has been carried out to the locomotive at Locomotive depot - Sofia, where irregularities in it have been removed, and then train driver perform visual inspection of the locomotive and accept it without any irregularity.

**By documents the repair activities on electric locomotive № 44.089.1 are made in accordance with the legal requirements of "BDZ-TPC (Locomotives)" - LTD. In the logbook, workbook model LP-9 (needed repair of a locomotive, EMV, DMV) and in the repair**

**descriptions are not registered malfunctions on the electrical part of the traction transformer, engine fans, rectifiers, smoothing reactor and other facilities located in the engine room.**

**During the travel of the locomotive with the train № 2615 on 20.07.2011 it is not triggered any protection or indication of irregularities in the above mentioned machines and apparatus.**

- with letter № 06-02-163/12.06.2007 of "BDZ - EAD" Central Unit "TPC (Locomotives)" a prescription is sent to all departments for technical amendment to the fire alarm installation of locomotives series 44/45, as the technical amendment to be made mandatory for all LPR, LR, MR or CR after 01.06.2007.

According to Instruction for servicing and repair of fire alarm system (FAS) of electric locomotives from series 44/45 a verification of the functioning of the FAS must be performed during TI. Such an inspection was made of electric locomotive № 44-080.1 at 15.07.2011.

Paragraph 4 of the above mentioned instruction says "It is not allowed to release a locomotive for exploitation with damaged FAS". Under this paragraph officials prepared the locomotive for service are obliged to check the status of FAS. After the performed TI-2 on 15.07.2011 until 20.7.2011 no malfunctions of FAS are registered in the log book.

In the last month - on 01.07.2011 and 19.07.2011 the technical condition of firefighting systems (FFS) of the electric locomotive № 44-089.1 is checked by the authorities of fire safety and no irregularities were found.

During the inspection of a locomotive after the fire it was found that FFS of the locomotive has been triggered, powder bottles were empty, which proves that it was undamaged. In the second cabin of the locomotive were found 8 pieces of activated fire extinguishers that are used in firefighting operations.

**According the documents Fire-alarm system of the locomotive was in order and had no damages.**

**The Fire-fighting system and the available fire extinguishers have been in good working condition and they have been used for firefighting operations.**

In conclusion, the technical condition of the electric locomotive № 44-089.1 prior the fire accident in it on 20.07.2011 while traveling on the road № 1 in the stage SP Lesichery-Resen is good, the nodes and elements have worked within an acceptable exploitation parameters, exception of the second compressor - high oil consumption.

**The Commission for technical investigation considers that it cannot uniquely define the cause of the fire in the electric locomotive № 44-089.1.**

During the performed inspections of the burned locomotive it was observed that the bottom of the rectifier unit of the second group, where the rectifiers of the auxiliary machines are positioned, is strongly affected, from which it could be assumed that the ignition of the locomotive is due to a rupture of a capacitor in "RC" groups for protection of the auxiliary rectifiers 221 from the internal switching over-voltages.

For the past 34 years of continuous operation the nominal parameters (capacity) of the capacitors have permanent degradation due to aging, which gives grounds to assume that at some unpredictable point to a given capacitor has burst (exploded) under the impact of over-voltage impulse and the produced spark ignited the electrolyte. The compactness of the rectifier cabinet where the elements are located in close proximity, in turn, determines the process of exponentially growth of the fire from the ignition of the cable connections in the cabinet, in which one after another began to pop off the adjacent capacitors. This subsequently causes ignition of the resultant air-oil emulsion and oil-

powder layer adhering to the air ducts, raising the temperature in the engine room, burning rubber connections, and hence leakage and ignition of the transformer oil (liquid dielectric with a flash point of 135-145° C) and other materials. The closed structure of the rectifier cabinet and the applied principle of cooling by creating by sub-baskets fan under-pressure in the ventilation duct in the cabinet, in which air is sucked from the engine compartment, blows top to bottom the valves radiator bodies and the "RC" groups and blown out under the locomotive. That is why in the created constructive organization of the air flow, after the start of the fire in the present case, the fire and the smoke are carried away and thrown out under the chassis of the locomotive, which is the reason the flames and smoke to be seen in the area of sub-baskets fan. Such ignitions of el. locomotives have occurred so far.

Any failure of "RC" groups distorts the distribution of voltage between the successively connected valves in the rectifier unit. In a case of ruptured or blocked valve shoulder of the rectifier group or ruptured (exploded) capacitor from the protection against internal over-voltages, at the control panel of the locomotive a lamp lights, and on the protection cabinet, located in the control cab of the locomotive, falls blinker.

According to the testimony of the locomotive driver and assistant driver, there was no indication on the control panel of the locomotive of any malfunction before the occurrence of the fire.

**Given the above, it can be concluded that the occurrence of a fire as a result of breakthrough of a capacitor from "RC" groups, as the cause, is unlikely.**

It is technically possible in the presence of corrupted sealing and leakage of cooling oil the pipes of the oil radiators, the last to be entrained by the cooling air and passing through the radiator bodies, to be mixed with the air, in which to form an air-oil emulsion. Passing through the cooling space of the engine-ventilators, it falls on the elements of electric motors (brush holders, coils, caps, etc.). Since the air filtration is not efficient, into air ducts are penetrating also dust with particles of different nature. It clogs on the greasy parts of electric motors, in which an oil-dust layer is formed. In some cases this type of electric motors is characterized by the presence of intense sparking in the collector due to worn brushes, reduced contact pressure between the brushes and collector, elliptical or wavy wear of the collector. The resulting sparking combined with existing nearby oil-dust layer is a possible precondition for the occurrence of ignition and formation of flame combustion. Dragged by the passing air, the flame goes out of the engine and engulfs the greasy surfaces of the duct. The presence of a forced movement of air from ventilation significantly accelerates the combustion process. In this case in the initial stage of combustion **there is no protection to provide an indication or exclude** certain power line. To the occurrence of the fire, serving train № 2615 on 20.07.2011, the electric locomotive was working in the eligible parameters (in case of breach of any parameter or failure an indicator lights on the control panel). According to the testimony of the locomotive driver and his assistant **there was no indication of any malfunction in the locomotive before the fire.**

