



MINISTRY OF TRANSPORTS AND INFRASTRUCTURE
ROMANIAN RAILWAY AUTHORITY - AFER



ROMANIAN RAILWAY INVESTIGATING BODY

INVESTIGATING REPORT

on the derailments of the electric multiple units type Z 6100
occurred between the 25th and 26th of January 2010



Final edition
the 18th of March 2010

NOTICE

With reference to the railway accidents happened between the 25th and the 26th of January 2010, in which were involved the electric multiple units type Z 6100, as follows:

- the derailment of the passenger train no. 4503, belonging to SNTFC “CFR” Calatori, happened on the 25th of January 2010, at 7,30 hour, at the km 54+862, between Malnas Bai and Bicsadu Oltului railway stations of the Railway Regional Branch Brasov;
- the derailment of the passenger train no. 5501, belonging to SNTFC “CFR Calatori”, happened on the 26th of January 2010, at 05,04 hour, on the switch no. 67 from the end X of the railway station Suceava of the Railway Regional Branch Iasi;
- the derailment of the passenger train no. 4506, belonging to SNTFC “CFR Calatori”, happened on the 26th of January 2010, at 14,22 hour, at the km 79+422, between Sansimion and Tusnad Sat railway stations of the Railway Regional Branch Brasov.

Romanian Railway Investigating Body (abbreviating OIFR) performed an investigation in accordance with the provisions of the law no. 55/2006 on the railway safety. Through the investigation, one gathered and analyzed the information on the occurrence of this accident, the conditions and causes were established.

OIFR investigation did not aim to establish the guilty or the responsibility in this situation.

Romanian Railway Investigating Body considers necessary to be taken corrective measures in order to improve the railway safety and to prevent the accidents, therefore it has issued a series of safety recommendations in this report.

The 18th of March 2010

Approved
Director
Dragos FLOROIU

I agree the compliance with the legal provisions on the investigation performance and drawing up of this Investigation Report, that I submit for approval.

Chief Investigator

Sorin Constantinescu

This approval is part of the Investigating Report on the railway accidents occurred on the 25th and on the 26th January 2010, in which were involved the electric multiple units Z 6100, as follows:

- *the derailment of the passenger train no. 4503, belonging to SNTFC “CFR” Calatori, happened on the 25th of January 2010, at 7,30 hour, at the km 54+862, between the railway stations Malnas Bai and Bicsadu Oltului of the Railway Regional Branch Brasov;*
- *the derailment of the passenger train no. 5501, belonging to SNTFC “CFR Calatori”, happened on the 26th of January 2010, at 05,04 hour, on the switch no. 67 from the end X of the railway station Suceava of the Railway Regional Branch Iasi;*
- *the derailment of the passenger train no. 4506, belonging to SNTFC “CFR Calatori”, happened on the 26th of January 2010, at 14,22 hour, at the km 79+422, between the railway stations Sansimion and Tusnad Sat of the Railway Regional Branch Brasov.*

	Page
Preamble	6
I.1. Introduction	6
I.2. Investigation process	6
A. Concise accidents	8
A.1 Brief presentation	8
A.1.1 The accident occurred between Malnas Bai and Bicsadu Oltului railway stations	8
A.1.2 The accident occurred in Suceava railway station	9
A.1.3 The accident occurred between Sansimion and Tusnad Sat railway stations	9
A.2. Accidents causes	10
A.2.1 Common elements of the 3 derailments	10
A.2.2 Direct cause	10
A.2.3 Contributing factors	10
A.2.4 Subsidiary causes	10
A.2.5 Root causes	10
A.3 Severity level	11
A.4 Safety recommendations	11
B. The investigation report	12
B.1 Accident presentation	12
B.1.1 Presentation of the accident occurred between Malnas Bai and Bicsadu Oltului railway stations	12
B.1.2 Presentation of the accident occurred in Suceava railway station	12
B.1.3 Presentation of the accident occurred between Sansimion and Tusnad Sat railway stations	14
B.2 Accidents circumstances	15
B.2.1 Involved parties	15
B.2.1.1 Accident occurred between Malnas Bai and Bicsadu Oltului railway stations	15
B.2.1.2 Accident occurred in Suceava railway station	15
B.2.1.3 Accident occurred between Sansimion and Tusnad Sat railway stations	16
B.2.2 Train forming and equipment	
B.2.2.1 Accident occurred between Malnas Bai and Bicsadu Oltului railway stations	16
B.2.2.2 Accident occurred in Suceava railway station	17
B.2.2.3 Accident occurred between Sansimion and Tusnad Sat railway stations	17

B.2.3 Railway equipment	17
B.2.3.1 Accident occurred between Malnas Bai and Bicsadu Oltului railway stations	17
B.2.3.2 Accident occurred in Suceava railway station	17
B.2.3.3 Accident occurred between Sansimion and Tusnad Sat railway stations	17
B.2.4 Communication facilities	18
B.3 Accident consequences	18
B.3.1 Fatalities and injuries	18
B.3.2 Material damages	18
B.3.2.1 Accident occurred between Malnas Bai and Bicsadu Oltului railway stations	18
B.3.2.2 Accident occurred in Suceava railway station	18
B.3.2.3 Accident occurred between Sansimion and Tusnad Sat railway stations	18
B.3.3 Accidents consequences in railway traffic	18
B.3.3.1 Accident occurred between Malnas Bai and Bicsadu Oltului railway stations	18
B.3.3.2 Accident occurred in Suceava railway station	18
B.3.3.3 Accident occurred between Sansimion and Tusnad Sat railway stations	18
B.4 External circumstances	19
B.4.1 Accident occurred between Malnas Bai and Bicsadu Oltului railway stations	19
B.4.2 Accident occurred in Suceava railway station	19
B.4.3 Accident occurred between Sansimion and Tusnad Sat railway stations	19
B.5 Investigation process	19
B.5.1 Brief presentation of the involved staff testimonies	19
B.5.1.1 Accident occurred between Malnas Bai and Bicsadu Oltului railway stations	19
B.5.1.2 Accident occurred in Suceava railway station	20
B.5.1.3 Accident occurred between Sansimion and Tusnad Sat railway stations	21
B.5.2 Safety management system	22
B.5.3 Norms and regulations. Sources and references for investigation	22
B.5.4 Operation of technical installation, infrastructure and rolling stock	22
B.5.4.1 Data on the lines	22
B.5.4.1.1 Accident occurred between Malnas Bai and Bicsadu Oltului railway stations	22
B.5.4.1.2 Accident occurred in Suceava railway station	24
B.5.4.1.3 Accident occurred between Sansimion and Tusnad Sat railway stations	25
B.5.4.2 Data found out on the rolling stock and its technical equipment operation	27
B.5.4.3 Findings and conclusions of the investigation commission on the operation of the involved multiple electric units	30
B.5.4.3.1 Electric multiple units involved in the accident occurred between Malnas Bai and Bicsadu Oltului railway stations	30
B.5.4.3.2 Electric wagon involved in the accident occurred in Suceava railway station	33

B.5.4.3.3 Electric wagon involved in the accident occurred between Sansimion and Tusnad Sat railway stations	36
B.6 Accidents causes	38
B.6.1 Common elements of those 3 derailments	39
B.6.2 Direct cause	39
B.6.3 Contributing factors	39
B.6.4 Subsidiary causes	39
B.6.4 Root cause	39
C Safety Recommendations	39

PREAMBLE

1.1 Introduction

With reference to the railway accidents happened between 25th and 26th of January 2010, in which were involved the electric multiple units type Z 6100, respectively :

- the derailment of the passenger train no. 4503, belonging to SNTFC “CFR” Calatori, happened on the 25th of January 2010, at 7,30 hour, at the km 54+862, between the railway stations Malnas Bai and Bicsadu Oltului of the Railway Regional Branch Brasov;
- the derailment of the passenger train no. 5501, belonging to SNTFC “CFR Calatori”, happened on the 26th of January 2010, at 05,04 hour, on the switch no. 67 from the end X of the railway station Suceava, of the Railway Regional Branch Iasi;
- the derailment of the passenger train no. 4506, belonging to SNTFC “CFR Calatori”, happened on the 26th of January 2010, at 14,22 hour, at the km 79+422, between the railway stations Sansimion and Tusnad Sat of the Railway Regional Branch Brasov.

Romanian Railway Investigating Body, abbreviating OIFR, started an investigation in order to prevent some accidents with similar causes, by establishing the conditions, causes and issuing some safety recommendations.

OIFR investigation did not aim to establish the guilty or the responsibility, its objective being the improvement of the railway safety and the prevention of the railway accidents.

1.2 Investigation process

On the 25th of January 2010, at 7,30 hour, in the Railway Regional Branch Brasov, between Malnas Bai and Bicsadu Oltului railway stations, at the km 54+862, the first bogie of the trailer coach no. 111 from the composition of the electric multiple unit no. 011 derailed. The electric multiple unit no. 011 was operated as the passenger train no. 4503 belonging to SNTFC “CFR Calatori”

between Brasov and Izvoru Oltului railway stations.

Soon after the occurrence of the railway accident, Romanian Railway Investigating Body was notified verbally and in written by Romanian Railway Safety Authority about it. It was also notified about:

- the passenger train no. 4503 was stopped on the running line at the km 55+650;
- the first bogie from the trailer coach no. 111 of the electric multiple unit no. 011 (the second in the running direction) was derailed and situated at 80 – 85 cm from the rail head;
- there were no problem at the line and railway equipments.

The accident didn't produce people injured or victims.

On the 26th of January 2010, at 5,04 hour, in the Railway Regional Branch Iasi, the both bogies of the trailer coach no. 207 derailed on the switch no. 67 positioned at the end X of Suceava railway station. The trailer coach no. 207 was the 3rd coach from the electric train no. 007 which was operated between Pascani and Suceava as the passenger train no. 5501 belonging to SNTFC “Calatori” SA.

Soon after the occurrence of the railway accident, Romanian Railway Investigating Body was notified verbally and in written by Romanian Railway Safety Authority. It was also notified about:

- the passenger train no. 5501 was stopped on the acceptance section of Suceava railway station;

- the first bogie of the trailer coach no. 207 in its running direction (the last of the electric train no. 007) was derailed, the left rail of the deflection line 1A being between the wheels of this bogie;
- the second bogie (in the running direction) of the wagon no. 207 was derailed at the km 446+440, at 20 m from the heel joint of the crossing of the switch no. 67, the right rail of the line II being between the wheels of this bogie;
- the line and the railway equipments have not been affected.

