MINISTRY OF TRANSPORTS AND INFRASTRUCTURE
ROMANIAN RAILWAY AUTHORITY - AFER

ROMANIAN RAILWAY INVESTIGATING BODY

INVESTIGATING REPORT

on the railway incident
occured on the 8th of September 2009 in the railway station Ilva Mică

Final Edition
May 25, 2010

NOTICE

As regards the railway incident occured on September 8, 2009, at 21:47 o'clock on the activity area of Railway District CFR Cluj, railway station Ilva Mică, **braking the axle no.4 from the electric locomotive EA 040-139-2 hauling the passenger train no.18703**, the Romanian Railway Investigating Body developed an investigating action according to the provisions of the Law no.55/2006 on railway safety. By this investigating action, were collected and analyzed information on the railway incident occurrence and also were established the conditions and was determined the cause.

The action of the Romanian Railway Investigating Body didn't have as purpose to establish the guilt or the responsibility in this case.

Bucharest, May 25*, 2010*

I give my positive opinion

Director

Dragoş FLOROIU

I fiind the observance of the legal provisions on the development of the investigating action and drawing the present investigating report that i'm proposing for approval.

Chief Investigator

Sorin CONSTANTINESCU

The present Notice is a part of the Report for investigating the railway incident occured on September 8, 2010, at 21:47 o'clock on the activity area of Railway District CFR Cluj, railway station Ilva Mică, braking the axle no.4 from the electric locomotive EA 040-139-2 hauling the passenger train no.18703.

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I. CONTENT **Page**

I. PREAMBLE

I.1. Introduction

As regards the railway incident occured on September 8, 2009, at 21:47 o'clock on the activity area of Railway District CFR Cluj, railway station Ilva Mică, **braking the axle no.4 from the electric locomotive EA 040-139-2 hauling the passenger train no.18703**, the Romanian Railway Investigating Body developed an investigating action according to the provisions of the Law no.55/2006 on railway safety, aimed to prevent some accidents with similar causes, by establishing the conditions and determining the causes.

The OIFR's investigating action didn't have as purpose to establish the guilt or the responsibility, its aim being to improve the railway safety and to prevent the railway incidents or the accidents.

I.2. The investigation process

On September 11, 2009, OIFR was notified by the SNTFC "CFR Călăroti" SA act no. 606/1/609/2009 on breaking the axle no.4 from the electric locomotive EA 040-139-2, in the railway station Ilva Mică, on the activity area of Railway District CFR Cluj, on September 8, 2009. Also, one requested the presence of OIFR specialists to examine this axle.

On September 16, 2010, at Suceava Nord engine shed, in the presence of OIFR specialists, the suspected axle was disassembled and examined and it was found out that it was broken in the area between the wheel membrane on the gear side and gear casing.

Taking into consideration that the occurred facts represent a railway incident, on the basis of the article 19 paragraph 2 of the Law no.55/2006 on the railway safety, the director of OIFR decided to open an investigation action. In this way, by decision no. 11 of September 23, 2009 of OIFR's director was appointed an inquiry commission composed of:

- ZAMFIRACHE Marian - investigator in charge
- DRĂGHICI Marin - investigator
- OLTENACU Livius - investigator
- MĂCICĂŞAN Vladimir - investigator

A. SUMMARY OF THE INCIDENT

A.1. Short description

On September 8, 2009, at 21:47 o'clock on the activity area of Railway District CFR Cluj, in the railway station Ilva Mică, the axle **no.4 breakage occur from the electric locomotive EA 040-139-2 hauling the passenger train no. 18703**, belonging to the railway undertakings SNTFC "CFR Călători" SA – running between Suceava – Ilva Mică.

After this incident there were no other damages to the locomotive or passenger wagons in the train composition.

Also, after this incident there were no victims or injured.

A.2. Direct cause, underlying and root causes

A.2.1. Direct cause

Direc cause of the incident – exceeding the fatigue limit of the material from witch the axle no.41751 was manufactured.

The favoured fact was a large number of stretching – compression cycles that were apllied on this axle along its length of operation. Thus, from the date the pair of wheels were mounted at the locomotive EA 040-139-2 - 12.01.2006 the axle covered a distance of 352.501 km.

A.2.2. Underlying causes

There weren't identified underlying causes of this railway incident.

