REPUBLIC OF BULGARIA
MINISTRY OF TRANSPORT, INFORMATION TECHNOLOGY AND COMMUNICATIONS

9 Dyakon Ignatiy str., Sofia 1000
tel.: (+359 2) 940 9317
fax: (+359 2) 940 9350
mail@mtitc.government.bg
www.mtitc.government.bg

FINAL REPORT

from
Technical investigation of railway accident –
fire occurrence during movement in electrical locomotive No 44096.6, which serviced fast train No 80290 in Chernograd - Karnobat interstation on 14.09.2016

November 2016

FINAL REPORT
from
technical investigation of railway accident – fire occurrence during movement in electrical locomotive No 44096.6, which serviced passenger train No 80290 in Chernograd – Karnobat interstation on 14.09.2016

Objective of the report and extent of responsibility

As per Directive 2004/49/EC of the European Parliament and the Council on safety of the rail transport in the Community, Rail Transport Act (RTA) of the Republic of Bulgaria and Ordinance No 59 dated 5.12.2006 on the safety management in the rail transport, the investigation of railway events aims: to find the causes for their occurrence in order to eliminate and avoid such in future, **without searching personal fault and responsibility.**

The investigation was performed in accordance with art. 115 k of RTA, art. 76 of Ordinance No 59 dated 5.12.2006, and by Order No RD-08-425/17.09.2016 of the Ministry of Transport, Information Technology, and Communications was assigned a Commission for investigation of the railway accident.

The Commission for investigation performed several inspections to the locomotive in Plovdiv locomotive depot, and conducted an interrogation with the persons directly involved in the accident. In order to achieve the fast clarification and to find the circumstances and causes that led to the accident occurrence, external experts were also involved in the Commission of technical investigation. In the course of the investigation there were analysed the report, observation protocols and documents, submitted by the Task Force, and additionally requested materials as well. In parallel, the Chairman of the Commission discussed and accepted the presented statements of the appointed external experts in implementation of the tasks that were assigned to them.

1. Established facts and circumstances in the investigation process.

On 14.09.2016 passenger train (PT) No 80290 in composition of 2 second class passenger coaches, serviced by electrical locomotive No 44096.6, which was operating in Burgas – Karnobat direction as per the train operation schedule (TOS).

The locomotive was operated by a locomotive crew in composition of a locomotive driver and an assistant locomotive driver, employees of Sofia locomotive depot at "BDZ-Passenger services" Ltd. The traffic crew, which serviced the train composed of a train master and a conductor, employees of "Territorial centre for passenger services" – Plovdiv at "BDZ – Passenger Services" Ltd.

The passenger train No 80290 departed from Burgas station at 13:58 p.m. with 11 min. delay due to a meeting with fast train No 8611. It had a stopover of 8 min. in Vladimir Pavlov station due to a meeting with fast train No 3621. The train arrived in Chernograd station at 14:57 p.m. and after a stopover of 1 min. departed to Karnobat station. After the train departure the same reached speed to 100 km/h, with which passed 2200 m, then the speed decreased gradually to 70 km/h, with that speed the train passed another 400 m, then the locomotive driver undertook fast stopping of the train, and it stopped at 15:01 p.m. at Klikach halt (evident from the encoding of the speedometer tape).

During movement before stopping at Klikach halt, the locomotive crew felt smoke smell. The locomotive crew looked in the engine compartment and found that the same was filled with smoke due to which undertook fast train stopping. After the stopping, the locomotive driver performed an inspection to the locomotive and found an occurred fire in the area of the fans under the body shell and the cabinet of the rechargeable batteries, as well as a leak of oil from the pipe for transformer oil draining under the oil radiator and the oil pump (evident from the locomotive driver explanations). He informed the trainmaster on the occurred fire, and the trainmaster

informed the train dispatcher of the section and gave the information to telephone number No 112.

The passenger train transported approximately 20 passengers. The trainmaster together with the train conductor undertook evacuation of the passengers out of the coaches at a safe distance, ensured the coaches against self-propelling and provided the fire extinguishers from the coaches to the locomotive crew.

Having in mind the expanded fire the locomotive crew undertook actions for separating the locomotive from the coaches. Using the track profile (downhill inclination) the locomotive driver rode away the locomotive by inertia at approximately 10 meters from the coaches. From the locomotive were taken out the speedometer tape and the on-board logbook. The fire-extinguishing installation was activated and with the assistant locomotive driver they undertook extinguishing of the fire by the means of the available four portable fire-extinguishers of the locomotive and the two brought by the traffic crew.

