Translation from Bulgarian language

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MINISTRY OF TRANSPORT, INFORMATION TECHNOLOGIES AND COMMUNICATION

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SPECIALIZED UNIT FOR INVESTIGATIONS OF ACCIDENTS AND INCIDENTS IN RAILWAY TRANSPORT AT MTITC

FINAL REPORT

From
investigation of a railway accident – fire occurred
in
electric locomotive №43310.9 while IDFT № 40772 moves between stations Belovo and Kostenets on August 11, 2019

2019

FINAL REPORT

Purpose of the investigation and degree of responsibility

The Investigation of serious accidents, accidents and incidents is carried out by an independent investigation authority of the Republic of Bulgaria - "Specialized Unit for Investigation of Accidents and Incidents in Railway Transport" in the "Ministry of Transport, Information Technologies and Communications" (MTITC) and it aims:

To identify the circumstances and the reasons that led to their implementation with a view to improve safety and prevent from others **without seeking personal responsibility and guilty.**

The investigation is carried out in accordance with the requirements of Directive 2004/49 / EC of the European Parliament and of the Council upon safety of the Community's railways transpositioned in the Law for Railways (LR), Ordinance № 59 from December 5, 2006 about the management of safety in railway transport, Ordinance № H-32 from September 19, 2007 about the coordination of the actions and the exchange of information during investigations of railway accidents and incidents and the Agreement for interaction during investigations of accidents and incidents in the air, waterway and railway transport between the Prosecutor's Office of the Republic of Bulgaria, Ministry of Interior and MTITC from April 17, 2018.

CONTENTS

1. Summary.

1.1. Brief description of the event.

On August 11, 2019 an international direct freight train (IDFT) № 40772 in composition of 27 wagons 1491 tons served by electric locomotive № 43515 departs from Plovdiv-distribution station at 14:47 hours to Dimitrovgrad station Zeleznica Srpska (SRT). From Plovdiv-distribution station to Septemvri station the train moves without stopping. It arrives at Septemvri Station at 15:44 hrs. Due to the forthcoming longitudinal slopes of the railway, two auxiliary locomotives No 43553 at the head of the train and a pushing locomotive No 43310 are attached to the train. The departure from Septemvri station takes place at 17:04 hrs. Locomotive 43310 is serviced only by a motorman, as the control of the locomotive is carried out from the first cabin. The route of the train is Svilengrad - Plovdiv - distribution - Septemvri - Sofia - Dragoman - Dimitrovgrad ZS. The duty staff at the stations from Plovdiv-distribution station to Belovo has not noticed anything unusual in the train movement and the pushing locomotive. IDFT № 40772 is operated by licensed railway company BDZ “FT” EOOD.

During the movement of the train without stopping through Belovo station, the maximum protection of 026B1 on the third traction engine of the pushing locomotive No 43310 is triggered, ground control 861 for the presence of a "circular fire" in the engine. Auxiliary relay 852 is then switched off, which causes the main air circuit breaker (MACB) to shut down. The locomotive driver restarts the locomotive's protections and restarted it in operating mode but with a reduced voltage on the traction motors. Between Belovo and Kostenets stations, after the Boyka stop, the locomotive driver feels a smell of burned insulation, looks in the engine room and sees that it is filled with thick black smoke, undertakes a service stop of the train through the train brake of the locomotive.

1.2. Main cause of the accident:

The cause of the fire in the electric locomotive 43310.9 is the long operation of the locomotive with an increased temperature of the second traction group due to a short circuit in the cooling fan of the rectifier unit.

1.3. Summary of the main recommendations.

The recommendations made by the Investigation Commission at MTITC are methodological and technical, relevant to the repair work outlined in the LOP and SSM.

Recommendation No. 1 proposes that when performing technical inspections and repairs (TI and BRM) of diesel and electric locomotives, to comply strictly with the prescribed order laid down in Order No. 01-01-191 / June 29, 2017 of BDZ “FT” EOOD Manager, to prevent the premises for occurrence of fires in locomotives owned by BDZ" FT "EOOD.

Recommendation No. 2 proposes that during the repairs by necessity (RN), real and accurate information after completing the repairs should be filled in the accounting documents;

Recommendation No. 3 proposes to provide the locomotive personnel at BDZ “FT” EOOD fire masks allowing access to the fire center and extinguishing with portable hand fire extinguishers in the event of fires in the engine room of the locomotives.

Recommendation No. 4 proposes BDZ “FT” EOOD to carry out inspections of their own locomotives in accordance with the requirements of Art. 192, para. 1, item 33 of Ordinance No. 58 / June 2, 2006, on the worthy radio stations for train-dispatcher radio connection during the movement in sections with radio coverage.

2. Direct facts and circumstances.

2.1. Date and time of the event.

On August 11, 2019, at 17:05 hrs, the Head of traffic on duty at Belovo station receives a departure signal for IDFT № 40772 from the Head of traffic at Septemvri station. The Head of traffic on duty at Belovo station via Route Relay Centralization (MN-70) at the station has prepared a route for the acceptance of IDFT № 40772. According to "Plan II-24", the train is accepted on the second main track as it doesn't stop at the station according to the Train Movement Schedule (TMS). When the train passes without stopping on the second main track of Belovo station towards Kostenets station, the main air switch of the pushing and operated by its first cabin locomotive № 43310 is switched off. On the cutoff dashboard, a "circular fire" of the third traction motor is indicated, the

motorman restarts the triggered actuators and restarts the locomotive in operating mode, limiting the voltage load of the locomotive. After the Boyka stop between Belovo and Kostenets stations on Road № 2, the motorman takes down the positions and switches off the fans, shortly afterward he notices thick black smoke in the engine room of the locomotive. The motorman immediately starts fast braking with the automatic train brake and at 17:28 hrs, train № 40772 stops extremely at km 78,200 in the section. Shuts down the Main Air Circuit Breaker (MACB) and the locomotive's accumulator battery. He enters the engine room with the powder extinguisher to find the fire center and neutralize it. The motorman of the locomotive manages to reach the middle of the locomotive, but the smoke becomes denser and he has to return back to the cab of the locomotive and activate the fire-fighting installation of the locomotive. He picks up the same extinguisher again and goes down to the right side of the locomotive to inspect its running gear, but there is no fire there. The driver climbs into the second cab and reactivates the locomotive's fire-fighting installation. He gets off the locomotive on the left side and notices that fire goes out under the hull of the locomotive and starts extinguishing with the fire extinguisher, while simultaneously trying to call the national emergency number 112. He passes the fire alarm signal, calls the motorman of the first auxiliary locomotive and notifies him of the fire.

The motorman of the auxiliary locomotive № 43533, after receiving a call from the motorman of locomotive № 43310, moves to the burning locomotive for assistance, breaks the Brake Coupling Sleeves between locomotive № 43310 and the wagons, but fails to unscrew the screw coupling. They call the motorman of train locomotive № 43515 by mobile phone and move the train forward to an accessible location for fire extinguishing with the specialized vehicles of the FS&PP, approximately 1000 m, about km 77 200 - (Figs. 1 and 2).

Fig. 1

Fig. 2

At 17:40 hrs, the senior train dispatcher at RINC CDM is notified by telephone 112 for the occurrence of a fire in locomotive № 43310 of the composition of freight train № 40772 between Belovo and Kostenets stations on road № 2. He immediately has notified the senior train dispatcher at the " Operational Dispatch Unit ”(ODU) - Sofia.

At 17:45 hrs, three specialized vehicles of FS&PP has arrived from Kostenets and Belovo.

At 17:47 hrs the voltage in the contact network between Belovo and Kostenets on roads № 1 and № 2 is switched off. Actions have been taken by the staff of the "Electricity Distribution Subarea" - Kostenets to mount portable grounding.

At 17:58 hrs, permission is granted to the authorities of the RO FS&PP - Kostenets to start extinguishing the locomotive.

At 18:20 hrs with the order of the train dispatcher in the Belovo - Kostenets railway section on the road № 1 and № 2, the traffic for all trains and vehicles is closed.

At 19:53 hrs the fire in the locomotive is extinguished.

At 19:55 hrs the voltage in the contact network is switched on in the Belovo - Kostenets railway section, on road № 1 and road № 2.

At 19:57 hrs the scheduled train traffic in Belovo - Kostenets section on road № 1 has been restored.

From 20:00 hrs to 22:35 hrs, inspections of the burned locomotive № 43310 have been carried out by the investigative bodies of the Regional Directorate of the Ministry of Interior - Sofia.

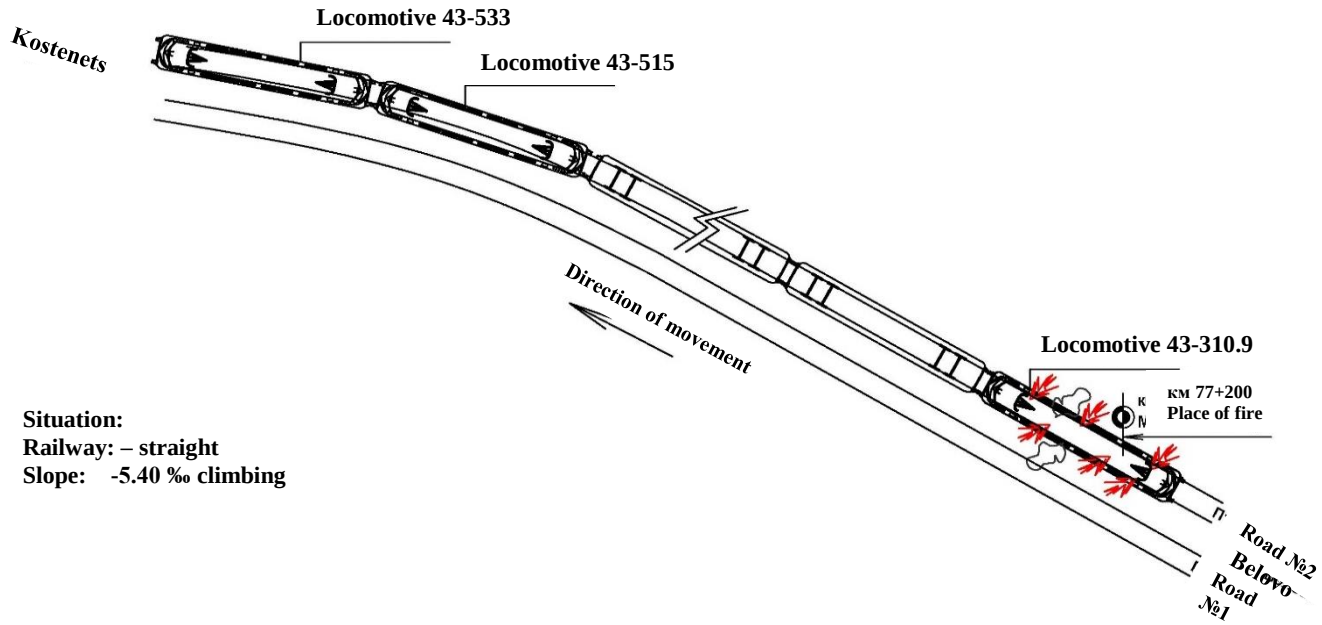
At 22:35 hrs IDFT № 40772 is released by the Ministry of Interior.