A.2.3. Root causes

There weren't identified root causes of this railway incident

A.3. Severity level

According to the provisions of article 3, letter o of the Law no. 55/2006 on railway safety, the event is qualified as railway incident.

A.4. Safety recommendations

The Romanian Railway Safety Authority together with the railway transport operators will analyse the opportunity that, at the pair of wheels of the type involved in this incident, after a certain operation period, to be increased the frequency of the ultrasonic inspections.

If, following this analyse, it will be determined that is appropriate to increase the frequency of ultrasonic checks at this type of pair of wheels, the Romanian Railway Authority shall draw up a railway technical norm that will be the base for the implementation of this safety recommendation.

The present investigating report will be transmitted to the Romanian Railway Authority, Romanian Railway Safety Authority, public railway infrastructure manager, CNCF "CFR" SA, SNTFC "CFR Calatori" – SA and to the others railway operators.

B. THE INVESTIGATING REPORT

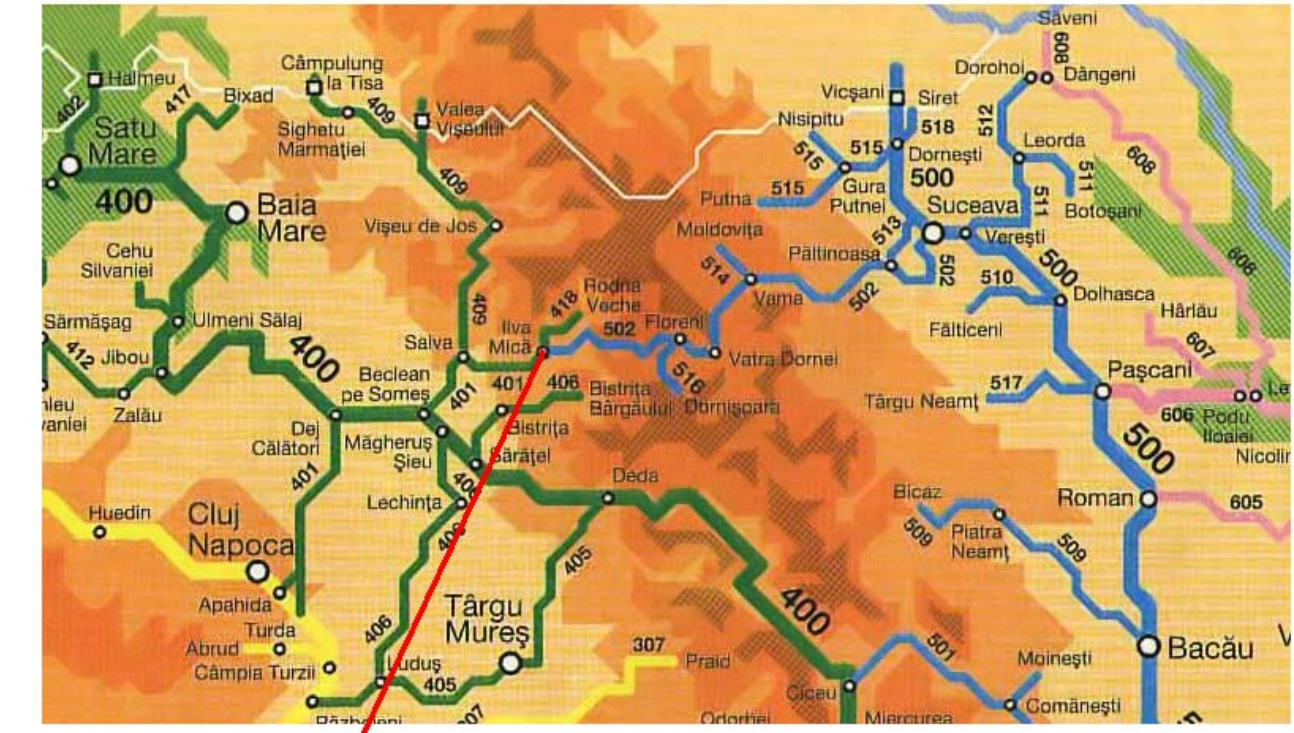
B.1. Description of the incident

On September 8, 2009, the passenger train no.18703, belonging to SNTFC "CFR Calatori" SA, composed of 4 passenger cars (3 wagons with compartments and one sleeping car running without passengers), 16 axles, 195 tons, 125 meters, hauled by the electric locomotive EA 040-139-2 was dispatch to Suceava railway station at 15:35 o'clock.