Follows the conclusion **that the most likely source of fire is the accumulated oil-dust layer on the electric motor of the air ventilator, located on the left side in the direction of movement of the locomotive, as the ignition is in result of the intensive sparking from the collector of the electric motor. The probable cause for the occurrence of the fire in the electric locomotive is confirming the conclusion from the carried-out Fire-technical Expertise and technical opinion.**





*The burned horizontal sub-baskets ventilator*

During the conducted inspections of the burned locomotive it was found, that in its running gear on the south side (right in the direction of movement) were observed smoked areas with almost missing scorching, as scorching can be seen on the hull of the air ventilator. On the north side (left in the direction of motion) is seen strong scorching, starting from the air ventilator, located underneath the basket of the locomotive, and continuing to the roof of the locomotive. The greatest deformation due to the fire is in the middle of the locomotive in the space between the second and third axles.

After the occurrence of the fire in the locomotive, the emergency stopping of the train, the destroyed rechargeable battery on the left side in the direction of movement, interruption of the power supply of the operational management circuits of the locomotive and the corresponding work stoppage of the fans, combustion spreads up on the formed oil-dust layer in air ducts, up under the impact of hot gases moving in the duct under the impact of convective flows. Later on, by convective, radiant and conductive way, hot gases into the metal duct spread combustion in the engine room, where combustible elements in it ignite and from there burning is transferred respectively to the first cabin and back to the second cabin. Under the influence of the hot gases released during the burning of the locomotive and supported by the southwest wind, the fire covers consequently the combustible elements of the first and second passenger coaches of the train composition.

In the created in this way situation of the accident the fire from the burning locomotive was brought back to the train composition and is the cause for the burning of the two passenger coaches.

In conclusion, the circumstances that contribute to the emergence and spread of the fire are:

- Greasing of the details of fans motors and the formation of oil-dust coating on their ducts;
- Lack of thermal protection in the air ducts of the locomotive, to signal for the increasing of the temperature in them above a certain value;
- The high temperature of 20.07.2011, which at 15:20 hrs. is 34,9° C and at 18.00 hrs. is 31,8° C;
- The presence of a wind with speed of 3-4 m / sec. in southwest direction, which has further accelerated the development of fire in the locomotive, and hence contributed to the rapid and consistent coverage by the flames of the two adjacent wagons of the train composition;
- Impossibility for inflow of extinguishing agent (fire extinguishing powder, foam or gas) in the outbreak of the fire with the portable fire-fighting equipment (fire extinguishers) by the locomotive and carriage brigades and by the stationary powder extinguishing installation of the locomotive;
- Located nearby to the outbreak of the fire oil radiator, pumps, oil conduits of the main transformer and the high volume of transformer oil located therein;

- The very tight screw coupling between the locomotive and first wagon, which prevented the uncoupling of the locomotive from the composition;
- Morally and physically obsolete electric locomotive № 44-089.1 (over 34 years), which is precondition for destruction of the insulation characteristics of the conductive parts due to aging and wear of units, parts and mechanisms;
- The delayed arrival of the personnel and the equipment of FSPP due to the collapse of a bridge, which required fire vehicles to be rerouted on a lengthy and extremely difficult to pass road.

## **12. Recommendations and proposals for measures to prevent other incidents of a similar nature.**

1. Managers of "BDZ - Passenger Transport" Ltd. to order the relevant responsible agencies to re-inspect and take appropriate measures and actions for:

- change of the extinguishing installation with more efficient one, giving possibilities for extinguishing outbreaks of fire in the rectifier cabinet and other difficult to reach areas in the electric locomotive;
- replacement of currently extinguishing agent with a more modern type, allowing for more successful firefighting;
- exploring the possibility of placement of additional resources (pyro-extinguishing cartridges) providing timely and reliable suppression of a fire.
- on the basis of the results from the conducted experiments with the planned new type dry capacitors for the rectifier unit of the electric locomotives, timely replacement of the old at the planned subsequent repairs (LR, MR and CR);
- upgrading the fire alarm installation of the electric locomotives of the same series;
- timely correction of any leaks or loss of oil from the links and aggregates of the locomotive;
- conducting of extraordinary instruction on fire and emergency safety and actions of train brigades in case of fire in the tractive rolling stock, as the same be acquainted with the particulars of the present case;
- to explore the possibilities for application of thermographic cameras for diagnostics of the thermal processes of the equipment and apparatus for low, medium and high voltage in the locomotives upon their entry into depot.

2. By 30.03.2012 the managers of "BDZ - Passenger Transport" LTD to inform in writing the "Unit for investigation of accidents in air, sea and rail transport" Directorate in the Ministry of Transport, Information Technologies and Communication about the measures and actions taken for the implementation of the recommendations in the previous section to prevent accidents and incidents of a similar nature.

## **Chairman of the commission for investigation,**

**Nikolay Tashev**

*Chief inspector in "AMRAIU" Directorate in MTITC*

I, the undersigned Ognyan Petkov Kirilov, certify that this is a true and accurate translation done by me from Bulgarian into English language of the attached document "FINAL REPORT". The translation comprises 14 (fourteen) pages.

Translator:

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