



MINISTRY OF TRANSPORTS AND INFRASTRUCTURE  
ROMANIAN RAILWAY AUTHORITY - AFER

ROMANIAN RAILWAY INVESTIGATING BODY



## INVESTIGATING REPORT

of the railway accident  
occurred on the 30<sup>th</sup> of August 2010 at the entry to the railway station CFR Livezeni



*FINAL REPORT*  
*The 14<sup>th</sup> of January 2011*

## NOTICE

In the case of the railway accident occurred on the **30<sup>th</sup> of August 2010**, at **5:30**, on the range of activity of CFR Timisoara Regional Branch, running section Subcetate-Livezeni (double line electrified) at the entry to running wire II in CFR Livezeni station at the deviated line no. 5 of the freight train no. 30471-2 (belonging to the railway undertaking SC SERVTRANS INVEST SA), crossing over the diagonal 10-18 occurred the derailment of the wagons no.31538762206-3 and no. 31538762192-5 (first by locomotive), both loaded, the Romanian Railway Investigating Body carried out an investigation, according to the provisions of the Government Decision no. 117/2010, in order to prevent similar accidents, by establishing the conditions and determining the causes. Through the investigation, the information on the respective accident was gathered and analyzed, the conditions were established and the causes determined.

Romanian Railway Investigating Body investigation did not aim to establish the guilty or the responsibility in this situation.

Romanian Railway Investigating Body considers necessary to take corrective measures in order to improve the railway safety and to prevent the accidents, so it included in the report a series of safety recommendations.

Bucharest, *the 14<sup>th</sup> of January 2011*

*Approved by*  
Dragos FLOROIU  
**Director**

*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 Report for the investigation of the accident occurred on the 3<sup>rd</sup> of August 2010, at 05:30, on the range of activity of CFR Timisoara Regional Branch, in CFR Livezeni station, at the entry at the deviated line no. 5 of the freight train no.30471-2 (belonging to the railway undertaking SC SERVTRANS INVEST SA), by the derailment of the wagons no.31538762206-3 and no. 31538762192-5 (first by locomotive), both loaded.***

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## **I. PREAMBLE**

### **I.1. Introduction**

In the case of the railway accident occurred on the 30<sup>th</sup> of August 2010, at 5:30, on the range of activity of **CFR Timisoara Regional Branch**, running section Subcetate-Livezeni (double line electrified) at the entry to running wire II in CFR Livezeni station at the deviated line no. 5 of the freight train no. 30471-2 (belonging to the railway undertaking SC SERVTRANS INVEST SA), crossing over the diagonal 10-18, by the derailment of the wagons no.31538762206-3 and no. 31538762192-5 (first by locomotive), both loaded, the Romanian Railway Investigating Body carried out an investigation, according to the provisions of the Government Decision no. 117/2010, in order to prevent accidents with similar causes, by establishing the conditions and determining the causes.

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

### **I.2. Investigation process**

Given the approval of General Inspectorate for traffic safety from CNCF “CFR” SA regarding the railway accident occurred on the 30<sup>th</sup> of August 2010, at 5:30, on the range of activity of CFR Timisoara Regional Branch, running section Subcetate-Livezeni (double line electrified) at the entry to running wire II in CFR Livezeni station at the deviated line no. 5 of the freight train no. 30471-2 (belonging to the railway undertaking SC SERVTRANS INVEST SA), crossing over the diagonal 10-18, by the derailment of the wagons no.31538762206-3 and no. 31538762192-5 (first by locomotive), both loaded and taken into consideration that the railway event is an accident according to art. 7(1), point b) from the Regulations for the investigation of the accidents and incidents, for the development and improvement of Romanian railway and subway safety, under the article no. 19 paragraph (2) of Low no. 55/2006 on railway safety, corroborated with the art. 48(1) from the Regulations for the investigation of the accidents and incidents, for the development and improvement of Romanian railway and subway safety, approved by Government Decision no. 117/2010, the OIFR Director decided to open an investigation. So, through the decision of the OIFR director no. 31 from the 30<sup>th</sup> of August 2010, the investigation commission was appointed, consisting in:

- Eduard STOIAN - main investigator
- Țena LUCIAN - investigator
- Păiș LUCA - investigator
- Mircea NICOLESCU - investigator

## **A. BRIEF PRESENTATION OF THE INCIDENT**

### **A.1. Brief presentation**

On the 29<sup>th</sup> of August 2010, at 5:30, the freight train no.30471-2, consisting in 21 loaded wagons, 84 axles, 1431 gross tons, 729 tons net, length 466 m, towed with the locomotive EA-766, was sent from the railway station CFR Sudrigiu to the railway station CFR Bucharest West.

On the 30<sup>th</sup> of August 2010, 5:25, the train arrived to the railway station CFR Livezeni, where it had route of entry at the deviated line no. 5. At the train crossing over the diagonal 10-18 from the station, at the kilometer position 83+520, at about 60 m in front of the switch no. 18 in direct position, the derailment of the first two wagons by locomotive occurred as follows:

- wagon no.31538762206-3 (first by locomotive) derailed from the second bogie in the running direction;
- wagon no. 31538762192-5, second by locomotive, derailed by both bogies.

The wagons in the freight train no. 30471-2 were loaded with mineral water being shipped from the railway station CFR Sudrigiu, sender European Drinks SA Stei village, with the recipient the



company T.G.I.E. Bucharest.

After the occurrence of this accident, the current line Petrosani-Livezeni wire II was closed for the railway traffic between 05:30 and 10:02.

After the occurrence of this incident, there were no deaths or injuries.