On the 26th of January 2010, at 14,22 hour, in the Railway Regional Branch Brasov, at the km 79+422, between Sansimion and Tusnad Sat railway stations, in the running of the passenger train no. 4506, belonging to SNTFC “CFR Calatori” operating between Izvoru Oltului – Brasov, happened the derailment of the first bogie of the motorized coach of the electric multiple unit no. 010.

Soon after the accident Romanian Railway Investigating Body – OIFR was notified verbally and in written by Romanian Railway Safety Authority.

OIFR staff immediately went to the accident place and they found out about:

- the passenger train no. 4506 was stopped on the running line at the km 55+650;
 - the first carrying bogie from the motor coach no. 1 of the electric multiple unit no. 010 was derailed at 30 – 35 cm from the head of the rail;
 - there were no problems with the line and railway equipments.
- The accident didn't produce people injured or victims.

At those 3 accidents places were also present the representatives of:

Emergencies Inspectorate

Operative Department of the Railway Transport Policy

Romanian Railway Safety Authority

National Railways Company “CFR” SA

National Railway Passenger Company “CFR Calatori” SA

According to the Decision no. 16 from the 27th of January 2010 of OIFR Director, according to the provisions of art. 19, paragraph 2, from the Law no. 55/2006 on the railway safety, was appointed the investigation commission, consisting in:

- Mr. Cristian Ionut BOBE – investigator in charge
- Mr. Eduard STOIAN – investigator
- Mr. Marin DRAGHICI – investigator
- Mr. Vladimir MACICASAN – investigator
- Mr. Cristian GROZA – investigator
- Mr. Dumitru SFARLOS – investigator

Also, according to the art. 20, paragraph 4 of the Law no. 55/2006 on the railway safety, in connection with these investigations OIFR required specialists as follows:

- Mr. Adrian PREDESCU – state central synthesis inspector from Romanian Railway Safety Authority;
- Mr. Mihai STANCIU – synthesis expert from Romanian Railway Notified Body;
- Mr. Radu LAZA – technical inspector from Romanian Railway Notified Body;
- Mr. Mircea URDEA – technical inspector from Romanian Railway Notified Body;

- Mr. Dragos IACOB – head of department for engine modernization from SNTFC “CFR Calatori” SA;
- Mr. Bogdan TIMIS – central inspector from SNTFC “CFR Calatori” SA
- Mr. Iulian TURDEAN – head of CTC Department and Laboratories from SC REMARUL 16 FEBRUARIE SA Cluj Napoca
- Mr. Mihai Sorin CROITORU – head of Technical Department from CFR SCRL BRASOV SA.

A. CONCISE ACCIDENTS

A.1 Brief presentation

A.1.1 The accident occurred between Malnas Bai and Bicsadu Oltului railway stations

On the 25th of January 2010, at 7,30 hour, in the running of the passenger train no. 4503 operating between Brasov and Izvoru Oltului, occurred the derailment of the first bogie from the trailer coach no. 111 of the electric multiple unit no. 011 between Malnas Bai and Bicsadu Oltului railway stations.

The accident was placed at km 54+862, in the curve with radius 324 m, situated at the km 54+760 and km 55+283.

The passenger train no. 4503 consisted in electric multiple units no. 011 and no. 012, both of them belonging to SNTFC “CFR” SA.

The railway accident consisted in the derailment of the both axles from the first bogie in the running direction of the coach no. 111 in the componence of the electric multiple unit no. 011. The derailment occurred at the km 54+862 by climbing the outside rail of the curve by the left wheel of the axle no. 5 (first in the running direction) from the first bogie of the wagon no. 111 (trailer coach of the electric multiple unit no. 011), followed by the fall of the wheel in the outside of the track. The derailment of the right wheel of the axle consisted in the fall of the wheel in the inside of the track, being a consequence of the derailment of the left wheel. The derailment of the axle no. 5 generated also the derailment of the axle no. 6 (the second in the running direction) from the same bogie. The distance run by the train from the climbing place up to the stop was 788 m.

There were neither injured people or lines and equipment damages. There were small damages at the wagon no. 111 of the electric multiple unit no.011.

The railway accident place is on Sfantu Gheorghe – Siculeni track section which is belonging to CNCF “CFR” SA - Railway Regional Branch Brasov.

A.1.2 The accident occurred in Suceava railway station

On the 26th of January 2010, at 5,45 hour, in the running of the passenger train no. 5501, between Pascani and Suceava, at the entry into the railway station Suceava, in the curve of the switch no. 67, giving the access on the deflecting section 1A, at the end X to Veresti, derailed the both bogies of the trailer coach no. 207 of the electric multiple unit no. 007. The train run the entry line with 25 km/h on permissive light of the signal XP on the deflecting section no. 1A.

The accident's point was on the left side of the no.67 switch's curve which permitted the access to the deflecting line 1A from the end X of Suceava railway station, at the km 446+406, at about 18 m from the stock rail joint of the switch.

The passenger train no.5501 consisted in electric multiple unit no. 007, belonging to SNTFC "CFR Calatori" SA.

The railway accident consisted in the derailment of the both bogies of the coach no. 207 from the electric multiple unit no. 007 in the curve of the switch no. 67 giving access on the deflecting section 1A from the railway station Suceava. The derailment consisted in the over-climbing of the outside rail of the curve of the switch no. 67 by the left wheel of the axle no. 11 (first in the running direction), from the second bogie in the running direction of the trailer coach no. 207 of the electric multiple unit no. 007, followed by the fall of the wheel outside the track. The derailment of the left wheel of the axle consisted in the fall of the wheel inside the track, being a consequence of the derailment of the left wheel. The derailment of the axle no. 11 involved also the axle no. 12 from this bogie and then led to the derailment of the first bogie in the direction of the wagon running.

The distance run by the train from the over-climbing up to the stop was of 52 m.

There were neither hurt people nor damages at the line or at the equipments. There were small damages at the electric multiple unit no. 007.

The place of the accident – railway station Suceava is in the Railway Regional Branch Iasi belonging to CNCF "CFR Calatori" SA.

A.1.3 The accident occurred between Sansimion and Tusnad Sat railway stations

On the 26th of January 2010, at 14,22 hour, in the running of the passenger train no. 4506, between Izvoru Oltului – Brasov, between Sansimion and Tusnad Sat railway stations, derailed the first bogie from the power coach no. 010 of the electric multiple unit no.010.

The accident's place was to the km 79+422, in the curve with the radius of 275 m, between the km 79+157 and the km 79+547.

The passenger train no.4506 consisted in electric multiple units no.010 and no.014, both of them belonging to SNTFC "CFR Calatori" SA.

The railway accident consisted in the derailment of both axles from the first bogie in the running direction of the electric multiple unit no.010. The derailment occurred at the km 79+422, by the over-climbing of the rail from the outside rail of the curve by the left wheel of the axle no. 1 (first in the running direction) from the first bogie in the running direction of the coach no. 1 (power coach) from the electric multiple unit no. 010, followed by the fall of the wheel inside the track. The derailment of the right wheel of the axle happened by the fall of the wheel inside the track, being a consequence of the left wheel derailment. The

derailment of the axle no. 1 led to the derailment of the axle no. 2 (second in the running direction) from the same bogie.

The distance between the over-climbing and the stop was 120 m.

There were neither injuries people nor damages at the line or at the equipment. There were small damages at the electric multiple unit no.010.

The accident place is on the track section Sfantu Gheorghe – Siculeni, belonging to CNCF “CFR Calatori” SA –Railway Regional Branch Brasov.

A.2 Accidents causes

A.2.1 Common elements of the 3 derailments

From the data concerning those 3 accidents resulted that, in all cases, the derailments had a series of common elements, as follows:

- they occurred in the running of the passenger trains, consisting in electric multiple units type Z 6100,
- the weather conditions of the 3 derailments consisted in low temperatures between -16°C and -29°C ,
- they involved the first axle of the carrying bogies and consisted in the derailment of the first wheel outside the track,
- as a consequence of the first wheel derailment the other wheel of the same axle (the first axle) derailed by falling inside the track,
- the derailments happened in the circular curves with radius between 275 m and 324 m;
- there were no failure of the lines or of the electric multiple units, that can be included in the direct causes of the accidents.

A.2.2 Direct cause

The direct cause of the accidents was the over-climbing of the inside shoulder of the rail outside the curve by the first wheel of the first axle of the carrying bogies, followed by its fall outside the track.

A.2.3 Contributing factors

The over-climbing on the inside shoulder of the rail from the outside shoulder of the rail occurred because of the exceeding the derailment safety limit, in the conditions of increasing the guiding force on the first wheel operating in curve.

The increase of the guiding force (horizontal one) appeared because of the limitation of the opening of the upper shoes of the body on the bogie, on the operation parts of the lateral support guides from the bogie, because of the existing ice, finally leading to the stop of the relative movement between the contact surfaces of the lateral guides (in the case of the derailment of the bogie no. 6 of the wagon no. 207 of the electric multiple unit no. 007).

Other factor that could influence the increase of the guiding force, but that could not be effectively identified by the train, is melting of the snow between the surfaces of the pivot centre jacket and the bogie bearing and the appearance of ice on the surfaces in contact, and being the low temperatures, it could lead to the stop of the relative movement between these and implicitly of the bogie rotary motion.

A.2.4 Subsidiary causes

None

A.2.5 Root causes

None

A.3 Severity level

According to the provisions of the art. 3, letter 1 of the Law no. 55/2006 on railway safety, the events by their consequences, are grouped as railway accidents.

A.4 Safety recommendations

The addressee of the safety recommendations is SNTFC "Calatori"SA, as owner of the electric multiple units type Z 6100.

The recommendation aims to solve:

- identification and implementing of some solutions to protect the area between the upper shoes of the bogie box and the lateral guide from the bogie against the penetration of snow.

If the safety recommendation shall be implemented, there are not necessary the safety recommendations proposed by OIFR by the Report no.4110/30/2010, concerning:

- interdiction on operate at the temperature under -20°C for the trains composed by electric multiple units type Z 6100, including handling;
- restriction of the speed at 50 km/h on the running and open lines and at 15 km/h on the deflecting section from the stations for the cases in which these electric multiple units have to run in conditions of out temperatures between -5°C and -20°C .

This investigation report shall be sent to CNCF "CFR" SA, SNCF "CFR" SA, Romanian Railway Notified Body and Romanian Railway Safety Authority.