At 22:40 hrs the train is accepted on the third track at Kostenets station.

Electric locomotive № 43310 is disconnected from the train composition following the MoI bodies' order and put away on the fifth track in Kostenets station, as the access to the locomotive is restricted by the bodies of the Ministry of Interior - Sofia. During the stay, investigative measures are carried out, appointed by the District Prosecutor's Office - Ihtiman.

2.2. Event's location.

The event has occurred at km 78 + 200 in the Belovo - Kostenets railway section on Road № 2. The adjacent station to Belovo is Septemvri and to Kostenets is Ihtiman. The stations are located in an electrified two-way railway section, on the first main railway from Dimitrovgrad ZS via Sofia to Plovdiv - distribution (Fig. 3).



Фиг. 3

2.3. Event's classification.

At 17:30 hrs on August 11, 2019, the head of the Specialized Unit for Investigation of Railway Accidents and Incidents (SUIRAI) at the Ministry of Transport, Information Technology and Communications (MTITC) is notified by mobile phone of a fire in auxiliary pushing electrical locomotive № 43310.9 of IDFT № 40772 while driving between Belovo and Kostenets stations on road № 2.

The information was submitted in accordance with the requirements of the "Safety Procedure SP 2.03." from September 01, 2018 of the "Railway Infrastructure" National Company (RINC).

The head of SUIRAI has visited the event at 19:30 hrs and has carried out a primary inspection of the locomotive after the fire has been extinguished. After analyzing the collected information, he has classified the event - a railway accident, in accordance with the requirements of Art. 19 (2) (b) of Directive 2004/49 / EC and Art. 68, para. 1, item 2 and para. 2 of Ordinance № 59, of which he has notified the interested parties.

2.4. Consequences of the Event:

- no injured personnel;;
- no damage to the railway infrastructure;
- no damage to the environment;
- the engine compartment of locomotive № 43310.9, is completely burned;

2.5. Decision to initiate an investigation:

The decision to initiate an investigation is taken by the head of the SUIRAI on the basis of the above-mentioned norms in item 2.3 and art. 115k, para. 1, item 2 of the Railway Transport Act.

Composition of the commission:

An independent investigation commission has been appointed at MTITC. The chairman of the commission is the head of the SUIRAI. The commission consists of external experts with appropriate qualifications and professional attitude to the accident.

Investigation:

On August 11, 2019, after the arrival of IDFT № 40772 at Kostenets Station, the head of the SUIRAI conducts an interview with the motormen of the three locomotives servicing the train.

On August 13, 2019, the Commission conducts an interview in the MTITC building with the motorman of locomotive № 43310 - auxiliary pusher of train № 40772 on August 11, 2019.

On August 14, 2019, following the order of OP - Ihtiman and subsequent written permission from the Ministry of Interior and the operational unit, the locomotive is cleared to be transported from Kostenets station to Dupnitsa Locomotive Depot and placed under the supervision of the Ministry of Interior.

On August 20, 2019, the Investigation Commission leaves for Dupnitsa Locomotive Depot. Inspections and measures are initiated to determine the circumstances and causes that have led to the fire in the locomotive. The inspections and tests carried out on TDRC reveal that it is defective (there are no separate elements for receiving and sending messages).The Investigation Commission has visited the Dupnitsa Locomotive Depot several times and has carried out inspections, experiments, measurements and comparative analyzes of the burned units and machines. Several hypotheses are formed by the facts that emerged from the findings, on which the Commission initiates the investigation.

On August 21, 2019, the Investigation Commission requests to measure the insulation resistance of the anchor and excitation windings of the four traction engines of the locomotive with "Meger Kyoritsu № 3125" and finds the following:

- the insulation resistance of the anchor winding of the 1st, 3rd and 4th traction motors goes from 0.1 to 0.5 MΩ (does not meet the requirements for the norm above 5 MΩ);

- the insulation resistance of the anchor winding of the 2nd traction motor is 8,5MΩ,(the same meets the required standard);

- The 3rd traction motor has a short circuit and a circular fire on the engine manifold;

Note: Measurements are taken after the fire in the locomotive has been extinguished with water and the measured values are likely to be reduced.

On August 23, 2019, the Investigation Commission requests RINC to read out the recorded data in the locomotive's electrometer for the electricity used from the contact network (voltage and operating current) at the time and before the fire occurrence in locomotive № 43310. The measured values are 26,5 KV during a fire, with a nominal range of 19 ÷ 27,5 KV.

On August 25, 2019, the Investigation Commission requests the insulation resistance of the engine-pumps (oil cooler) of the traction transformer of the locomotive to be measured after the measurement with "Meager № 1583 / M4100 / 3, 500V, 120r / min / ". Thus it is found out that one of the pumps has a short circuit in its operating coil, with a value of 0 MΩ.

On October 23, 2019, the Investigation Commission visits the Dupnitsa Locomotive Depot and inspects again the burned machines and units in the locomotive. New measurements are made of the insulation resistance of the anchor and excitation windings of the four traction engines of the locomotive with "Meger Kyoritsu No. 3125" and the following is established:

- the insulation resistance of the anchor winding of the 1st, 2nd, 3rd and 4th traction motors varies from 0,1 to 3,7 MΩ (does not meet the requirements for norm above 5 MΩ);

- the insulation resistance of the excitation coil of the 1st, 2nd and 4th traction motors varies from 0,5 to 3,3 MΩ (does not meet the requirements for norm above 5 MΩ);

- the insulation resistance of the excitation coil of the 3rd traction motor is 9.6 MΩ (meets the requirements for a norm above 5 MΩ);

New measurements are made of the insulation resistance of the anchor and excitation windings of the engines of the cooling air intakes (CAI) of the locomotive with "Meger Kyoritsu No. 3125" and the following is found:

- the measured insulation resistance of the anchor and excitation windings of the 1st fan motor is 0.0 MΩ (has not operated after its firing);

- the measured insulation resistance of the anchor and excitation windings of the 2nd fan motor

is 2.6 and 1.0 MΩ (not operating at the time of the accident);

New measurements are made on the insulation resistance of the working and starting windings of the engine of the locomotive pumps with "Meger Kyoritsu № 3125" and the following is found:

- on the 1st pump working and starting coils is 0.0 (faulty);
- on the 2nd pump, the working and starting coils is ∞ (working);

At the Dupnitsa Locomotive Depot, other electric locomotives of the same series are being repaired in parallel, which enables the Commission to make comparative analyses of the burned units with those of the locomotives under repair.

On November 12, 2019, at the Locomotive Depot Plovdiv, the Investigation Commission performs tests on a speedometer stand. It has been established that the speedometer of electric locomotive № 43310 does not carry out the registration of distance and speed.

In the course of the investigation, the report submitted by the Operational Group and the documents collected to it are analyzed, as well as the further requested materials and documents submitted by the RINK and BDZ "FT" EOOD related to the investigation.

The Chairman of the Commission accepts the written comments of the external experts included in the Commission of Investigation on the performance of the investigative tasks assigned to them.

2.6. Conducting rescue and emergency-restoration actions:

No injured personnel - no rescue operations.

At 17:45 hrs, three specialized vehicles of RO FS&PP - Kostenets arrive at the scene.

At 17:58 hrs, the voltage in Belovo - Kostenets railway section of roads №1 and № 2 is switched off and earthing is installed to secure the contact network and the authorities of FS&PP start quenching the burning locomotive.

At 19:53 hrs the fire in the locomotive is extinguished. After the permission from the investigative bodies of the Ministry of Interior, the train is taken to Kostenets station, where the burnt locomotive is disconnected from the train and left on the 5th track in the station.

At 22:45 hrs the traffic in the section Kostenets - Belovo of road № 2 for all trains and vehicles at scheduled speed is restored.

3. General data established during the investigation process.

3.1. Participating officers:

Shift personnel - RINC staff:

- head of traffic on duty at the Belovo and Kostenets stations;

The personnel servicing IDFT № 40772 - BDZ "FT" EOOD employees:

- motorman of auxiliary electric locomotive № 43553;

- Assistant motorman of auxiliary electric locomotive № 43553;

- motorman of electric locomotive № 43515;

- motorman of auxiliary - pushing electric locomotive № 43310;

3.2. Data on the Train:

- MTTB № 40772 runs daily according to the train schedule (ГДВ) along the route Halkala - Kapakule - Svilengrad - Plovdiv - distribution - Sofia - Dragoman - Dimitrovgrad ZS- Duisburg;

- according to the Train Composition Plan (TCP) for 2019 of BDZ "FT" EOOD, IDFT № 40772 consists of - electric locomotive 43 series and gross weight 1300 tons.

3.3. Data on the carrier:

- BDZ "FT" EOOD is a railway carrier, licensed to carry freight in the Republic of Bulgaria;
- it holds a national cargo transport license № 203 / January 24, 2019;
- it holds a Safety Certificate Part A A BG 11 2017 0008 valid from December 31, 2017, till December 30, 2022;
- it holds a safety certificate Part "B" BG 12 2017 0008 valid from December 31, 2017, till December 30, 2022;

- it holds a certificate of an entity responsible for the maintenance of railway vehicles BGRA / 2017/0003 valid from December 31, 2017, till December 30, 2022;

3.4. Train type, number and category:

- international direct freight train, № 40772;

3.5. Train tractive rolling stock type and number:

- electrical locomotive № 43310.9 - with regular registration in the vehicle register;

3.6. Railway infrastructure description:

Railroad:

- railroad – with joints, rails type S 49, laid on sleepers CT-4, in curve with a radius R= 540 m, with profile -5,40 ‰ in climbing to Kostenets station;
- contact network Belovo-Kostenets– compensated, sectioned;

3.7. Signalization, station safety installations and between-station block system:

- Kostenets station is equipped with Route-relay centralization (H 70);
- Belovo station is equipped with Route-relay centralization (H 70);
- traffic signalling are equipped with indications for speed;
- railway section Belovo-Kostenets is equipped with automatic blockage with feedthrough signals;

3.8. Train protection:

- electric locomotive № 43310.9 is equipped with sealed vigilance device;
- electric locomotive № 43310.9 has no ALS;
- an Automatic Locomotive Signalisation (ALS) is active in railway section Sofia-Belovo;