After the received information, the train dispatcher informed the energy dispatcher on duty for the undertaking of switch off of the tension/voltage in the catenary.

A firefighting vehicle of Fire Safety and Civil Protection Regional Office (FSCPRO) – Karnobat arrived at 15:28 p.m. on the accident site and after performed earthing of the catenary was undertaken a fire suppressing.

As a result from the occurred wind East-North, the expanded fire burned the conductor and the main cable of the catenary on track No 1, and immediately after of track No 2.

The railway undertaking "BDZ-Passenger Services" Ltd. ensured a bus at Klikach halt for transshipment of the passengers of the passenger train.

From Chernograd station at 16:40 p.m. departed a diesel locomotive No 55132, which drew the coaches from the train back in the station at 17:05 p.m.

The locomotive was definitively suppressed at 18:56 p.m.

At 19:14 p.m. from Chernograd station for repair of the catenary along track No 1 departed two specialized machines ADM 862 and SL-26, which completed work at 22:10 p.m. The train operation on track No 1 in Chernograd – Karnobat interstation was restored at 22:44 p.m. on 14.09.2016.

On 15.09.2016 at 12:48 p.m. from Karnobat station departed a diesel locomotive No 55209, which drew back in the station, the burned locomotive No 44096.6 at 14:37 p.m.

The place of burning of the electrical locomotive No 44096.6 – Karnobat halt is within the scope of the implemented **Project:** *"Rehabilitation of the railway infrastructure under sections of the Plovdiv – Burgas railway line"* **Site:***"Rehabilitation of Tserkovski – Karnobat railway section and renewal of the track in Karnobat – Burgas length with approximate total length of the rail track 122 km"*.

Contractor of the site is DZZD (company, established under the contracts and obligations act) "Consortium GCF – SK 13 – Trace Railinfra". The site is not placed into service to NRIC.

After performance of repair activities along the railway infrastructure the train operation in Chernograd – Karnobat interstation on track No 2 was restored on 16.09.2016 at 13:27 p.m., as the movement speed through the accident site (from km 240^{+480} to km 240^{+580} – front 100 meters) is reduced to 40 km/h.

2. Officials, involved in the case.

2.1 Locomotive crew:

2.1.1. "Locomotive driver" of electrical locomotive No 44096.6 in Sofia locomotive depot to "BDZ-Passenger Services" Ltd. – 23 years of working experience";

2.1.2. "Assistant locomotive driver" of electrical locomotive No 44096.6 in Sofia locomotive depot to "BDZ-Passenger Services" Ltd. – 11 years of working experience;

2.2. Traffic crew:

2.2.1. ,"Trainmaster" in Plovdiv territorial center for passenger services, to "BDZ-Passenger Services" Ltd. – 2 years and 8 months of working experience;

2.2.2. ,"Conductor" in Plovdiv territorial center for passenger services to "BDZ-Passenger Services" Ltd. – 10 years of working experience.

2.3. Station employees:

2.3.1. ,"Traffic manager" – Chernograd station – employee at Train operation and station activity management division – branch Plovdiv (TOSAM-Plovdiv), NRIC – 9 years of working experience;

2.3.2. ,"Switchman level-crossing guard" – Chernograd station – employee at TOSAM – Plovdiv, NRIC – 8 years of working experience;

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

To the officials, involved in the accident was ensured the necessary duration of rest before starting work as required by the Labour Code and Ordinance No 50 dated 28.12.2001 on the Working time of the management and executive personnel, involved in the provision of passenger and freight rail transport.

To the officials, involved in the accident was performed a pre-travel (pre-shift) instruction and they were declared to be alerted, rested and that did not drink 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.

The officials from SE NRIC involved in the accident possess the necessary qualification and documents for their working position.

The locomotive personnel of „BDZ - Passenger services" Ltd. operated electrical locomotive No 44096.6 possess the necessary qualification documents and qualification for driving the respective locomotive series

5. Activities of the officials before and during the accident

The SE NRIC officials, acted immediately prior and during the accident in accordance with the established regulations and internal rules, which regulate the rail transport safety.

The „BDZ - Passenger services" Ltd. officials, acted immediately prior and during the accident in accordance with the established regulations and internal rules, which regulate the rail transport safety.