According to the Law no. 55/2006 on railway safety, Romanian Railway Safety Authority will monitor the implementation of these recommendations

B. INVESTIGATING REPORT

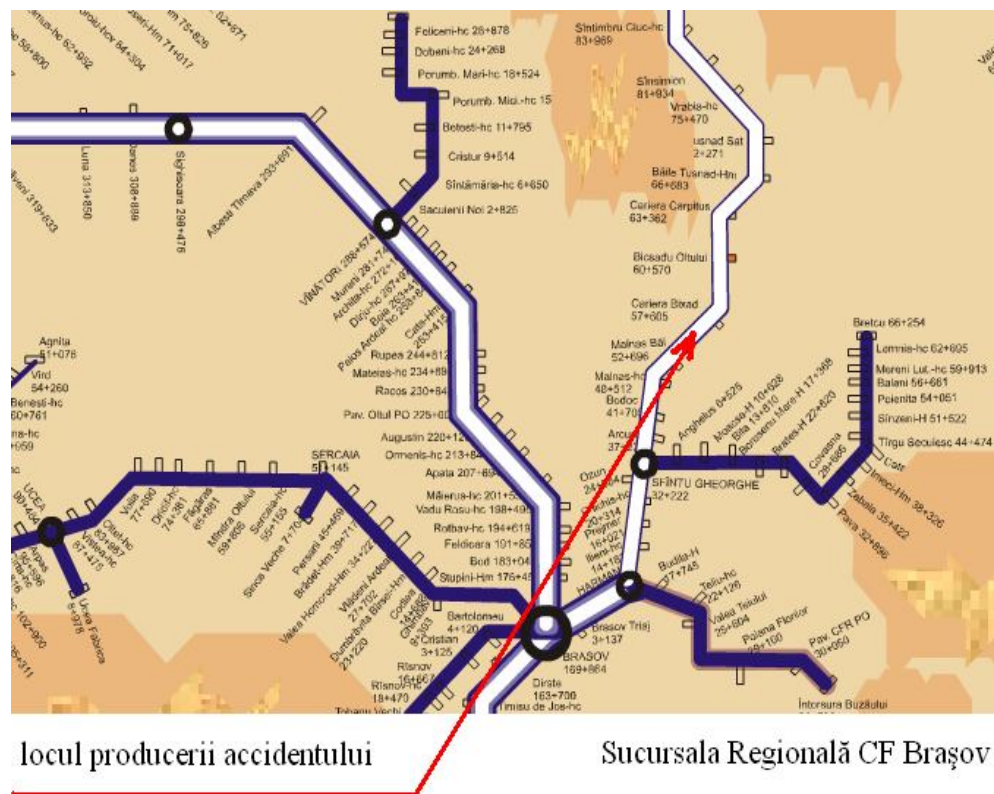
B.1 Accidents presentation

B.1.1 Presentation of the accident occurred between Malnas Bai and Bicsadu Oltului railway stations

On the 25th of January 2010, at 06:12 hour, the passenger train no. 4503 was dispatched from the railway station Brasov, running without problems up to the railway station Malnas Bai where it was stabled at 7:25 hour. After a one minute stop, at 7:26 hour the train was dispatched without remarks to the railway station Bicsadu Oltului.

According to the scheduled train-path, the next stop after the departure from the railway station Malnas Bai was to be the railway station Bicsadu Oltului.

The train ran without problems up to the km 54+862 where occurred the derailment of the first carrying bogie from the trailer coach no. 111 of the electric multiple unit no. 011, speed of 64 km/h. The train stopped at the km 55+650, at 7,30 hour, when the speed decreased from 64 km/h to 0 km/h.



The passenger train no. 4503 consisted in the electric multiple units no. 011 and 012, both of them belonging to SNTFC “CFR Calatori” SA.

The railway accident consisted in the derailment of both axles from the first bogie in the running direction of the wagon no. 2 of the electric multiple unit no. 011, in the curve between the km 54+760 and the km 55+283.

B.1.2 Presentation of the accident occurred in the railway station Suceava

On the 26th of January 2010, at 04,00 hour, the passenger train no. 5501 was dispatched from the railway station Pascani, running without problems up to the railway station Varatec,

where it was stabled at 4,59 hour. After a stop of 1 minute, at 5,00 hour, the train was dispatched without remarks to the railway station Suceava.

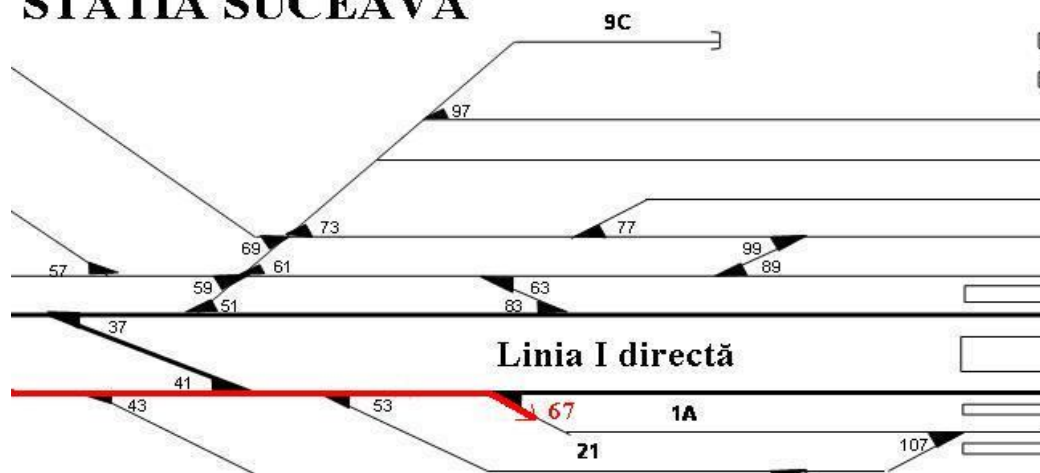


locul producerii accidentului

Sucursala Regională CF Iași

According to the scheduled train-path, after the departure from the railway station Varatec, the next stop was to be the railway station Suceava.

STATIJA SUCEAVA



Cap X

At the entry in the railway station Suceava, at the passing over the switch no. 67 (run over the facing point), operated on the potion “deflecting section” ,on the connection rails area occurred the derailment of the second bogie (in the running direction) of the trailer coach no. 207 from the electric multiple unit no. 007, generating also the derailment of the first bogie of the same wagon.

The train entered, having permissive indication from the signal XP from the deflecting section 1A of the railway station Suceava, with a speed of 25 km/h.

The accident place is in the connection rails area, on the left side of the curve of the switch no. 67, that gives access on the deflecting section 1A, from the end X of the railway station Suceava, at the km 446+406, at about 18m from the tip joint of the switch.

The passenger train no. 5501 consisted in the electric train no. 007, belonging to SNTFC “CFR Calatori” SA.

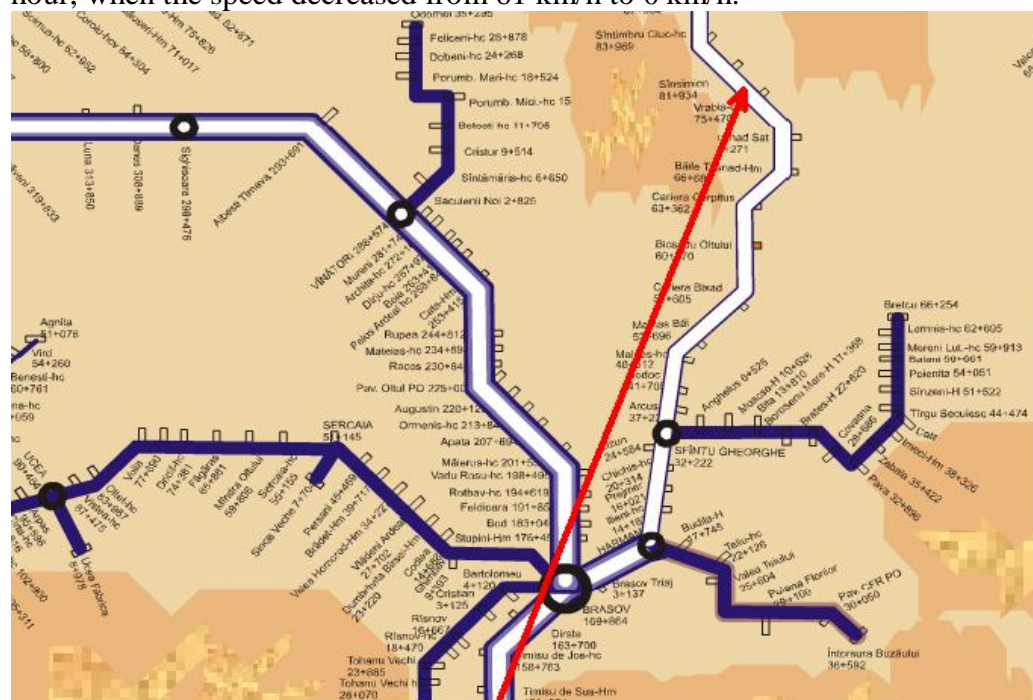
The railway accident consisted in the derailment of both bogies of the trailer coach no. 207 of the electric multiple unit no. 007, in the curve of the switch no. 67, that gives access on the deflecting section 1A from the railway station Suceava.

B.1.3 Presentation of the accident occurred between Sansimion and Tusnad Sat railway stations

On the 26th of January 2010, at 13:03 hour, the passenger train no. 4506 was dispatched from the railway station Izvoru Oltului, running without problems up to the railway station Sansimion where it was stabled at 14,15 hour. After a stop of 4 minutes, at 14:19 hour, the train was dispatched without remarks to the railway station Tusnad Sat.

According to the scheduled train-path, after the departure from the railway station Sansimion, the next stop was to be the railway station Tusnad Sat.

The train ran without other problems up to the km 79+422 where derailed the first bogie (carrying bogie) from the power coach of the electric multiple unit no. 010 (first in the running direction), at the speed of 61 km/h. The train stopped at the km 79+302, at 14:22 hour, when the speed decreased from 61 km/h to 0 km/h.



locul producerii accidentului

Sucursală Regională CF Braşov

The accident place is at the km 79+422, in an area in curve with the radius of 275 m.

The passenger train no. 4506 consisted in electric multiple units no. 010 and 014, both of them belonging to SNTFC “CFR Calatori” SA.

The railway accident consisted in the derailment of both axles from the first bogie in the running direction of the power coach of the electric multiple unit no. 010, in the curve between the km 79+157 and the km 79+547.