3.9. Communication system:

- Belovo and Kostenets stations are equipped with Radisun & Dikora F15 hubs. The traffic officer on duty makes a telephone connection through it with the points posts in the stations, with the adjacent stations, with the train and energy dispatcher, both stations have official mobile phones;
- the locomotive crews in the three locomotives have official mobile phones;

3.10. Implementation of a plan for railway accidents and events.

- in implementation of the approved on February 25, 2015 „Plan for rescue and urgent emergency-repair works in the event of crisis situations, natural disasters, railway accidents, industrial accidents, catastrophes and terrorist acts in BDZ "Freight Transport" Ltd“ and the requirements of the "Instruction on fire safety rules and requirements for rolling stock in operation, buildings, areas and sites of BDZ" Freight Transport "Ltd and actions in events of fire", the personnel (locomotive and transport brigades serving IDFT № 40772) immediately undertake the execution of their official duties concerning the occurrence of fire in traction rolling stock in a station area (as can be seen from the explanations of staff);
- after IDFT № 40772 stops in Belovo Kostenets section, the motorman undertakes the extinguishing of the locomotive, incl. and notifying interested services and officials;
- the head of traffic on duty at Belovo station, after the train passing through the station, sees that smoke comes out of the last locomotive № 43310 of the train. He notifies the motorman of the smoking locomotive and the train dispatcher of the section;
- the train dispatcher on duty in the Sofia - September section, after becoming aware of the smoky locomotive of freight train № 40772 immediately notifies the locomotive driver;
- the heads of traffic on duty in both adjacent stations organize, in coordination with the energy dispatcher - Sofia, the voltage switching off in the contact network of the railway section;
- the heads of traffic on duty in both adjacent stations organize, in agreement with the RINC train dispatcher and the BDZ "FT" EOOD dispatcher, to tranship the passengers from the trains by buses between both stations.

4. Deaths, injuries and material damages.

4.1. No deaths;

4.2. No injured personnel;

4.3. Material damages:

For BDZ "Freight Transport" EOOD:

The book value of electric locomotive № 43310.9 as of July 30, 2019 – 253 495,56 BGN

- electric locomotive № 43310.9 – burned engine room and 1st cabin amounted to 253 495,56 BGN;
- costs of traffic interruption in the railway section for RINC - 1872,10 BGN;

For "RI"NC:

- expenses for railway – none;
- contact network - no damages, switching on and off voltage, regulation with specialized equipment PCCM – 858,88 BGN;

For the environment – none;

Total damage from the accident amount to: **255 367,67 BGN**

5. External circumstances - weather and geographic conditions.

Meteorological report for August 11, 2019 by MC – Sofia:
- in the light part of the day – 17:30 hrs;
- air temperature +21º C;
- wind 3 м/s from east/northeast;
- clouds - clear.

6. Data for railway infrastructure and railway carrier staff related to the accident.

6.1. Position, place of work, sex and age.

Personnel of RINC:

RINC staff are not involved in the accident;

Personnel of BDZ "FT" EOOD:

- motorman of el.locomotive № 43310 – Stara Zagora locomotive depot, BDZ "FT" EOOD, man at 36 years;

6.2. Position certificate and certificate data.

Personnel of BDZ "FT" EOOD:
Motorman of locomotive 43310

- Certificate № 484/November 07, 2012 for occupying position locomotive motorman;
- Certificate of vocational training № 4972-833 /June 23, 2008 for el. locomotives s. 43,44 and 45;
- Certificate of vocational training № 359-359/April 23, 2012 for el. locomotives s;
- Qualification for test "A" Cert. № 3845-49/January 05, 2011;

6.3. Qualification certificate and certificate data.

Personnel of BDZ "FT" EOOD:

Motorman of locomotive 43310;

- Certificate № 9110/June 20, 2008, acquired qualification: motorman of el.locomotives, teaching structure VOC-BDZ;
- Certificate for locomotive driving BG 7120171027 – EA RA;

6.4. Document for professional qualification.

Personnel of BDZ "FT" EOOD :

- Motorman of locomotive 43310 – a diploma for completed secondary specialised education № 0020885/July 01, 2002;

6.5. Certificate for passing an examination as per Ordinance № 56 from 2003

Personnel of BDZ "FT" EOOD:

- Motorman of locomotive 43310– Protocol: XI - 42 -23 from May 30, 2018;

6.6. Personnel break duration before staff time:

In accordance with the requirements of the normative acts - Labour Code and Ordinance № 50 / December 28, 2001 – the personnel are provided with the required rest period before their work:

Personnel of BDZ "FT" EOOD:

- Motorman of locomotive 43310– rests from 16:40 hrs on August 10, 2019 till 16:40 hrs on August 11, 2019;

6.7. Work experience of the staff.

Personnel of BDZ "FT" EOOD:

- Motorman of locomotive 43310 – 12 years;

6.8. Shift (travel) briefing.

Personnel of RINC

- Personnel at Belovo and Kostenets station is briefed for duty on August 11, 2019, and they sign in the instruction book stating that they were cheerful, rested and haven't used alcohol and other narcotics.

Personnel of BDZ "FT" EOOD:

- the motormen of locomotives 43533 and 43310 are briefed before travel by the depot master on duty at the Locomotive Depot Septemvri and, by their signature in the instruction book, they have declared that they have been cheerful, rested and have not used alcohol and other intoxicants. Test performed by a breathalyzer - negative;

7. Summary of testimony.

The investigation commission doesn't have testimony.

8. System of Safety Management (SSM) .

8.1. Observing the procedures set out in SSM of RINC:

The Investigation Commission requests and takes note of the provided procedures written in SSM for the staff of the Railway Traffic Management and Station Activities (RTMSA) - Sofia. These procedures have been met by the staff of Belovo and Kostenets stations. This is evident by the report of the operational group, further requested materials and station personnel statements.

8.2. Compliance with the procedures in Safety Management System (SSM) of BDZ "FT" EOOD:

The Investigation Commission requested the procedures written in SSM and PRM and information for last locomotive repair works carried out by necessity of the railway carrier BDZ "FT" EOOD and after having become acquainted with them, established the following:

8.2.1. BDZ "FT" EOOD has an order № 01-01-191 /June 29, 2017, concerning the performance of operational inspections and routine inspections and repairs (TI and BMR), as well as additional performance of the following operations for the safety of locomotives in technical and firefighting regard.

8.2.2. In item II.1. is written *„"The measurement of the insulation resistance of a traction transformer, traction motors, reactors, auxiliary machines, power high-voltage and operational circuits, according to the parameters of the Regulations for depot repair and maintenance of electric locomotives of BDZ"".*

8.2.3. In item II.4 – *„On locomotives series 43.000, basic cleaning and washing of oil coolers from the transformer cooling system to be performed".*

8.2.4. In item II.5 – *„Cleaning of all oiled and contaminated electrical machines and units, terminal boards, power, and operational cable ducts, floorboards and below them in the engine room and control cabins".*

9. Rules and norms.

9.1. The shift staff at the Belovo and Kostenets stations of the National Railway Infrastructure Company, before and during the accident, acts in accordance with the approved legal framework and

internal rules governing the safety of railway infrastructure traffic - "Rules for the movement of trains and shunting work in rail transport“, "Plan for disaster protection in RINC":

9.2. According to the collected materials and documents, the motorman servicing the auxiliary pushing locomotive № 43310.9 of the IDFT № 40772, before the accident, has acted in accordance with the regulations governing the safety of rail transport - "Ordinance № 58 from August 02, 2006, on rules for the technical operation, movement of trains and signaling in railway transport "," Rules for the movement of trains and shunting work in railway transport ". And after the emergency stopping of the train in Belovo - Kostenets section, he immediately undertakes actions to fulfill the requirements of the Instruction for fire-fighting and the Crisis Action Plan, incl. and::

- taking down the pantograph from the contact network and switching off the battery;
- taking the available fire extinguishers from the locomotive and starting fire fighting;
- notification by telephone 112 to the bodies of FS&PP for the fire

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

10.1. Functional condition of the railway infrastructure:

Railway and points:

- troublefree;

Safety equipment, communications, radio and power supply:

- troublefree;

Contact network:

- troublefree;

10.2. Functional condition of electrical locomotive № 43310.9.

- functional state of the locomotive - machines and units have been destroyed in the engine room and thus it is unfit for operation;
- first cabin of the locomotive - smoked by the fire;
- second cabin of the locomotive - operational;
- both cabs for the control of the electric locomotive are equipped with a speedometer installation for recording the speed of movement in the range from 0 to 150 km/h. In the 1st cabin of the locomotive a wall tape tachograph type RT9 (registering) is mounted, and in the 2nd cabin - tachometer A16 (not-registering) type "Hasler", for technical reasons the locomotive is restricted for movement from 0 to 100 km / h. The speedometer installation registers graphically, using nibs on a paraffined paper band with perforations at the top and bottom along the strip, the following parameters:
- astronomical time - in a 24-hour digital scale;
- movement and stop time in minutes;
- speed - in km / h;
- Distance;
- air pressure in the main air tube of the pneumatic automatic brake at the value of which is judged to be triggered.

Decodification of speedometer strip of electric locomotive № 43533 performed in Stara Zagora Locomotive Depot for the movement of IDFT № 40772 in Septemvri – Kostenets section:

The speedometer tape decoding of electric locomotive №43310 is not performed due to lack of recording on the tape due to the speedometer failure. For this reason, the decoder of the leading auxiliary locomotive № 43533 is decoded.

,,On August 11, 2019, IDFT № 40772, towed by locomotives № 43515 and auxiliary № 43533, and auxiliary pushing № 43310, departs from Septemvri station at 17:04 hrs, keeping the section speed and its reductions along the railway. During its movement in the Septemvri - Kostenets section, there is gradual detention in the main air tube. The speed of 47 km/h drops sharply to 0 km/h and at 78 + 300 km the train stops at 17:28 hrs. It departs at 17:40 hours and speeds up to 12 km/h and stops at 77 + 600 km. After carrying out a test "D" it starts at 22:36 hrs. It arrives at Kostenets station at 22:43 hours. It leaves at 02:34 hrs and continues on its route."

From the analysis of the decryption performed on locomotive № 43533 at the Locomotive Depot Stara Zagora, the Investigation Commission finds the following:

- real time of emergency stopping of the train in the railway section at 17:28 hrs ;
- real train moving time by about 1000 m forwards at 17:40 hrs;
- the real time of arrival of the train at Kostenets station is at 22:53 hrs;
- the train actually leaves Kostenets station at 02:24 hrs;

11. Operational System Documentation.

11.1. Reviews, inspections, repairs, maintenance and prevention.

On Fig. 4 are shown excerpts of planned maintenance carried out on the locomotive № 43310.9 until the time of the accident.