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

6.1. Meteorological weather data, which had impact on the visibility of the signals:
- in the daylight hours;
- air temperature: 29 ÷ 30 °C;
- moderate wind with speed of 7m/s;
- clear weather without clouds;

6.2. Track:
- regular with no reference to the occurred railway accident;

6.3. Station and interstation signalling equipment before the accident:
- the interstation is equipped with Automatic block system with axle counters, regular does not refer the occurred accident.
- the two neighbouring stations are equipped with Route-relay interlocking (RRI) regular, and do not refer the occurred accident.

6.4. Catenary:
- regular with no reference to the occurred railway accident.

6.5. Train composition station:
- Burgas.

6.6. Communication technique and telecommunications interfaces
- technically regular.

6.7. Profile, geometry and track layout:
- the train stopped in Chernograd – Karnobat on track No 2 at km 240^{+530} in straight section of the track with downhill inclination 3,9 ‰.

6.8. Rolling stock:
The electrical locomotive No 44096.9, serviced PT No 80290 was with regular draft gear, brake system, light and sound signalling means as per the technical standards and requirements, which is evident from the records of the respective logbooks, copies of which were presented in the report of the Task force.
Coaches: 2 of which second class – B_4 – technically regular.
Total number of the train axles – 12.

7. Fulfilment of the working procedures and technologies within the system of the SE NRIC 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 complied. It was evidenced by the report of the Task Force and its annexes, additionally requested materials and conducted interrogations with the persons, involved in the accident by the investigation Commission.

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

The railway undertaking "BDZ - Passenger Services" Ltd. possesses Safety certificate Part A with No BG1120130003 and Part B with No BG1220130003 valid until 30.12.2017.
The passenger train No 4681 was ensured with the necessary brake mass, and equipped with the necessary train documents. The locomotive and traffic crews were equipped with business mobile phones.
The electrical locomotive No 80290 was manufactured in 1977 and assigned to the Sofia Locomotive Depot's fleet in 1977.
The balance value of locomotive No 44096,6 at 31.08.2016 was 61 167,50 BGN.
In the table below are shown the runs of the electrical locomotive from the recent planned repairs:

TYPE OF REPAIR	DATE OF REPAIR	RUN FROM REPAIR
Capital repair (CR)	22.08.1997	2 265 532 km.
Mid-term repair (MTR)	20.07.2011	772 778 km.
Raising repair (RR)	-	-
Major periodic repair (MPR)	13.12.2013	388 259 km.
Light periodic repair (LPR)	24.02.2016	91 996 km..
Technical inspection (TI)	03.08.2016	2 019 km..
Operation inspection (OI)	13.09.2016	-

During the performed check of the technical documentation was found that from the date of the Capital repair on 01.12.2017 up to the date of the accident occurrence all the inspections and repairs were in accordance with PP_PLS 100/11 and "Instruction for inter repair runs and cyclic recurrence of the planed inspections and repairs to electrical locomotives and Electrical multiple units (EMU)" of "BDZ - Passenger services" Ltd. as per the approved inter-repair cycle.

Within the performed check of the "Technical passport of locomotive No 44096.6" (LS 005-1) and „Logbook for necessary repairs of traction rolling stock (Form. LP - 9) there were not found and registered any breaches of the effective "Rules for factory and depot repair, and maintenance of electrical locomotives", as well as of the procedures in the repair activity that are related to the fire occurrence.

From the performed check of the Logbook on-board were found number of repeating irregularities, duly noted by the locomotive crews that serviced the locomotive, however none of them refers the locomotive regarding the firefighting and cannot be linked to the reviewed case.

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

9.1. Status before the accident.

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

9.1.1. Permanent way and structures:

Before the accident the permanent way (track) and its adjacent structures were technically regular – do not refer.

9.1.2. Signaling

The interstation was equipped with automatic block system (ABS) with axle counters– regular does not refer.

9.1.3. Catenary

Before the accident the catenary was technically regular – does not refer.

9.1.4. Rolling stock

- Before the accident electrical locomotive No 44096.6, which serviced passenger train No 80290 was technically regular.
- Before the accident, the coaches from the composition of train No 80290 were technically regular and do not refer the occurred accident.

9.2. Status after the accident.

9.2.1. Fatalities – there were no any;

9.2.2. Seriously injured – there were no any;

9.2.3. Failures and damages caused to the locomotive:

Electrical locomotive No 44096.6 is property of "BDZ-Passenger Services" Ltd. During the performed inspection to the locomotive by the Investigation Commission of MTITC was found that the same was completely burned.