B.2 Accidents circumstances

B.2.1 Involved parties

B.2.1.1 Accident occurred between Malnas Bai and Bicsadu Oltului railway stations

The track section Sfantu Gheorghe – Siculeni (electrified single line) where occurred the railway accident is administrated by CNCF “CFR” SA and maintained by its employees.

The infrastructure and superstructure are administrated by CNCF “CFR” SA and maintained by the employees of the Track District 2 Malnas Bai from the Track Section L5 Miercurea Ciuc, of the Railway Regional Branch Brasov.

The interlocking system between the railway stations Malnas Bai and Bicsadu Oltului is administrated by CNCF “CFR” SA and maintained by the employees of the Interlocking District Sfantu Gheorghe of the Track Section CT 1 Brasov of the Railway Regional Branch Brasov.

The railway communication equipment between the railway stations Malnas Bai and Bicsadu Oltului is administrated by CNCF “CFR” SA and maintained by the employees of SC TELECOMUNICATII CFR SA.

Power and traction equipment (IFTE) is administrated by CNCF “CFR” SA and maintained by SC ELECTRIFICARE CFR SA.

The railway communications equipment from the electric involved multiple units belong to SNTFC “CFR Calatori” SA and maintained by CFR SCRL Brasov SA and the repairs are performed by the economic agents, authorized railway suppliers.

The electric multiple units from the train involved in the accident are owned by SNTFC “CFR Calatori ”SA and maintained by CFR SCRL BRASOV SA, and the repairs are performed by the economic agents, authorized railway suppliers.

The Investigating commission questioned all the employees involved in driving and operating the electric multiple units (driver, head conductor, conductor).

The investigating commission did not question other witnesses of the accident (passengers, other witnesses) because it was not necessary in the establishment of the accident causes.

B.2.1.2 Accident occurred in Suceava railway station

The track section Pascani – Suceava (double electrified track) where occurred the accident is administrated by CNCF “CFR” SA and maintained by its employees.

The infrastructure and superstructure are administrated by CNCF “CFR” SA and maintained by the employees of the Track District 2 Suceava from the Track Section L5 Suceava, of the Railway Regional Branch CFR Iasi.

The Traffic control equipment from the railway station Suceava, as well as the interlocking system from the railway station Suceava are administrated by CNCF “CFR” SA and maintained by the employees of the Interlocking District 1 from the Track Section CT 3, of Railway Regional Branch Iasi.

The railway communication equipment from the railway station Suceava is administrated by CNCF “CFR” SA and maintained by the employees of SC TELECOMUNICATII CFR SA.

Power and traction equipment (IFTE) is administrated by CNCF “CFR” SA and maintained by SC ELECTRIFICARE CFR SA.

The railway communications equipment from the involved electric multiple units belongs to SNTFC “CFR Calatori” SA and maintained by CFR SCRL Brasov SA.

The electric multiple units from the train involved in the accident are owned by SNTFC “CFR Calatori ”SA and maintained by CFR SCRL BRASOV SA, and the repairs are performed by the economic agents, authorized railway suppliers.

The Investigating commission questioned all the employees involved in driving and operating the electric multiple units (driver, head conductor, conductor)

The investigating commission did not question other witnesses of the accident (passengers, other witnesses) because it was not necessary in the establishment of the accident causes.

B.2.1.3 Accident occurred between Sansimion and Tusnad Sat railway stations

The track section Sfantu Gheorghe – Siculeni where occurred the accident is administrated by CNCF “CFR” SA and maintained by its employees.

The infrastructure and superstructure are administrated by CNCF “CFR” SA and maintained by the employees of the Interlocking District 3 Tusnad Sat from the Track Section L5 Miercurea Ciuc of the Railway Regional Branch Brasov.

The interlocking system between the railway stations Sansimion and Tusnad Sat is administrated by CNCF “CFR” SA and maintained by the employees of the Interlocking District Sfantu Gheorghe from the Track Section CT 1 Brasov of the Railway Regional Branch Brasov.

The railway communication equipment between the railway stations Sansimion and Tusnad Sat is administrated by CNCF “CFR” SA and maintained by the employees of SC TELECOMUNICATII CFR SA.

Power and traction equipment (IFTE) is administrated by CNCF “CFR” SA and maintained by SC ELECTRIFICARE CFR SA.

The railway communications equipment from the involved electric multiple units belongs to SNTFC “CFR Calatori” SA and maintained by CFR SCRL Brasov SA.

The electric multiple units of the train involved in the accident belong to SNTFC “CFR Calatori” SA and maintained by CFR SCRL Brasov SA and the repairs are performed by the economic agents, authorized railway suppliers.

The Investigation commission questioned all the employees involved in driving and operating the electric multiple units (driver, head conductor, conductor)

The investigation commission did not question other witnesses of the accident (passengers, other witnesses) because it was not necessary in the establishment of the accident causes.

B.2.2 Train forming and equipment

B.2.2.1 Accident occurred between Malnas Bai and Bicsadu Oltului railway stations

The train was formed from electric multiple units type Z 6100 no. 011 (consisting in the power coach 580011-5 and the trailer coach 580111-3) and no. 012 (consisting in the power coach 580012-1 and trailer coach 580112-3), coupled by the multiple driving system and driven from the driving cab of the electric multiple unit no. 011. The train had 198 t, 16 axles, automatic braking 235 t, actual braking 278 t, plus 43 t against the timetable, hand braking 35 t, actually 66 t, plus 31 t, length 100m. Both electric multiple units belong to the railway undertaking SNTFC “CFR Calatori” SA.

Safety and Vigilance Devices (DSV), device for the punctual control of the speed and auto stop (INDUSI) from the electric multiple units were active and operated according to the instruction and with the automatic brake active.

B.2.2.2 Accident occurred in Suceava railway station

The train was formed from electric multiple units type Z 6100, consisting in the power coach 580007-3 and the trailer coaches 580107-1 and 580207-9. The train had 137 t, 12 axles, automatic braking 164 t, actual braking 229 t, plus 65 t against the timetable, hand braking 25 t, actually 32 t, plus 7 t, length 76 m. The electric multiple unit belongs to the railway undertaking SNTFC “CFR Calatori” SA.

Safety and Vigilance Devices (DSV), device for the punctual control of the speed and auto stop (INDUSI) from the electric multiple unit endowment were active and operated according to the instruction and with the automatic brake active.

B.2.2.3 Accident occurred between Sansimion and Tusnad Sat railway stations

The train was formed from electric multiple units type Z 6100 no. 010 (consisting in the power coach 580010-7 and the trailer coach 580110-7) and no. 014 (consisting in the power coach 580014-9 and trailer coach 580114-7), coupled by the multiple driving system and driven from the driving cab of the electric multiple unit no. 010. The train had 198 t, 16 axles, automatic braking 235 t, actual braking 251 t, plus 16 t against the timetable, hand braking 35 t, actually 64 t, plus 29 t, length 100m. Both electric multiple units belong to the railway undertaking SNTFC “CFR Calatori” SA.

Safety and Vigilance Devices (DSV), device for the punctual control of the speed and auto stop (INDUSI) from the electric multiple units endowment were active and operated according to the instruction and with the automatic brake active.

B.2.3 Railway equipment

B.2.3.1 Accident occurred between Malnas Bai and Bicsadu Oltului railway stations

The route of the railway accident place consists in a circular curve with parabolic connections to the adjacent straight lines.

The derailment occurred in the circular curve, whose plan characteristics are: $R=324$ m, cant of the track $h=95$ mm, track deflection $f=154$ mm, over-widening $s=10$ mm.

Line superstructure is type 65, concrete sleepers T30, indirect fastening type K, track with joints and in cross section type embankment.

B.2.3.2 Accident occurred in Suceava railway station

The switch no. 67 where occurred the derailment is type 49, having the tangent $1/9$, with the radius of 300 m, right deviation, spring point, crossing from alloy steel, indirect fastening type K, wooden sleepers and inside and middle locking.

The switch was fitted on the track in 1987 and is situated in a straight line and on the flat.

The tip joint of the switch no. 67 is situated at the km 446+388 and the joint from the heel of blade is situated at the km 446+420.

The derailment of the trailer coach no. 207-9 occurred on the connection rails from the left side of the curve, at about 18m from the tip joint of the switch.

B.2.3.3 Accident occurred between Sansimion and Tusnad Sat railway stations

The plan route in the railway accident area consists in a circular curve, with parabolic connections to the adjacent straight lines.

The derailment occurred in the circular curve, whose plan characteristics are: $R=275$ m, cant of the track $h=110$ mm, track deflection $f=182$ mm, over-widening $s=15$ mm.

Line superstructure is type 65, concrete sleepers T30, indirect fastening type K, track with joints and it is in cross section type embankment.

B.2.4 Communication equipment

In those 3 cases the contact between the drivers and the service officials, as well as between the drivers and the train crews were ensured by radio.

B.3 Accident consequences

B.3.1 Fatalities and injuries

In all those 3 cases of railway accidents there were no victims and hurt people.

B.3.2 Material damages

B.3.2.1 Accident occurred between Malnas Bai and Bicsadu Oltului railway station

- at the rolling stock: according to the estimation no. 457/130/2010 of SNTFC “CFR Calatori” SA –Passenger Railway Regional Branch Brasov - Engine Shed Brasov - 500,13 lei
- at the lines and equipment - none
- at the environment - none
- cost with the intervention equipment - according to the estimation no. 230/1/14/2010 of CNCF “CFR” SA – Railway Regional Branch Brasov – Track Division =10.268,38 lei.

B.3.2.2 Accident occurred in Suceava railway station

- at the rolling stock: according to the estimation no. 213/2/38/2010 of SCRL “CFR SCRL Brasov” SA – Section on Engine Maintenance Suceava - 1.367,61 lei
- at the lines and equipment - none
- at the environment - none
- cost with the intervention equipment - none.

B.3.2.3 Accident occurred between Sansimion and Tusnad Sat railway stations

- at the rolling stock: according to the estimation no. 457/131/2010 of SNTFC “CFR Calatori” SA –Passenger Railway Regional Branch Brasov, Engine Shed Brasov - 802,26 lei
- at the lines and equipment - none
- at the environment - none
- cost with the intervention equipment - according to the estimation no. 230/1/15/2010 of CNCF “CFR” SA –of Railway Regional Branch Brasov – Track Division =12974,66 lei.