Type of repair	**Date of repair dd.mm.yyyy**	**Mileage as of August 10,2019 km …**	**Place of repair**	**Defective elements and joints**
CAPITAL REPAIR /CR/	17.09.1998	2 369 792 km	RF-Sofia	Factory repair regulations
LIFT REPAIR /LR/	26.04.2013	572 530 km	Stara zagora	Depot repair regulations
LITTLE PERIODIC REPAIR /LPR/	05.06.2019	15 477 km	Dupnitsa	Depot repair regulations
	29.07.2019	LPR- 8 524 km	Dupnitsa	Depot repair regulations
	02.08.2019	LPR- 12 925 km	TI - Sofia	Depot repair regulations
REPAIR BY NECESSITY TI /RN/	09.06.2019		Dupnitsa	Earthing, 861B Diode-022, 285-SO1
	14.06.2019		Dupnitsa	I ДК, lighting, projector
	20.06.2019		Dupnitsa	IIДК, IДК, ПК,341_{21}
	24.06.2019		Dupnitsa	IIДК, IДК ПК
	28.06.2019		Dupnitsa	ПК, 285
	26.07.2019		Dupnitsa	Oil ДК, leakage 1ДК,noise 3 reduction gear, 819, $341_{21,}$ S1
TECHNICAL INSPECTION /TI/	10.07.2019		TI - Sofia	Depot repair regulations
	12.07.2019		TI - Mezdra	
	13.07.2019		TI - Mezdra	
	16.07.2019		TI - Mezdra	
	17.07.2019		TI - Mezdra	
	18.07.2019		TI - Mezdra	

	19.07.2019		TI - Mezdra	
	20.07.2019		TI - Mezdra	
	22.07.2019		TI - Mezdra	
	24.07.2019		TI - Mezdra	
	29.07.2019		Dupnitsa	
	30/31.07.2019		Dupnitsa	
	02.08.2019		TI - Sofia	
	06.08.2019		TI - Sofia	
	07.08.2019		TI - Mezdra	
	10.08.2019		TI - Sofia	

Fig. 4

Between repairs mileages and cyclic recurrence of planned inspections and repairs of electric locomotives series 43 000

1. Between repair mileages (nominal values) for routine inspections and repairs:

TI – Technical Inspection – every 14 000 km;
LPR – Little Periodic Repair – every 56 000 km;
BPR – Big Periodic Repair – every 225 000 km;
LR – Lift Repair – every 450 000 km.
Tolerances in nominal values of the mileages: **– 10% ÷ + 20%.**

2. Cyclic recurrence of planned inspections and repairs:
Fig.7 and 7a show schematically and tabular BRM of loc. 43310.

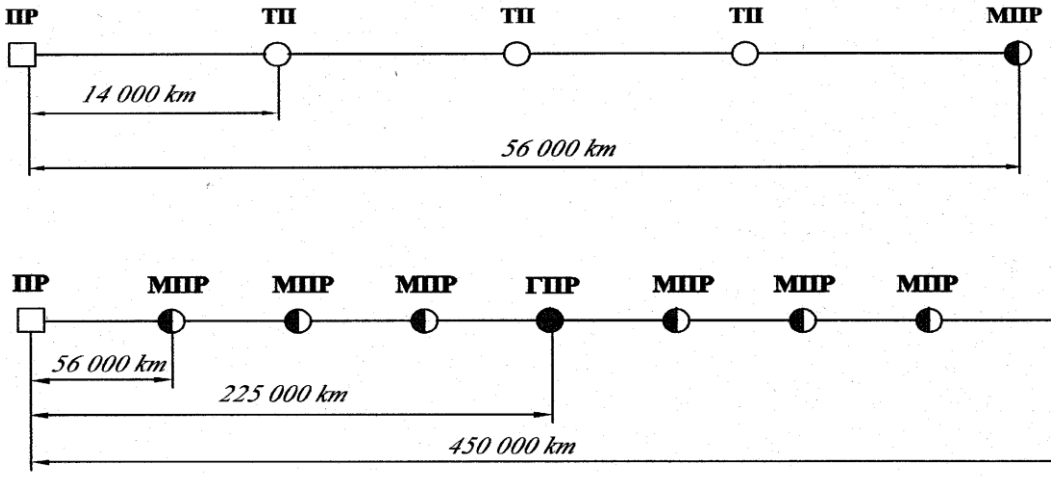


Fig. 7

№	Type of repair	Date when reapair begins	Date when repair ends	Mileage from the last scheduled repair, km	Mileage from last LPR km	Mileage from PR, km	Mileage from CR, km
1.	LPR	05.06.2018	06.06.2018	14 624	76 911	473 649	2 270 911
2.	TI1	21.09.2018	21.09.2018	13 565	13 565	487 214	2 284 476

3.	TI2	20.11.2018	20.11.2018	19 492	33 057	506 706	2 303 968
4.	TI1(3)	23.01.2019	23.01.2019	16 054	49 111	522 760	2 320 022
5.	TI2(4)	16.04.2019	16.04.2019	19 313	68 424	542 073	2 339 335
6.	LPR	04.06.2019	05.06.2019	14 980	83 404	557 053	2 354 315
7.	RN	09.06.2019	09.06.2019				
8.	RN	14.06.2019	14.06.2019				
9.	RN	20.06.2019	21.06.2019				
10.	RN	24.06.2019	24.06.2019				
11.	RN	28.06.2019	01.07.2019				
12.	RN	26.07.2019	29.07.2019				

Fig. 7a

11.2. Measures taken by staff to regulate train movements.

The Operational Management Unit (OMU) for the train traffic at RTMSA - Sofia, coordinated with BDZ PT EOOD and the CDM at RINC, have taken timely operational actions regarding changes in the train schedule in Kostenets - Septemvri section. Passenger trains in the section have been canceled and passengers have been transhipped by buses of the railway carrier.

11.3. Exchange of Oral Orders and Written Messages.

At 17:40 hrs from telephone 112 the senior train dispatcher at CDM of RINC is notified of a fire occurring in locomotive № 43310 from the composition of IDFT № 40772 in Belovo - Kostenets section of Road №2;

At 17:50 hrs from the Subarea for Electricity Distribution - Kostenets portable earthing are installed to the contact network;

At 17:58 hrs, permission is granted to the bodies of the RO FS&PP - Kostenets to start firefighting in locomotive № 43310;

At 18:20 hrs the traffic for all trains and vehicles in Belovo - Kostenets section along roads № 1 and № 2 is closed;

The fire in the locomotive is extinguished at 19:53 hrs;

At 19:55 hrs in Belovo - Kostenets section, the voltage is applied to the contact network along the roads № 1 and № 2;

At 19:57 hrs, the traffic in Kostenets - Belovo section along road №1 is restored for all trains at a timetable speed.

At 22:40 hrs, the traffic in Kostenets - Belovo section along road №2 is restored for all trains at a timetable speed.

11.4. Measures taken to protect and guard the scene of accident.

From 17:30 hrs to 22:40 hrs on August 11, 2019, the area of accident in Belovo - Kostenets railway section is cut off by MoI bodies and it is restricted for external persons' access with the exception of the staff of FS&PP - Kostenets, the bodies of MoI - Sofia and the Head of SUIRAI at MTITC. From August 11, 2019, the locomotive is under the supervision of Regional Prosecutor's Office - Ihtiman and MoI - Sofia with limited access, at Kostenets Station.

12. Health and Safety work conditions.

- With reference to the requirements of Art. 13, para. 1 and Art. 14, para. 1 of Ordinance №50 / December 28, 2001 no violations are observed in the reporting of personnel working hours at RINC and BDZ, "Freight Transport" Ltd.

- With reference to the requirements of Art. 28, para. 1 of Ordinance № 54 / June 02, 2003 for medical examinations of the personnel related to the accident, at RINC and BDZ "Freight Transport" Ltd., no violations are found.

- With reference to the requirements of Art. 20, para. 2 of Ordinance № 54 / June 02, 2003 the officials of RINC and BDZ FT Ltd., related to the accident, have valid certificates for psychological examination.

13. Accidents of similar nature previously registered.

Registered accidents of a similar nature in the period 2017 - 2019 with electric locomotives of the railway carrier BDZ "FT" EOOD, while servicing freight trains.

- on February 20, 2017, during a stay in Kalofer station, a fire occurs in electric locomotive № 43509, servicing FT № 30602;
- on June 13, 2017, during a stay in Vakarel station, a fire occurs in electric locomotive № 43509, servicing FT № 44152;
- on June 27, 2017, during a movement between Belovo and Kostenets stations, a fire occurs in electric locomotive № 43502, servicing FT № 50551;
- on February 10, 2019, during a stay at Stryama station, a fire occurs in electric locomotive № 43545, servicing FT № 30612;
- on March 30, 2019, during a stay in Aldomirovtsi station, a fire occurs in electric locomotive № 43551, servicing FT № 45003;

14. Analysis and conclusions.

14.1. Description of the chain of events based on established facts.

The MTITC Investigation Commission gathered the necessary documentation and materials. It analyzed possible circumstances, facts, and evidence that could lead to the identification of the cause of the fire in the locomotive. It carried out several detailed examinations of the burned locomotive, as well as an analysis of the materials and documents provided by the Operational Unit, and discussed the views of the experts involved in the Commission. It conducted interviews and requested the written testimony of the personnel involved in the accident. It required additional documents and materials regarding past repairs of the locomotive. It analyzed downloaded insulation resistance measurements made on:

- the four traction engines of the locomotive;
- both oil pumps of the traction transformer;
- both motor-fans for cooling the rectifying units.

Measurements made by the personnel at the Dupnitsa Locomotive Depot during the planned and necessary repairs of the locomotive were found to be made with an insulation resistance measuring device (Megher for 1000V) instead of (Megher for 2500V) in accordance with the requirements of,, Rules for depot repairs of 43000 series electric locomotives".

It analyzed the information provided for the repairs of the locomotive and focused on necessary repairs for which there is no accountability (inventory of the damage but no account is taken of what activity is performed). In the period from June 09. till July 26, 2019, six necessary repairs are carried out, including three times for the auxiliary compressor, four times for the engine-compressor. The Investigation Commission, after the measurements are made, considers that the necessary repairs carried out have not produced the expected results, which has led to repetitive failures of the locomotive during its operation and prolongation of its stay for repair.

14.2. Analysis of the facts and conclusions on the causes of the accident.

Analysis of Locomotive № 43533 recording device's record by the Commission for Investigation in Septemvri - Kostenets railway section while servicing IDFT № 40772.

I. Circumstances in which the accident has occurred.

On August 11, 2019, train № 40772, serviced by BDZ FT EOOD, consisting of 27 wagons, 98 axles, 1491 tons, served by two towing electric locomotives: leading one by № 43515 and auxiliary one by № 43533, and pushing auxiliary locomotive № 43310 of the train leaves Septemvri station at 17:04 hrs.

The route of train № 40772 is presented in the following figure.