9.2.4. Failures and damages caused to the coaches:

To the coaches from composition of train No 80290 as a result from the occurred accident there were no any caused failures and damages.

9.2.5. Failures and damages caused to the railway infrastructure:

9.2.5.1. Permanent way and structures:
- rails type 60 E 1 – 2 pcs., 15 m. each;
- equipped sleepers with fastening and padding material – 25 pcs.;
- ballast – 35 m^3;
- track levelling – 250 m.;
- track neutralization – 300 m.;

9.2.5.1. Catenary:
- Contact wire – 125 m.;

- terminal “Kruh” – 20 pcs.;
- main cable – 45 m.;
- connecting terminal – 4 pcs.;
- regulator for consoles – 8 pcs.;
- regulator for catenary – 2 fields;

9.2.5.3. Other caused damages and costs:

- The costs of “BDZ Passenger-Services” Ltd. for passengers transshipment amount to 11585,16 BGN with VAT.
- The costs of Plovdiv Energy section regional division to NRIC for securing the accident site amount to 1314,17 BGN with VAT.

9.2.6. Traffic interruption:

As a result from the occurred accident, the train movement in Chernograd – Karnobat interstation was interrupted:

- on current track No 1 from 15:03 p.m. to 22:44 p.m. on 14.09.2016.
- on current track No 2 from 14:58 p.m. on 14.09.2016 to 13:27 p.m. on 16.09.2016.

9.2.6.1. Caused train delay:

Cancelled trains:

- train No 80122 of “BDZ Passenger-Services” Ltd. in Burgas – Yambol section;
- train No 80123 of “BDZ Passenger-Services” Ltd. in Yambol – Burgas section;
- train No 3624 of “BDZ Passenger-Services” Ltd. in Chernograd – Sofia section;
- train No 8612 of “BDZ Passenger-Services” Ltd. in Aytos – Sofia section;
- train No 30154 of “BDZ Passenger-Services” Ltd. in Karnobat – Burgas section;
- train No 80290 of “BDZ Passenger-Services” Ltd. in Chernograd – Karnobat section;
- train No 3623 of “BDZ Passenger-Services” Ltd. in Karnobat – Burgas section;
- train No 8613 of “BDZ Passenger-Services” Ltd. in Karnobat – Burgas section;
- train No 80124 of “BDZ Passenger-Services” Ltd. in Burgas – Yambol section;
- train No 80251 of “BDZ Passenger-Services” Ltd. in Karnobat – Burgas section;
- train No 30604 of “BDZ Cargo” Ltd. in Druzhba – Iliyantsi section;
- train No 80622 of “BDZ Cargo” Ltd. in Dolno Ezerovo – Karnobat section;
- train No 80431 of NRIC in Karnobat – Druzhba section;

Assigned trains:

- train No 80390 of “BDZ Passenger-Services” Ltd. with Karnobat – Sofia route;
- train No 80990 of “BDZ Passenger-Services” Ltd. with Burgas – Karnobat route;
- train No 84393 of “BDZ Passenger-Services” Ltd. with Chernograd – Burgas route;
- train No 84391 of “BDZ Passenger-Services” Ltd. with Aytos – Burgas route;
- train No 84991 of “BDZ Passenger-Services” Ltd. with Chernograd – Vladimir Pavlov route;
- train No 80994 of NRIC with Druzhba – Chernograd route;
- train No 99772 of GCF with Bulgarovo – Chernograd route;
- train No 99773 of GCF with Chernograd – Dolno Ezerovo route;
- train No 99774 of GCF with Dolno Ezerovo – Chernograd route;
- train No 99775 of GCF with Ghernograd – Bulgarovo route;

9.2.6.2. Costs for modifying the Train operation schedule **–** there were no any.

9.3. Rehabilitation vehicles movement.

9.3.1. Rehabilitation train: there was no

9.3.2. Other rehabilitation means: there were no

9.4. Total damages from the accident: 74066,83 BGN.

10. Causes for the occurred accident.

After the performed number of detailed inspections and indepth analysis of the facts and taken to an account the written explanations and statements of the locomotive crew as well as the fast development of the events, the Investigation Commission came to the conclusion that the original cause for the lighting of a fire in locomotive No 44096.6 was a rupture of the rubber joint, which served the oil circulation from the ATP to the transformer located over the radiator for cooling the oil in the transformer (fig. 1).