B.3.3 Consequences of the accident in the railway traffic

B.3.3.1 Accident occurred between Malnas Bai and Bicsadu Oltului railway stations

Between 07:30 and 13:23 the running line between Malnas Bai and Bicsadu Oltului railway stations was closed on the 25th of January 2010.

Because of the railway accident were canceled 2 passenger trains and other two passenger trains had delays of 467 minutes totally.

B.3.3.2 Accident occurred in Suceava railway station

The line 1A from the railway station Suceava was closed for the traffic and shunting on the 26th of January 2010, between 05:04 and 10:45.

The accident did not generated delays at the freight or passenger trains.

B.3.3.3 Accident occurred between Sansimion and Tusnad Sat railway stations

The running line between the railway stations Sansimion and Tusnad Sat was closed for the traffic on the 26th of January 2010, between 14:22 and 19:43.

Because of the accident 2 passenger trains were canceled and other 8 passenger trains had delays of 1305 minutes totally.

B.4 External circumstances

B.4.1 Accident occurred between the railway stations Malnas Bai and Bicsadu Oltului

On the 25th of January 2010, when the accident occurred, the visibility was good, cloudy sky, no wind, with good visibility specific to cloudy sky.

According to the data sent by National Meteorological Administration, at the accident area, the air temperature was about -29⁰ C, white frost of 20 mm, and the snow level was 16cm.

In the railway accident area the line is curved with a radius of 324 m and gradient of 3,5‰.

The visibility of the light signals positions was in accordance with the provisions of the specific regulations in force.

B.4.2 Accident occurred in Suceava railway station

On the 26th of January 2010, when the accident occurred, the visibility was good, cloudy sky, no wind, with good visibility specific to cloudy sky.

According to the data sent by National Meteorological Administration, at the accident area, the air temperature was about -21⁰ C and the snow level was of 24cm.

In the railway station Suceava all the lines were open, excepting the direct line III occupied by the train no. 552, stabled for dispatching.

In the railway accident area the line is in a straight line and on the flat.

The visibility of the light signals positions was in accordance with the provisions of the specific regulations in force.

B.4.3 Accident occurred between Sansimion and Tusnad Sat railway stations

On the 26th of January 2010, when the accident occurred, the visibility was good, clear sky, no wind, with good visibility.

According to the data sent by National Meteorological Administration, at the accident area, the air temperature was about -16⁰ C and the snow level was 10 cm.

In the railway accident area the line is curved with a radius of 275 m and gradient of 0,6 ‰.

The visibility of the light signals positions was in accordance with the provisions of the specific regulations in force.

B.5 Investigation process

B.5.1 Brief presentation of the involved staff testimonies

B.5.1.1 Accident occurred between Malnas Bai and Bicsadu Oltului railway stations

The driver in charge, on the 25th of January 2010, with the driving of the passenger train no. 4503, consisting in the electric multiple units no. 011 and 012, stated as follows:

- there were no technical problems at the electric multiple units or in running between Brasov-Malnas Bai
- after dispatching from the railway station Malnas Bai to the railway station Bicsadu Oltului, the driver took measures in order to comply with the speed restriction of 65 km/h and ran with speeds between 62 and 63 km/h;
- at the km 55+600 he took measures to decrease the speed in order to comply with the speed restriction of 30 km/h between the km 55+950 -56+000, stipulated in the Form for the Restrictions Notification (BAR) and then he felt in the driving cab unusual vibrations in the train running and took measures to stop;

- after stopping the train with the automatic braking and the application of the handbrake by the head conductor, he checked the running gears of the electric multiple unit and found out the derailment of the third bogie of the electric multiple unit no. 011 (first bogie in the running direction of the trailer coach no. 111) against the outside rail of the curve.
- he notified through the radio the service official of Malnas Bai railway station about the accident;
- at the arrival in the depot, he drew up the event report with what happened.

The head conductor of the train no. 4503 from the 25th of January 2010 stated as follows:

- he was in charge with the first two wagons of the train;
- he started his job in the railway station Brasov and was in charge with the train up to the railway station Malnas Bai;
- he did not found out problems in the train running;
- at the derailment he did not found anything curious, being notified by the driver about what happened.

The conductor of the train no. 4503 from the 25th of January 2010 stated as follows:

- he was in charge with the last two wagons of the train;
- he started his job in the railway station Brasov and was in charge with the train up to the railway station Malnas Bai;
- he did not found out problems in the train running;
- at the derailment he did not found anything curious, being notified by the driver about what happened.

B.5.1.2 Accident occurred in Suceava railway station

The driver in charge, on the 26th of January 2010, with the driving of the passenger train no. 5501, consisting in the electric multiple unit no. 007, stated as follows:

- up to the railway station Suceava he did not feel any curious noise;
- from the railway station Pascani up to the railway station Suceava the passenger train no. 5501 ran only on direct lines;
- at the derailment he felt some vibrations and the curious decrease of the speed;
- he took measures for emergency braking and put the controller on “O”

The movements inspector on duty in the railway station Suceava stated as follows:

- at 05:05 the driver of the train no. 5501 notified by radio that the both bogies of the last wagon derailed on the switch no. 67.
- the route of the train no. 5501 was locked, the signals on open position, the switches being with control;
- he notified the station manager, the head driver from the Traffic Controller and the electromechanic personnel about the accident.

The head conductor, in charge with the train no. 5501 on the 26th of January 2010, stated as follows:

- during the running he did not hear any curious noises;

- after the passing of the train on the deflecting section 1 he felt vibrations, the train stopped and after leaving the train he found out that the last wagon derailed;
- than in the train there were about 120 passengers.

The conductor in charge with the train no. 5501 from the 26th of January 2010 stated as follows:

- during the running he did not hear curious noises;
- at the derailment in the last wagon was felt a jerk;
- in that wagon there were about 25-30 passengers;
- after leaving the train he found out that both bogies of the last wagon were derailed;
- he notified about it the head conductor.

The head driver being at the train manning, in the training program, stated as follows:

- in the running of the train no. 5501, the outside temperatures were between -22⁰ C and -29⁰ C;
- on the deflecting section of Suceava railway station he found out pieces of ice between the rails, that could have contribution to the derailment, the coach being of small weight;
- at the derailment the train speed was about 26km/h, the traction power small, the stick being on "O".

The trackman on duty in the shift 25/26.01.2010 stated as follows:

- at about 04:50, from the order of the movements inspector, he was in the area of the switches no. 37/41 to clean them;
- after the passing of the train no. 5501 on the switch no. 67 he heard a strong noise and then he observed the train derailment;
- he notified by radio the movements inspector and the head of the Track District.

B.5.1.3 Accident occurred between Sansimion and Tusnad Sat railway stations

The driver in charge, on the 26th of January 2010, with the driving of the passenger train no. 4506, consisting in the electric multiple units no. 010 and 014, stated as follows:

- between Izvoru Oltului and Sansimion there were no technical problems in the running of the electric multiple units;
- after dispatching from the railway station Sansimion, the driver took measures in order to comply with the speed restriction of 65 km/h stipulated with inductor of 2000 Kz;
- during the running on the speed restriction with a speed between 61 and 63 km/h, he felt in the driving cab of the electric multiple unit a transversal impact to the right line (inside rail of the curve), at the km 79+3000, in the joints area, then he observed a curious running and took measures to brake;
- after stopping the train with the automatic brake and the application of the handbrake by the head conductor, he found out the derailment of the first bogie of the first coach of the electric multiple unit, at 25 cm against the outside rail of the curve;
- he notified through the radio the movements inspector from the railway station Sansimion about the accident;
- at the arrival in the depot, he drew up the event report about what happened.

The head conductor of the train no. 4506 from the 26th of January 2010 stated as follows:

- he started the job in the railway station Siculeni and up to the railway station Sansimion he did not find out problems in the train running;

- at the derailment he was in the second coach of the first electric multiple unit (electric multiple unit no. 010) of the train and did not feel anything curious, being notified about the accident by the driver;
- he informed the passengers about what happened and took measures to move them in other transport means;
- following the accident there were no hurt persons and one ensured the necessary thermal conditions up to the movement of the passengers.

B.5.2 Safety management system

In order to achieve their tasks and responsibilities, the infrastructure administrator CNCF “CFR” SA and SNTFC “CFR Calatori” SA established and implemented their own safety management system.

In this situation, CNCF “CFR” SA and SNTFC “CFR Calatori” SA ensure the control of the risks afferent to the administrator activity respective the railway undertaking.

B.5.3 Norms and regulations. Sources and references for investigation

In the investigation of the railway accidents one took into account:

- the photos made soon after the accidents occurrence, made by the investigation commission members;
- the minutes and measurements carried out soon after the accidents occurrence by the members of the investigation commission and by the members of the inquiry commission;
- the documents concerning the maintenance of the lines and equipments, submitted by the persons in charge with their maintenance;
- analysis and interpretation of the technical situation of the parts involved in the accident (lines, switches and electric multiple units);
- drawing of the carrying bogie ZE 19 058, no. 10-834 752 (drawing boards 1 and 2) of SNCF (French railways);
- drawing of the carrying bogie fitting ZS 19 058Pa, no. Ao 30647 of SNCF (French railways);
- questionnaires of the involved employees.

B.5.4 Operation of the technical equipments, infrastructure and rolling stock

B.5.4.1 Data about the lines

B.5.4.1.1 Accident occurred between Malnas Bai and Bicsadu Oltului railway stations

The track superstructure is type 65, concrete sleepers T30, indirect fastening type K, track with joints and in cross section type embankment.

At the accident place the line fastening was active and complete and the bed track was complete and iced.

The gradient profile at the accident place consists in a circular curve with parabolic connections to the adjacent straight lines.

The line is curved on the right in the running direction of the train, having the next constructive elements, according to the technical data from the Section for the Track maintenance:

- straight line point – connection (AR) at the km 54+760;
- connection point – circular curve (RC) at the km 54+810;
- circular curve point – connection (CR) km 55+231;
- connection point – straight line (RA) km 55+283;

- over-widening, $s=10\text{mm}$;
- radius, $R=324\text{ m}$;
- circular curve deflection at a measurement of 20m, $f=154\text{ mm}$;
- cant of track, $h=95\text{ mm}$.

The derailment occurred in the circular curve.

The running speed established for this curve is 65 km/h.

The specialists of CNCF “CFR” SA –of Railway Regional Branch Brasov carried out on the 25th of January 2010 gauge and level measurements with the measuring print path on the measurement basis of 2,5 m, starting with the km 54+840, increasingly, the values being presented in the below table.