The train circulated on the basis of colour-light signals of automatic section block (BLA) to the railway station Câmpulung Est where it arrived at 18:03 o'clock.

After exchanging the driving staff, the train departure at 18:05 o'clock and circulated in the same composition to the railway station Vatra Dornei, where it arrived at 19:15 o'clock.

After separating the sleeping car according to the passenger-train composition list, the train was dispatch from the railway station Vatra Dornei at 19:20 o'clock and running until the entry in the railway station Ilva Mică where it had the order for stabling at line 6.



Before parking the train in the railway station CFR Ilva Mică, at 21:47 o'clock, the driver noticed abnormal sounds from the locomotive and after the moth-balled, one requested guidance of another

locomotive to haul the next train, as well as an intervention team from SCRL „CFR – SCRL Braşov" SA - Suceava locomotive repair department to determine the abnormal noise causes.

Following the checks at the locomotive, by the intervention team one found out that the axle no. 4 was broken. Under this circumstances one took the measure to remove the load and put the broken axle on Diplory push-car, and the locomotive EA 040-139-2 was guided to Suceava Nord engine shed in light state with a miximum speed of 5 km/h.

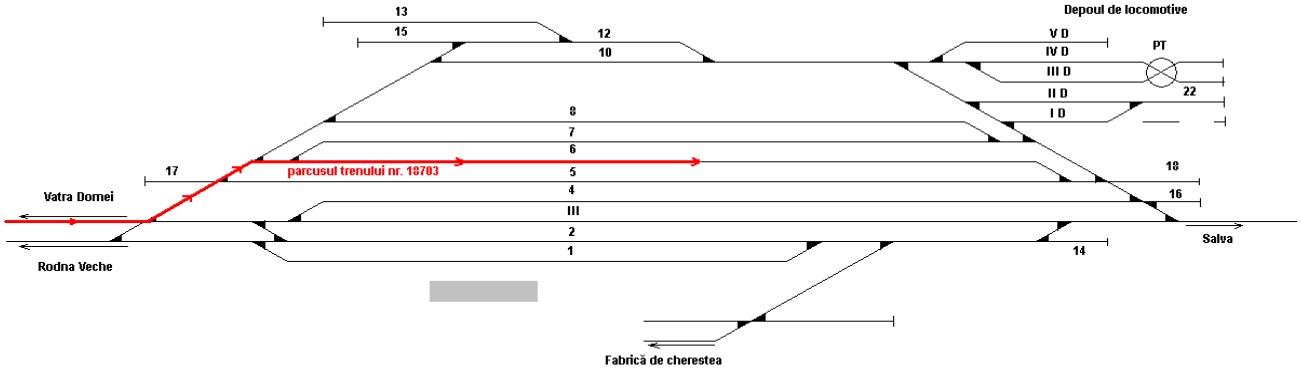
There were no injures or line damages, equipment or rolling stock, except the locomotive EA 040-139-2.

B.2. The circumstances of the accident

B.2.1. The involved parties

The railway station Ilva Mică were the incident occured is located on the running section Floreni - Ilva Mică and it is administrated by CNCF "CFR" SA, as is maintained by its employees.

After directing the trains, the railway station Ilva Mică is equipped with interlocking system type CR6 with key button and vertical control panel.



Staţia ILVA MICĂ

The hauling locomotive and wagons formed the train no. 18703 are owned by the rail operator SNTFC „CFR Călători" SA and are inspected during the route and maintained by its employees, and the repairs are performed by economic agents authorized railway suppliers.

The investigation commision questioned the employees involved in running the locomotive (the driver, who drove the locomotive on the distance Câmpulung Est – Ilva Mică - SNTFC „CFR Călători" SA employee) and in locomotive maintenance (the operator who carried out the latest ultrasonic testing at the locomotive axles, before the axle breakage – employee at Locomotive Repair Commercial Company „CFR – SCRL Braşov" SA).

The investigation commision did not questioned other witnesses at the incident occurence (passengers, other witnesses) since it was not necessary for establishing the incident occurence causes.

B. 2.2. Composition and equipments of the train

The passenger train no.18703, composed of 4 passenger cars (3 wagons with compartments and one sleeping car running without passengers), 16 axles, 195 tons, 125 meters, was running on the distance Suceava – Ilva Mică.