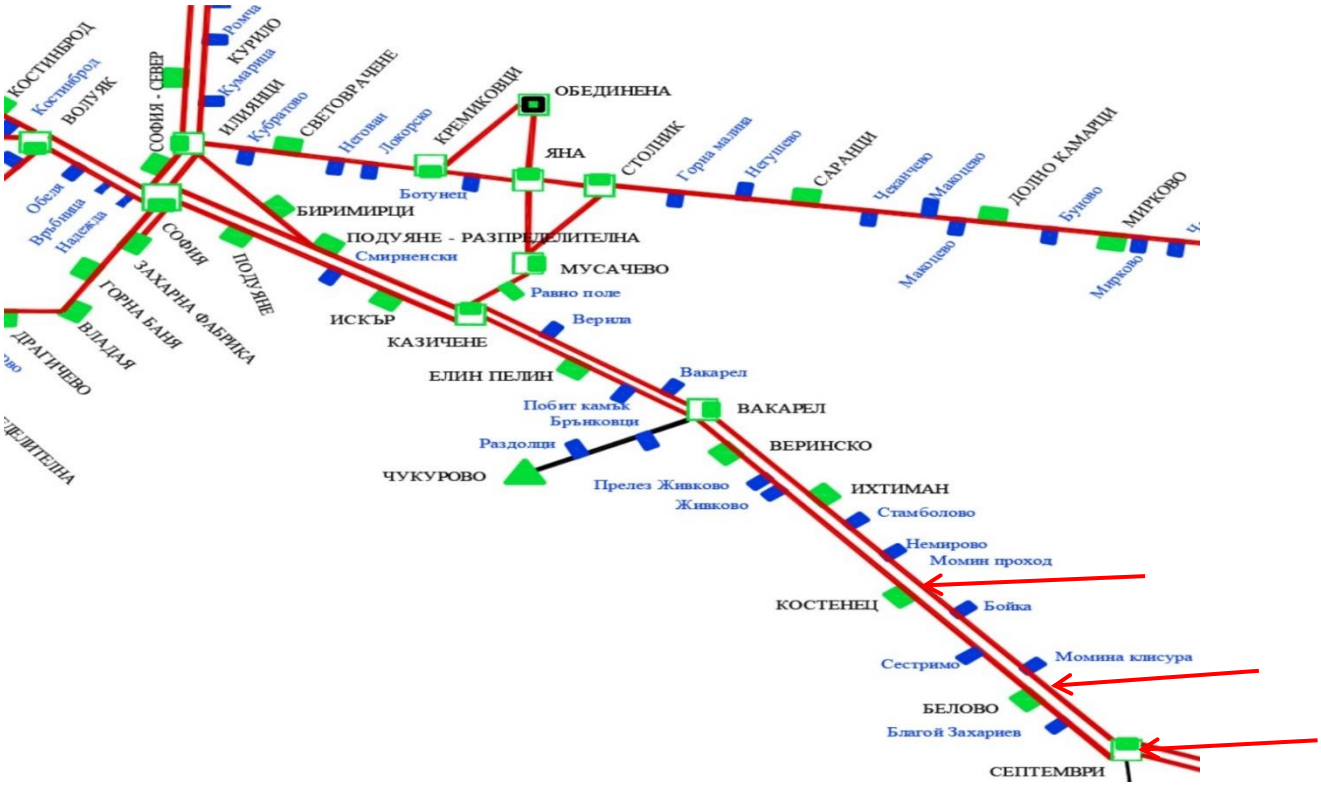


Fig. 8

Fig. 8 shows a map of the route with marked stations and stops along it (in red are indicated Septemvri, Belovo and Kostenets stations, between which the locomotive fire has occurred).

Timetable for train № 40772 is shown scanned in the following two figures, as IDFT № 40772 is marked with green and departure station September is marked with red colour.

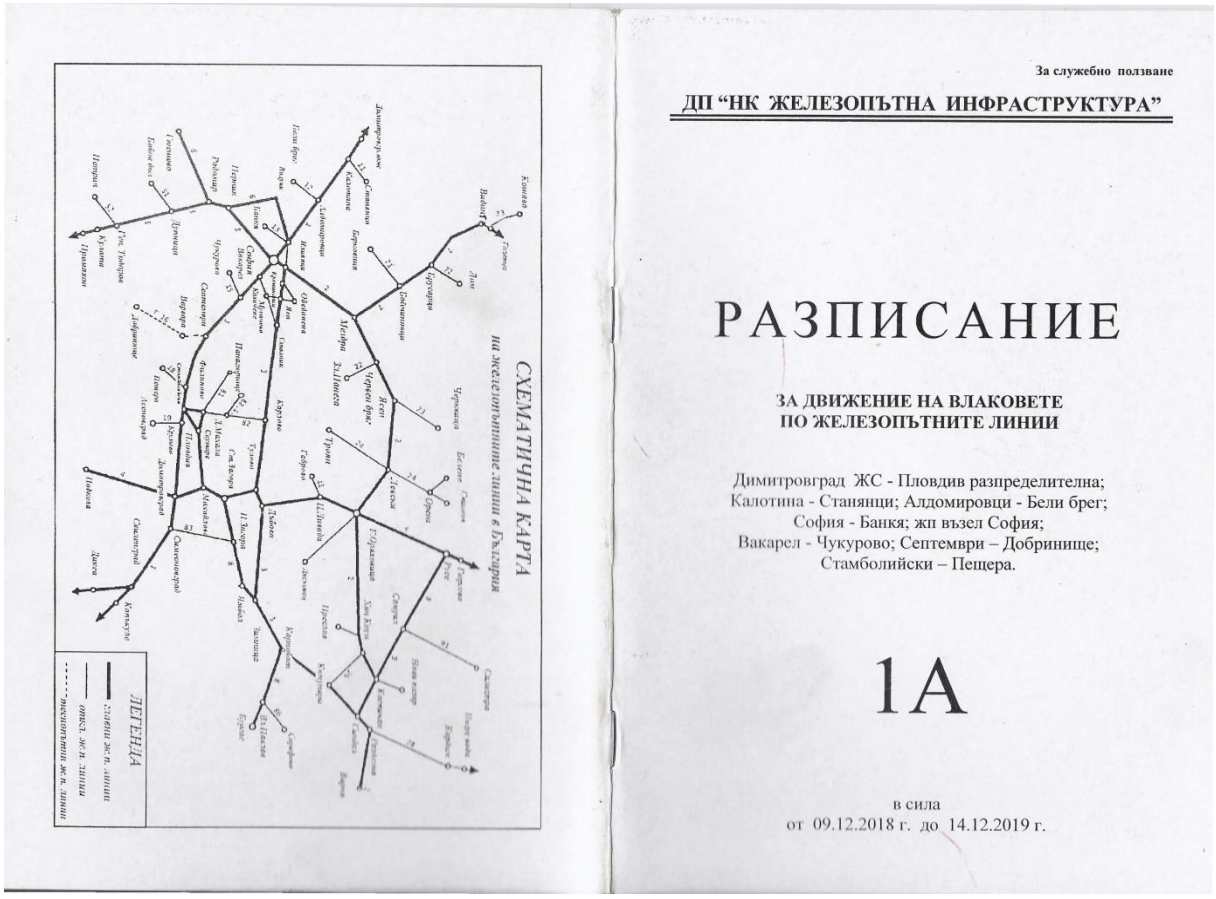
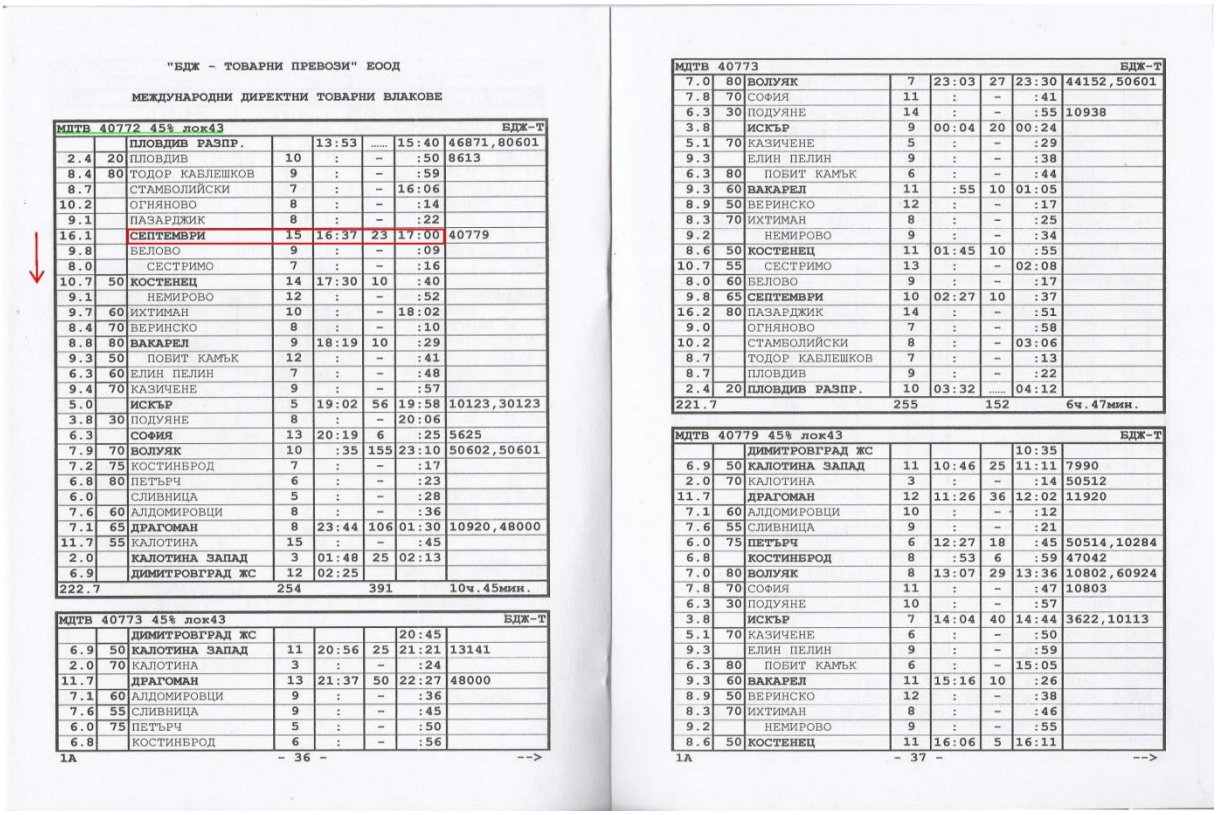