Km position	54+840							J	P esc					Footbridge
Gauge (mm)	14	14	12	12	10	11	13	8	12	13	12	14	15	16
Level (mm)	101	104	106	108	107	103	102	97	99	98	99	98	99	99

J – joint

P esc – point of over-climbing starting from the km 54+862

Also, at the same moment, one measured the vertical and horizontal wears from 2,5 m to 2,5 m, from the km 54+840 to the km 54+870 on the outside rail of the curve, the values being presented in the below table.

Km position									J	P esc	
Vertical reading	180/0	179/1	179/1	179/1	179/1	179/1	179/1	179/1	179/1	179/1	179/1
Horizontal reading	42/2	41/3	42/4	42/4	42/4	42/4	42/4	42/4	43/5	44/6	45/7

On the inside rail of the curve one found out seams of 3 – 4 mm and their small detachments from the rail.

According to the measurement sheet of the expansion joints, drawn up during the yearly measurement from the 20th of March 2009, on the distance between the km 54+800 and the km 55+100 one regularized the expansion joints.

During the last measurement performed with the mechanical testing and recording wagon, on the 14th of September 2009, in this circular curve there were found out 2 failures, level 2 at the joints and 7 failures level 2 at the cross level , permitting the train running with common speed.

Conclusions:

- the gauge and crossing level values, resulted after the checking performed with the measuring print path at the measurement basis of 2,5 m, in the derailment area, were between the accepted tolerances, according to the art. 1 and art. 7 of the Instruction for norms and tolerances for the track construction and maintenance – lines with standard

gauge no. 314/1989, excepting the cross level in the first seven points of measurement, at which the tolerance of 5 mm at the prescribed cross level of 95 mm was exceeded with values between 1mm and 13 mm, being, in running conditions, favorable factors for the appearance of seams of 3 – 4 mm on the inside rail of the curve.

The values of the displacement at the cross level in those 7 points did not influence the wheel over-climbing, because it occurred at 5 m from the last displacement from the cross section, and on all distance measured the track twist limits, stipulated of 9 mm at the measurement basis of 2,5 m, according to the art. 7 from the Instruction for Norms and Tolerances for the track construction and maintenance – standard gauge line no. 314/1989, were not exceeded.

- interpretation of the measurements corresponding to the wears of the outside rail of the curve in accordance with the Technical prescriptions concerning the measured vertical and lateral wears of the rails – version 1987 presents vertical wears of 1-2 mm and lateral wears under 3 – 5 mm. The measured values were between the tolerances accepted by the provisions of the tables 24 and 25 from the Instruction of Norms and Tolerances for the track construction and maintenance – standard gauge lines no. 314/1989.

B.5.4.1.2 . Accident occurred in the railway station Suceava

The switch no. 67, on which occurred the derailment is type 49, having the tangent 1/9, with the radius of 300 m, right deviation, spring points, crossing from alloy steel, indirect fastening type K, wooden sleepers and inside and middle locking.

The switch was fitted on the track in 1987 and is situated in a straight line and on the flat.

The tip joint of the switch no. 67 is situated at the km 446+388 and the joint from the heel of blade is situated at the km 446+420.

The accepted running speed on the deflecting section, on this switch, was 30 km/h.

The inquiry and investigation commission performed checking, with the measuring print path of the gauge and cross level in the characteristic points of the switch, as well as of the width and depth of the grooves at the crossing and checkrails from the crossing. The measured values are presented in the below tables:

Gauge and level

First joint		Point of switch		Heel of blade (mm)				Middle curve (mm)		Crossing (mm)			
				Direct line		Deflecting section				Direct line		Deflecting section	
Gauge	Level	Gauge	Level	Gauge	Level	Gauge	Level	Gauge	Level	Gauge	Level	Gauge	Level
+3	0	+3	0	+2	0	+6	0	+6	0	0	0	2	0

Measured values of the grooves

Crossing (mm)				Crossing checkrail (mm)			
Direct		Deflecting section		Direct		Deflecting section	
Width	Depth	Width	Depth	Width	Depth	Width	Depth
45	46	44	46	41	40	41	42

From the documents of the Track Section L5 Suceava resulted that the last checking of the hidden parts of the switch no. 67 was performed on the 10th of September 2009, and the last measurement before the derailment was performed on the 20th of January 2010, according the registering from the Inspection register of the switches of the Track District no. 2 Suceava. According to those measurements, the expansion joints from the switch had the next values.

First joint (mm)		Heel of blade (mm)				Last joint (mm)		Switch diamond (mm)			
		Direct line		Deflecting section				Direct line		Deflecting section	
Gaug e	Leve l	Gaug e	Leve l	Gaug e	Leve l	Gaug e	Leve l	Gaug e	Leve l	Gaug e	Leve l
9	10	6	5	7	8	5	5	11	11	7	5

Conclusions:

- According to the measurements performed both before the derailment and after there were no exceeding of the tolerances at the gauge, crossing level, wears or sizes of grooves of the switch no. 67, excepting 2 points situated at the heel of the blade on the deflecting section and the middle curve, where the operation tolerance was exceeded with 1 mm. The value of the gauge deviation in those 2 points does not exceed the tolerance for the speed of 30 km/h accepted on the switch.
- The deviations measured at the expansion joints, that exceed the values of the laying gap established by the fitting and laying plan, do not exceed the values accepted in operation.

B.5.4.1.3 . Accident occurred between the railway stations Sansimion and Tusnad Sat

Line superstructure is type 65, concrete sleepers T30, indirect fastening type K, track with joints and it is in cross section type embankment.

At the accident place, the line fastening was complete and active about 85%, and the broken bed track was complete and iced.

The route profile at the accident place consists in a circular curve with parabolic connections to the adjacent straight lines.

The line is in right curve, in the running direction of the train, having the next constructive parts, according to the technical data detained by the Track Section Maintenance:

- straight line point – connection (AR) at the km 79+157,
- connection point – circular curve (RC) at the km 79+227
- circular curve point – connection (CR) km 79+477;
- connection point – straight line (RA) km 79+547;
- over-widening, s=15 mm;
- radius, R=275 m;
- circular curve deflection at a measurement of 20m, f=154 mm;
- cant of track, h=110 mm.

The derailment occurred in the circular curve.

The running speed established for this curve is 65 km/h.

The specialists of CNCF “CFR” SA –Railway Regional Branch Brasov carried out on the 26th of January 2010, in the presence of the investigation commission, gauge and level measurements with the measuring print path on the measurement basis of 2,5 m, starting with the km 74+440, decreasingly, the values being presented in the below table.

Km position								J	P esc		P cad			
Gauge (mm)	27	22	23	20	17	18	17	22	23	18	17	18	20	20
Level (mm)	108	107	108	108	108	108	107	108	109	109	108	108	108	108

J – joint

P esc – point of over-climbing starting from the km 54+862

Pcad – point of the first wheel fall outside the curve.

Also, at the same moment, one measured the vertical and horizontal wears from 2,5 m to 2,5 m, from the km 79+425 to the km 79+405 on the outside rail of the curve, the values being presented in the below table.

Km position	79+425						79+405
Vertical reading(mm)/wears	175/5	175/5	175/5	176/4	177/3	177/3	177/3
Horizontal reading (mm)/wears	41/3	41/3	40/2	39/1	41/3	41/3	41/3

On the inside rail of the curve one found out seams of 3 – 4 mm and their small detachments from the rail.

The expansion joints before the over-climbing are of 15 mm on the outside rail and of 4 mm on the inside rail

According to the measurement sheet of the expansion joints, drawn up during the yearly measurement from the 23rd of March 2009, on the distance between the km 79+125 and the km 79+700, one regularized the expansion joints.

During the last measurement performed with the mechanical testing and recording wagon, on the 14th of September 2009, in this circular curve there were 6 failures, level 2 at the joints and 1 failure level 2 at the cross level , permitting the train running with common speed.

Conclusions:

- the crossing level values, resulted after the checking performed with the measurement print path on the measurement basis of 2,5 m, in the derailment area, were between the accepted tolerances, according to art. 7 of the Instruction for norms and tolerances for the track construction and maintenance – lines with standard gauge no. 314/1989;
- the over-widening S=15 mm applied to the curve does not comply with the value established at the chapter 1, art. 1, point 2 of the Instruction for norms and tolerances for the track construction and maintenance – lines with standard gauge no. 314/1989, where on a radius of 275 mm is applied an over-widening of 10 mm.

Comparing the gauge measurements performed from 2,5 m to 2,5 m, with the over-widening of 10mm, it is found out that the gauge tolerances of 10 mm are exceeded in 5 measuring points with values between 2 and 7 mm. This exceeding of the tolerances is gauge failure, reaching the maximum level 2, according to the instruction 326/1995 for the use of the testing and recording wagon, annex 1, table 2, but the values of these failures do not suppose

restrictions of the maximum speeds accepted by the line. The last full repair (RK) was performed in 1986.

- interpretation of the measurements corresponding to the wears of the outside rail of the curve, in accordance with the Technical Prescriptions concerning the measurement of the vertical and lateral wears of the rails – version 1987 presents vertical wears of 4-5 mm and lateral wears under 3 mm. The measured values were between the tolerances accepted by the provisions of the tables 24 and 25 from the Instruction of Norms and Tolerances for the track construction and maintenance – standard gauge lines no. 314/1989.
- The measurements corresponding to the expansion joints, before the rail over-climbing do not exceed the values stipulated in the table no. 13 and art. 10, point B2 of the Instruction for norms and tolerances for the track construction and maintenance – lines with standard gauge no. 314/1989.

B.5.4.2 Data found out on the rolling stock and its technical equipment operation

In all these 3 cases the equipment for the punctual control of the speed (INDUSI) and for the speed showing and recording type IVMS 2001, as well as the safety and vigilance one (DSV) operated and were sealed.

Also, following the analysis of the records of IVMS 2001 equipment from those 3 trains, it was found out that, at the derailment, their speed was under the accepted maximum speed on the track sections where occurred the railway accidents, as follows:

- 64 km/h as against 65 km/h in the case of the accident occurred between the railway stations Malnas Bai and Bicsadu Oltului
- 25 km/h as against 30 km/h in the case of the accident occurred in the railway station Suceava;
- 61 km/h as against 65 km/h in the case of the accident occurred between the railway stations Sansimion and Tusnad Sat.

The braking equipments of the electric multiple units operated.