The safety and vigilance devices, the INDUSI installation from the traction locomotive's endowment were active and were functioning according to the instructions, the automatic brake being active.

B.2.3. Means of communication

The communication between the engine driver, crew members and the movement inspectors was ensured by radiophone installation.

B.3 Accident consequences

B.3.1 Losses and casualties

Following this incident there were no victims or injured.

B.3.2 Material damages

Except the broken axle, at the locomotive (EA 040-139-2) hauling the train, there were no other damages.

The railway infrastructure and its equipments were not affected as a result of this incident occurence.

The value of physical damages, respectively 13.548,73 lei is equal with the value of the work for replacing the broken axle.

B.3.3 Consequences of the incident in the railway traffic

Since the incident took place on a line in the railway station, it didn't lead to interruption to train movement.

B.4 External circumstances

On 08.09.2009, between 21:00 - 22:00 the visibility was good, clear sky, with specific brightness at night.

In the railway station Ilva Mică the railway lines situation when the incident occured was:

- the lines 1, III direct, 4, 6 and 10 were open;
- line 2 occupied with train no. 4486/4481;
- line 8 occupied with freight cars;
- line 7 was closed;
- line 5 was closed down (dismantled track).

At the railway incident spot (line 6), the line was curved with radius of 440 m and gradient of 5 ‰.

The visibility of colour-light signals was according to the provisions of the specific regulations in force.

B.5 Investigation process

B.5.1 The summary of the testimonies of the railway staff**.**

The **engine driver** stated as follows:

- he took over the locomotive in the railway station Câmpulung Est, in good operational conditions;
- the locomotive was normally operating until entering into the railway station Ilva Mică;
- entering into the railway station Ilva Mică he heard an abnormal noise coming from the running part of the locomotive and he took immediately measures for braking, managing to park the train at line 6;
- the abnormal noise consists in sounds specific to a friction when crossing over joints;
- after stopping the train he ensure the locomotive against departure and then he performed an inspection, when he felt a strong smell of hot metal coming from the axle no. 4;
- following the ones found out he declared that the locomotive is out of operation and requested an emergency locomotive to haul the next train;
- he notice by phone the Suceava Nord depot management about the ones found out and requested an intervention team to check the locomotive.

The operator who performed the last ultrasonic test at the locomotive axles prior the axle breakage, stated as follows:

- the last ultrasonic non-destructive checking (CUS) at the locomotive was performed on 09.06.2009;
- during this control there were found no defects at this locomotive axles;
- he performed the ultrasonic non-destructive checking and probes according to the specific regulations in force;
- the checking was performed according to the methodology and steps provided in the specific regulations in force;
- the place where the ultrasonic checking was performed meets the conditions of environment established by the specific regulations in force;
- during the year he performed ultrasonic checking at about 600 locomotive axles, and he found out about, in average, 4-5 axles with defects, and about 5-6 axles that, following the ultrasonic checking, require additional measures for tracking into operation.

B.5.2. Safety Management System

In order to comply with its tasks, SNTFC "CFR Calatori" SA and CNCF "CFR" SA established and implemented their own safety management system.

One did not observe problems in the application of its provisions.

B.5.3 Norms and regulations

During the investigation of the railway incident one took into account the next norms and regulations**:**

- SNCFR order – General Traction Direction no. 310/4/a/2800/1993 on technical conditions for operation for electric locomotive axles;
- The Romanian Railway Register act - REFER RA no. 32/5740/1997 – on the interpretation of the oscillographs resulting from the ultrasonic tests at the electric locomotive axles;
- Instructions for the locomotive staff activity in railway transport no. 201/2007;

B.5.4 Sources and references for investigation

- photos taken during the removal and examination of the axle by the inquiry commission members;
- the assessment report for technical findings no. 224/769/16.09.2009 concluded with the occasion of the broken axle removal from the locomotive EA 040-139-2 in the Suceava Nord depot;
- locomotive EA 040-139-2 incident record;
- documents on inspections and repairs at the locomotive EA 040-139-2;

- documents on train movement no. 18703 from 08.09.2009;
- the questionnaires taken from the involved employees;
- the Testing Report no. 3050 - 001 from 12.04.2010 on mechanical tests, metal radiography and chemical analysis of the Romanian Railway Notified Body within the Romanian Railway Authority – AFER;
- non-destructive examination report no. 3080/202/01.04.2010 of the Romanian Railway Notified Body within the Romanian Railway Authority – AFER.