Fig. 9



"ЕДЖ - ТОВАРНИ ПРЕВОЗИ" ЕООД

МЕЖДУНАРОДНИ ДИРЕКТНИ ТОВАРНИ ВЛАКОВЕ

МДТВ 40772 45% лок43							ЕДЖ-Т
		ПЛОВДИВ РАЗПР.		13:53	.....	15:40	46871,80601
2.4	20	ПЛОВДИВ	10	:	-	:50	8613
8.4	80	ТОДОР КАБЛЕШКОВ	9	:	-	:59	
8.7		СТАМБОЛИЙСКИ	7	:	-	16:06	
10.2		ОГНЯНОВО	8	:	-	:14	
9.1		ПАЗАРДЖИК	8	:	-	:22	
16.1		СЕПТЕМВРИ	15	16:37	23	17:00	40779
9.8		БЕЛОВО	9	:	-	:09	
8.0		СЕСТРИМО	7	:	-	:16	
10.7	50	КОСТЕНЕЦ	14	17:30	10	:40	
9.1		НЕМИРОВО	12	:	-	:52	
9.7	60	ИХТИМАН	10	:	-	18:02	
8.4	70	ВЕРИНСКО	8	:	-	:10	
8.8	80	ВАКАРЕЛ	9	18:19	10	:29	
9.3	50	ПОБИТ КАМЪК	12	:	-	:41	
6.3	60	ЕЛИН ПЕЛИН	7	:	-	:48	
9.4	70	КАЗИЧЕНЕ	9	:	-	:57	
5.0		ИСКЪР	5	19:02	56	19:58	10123,30123
3.8	30	ПОДУЯНЕ	8	:	-	20:06	
6.3		СОФИЯ	13	20:19	6	:25	5625
7.9	70	ВОЛУЯК	10	:35	155	23:10	50602,50601
7.2	75	КОСТИНБРОД	7	:	-	:17	
6.8	80	ПЕТЪРЧ	6	:	-	:23	
6.0		СЛИВНИЦА	5	:	-	:28	
7.6	60	АЛДОМИРОВЦИ	8	:	-	:36	
7.1	65	ДРАГОМАН	8	23:44	106	01:30	10920,48000
11.7	55	КАЛОТИНА	15	:	-	:45	
2.0		КАЛОТИНА ЗАПАД	3	01:48	25	02:13	
6.9		ДИМИТРОВГРАД ЖС	12	02:25			
222.7			254		391		10ч.45мин.

МДТВ 40773 45% лок43							ЕДЖ-Т
		ДИМИТРОВГРАД ЖС				20:45	
6.9	50	КАЛОТИНА ЗАПАД	11	20:56	25	21:21	13141
2.0	70	КАЛОТИНА	3	:	-	:24	
11.7		ДРАГОМАН	13	21:37	50	22:27	48000
7.1	60	АЛДОМИРОВЦИ	9	:	-	:36	
7.6	55	СЛИВНИЦА	9	:	-	:45	
6.0	75	ПЕТЪРЧ	5	:	-	:50	
6.8		КОСТИНБРОД	6	:	-	:56	

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МДТВ 40773							ЕДЖ-Т
7.0	80	ВОЛУЯК	7	23:03	27	23:30	44152,50601
7.8	70	СОФИЯ	11	:	-	:41	
6.3	30	ПОДУЯНЕ	14	:	-	:55	10938
3.8		ИСКЪР	9	00:04	20	00:24	
5.1	70	КАЗИЧЕНЕ	5	:	-	:29	
9.3		ЕЛИН ПЕЛИН	9	:	-	:38	
6.3	80	ПОБИТ КАМЪК	6	:	-	:44	
9.3	60	ВАКАРЕЛ	11	:55	10	01:05	
8.9	50	ВЕРИНСКО	12	:	-	:17	
8.3	70	ИХТИМАН	8	:	-	:25	
9.2		НЕМИРОВО	9	:	-	:34	
8.6	50	КОСТЕНЕЦ	11	01:45	10	:55	
10.7	55	СЕСТРИМО	13	:	-	02:08	
8.0	60	БЕЛОВО	9	:	-	:17	
9.8	65	СЕПТЕМВРИ	10	02:27	10	:37	
16.2	80	ПАЗАРДЖИК	14	:	-	:51	
9.0		ОГНЯНОВО	7	:	-	:58	
10.2		СТАМБОЛИЙСКИ	8	:	-	03:06	
8.7		ТОДОР КАБЛЕШКОВ	7	:	-	:13	
8.7		ПЛОВДИВ	9	:	-	:22	
2.4	20	ПЛОВДИВ РАЗПР.	10	03:32	.....	04:12	
221.7			255		152		6ч.47мин.

МДТВ 40779 45% лок43							ЕДЖ-Т
		ДИМИТРОВГРАД ЖС				10:35	
6.9	50	КАЛОТИНА ЗАПАД	11	10:46	25	11:11	7990
2.0	70	КАЛОТИНА	3	:	-	:14	50512
11.7		ДРАГОМАН	12	11:26	36	12:02	11920
7.1	60	АЛДОМИРОВЦИ	10	:	-	:12	
7.6	55	СЛИВНИЦА	9	:	-	:21	
6.0	75	ПЕТЪРЧ	6	12:27	18	:45	50514,10284
6.8		КОСТИНБРОД	8	:53	6	:59	47042
7.0	80	ВОЛУЯК	8	13:07	29	13:36	10802,60924
7.8	70	СОФИЯ	11	:	-	:47	10803
6.3	30	ПОДУЯНЕ	10	:	-	:57	
3.8		ИСКЪР	7	14:04	40	14:44	3622,10113
5.1	70	КАЗИЧЕНЕ	6	:	-	:50	
9.3		ЕЛИН ПЕЛИН	9	:	-	:59	
6.3	80	ПОБИТ КАМЪК	6	:	-	15:05	
9.3	60	ВАКАРЕЛ	11	15:16	10	:26	
8.9	50	ВЕРИНСКО	12	:	-	:38	
8.3	70	ИХТИМАН	8	:	-	:46	
9.2		НЕМИРОВО	9	:	-	:55	
8.6	50	КОСТЕНЕЦ	11	16:06	5	16:11	

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Fig. 10

II. Decryption of the records of the speedometer installation.

Fig. 11 shows part of a speedometer tape with inscriptions referring to locomotive № 43310, downloaded from the registering speedometer of the locomotive on August 14, 2019, at 09:10 hrs by a locomotive instructor from Locomotive Depot Dupnitsa and submitted to the head of the operational unit of RINC. It is explained that the cab of the locomotive is fired. There are no visible and usable records on the tape due to damage to the speedometer. The damage is established by a protocol on November 12, 2019, after measurements by a speedometer test stand in Locomotive Depot Plovdiv.

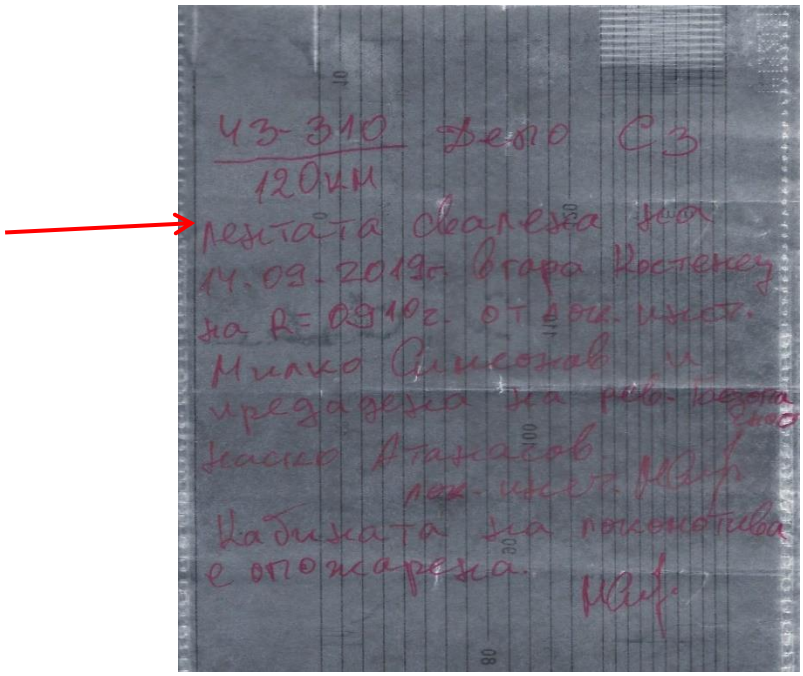

Fig. 11

For this reason, the speedometer strip of the head locomotive № 43533 is used for the movement of the train composition prior to the accident to be analyzed. Fig. 12 shows the inscribed

portion of the strip, and the strip itself, scaled, with markers and markings is shown in Fig. 7. Although it is used a speedometer belt for a maximum speed of up to 120 km/h, the speedometer of the locomotive is designed for a maximum speed of movement up to 150 km/h (as shown in the upper left corner of Fig. 6 with a red arrow). For this reason, all the speed values recorded by the stylus in Fig. 7 should be scaled by a factor of 1.5 / 1.2 = 1.25.

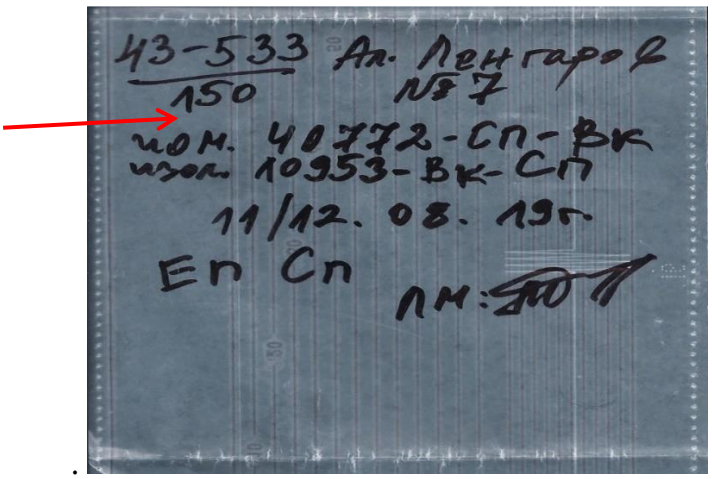

Fig. 12

Locomotive № 43533 is equipped with a speedometer installation to record speed in the range from 0 to 150 km / h.

The features of recording the time on the speedometer strip are described below. Through a lever system, the clock mechanism of the Hasler speedometer drives the stylus, which performs a gradual movement (up and down). The maximum stroke of the stylus is 20 millimeters, which corresponds to a time of 10 minutes. Therefore, in one astronomical hour, the stylus makes six movements (each lasting 10 minutes) - 3 times up and 3 times down. At the top of the upper field of the strip, the astronomical hour is marked with a dot below it (on a 24-hour scale).

The "Hasler" drives the registration tape at different speeds:

In Fig.13 is shown a graphical representation of the speedometer belt of locomotive № 43533 in the accident zone.