Presentation of the bogies of the electric multiple units Z 6100

The carrying bogie of the power coach and of the trailer vehicles consists in a lowered chassis, with coil spring suspensions on the ends of the axle boxes. This chassis is connected at the ends at 2 joined sleepers.

The bogie bolster on which are put the lateral support shoes on the box and the central pivot box-bogie, makes the drive by longitudinal rods.

This bogie bolster is put on the frame through the mixed springs steel – rubber of variable flexibility.

The carrying bogies are provided with axles with cast wheels.

Between the bogies of the electric multiple units involved in the accident occurred in the Railway Regional Branch Brasov and those of the electric multiple units involved in the accident occurred in the Railway Regional Branch Iasi there are very important constructive differences, as follows:

- the carrying bogies of the electric multiple units involved in the accidents occurred in the Railway Regional Branch Brasov had at the secondary suspension pneumatic air cushions (one on each part of the bogie bolster) supplied with force air pressure discharge from the electric multiple unit equipment, and those of the electric multiple unit involved in the accident from the Railway Regional Branch Iasi had at the secondary suspension steel-rubber springs of variable flexibility;
- at the carrying bogies of the electric multiple unit involved in the accidents occurred in the Railway Regional Branch Iasi, the longitudinal rods are put between the bogie frame and the

ends of the bogie bolster in contrast with the carrying bogies from the electric multiple units involved in the accidents occurred in the Railway Regional Branch Brasov at which the longitudinal rods are put between the ends of the bogie bolster and the coach body (power or trailer).

- after the derailments, in the presence of the members of the investigation commission one measured the mechanical clearance axle – bogie and the geometrical parts of the running profiles of the wheels of the derailed bogies from these electric multiple units. The values of the measurements performed at the derailed bogies are presented below:
- For the electric multiple unit no. 011 (involved in the accident occurred between the railway stations Malnas Bai and Bicsadu Oltului) – trailer coach 580111-3

Measured quotas	Measured values (mm)			
	Axle no. 5		Axle no. 6	
	L	R	L	R
A	0	0	0	0
C	31	29,5	31,5	31
q _r	10,5	10,5	10,5	11
D(N)	1421		1422	
E(K)	1360,5		1359,5	
Φ strung Bv 20.01.2010	784	784	784	784
Φ RG Cluj 02.04.2007	800,15	800,15	800,5	800,5

- For the electric multiple unit no. 007 (involved in the accident occurred in the railway station Suceava) – trailer coach 580207-9

Measured quotas	Measured values (mm)							
	Axle no. 9		Axle no. 10		Axle no. 11		Axle no. 12	
	L	R	L	R	L	R	L	R
	0	0	0	0	0	0	0	0
A	32	32	31	31	31	31	30	30,5
C	10	10	10	10	10	10	10	10
q _r	1424,5		1422		1422		1421,5	
D(N)	1360,5		1360		1360		1361	
E(K)	742	742	747	747	747	747	741	741
Φ strung Bv 18.01.2010	754	754	758	758	762	762	770	770

- For the electric multiple unit no. 010 (involved in the accident occurred between Sansimion and Tusnad Sat railway stations) – trailer coach 580110-5

Measured quotas	Measured values (mm)			
	Axle no. 1		Axle no. 62	
	L	R	L	R
A	0	0	0	0
C	30,5	31,5	30,5	31

q _r	10	10	10	10
D(N)	1421,5		1421	
E(K)	1359,5		1359,5	
Φ strung Bv 25.01.2010	740	740	752	752
Φ RG Cluj 05.06.2007	801,1	801,1	801,1	801,1

A – wears on the running treads

C- thickness of the lip if tyre

q_r - quota

D(N) – distance between the outside surfaces of the wheels

E(K) – distance between the inside surfaces of the wheels

- For the electric multiple unit no. 010 (involved in the accident occurred between the railway stations Sansimion and Tusnad Sat) – trailer coach 580110-5

Clearance	Part	Accepted	Derailed carrying bogie			
			1	2	3	4
Longitudinal	L+R	1-8	4,05	6,55	5,15	5,35
Transversal	L+R front	1-10	3,95 4			
	L+R back	1-10	1,4 5,4			

- For the electric multiple unit no. 007 (involved in the accident occurred in the railway station Suceava) – trailer coach 580207-9

Clearance	Part	Accepted	Carrying bogie no. 5			
			1	2	3	4
Longitudinal	L+R	1-8	The measurements were not performed because of the ice presence			
Transversal	L+R front	1-10	2,5		3,5	
	L+R back	1-10	3,5		3	

Clearance	Part	Accepted	Carrying bogie no. 6			
			1	2	3	4
Longitudinal	L+R	1-8	The measurements were not performed because of the ice presence			
Transversal	L+R front	1-10	4,7		5	
	L+R back	1-10	4,8		5,5	

- For the electric multiple unit no. 011 (involved in the accident occurred between Malnas Bai and Bicsadu Oltului railway stations) – trailer coach 580111-3

Clearance	Part	Accepted	Derailed carrying bogie			
			9	10	11	12
Longitudinal	L+R	1-8	2	2,05	1,9	2,6
Transversal	L+R front	1-10	4,15		4,65	
	L+R back	1-10	5,15		5,4	

Conclusion

The values of the measurements performed at the wheel geometry of the derailed bogies are between the limits stipulated in the Regulations for the Railway Technical operation no. 002/2001, and the values of the mechanical clearances are between the limits stipulated in the technical specification.

B.5.4.3 Findings and conclusions of the investigation commission on the operation of the involved electric multiple units

B.5.4.3.1 Electric multiple units involved in the accident occurred between Malnas Bai and Bicsadu Oltului railway stations

Central pivot and the bogie bearing of the pivot



in the operation area it is found out metallic luster, following the friction with the pivot bearing;

- one found out ice on the existing friction areas, between the outside surface of the pivot centre jacket and the inside surface of the bogie bearing;
- one found out pressed snow and ice between the outside surface of the pivot centre jacket and the inside surface of the bogie bearing, in the area with constructive clearance, above the friction area between the outside surface of the pivot jacket and the inside surface of the bogie bearing;
- one found out pressed snow and ice inside the bogie bearing;

- no lubrication traces were found out.

Metalastic parts existing between the pivot jacket and the bogie bearing of the pivot (placed inside the bogie bearing)



- there were pressed snow and ice on the outside lateral surface of the inferior metalastic part (existing inside the bogie bearing);
- one found out rust traces in the pressed snow and ice, resulted from the contact between the pressed snow and ice with the inside lateral metallic surface of the pivot centre jacket;
- there were snow and ice on the superior surface of the outside metallic part of the inferior metalastic;
- metallic plates of the lower metallic part have rust traces.

Upper shoes for support of the body on the bogie and the lateral guides

from the bogie



- On the operation parts of the upper shoes there were snow and ice
- On the contact surfaces of the upper shoes there were lubrication irregular traces,

- In the cross oil grooves stipulated in the median area of the shoes there was a mixture of lubricant, pressed snow and ice;
- In the lower sliding trays, in the areas limited by the lateral edges and the working longitudinal – axial limits of upper shoes, there were snow and ice mixed with lubricant;
- On the friction metallic layer of the contact surfaces both at the upper shoes and at the lower trays are presented in the thermic influence area.

Primary suspension



- The primary suspensions had no parts missing, out of shape or broken and inside it had snow;
- There were no traces of lubrication of the friction areas between the axle boxes and the vertical guides of the bogie sidebars;

Secondary air suspension

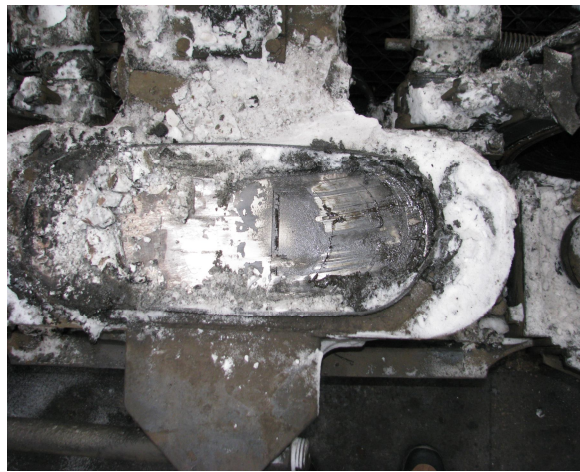


- The air suspension parts of the derailed bogie had no distortion, degradation or breakage of the rubber parts;
- On the outside metallic reinforcements of the pneumatic air suspension parts there were very dense and adherent ice at the lateral side (situated to the wagon centre);
- The ice on the lateral surfaces of the outside metallic reinforcement extended also above the active rubber parts of the bellows;

- On the active rubber parts of the bellows there were ice traces, but one could not evidence possible friction traces between the ice from the rubber parts and the inside metallic reinforcements;
- On the active rubber parts of the bellows one did not find out traces of wears resulted by their distortion following the vertically – axially or horizontally – transversally friction with the inside metallic reinforcements.

B.5.4.3.2 Electric wagon involved in the accident occurred in Suceava railway station

Lateral guides from the bogie no. 6



- In the sliding tray one found out a mixture from ice and solidified lubricant, accumulated in the front of the box, related to the running direction;
- One found out ice mixed with solidified lubricant between the edge of the sliding tray and the operation parts of the upper shoes (breadth of about 90 mm, representing about 20% from the length of the sliding tray);
- On some areas of the operation part of the sliding tray one can notice metallic luster following the dry friction.

Upper shoes of the wagon body on the bogie no. 6



- One found out pressed snow and ice mixed with solidified grease, both between the both shoes and on the lateral side of the shoes (to the centre of the wagon body)
- One found out pressed snow on the operation parts of the shoes;
- On the contact surfaces of the upper shoes there were irregular lubricant traces;
- In the cross lubrication grooves in the median area of the shoes there was a mixture of lubricant, pressed snow and ice;

Central pin of the bogie no. 6

- On the operation part of the outside surface of the pivot centre is observed metallic luster following the friction with the pivot bearing;
- One found out ice mixed with lubricant on the friction areas on the outside surface of the pivot centre jacket;
- One found out pressed snow and ice on the outside surface of the pivot centre bearing, in the area with constructive clearance between the outside surface of the pivot jacket and the inside surface of the bogie bearing (above the friction area between the outside surface of the pivot jacket and the inside of the bogie bearing);
- One found out pressed snow and ice under the area between the outside surface of the pivot centre jacket and the inside surface of the bogie bearing.