B.5.5 The rolling-stock functioning

B.5.5.1. The Locomotive EA 040-139-2

B.5.5.1.1. Technical characteristics of the locomotive

- normal voltage in catenary-type overhead contact line 25,0 kV;
- tractive energy 5.100 kW;
- axles arrangement Co-Co;
- length between coupler heads 19.800 mm;
- body width 3.000 mm;
- height with lowered pantograph 4.500 mm;
- distance between bogies centers 10.300 mm;
- bogie pitch 4.350 mm;
- wheel diameter in new condition 1.250 mm;
- minimum radius for the entrance in the curve 90 m;
- constructive maximum speed 120 km/h.

B.5.5.1.2. Inspections and repairs made at the locomotive

- full repair type RK in 1993 at SC ELECTROPUTERE SA Craiova;
- repair by jacking type RR in 2006 at SCRL „CFR – SCRL Braşov" SA – Braşov section;
- inspection type R2 on 10.06.2009 at SCRL „CFR – SCRL Braşov" SA – Suceava Nord section.

B.5.5.2. Broken pair of wheels

B.5.5.2.1. Data on the axle history

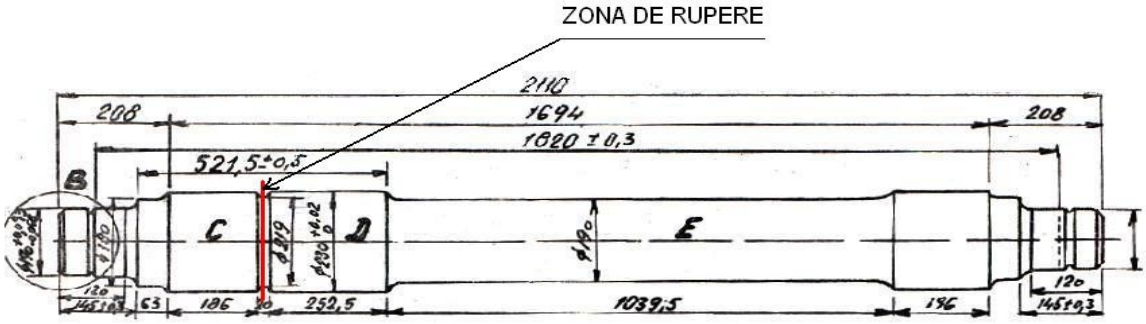
- registration number in the CFR stock: 41751;
- melting stock no: 87283;
- year: 1981;
- manufacturer: ICMC Caransebeş (current name SC CAROMET SA Caransebeş);
- the date when the axle was put on the locomotive EA 040-139-2: 12.01.2006 (with the occasion of the repair by jacking type RR);
- the locomotive: EA 261;
- km performed by the axle from the date when the axle was put on the locomotive EA 040-139-2 until the breakage date: 352.501;
- the date when the last non-destructive check with ultrasonic was performed: 09.06.2009;
- km performed by the axle from the date when the last non-destructive check with ultrasonic was performed: 28.505.

B.5.5.2.2. Findings performed on the pair of wheels – gear drum during its removal from the locomotive on September 16, 2009

- at the bogie frame on which the axle was put on, one found friction traces due to changes in position after the axle center breakage;
- the axle-bearings, axle roller bearings and pinion Z 20 were in good condition;
- after removing the gear drum from this axle, the followings were found out:

- the toothhed wheel and the drive pinion didn't have the teeth affected and didn't show any signs of pitting;
- the oil in the gear drum was in an appropriate amount and didn't contain any metalic filings;
- the bearings supporting the gear drum didn't have the tendency to lock, without clearance and without abnormal noise;

- the axle breakage happened at 402 - 408 mm from the axle head, perpendicularly on its longitudinal axis, on the connection between the wheel-seat area of the wheel membrane on the gear side (C) and the wheel-seat area of the toothhed wheel (D) (drawing no.1);



Drawing no. 1

- the weld size shows two distinct areas (photo no. 1) :
  - a specific area with fatigue fracture representing about 80 % of the breaking section;
  - an area with sharp breaking aspect, with material pluck representing about 20 % of the breaking section;