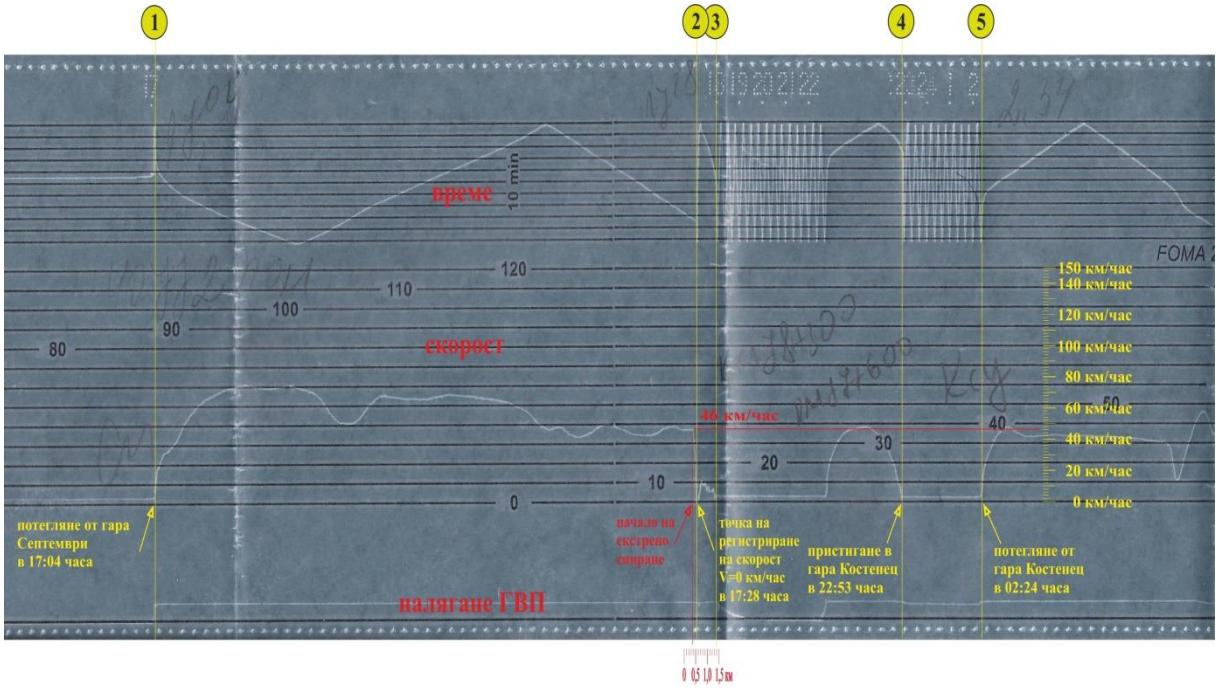

Fig. 13

Marker 1 (Fig.13) - the train leaves Septemvri station at 17:04 hrs.

Marker 2 Fast train stop from 46 km/h at 17:28 hrs.

Marker 3 stopping of the train after moving about 900 meters forward.

Marker 4 arriving and stopping at Kostenets station at 22:53 hrs.

Marker 5 departure of the train from Kostenets station at 02:24 hrs.

A vertical line in red indicates the activation of the train brake, stating that the speed before stopping is 46 km / h, and after about 150 meters at a speed of 46 km/h rapid braking is registered.

The records show that due to inaccurate roller placement or speedometer settings, there is a displacement of the stylus by time and speed of approximately 1 mm.

As is apparent from the speed diagram as a function of the traveled distance - V (S), located in the middle field of the speedometer strip, the actual speed realized does not exceed the maximum permissible speed for train movement in the railway section Septemvri - Kostenets, which is 80 km/h.

Given the train length - 550.45 m and the location of the three locomotives, the distance from the sensor of locomotive № 43533 and locomotive № 43310 is 583.45 m, i.e. the records of Fig. 13 refer to locomotive № 43310 by adding these 583.45 meters.

From the traction characteristic of the locomotive, it can be established that traction positions between the 18th and the 32nd, were possible to be used when operating in Septemvri - Belovo section at speeds between 50 and 75 km/h which is directly relevant to the possibility of a circular fire occurring on one of the traction engines of the locomotive.

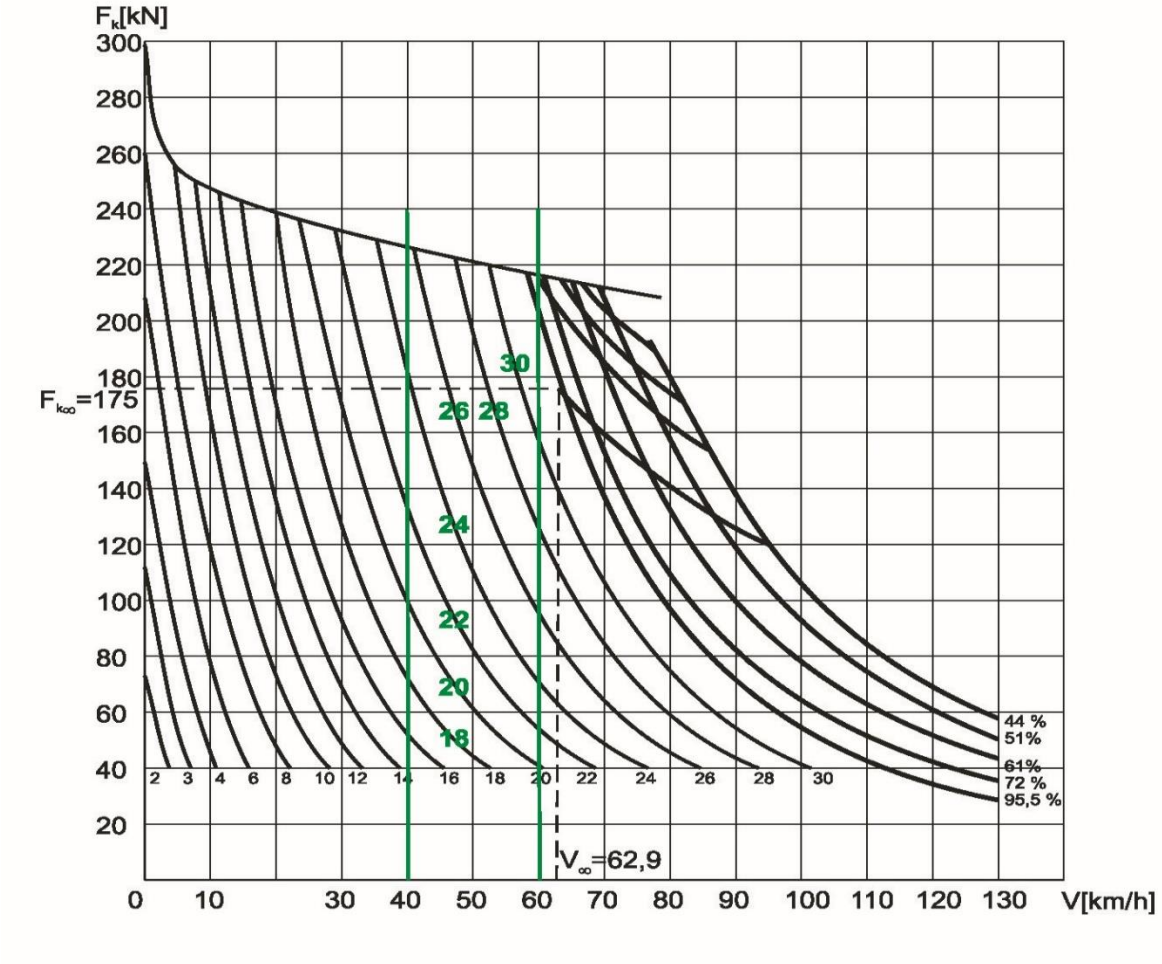

Fig. 14

If it is provisionally assumed that, without operating in a multi-unit system, all three locomotives in the composition are approximately equally loaded in the ascents of train № 40772 route, then the maximum possible speed of the composition in the largest ascents (20 ‰ - see. Fig. 17) is slightly above the estimated speed of 62.9 km/h.

The specific accelerating force of a single locomotive for the composition is shown in Fig. 15.

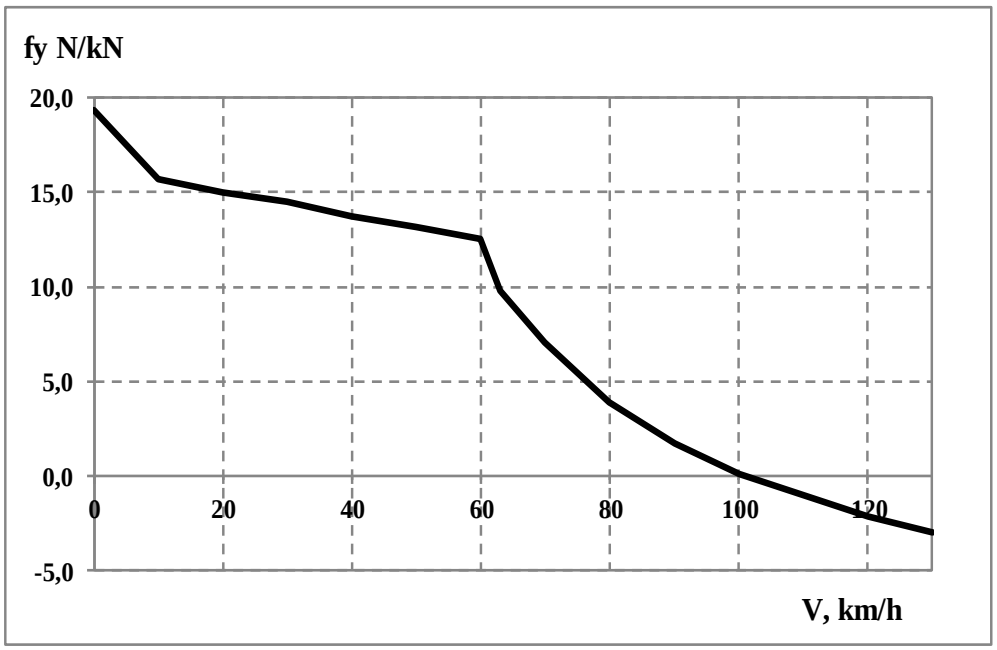

Fig. 15

Fig. 16 shows the diagrams of the voltage in the contact network and the traction current taken as a record from the electrometer of locomotive № 43310 in the interval 17:00 ÷ 17:32 hours in a 15 minutes step. As the period of averaging of the recorded parameter readings is considerable, it is practically impossible to make certain analyzes and valid assumptions about the power modes and the load of the burned locomotive.