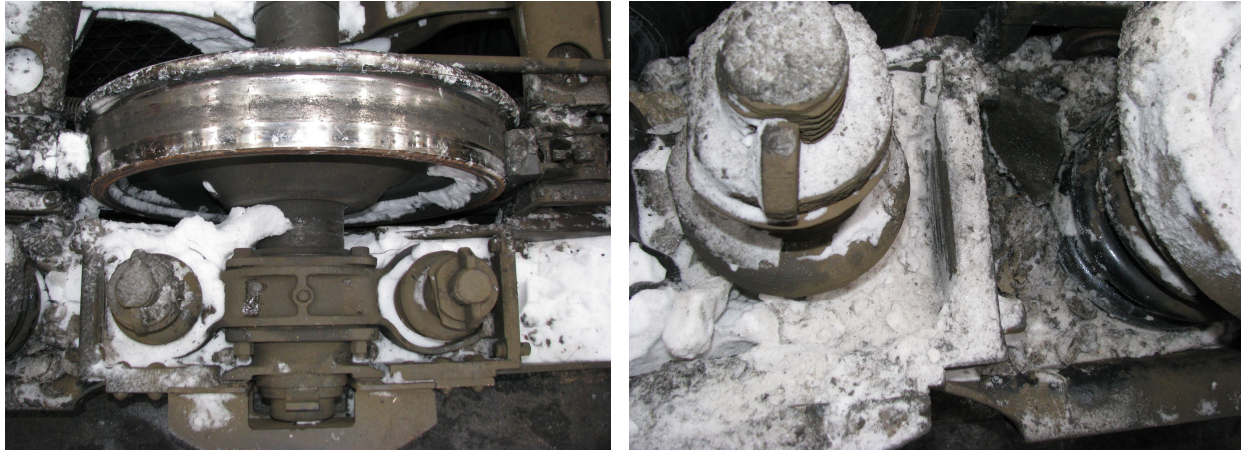


Pivot bearing of the bogie no. 6



- One found out pressed snow and ice both on the inside surface of the bogie bearing and on the metalastic elements.

The primary suspension of the bogie no. 6



- One found out ice on the bogie sidebar (leading to the disappearance of the longitudinal clearance of the axle boxes);

Central pivot of the bogie no. 5

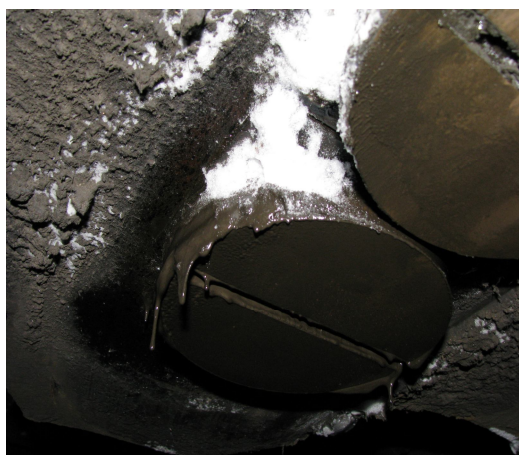


On the

operation part of the outside surface of the pivot axis jacket are found out metallic luster areas following the friction with the pivot bearing;

- One found out ice mixed with lubricant on the friction areas on the outside surface of the pivot centre jacket;
- One found out pressed snow and ice on the outside surface of the pivot centre jacket, in the area with constructive clearance between the outside surface of the pivot jacket and the inside surface of the bogie bearing (above the friction area between the outside surface of the pivot jacket and the inside of the bogie bearing);
- One found out pressed snow and ice under the area between the outside surface of the pivot centre jacket and the inside surface of the bogie bearing.

Upper shoes of the wagon body on the bogie no. 5



- On the

contact surfaces of the upper shoes there is lubricant;

- At the lifting of the body from the bogies, the surface tension of the lubricant does not allow its keeping in the cross lubrication grooves stipulated in the median area of the shoes

B.5.4.3.3 Electric wagon involved in the accident occurred between Sansimion and Tusnad Sat railway stations

Secondary pneumatic suspension



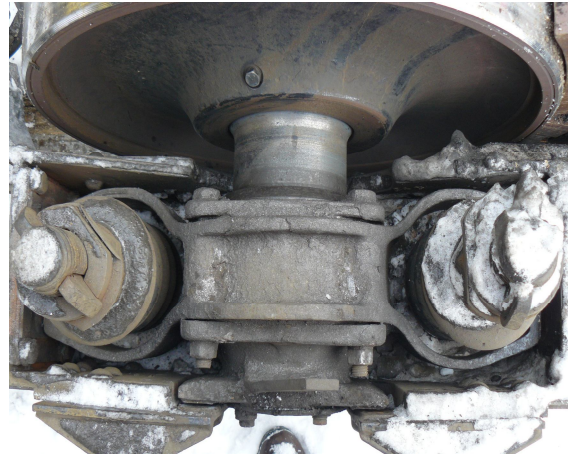
The air suspension parts of the derailed bogie had no distortion, degradation or breakage of the rubber parts;

On the outside metallic reinforcements of the pneumatic air suspension parts there were very dense and adherent ice at the lateral sides (situated to the axle of the wagon);

The ice on the lateral surfaces of the outside metallic reinforcement extended also above the active rubber parts of the bellows;

- On the active rubber parts of the bellows there were ice traces, but one could not evidence possible friction traces between the ice from the rubber parts and the inside metallic reinforcements;
- On the active rubber parts of the bellows one did not find out traces of wears resulted by their distortion following the vertically – axially or horizontally – transversally friction with the inside metallic reinforcements.

Primary pneumatic suspension



- The

primary suspensions had no parts missing, out of shape or broken and inside it had pressed snow and ice;

- There were no traces of lubrication of the friction areas between the axle boxes and the vertical guides of the bogie sidebars;
- The friction traces existing on the axle journal of the first wheel are due to a stone entered at the derailment between it and the bogie frame.

Upper shoes of the body on the bogie and the lateral guides from the bogie



- On the operation parts of the upper shoes there were snow and ice;
- On the contact surfaces of the upper surfaces there were irregular lubricant traces;
- In the cross oil grooves stipulated in the median area of the shoes there was a mixture of lubricant, pressed snow and ice;
- In the lower sliding trays, in the areas limited by the lateral edges and the working longitudinal – axial limits of upper shoes, there were snow and ice mixed with lubricant;
- On the friction metallic layer of the contact surfaces both at the upper shoes and at the lower trays are presented in the thermal influence area.

Central pivot and the bogie bearing of the pivot



On the operation part of the outside surface of the pivot centre jacket are found out metallic luster areas following the friction with the pivot bearing;

One found out ice mixed with lubricant on the friction areas on the outside surface of the pivot centre jacket;

- One found out pressed snow and ice on the outside surface of the pivot centre jacket, in the area with constructive clearance between the outside surface of the pivot jacket and the inside surface of the bogie bearing (above the friction area between the outside surface of the pivot jacket and the inside of the bogie bearing);
- One found out pressed snow and ice under the area between the outside surface of the pivot centre jacket and the inside surface of the bogie bearing.

Conclusions

- at the sending of the forces between the body of the power coaches or trailer coach and the carrying bogie appeared keys between the surfaces in contact, that is between the central pivot and the bogie bearing of the pivot, respectively between the upper shoes for the support of the body on the bogie and the lateral guides from the bogie;
- the parts of the air suspension operated uniformly.

B.6 Accidents causes

B.6.1 Common elements of those 3 derailments

From the data concerning those 3 accidents resulted that, in all cases, the derailments had a series of common elements, as follows:

- they occurred in the running of the passenger trains, consisting in electric multiple units type Z 6100;
- the weather conditions from those 3 derailments places consisted in low temperatures between -16°C and -29°C ;
- they involved the first axle of the carrying bogies and consisted in the derailment of the first wheel outside the track.
- the second wheel of the same axle (first axle) derailed by falling inside the track, as a consequence of the first wheel derailment;
- the derailments happened in the circular curves with radius between 275 m and 324 m;
- there were no failure at the lines or at the electric multiple units, that can be included in the direct causes of the accidents.

B.6.2 Direct cause

The direct cause of the accidents was the over-climbing of the inside shoulder of the rail outside the curve by the first wheel of the first axle of the carrying bogies, followed by its fall outside the track.

B.6.3 Contributing factors

The over-climbing of the inside shoulder of the rail from the outside part of rail occurred because of the exceeding of the derailment safety limit, in the conditions of the guiding force on the first wheel, in curve.

The increase of the guiding force (horizontal) appeared because of the limitation of the opening of the upper shoes of the body on the bogie, on the operation parts of the lateral support guides from the bogie, because of the existing ice, finally leading to the stop of the relative movement between the contact surfaces of the lateral guides (in the case of the derailment of the bogie no. 6 of the coach no. 207 of the electric multiple unit no. 007).

Other factor that could influence the increase of the guiding force, but that could not be effectively identified by the train, is melting of the snow between the surfaces of the pivot centre jacket and the bogie bearing and the appearance of ice on the surfaces in contact, and being the low temperatures, it could lead to the stop of the relative movement between these and implicitly of the bogie rotary motion.

B.6.4 Subsidiary causes

None

B.6.5 Root causes

None

C. Safety recommendations

The addressee of the safety recommendations is SNTFC "Calatori" SA, as owner of the electric multiple units type Z 6100.

The recommendation aims to solve:

- identification and implementing of some solutions for the protection of the area between the upper shoes of the bogie box and the lateral guide from the bogie, against the snow penetration.

If the safety recommendation shall be implemented, there are not necessary the safety recommendations proposed by OIFR by the Report 4110/30/2010, concerning:

- interdiction of the running of the trains consisting in electric multiple units type Z 6100 in conditions of temperature under -20°C , both in the routing stations and in the further route;
- restriction of the speed at 50 km/h on the running and open lines and 15 km/h on the deflecting section from the stations for the cases in which these electric multiple units have to run in conditions of out temperatures between -5°C and -20°C .

This Investigation Report shall be sent to CNCF "CFR" SA, SNCF "CFR" SA, Romanian Railway Notified Body and Romanian Railway Safety Authority.

According to the Law no. 55/2006 on railway safety, Romanian Railway Safety Authority will monitor the implementation of these recommendations

Members of the investigation commission:

- Cristian BOBE – investigator in charge
- Eduard STOIAN – investigator
- Marin DRAGHICI – investigator
- Vladimir MACICASAN – investigator
- Cristian GROZA – investigator
- Dumitru SFARLOS – investigator