Photo nr. 1

B.5.5.2.3. Results of tests and examinations performed on the pair of wheels in AFER laboratories

- at the pair of wheels the following tests and examinations were performed:

- macroscopic view;
- traction testing;
- Charpy notch-impact test;
- measurement of Brinell hardness on longitudinal and cross section;
- determine the chemical composition;
- macroscopic metal radiography analysis:
  - macrograph examination by sulphur print;
  - macroscopic examination after hot attack;
- microscopic metal radiography analysis:
  - microstucture examination;
  - hereditary austenitic grain size determination (Kohn method);
  - non-metallic inclusions determination;
- non-destructive examination:
  - ultrasonic control;
  - penetrating liquid control;

- from these tests and examinations the followings were found out:
  - on the breaking surface one observe an area with fatigue breakage (gradual) representing about 90 % of the total breaking surface;
  - rhumb lines trace of fatigue crack (concave arcs against breakage centre showed that upon the axle was applied cyclical stress by stretching – compression until complete breakage);
  - on the breakage section edge there weren't any tendency to fatigue fracture due to the material distortion and print from repeated blows of the open cracks surfaces until the axle centre breakage;
  - the results from these tests, examinations and determination are within the limits imposed by reference documents.

B.6. Analysis and conclusions

From the analysis of findings on the broken axle and of the results of the tests and examinations performed in AFER laboratories, one can conclude the followings:

- the axle breakage is a fatigue fracture;
- one could not identify the tendency to this fatigue fracture because the exterior areas of the two fracture surfaces were distorsioned due to the repeated blows of the open cracks surfaces until complete breakage;
- because the results of these tests, examinations and determinations were within the limits imposed by reference documents, one could not identify any favoured factors of these breakage;
- the breakage occured as a result of exceeding the fatigue limit of the material from which the axle was made, which favoured a large number of stretching – compression cycles that were apllied on this axle along its length of operation, from the date the pair of wheels were mounted at the locomotive EA 040-139-2 - 12.01.2006 the axle covered a distance of 352.501 km.

B.7. Measures taken or adopted due to the incident

Following this railway incident the Romanian Railway Notified Body requested the railway transport operators holding electric locomotives equipped with pair of wheels of the type involved in this incident to verify if these locomotives are equipped with axles whose axle center comes from the same melting stock with the one of the broken axle (melting stock no. 87283/81) and where such axle are identified, they are non-destructive checked by ultrasonic control. If, after these checks, the axles

didn’t have any defects, they could be kept in operation only in terms of ultrasonic control monthly performed for a period of one year.

Following those checks there were identified 5 pair of wheels of which the axle center comes from the melting stock no. 87283/81, axles from 5 electric locomotives, owned by 2 transport operators. All 5 pair of wheels were non-destructive checked with ultrasonic control and there were not found any defects in their axles center.

Until the completion of the inquiry, following the monthly ultrasonic controls, in none of the 5 pair of wheels were found fault echoes.

B.8. The incident causes

B.8.1. Direct cause

The direct cause of the incident occurence exceeding the material fatigue limit from witch the axle no.41751 was manufactured.

The favoured fact was a large number of stretching – compression cycles that were apllied on this axle along its length of operation. Thus, from the date the pair of wheels were mounted at the locomotive EA 040-139-2 - 12.01.2006 the axle covered a distance of 352.501 km.

B.8.2. Underlying cause

There weren’t identified any underlying causes of this railway incident.

B.8.3. Root causes

There weren’t identified any root causes of this railway incident.

C. SAFETY RECOMMENDATIONS

The Romanian Railway Safety Authority together with the railway transport operators will analyse the opportunity that, at the pair of wheels of the type involved in this incident, after a certain operation period, to be increased the frequency of the ultrasonic inspections.

If, following this analyse, it will be determined that is appropriate to increase the frequency of ultrasonic checks at this type of pair of wheels, the Romanian Railway Authority shall draw up a railway technical norm that will be the base for the implementation of this safety recommendation.

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The present investigating report will be transmitted to the Romanian Railway Authority, Romanian Railway Safety Authority, public railway infrastructure manager CNCF "CFR" SA, SNTFC "CFR Călători" SA and to the others railway operators.

Members of the investigating commission:

Zamfirache Marian - investigator in charge

Drăghici Marin - investigator

Oltenacu Livius - investigator

Măcicăşan Vladimir - investigator