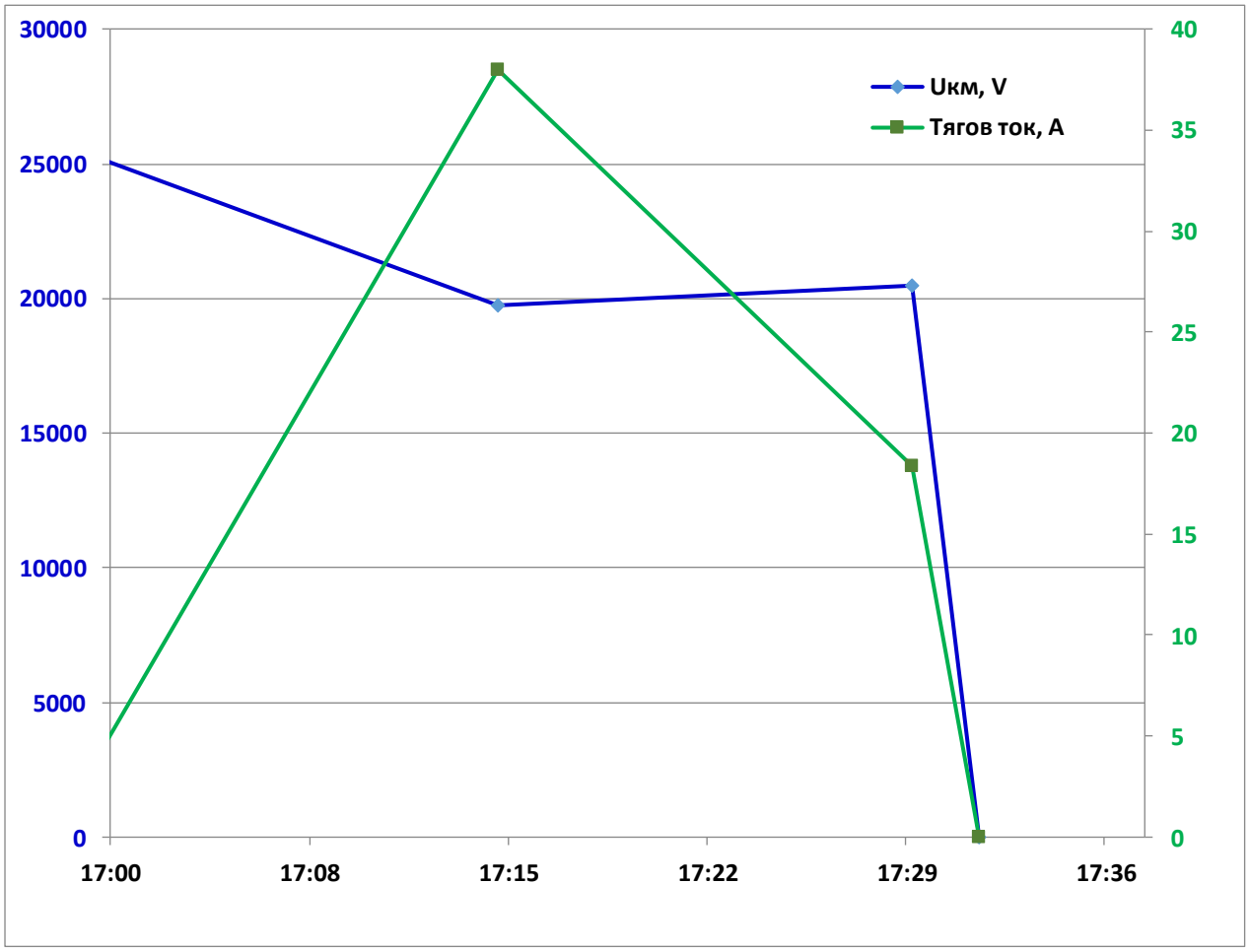

Fig. 16

Fig. 17 shows the longitudinal profile of the railway in section Septemvri - Kostenets.

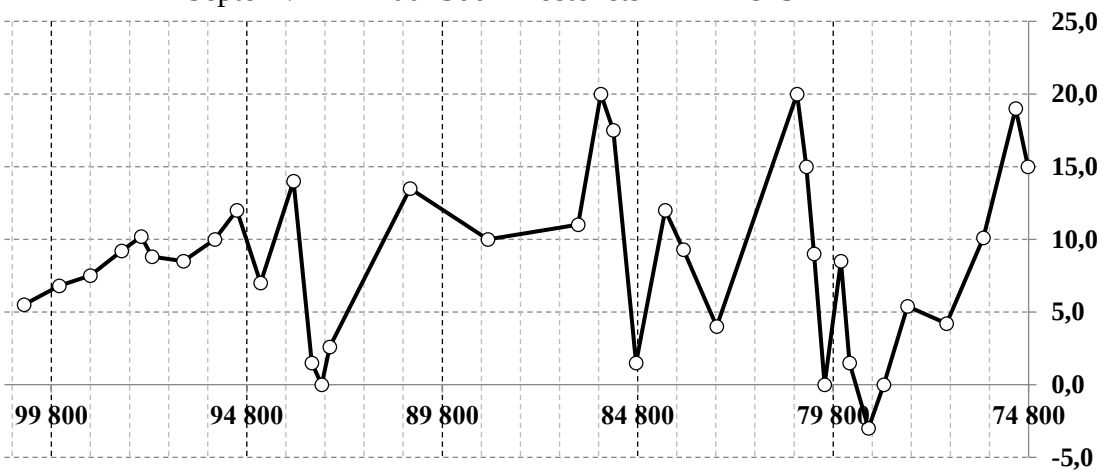

Fig. 17

14.3. Conclusions - direct and main causes of the accident additional factors related to the technical condition of the rolling stock.

From the studies, measurements and analyses of the locomotive and the technical documentation of its condition, the Investigation Commission concludes that the quality of the repairs carried out is reduced due to the non-compliance with the regulated repair technologies which is established during the investigation.

Fig. 18

An immediate cause of the fire is the transient short-circuit occurring in the motor-fan (233) which cools the rectifier unit of the second traction group (022). The short circuit in the motor-fan 233 has caused the temperature in the rectifier 022 to increase (Fig. 18). The significant increase in temperature has caused the heat up of the R-C groups for protection against switching surges, the blow-up of the capacitors and the self-ignition of the electrolyte in them.

Fig. 19

The short circuit in the operating coil of the oil pump 238 has led to a lack of circulation in the second oil cooling circuit in the traction transformer 0151, Fig. 19. The increased oil temperature greatly raises the temperature in the oil cooler of the transformer. This results in a severe overheating of the auxiliary rectifier 220 (for compressor 234), which is located near the oil pump. When MAT is switched off, the 020, 220 rectifiers remain uncooled. The temperature rises significantly and a fire occurs from the exploded capacitors of the R-C group. By switching on MAT again, fan 231 kindles the fire further. After leaving the hill and entering Belovo station, the motorman lowers the positions and switches off the motor-fans.

Fig. 20

After dismantling the traction transformer on September 22, 2019, APS, and power rectifiers 020 and 022, the inspection revealed the following:

- The traction transformer is externally burned by the high temperature.
- APS is working properly, contactors K1, K2, K3 and K4 are working properly.
- Oil pump radiator hoses - burned out.

- Power rectifier 022 completely destroyed, only the rectifier (frame construction) is left. Fig. 21.

- On the first rectifier 020, only the auxiliary 220 and 221 rectifier modules are burned (Fig. 20).

Fig. 21

Fig. 20 and Fig. 21 show photos of rectifying cabinet 020 of the first engine group (bogie 1) and of rectifying cabinet 022 of the second engine group (bogie 2). Cabinet 020 fire damage is partial at the bottom of the cabinet, while cabinet 022 is completely destroyed by fire. The arrangement (location) of both cabinets in the engine room of the locomotive is such that a conclusion is drawn for two independent fires centers (in each cabinet). A confirmatory circumstance is ascertained in the inspections that no oil has leaked from the cooling circuits of the main transformer of the locomotive, i.e. the fire is not spread as in other accidents - from bursting oil compounds and spilled burning oil.

The main causes of fire in electric locomotive № 43310.9 are the continuous operation of the locomotive with an increased temperature of the second traction group and of the first traction group, as a result of a short circuit in the cooling fan of the second rectifier unit and a short circuit in the motor pump. For this reason, a breakthrough has occurred in some of the elements (thyristors, diodes, etc. - Figs. 20, 21), which has operated under high current and without cooling. Due to the increased temperature in the capacitors for protection against switching surges, the temperature of the electrolyte in them has increased. This has resulted in the unpressurized metal housings and the dispersion of the electrolyte on the heated elements of both rectifying units, resulting in the almost simultaneous ignition and expansion of the fire.

15. Recommendations issued in order to avoid accidents upon the same reasons.

In accordance with the requirements of Art. 94 para. 1 and para. 3 of Ordinance № 59 from December 5, 2006 in order to improve safety in railway transport, EA "Railway Administration" orders BDZ "Freight Transport" Ltd to implement the given safety recommendations:

Recommendation No. 1 proposes that when performing technical inspections and repairs (TI and BRM) of diesel and electric locomotives, to comply strictly with the prescribed order laid down in Order No. 01-01-191 / June 29, 2017 of BDZ “FT” EOOD Manager, to prevent the premises for occurrence of fires in locomotives owned by BDZ" FT "EOOD.

Recommendation No. 2 proposes that during the repairs by necessity (RN), real and accurate information after completing the repairs should be filled in the accounting documents;

Recommendation No. 3 proposes to provide the locomotive personnel at BDZ “FT” EOOD fire masks allowing access to the fire center and extinguishing with portable hand fire extinguishers in the event of fires in the engine room of the locomotives.

Recommendation No. 4 proposes BDZ “FT” EOOD to carry out inspections of their own

locomotives in accordance with the requirements of Art. 192, para. 1, item 33 of Ordinance No. 58 / June 2, 2006, on the worthy radio stations for train-dispatcher radio connection during the movement in sections with radio coverage.

With reference to the implementation of Art. 94 para. 4 of Ordinance № 59 from December 5, 2006 for Railway Safety Management recommendations addressees to notify in writing the head of SUIRAI in MTITC for the implementation of the given recommendations.

Sofia November 20, 2019

Chairman:

…….. **(Dr. Eng. Boycho Skrobanski)**
State investigation inspector in MTITC

Members:

1. **..... (Prof. Dts Eng. Nencho Nenov)**
   External expert

2. **..... (Assoc. Prof. Eng. Ivan Petrov)**
   External expert

I, the undersigned Galina Krasimirova Grozeva in my capacity of official translator, hereby certify that the above document, consisting of 26 (twenty six) pages is a true and complete translation into English of the attached official document, originally composed in Bulgarian. In testimony thereof I have hereunto set my hand and affixed the official seal of the company.
Translator:
Galina Krasimirova Grozeva