Fig. 1

11. Analysis of the causes for the railway accident.

In the course of the investigation, the Commission performed several detailed inspections to the burned locomotive in Plovdiv locomotive depot, it got acquainted in details with the documentation referring the ignition and conducted detailed interrogations to the operational staff involved in the specific case on all the actions undertaken by the locomotive and traffic crews before and during the fire (fig. 2).

During the inspections was found that the fire destroyed almost all the aggregates and nodes of the locomotive to an extent, from which their recovery was impossible (fig. 3 and 4). The first signs for ignition were the presence of smoke smell from the engine compartment of the locomotive (evident from the explanations of the locomotive crew).

Fig. 2

Fig. 3

Nevertheless that, they aimed their efforts for fire extinguishing from outside, under the locomotive frame, in the area of the fans under the body shell. That gave possibility the fire in the engine compartment to expand and reach dimensions, within which was impossible to be overcome, which from its side led to the complete burning of the bigger part of the aggregates in the locomotive.

Important moment from the explanations of the locomotive driver was the part in which he explained that during the extinguishing of the locomotive in the area of the fans under the body shell he noticed oil leakage from the drainage pipe on (fig. 5).

Fig. 4

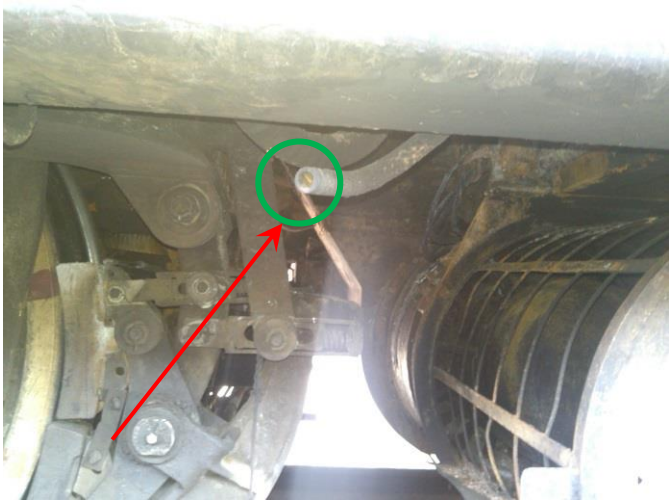

Fig. 5

The abovedescribed aggregates are located in the high-voltage camera of the engine compartment next to many other nodes, located under high-voltage, including the traction transformer and the auto-transforming switch to the walls (ATP). The cracking of the rubber compound caused oil spreading (most probably in many directions), under which part of it touched the nearly located upwards, smoothing reactor of the supporting machinery. It is necessary to be noted that in working regime, the temperature of the aggregate may reach values up to 170°C. In the same time is important the fact that the ignition temperature of the oil, which circulates in the rubber compound even in freshly condition is approximately 140°C. All that is a real precondition for its ignition.

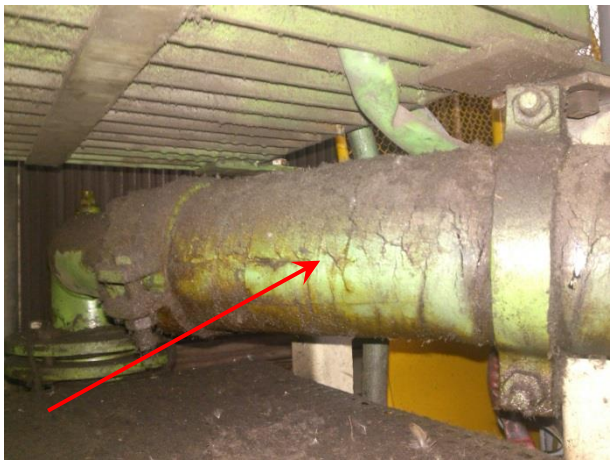

Fig. 6

The spreaded in the engine compartment oil covered the bigger part of the apparatuses, located in the high-voltage camera. In the case decisive for its ignition was its touch to the smoothing reactor of the supporting machinery. As a result from the temperature increasing and thanks to the intensive air circulation in that area (because of the work of the cooling fans) ignited serious quantity of spreaded oil. A part of the oil did not ignite, but entered in the tank of the radiator for oil cooling in the traction transformer and on the drainage started to leak outside from the locomotive. Important particularity is that the pipes are closed with plugs. During the inspection, the Commission found that the plugs of the locomotive are missing on the both pipes.

The cracking of the rubber compound is an event with rather insignificant probability and should not happen during the locomotive operation. The Commission, however performed an inspection to some locomotives of the same series and found that there exist also other locomotives on (fig. 6), within which is clearly seen that these rubber compounds are not in good

condition, they are old, cracked and rheumy, which confirms the reviewed version as the most probable for the locomotive ignition.

As a result from the oil ignition, the temperature in the engine compartment increased to values (minimum 800°C), which led to melting of the ATP body shell, aggregate located next to the fire ignition – the cooling radiator of first traction group, which body shell was manufactured in allumina. Because the ATP is full with oil, approximately 200 liters during the melting of the bodyshell the oil from it ignited from the high temperature and increased additionally the force of the fire. This hypothesis is confirmed from the allumina melt, found under the locomotive on the two rails on (fig. 7).

Fig. 7

During the consecutive case of occurred fire in locomotive, analogically to previous cases, the locomotive crew could not understand where the fire occurred, which from its hand led to increasing of the level of risk not only for them, but also for the train personnel, passengers and the rolling stock. This shows that the risk from fire occurrence in TRRS after a failure in the locomotive was not sufficiently assessed. Evident from the provided Register of hazards during the operation, repair and maintenance of RRS in BDZ "Passenger Services" Ltd. the risk is presented only in one position and was not assessed to the necessary extent.

The frequent cases of locomotive ignition impose also an analysis of the probability a source of ignition spark to be different node or aggregate, located in the high-voltage camera. In this line on fig.8 are shown the voltage measuring transformer of the new electronic electrical meters installed within the period 2014 - 2015 (the vertically located on the floor white parallelepiped), the insulator at the entrance of the ATP and the cable connection in-between. It is possible due to strong vibrations occurring during the movement of the locomotive and insufficient length of the cable connections, which connects them, it is possible the cable to be taken out from the cable nozzle. In that case during the movement of the locomotive, the free edge of the cable within touch with metal parts cause voltaic arc, (having in mind the high voltage – 25 kV and earthed body shell parts on the nearly located aggregates of the locomotive).

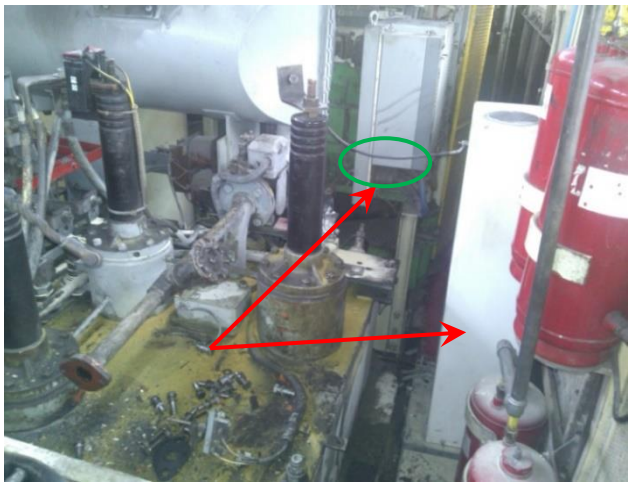

Fig.8

12. Recommendations and suggestions for events that prevent against other accidents of similar nature.

In order to improve the safety level and to avoid other accidents of similar character and under art. 94, par. 1 of Ordinance No 59 dated 5.12.2006 on the management of the railway safety of the Minister of Transport, the Railway Administration Executive Agency (RAEA) in its quality of National Safety Authority shall order the implementation and implementation of the given safety recommendations

1. To be examined the behavior of the voltage transformer of the installed in the electrical locomotives of 44 and 45 series electronic electrometers during movement. To be assessed the risk from occurrence of hazards as a result from irregularities and the connection of the electrometers.

2. During each small periodical repair (SPR), it shall be performed inspection to the condition and density of the oil cooling contour of the locomotive transformer with focus on the connecting rubber compounds.

With reference to the requirements of art. 94, par. 4 of Ordinance No 59 dated 5.12.2006 on the management of the railway safety the addressees of the recommendations shall notify in written the Chairman of the Investigation Commission at MTITC on the undertaken actions for the implementation of the given recommendations

Chairman:

…….... **(Boycho Skrobanski)**
State investigating inspector at MTITC

Members:

1 ..…….**(Yavor Minev)**
Chief investigating inspector at MTITC

2 .....**(NenchoNenov)**
External expert

3 .....**(Vasko Nikolov)**
External expert