## A.2. Direct cause, contributing factors and root causes

**A.2.1. The direct cause:** of the occurrence of this railway accident is the movement of the contact point wheel-rail beyond the tread of the wheel no. 6 due to the difference between the point  $A_{q0}$  from the wheel no. 5 and the outside of the wheel no. 6 on the one hand and the distance between the inner flanks of the rails.

**Factors that contributed** to this accident were:

- wear of the wheel rim no. 5 which have a thickness of 20 mm, compared with 22 mm;
- wear of the rail superstructure construction elements, which led to a gauge value of 1472 mm;

**A.2.2. Underlying cause** was the admission in traffic of the wagon no. 31538762206-3 (first by locomotive) having the wheel no. 5 rim thickness, measured at 10 mm above the rolling circle, of 20 mm to 22 mm allowable value in the Instructions regarding the technical inspection and maintenance of the wagons in service no. 250/2005, table 1, position no.8. This was possible under the conditions of failing to ensure by the wagons technical inspector of the mandatory works and checks that he should have provided during the technical overhaul in composition, as a result of a human error occurred during the technological process of preparation and technical inspection of the train no. 30471-2.

## A.2.3. Root causes

None.

## A.3. Severity level

According to the provisions of the art.7, paragraph (1), letter b of the Regulations for the investigation of the accidents and incidents, for the development and improvement of Romanian railway and subway safety, approved by Government Decision no. 117/2010, the event is categorized as railway accident.

## A.4. Safety recommendations

None.

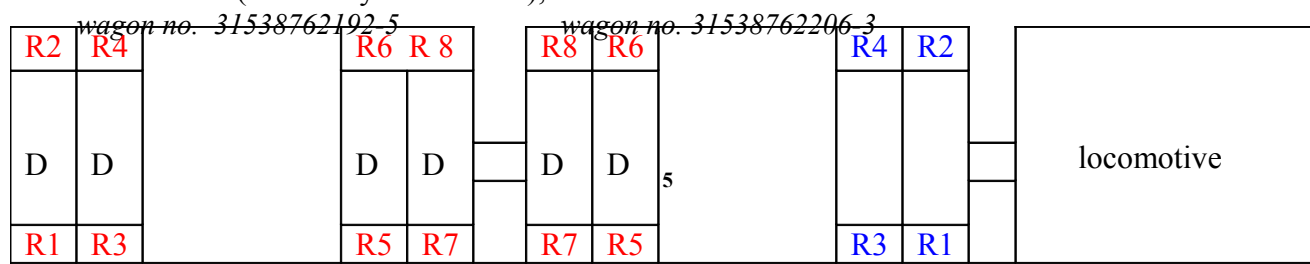
## B. INVESTIGATION REPORT

### B.1. Description of the accident

On the 29<sup>th</sup> of August 2010, at 5:30, the freight train no. 30471-2, belonging to the railway undertaking SC SERVTRANS INVEST SA was sent from the railway station CFR Sudrigiu, having as destination the railway station CFR Bucharest West.

The train arrived to CFR Livezeni railway station on the 30<sup>th</sup> of August 2010, where it had route of entry at the deviated line no. 5.

At the train crossing over the diagonal 10-18, at about 60 m before the joints of the switch no. 18 in direct position, occurred the derailment of the wagon no.31538762206-3 (first by locomotive) from the second bogie in the running direction and the derailment by both bogies of the wagon no. 31538762192-5 (second by locomotive), as illustrated below:



*note: D = derailed axles*

Arriving on the spot, the members of the investigation commission found the following:

a) findings on the wagons

- **wag. no. 31538762206-3**, first by locomotive, derailed by the second bogie in the running direction:

wagon features

- wagon series	Iaeghis;
- automatic brake type	KE-GP;
- bogies type	Y25 Cs II ;
- automatic wheelhouse regulator type	DRV 3-600;
- wagon wheelbase	15800 mm ;
- length over buffers	21040 mm;
- date of the last scheduled repair (RP)	the 19 <sup>th</sup> of March 2010 every
6 years;	
- maximum term for overhaul	6 years

findings after the derailment:

- **the bogie with the wheels 5-8 (derailed bogie)**
  - on the active side of the rim tire sidewall of the wheel no. 7 was found a circular edge;
  - all wheels have dents and indenture on the running profile, due to their run in derailed condition;
  - checking the rate  $q_R$  at the wheel appeal no.5 were found the following values measured in 3 points to 1200 offset each other: 6 mm, 6.2 mm, 6.5 mm.
- **the derailed bogie frame:**
  - deformation over a length of 280 mm and a depth of 20 mm;
  - the wing of the U profile of the front beam deformed in vertical plane next to the hanging support.
- **the condition of the slides on the left**
  - the first spring support of the elastic slide in the running direction (to spindle no. 6) was broken from the first whirl down. The breaking surface looked like a new break;
  - the second spring support of the elastic slide (to spindle no. 8) was deformed and had impact evidences, the imprint left by the box being found both in the fixed side of the wagon strut and in the guiding bolt.;
  - the end of the elastic slide corresponding to the end side of the wagon was deformed, its wear plate was broken and the slide support on the wagon chassis had impact evidences from the spring turns and side impact evidences from hitting the slide of the bogie frame.
- **the wagon chassis**
  - the lower foot of the central strut was deformed and had impact evidences on about 200 mm from the contact with the hanging support of the bogie headstock;
  - the headstock was deformed in the fixation buffer on the left of the running direction from the contact with the pad on the right in the running direction from the next wagon that was involved in the derailment;
  - the rotary of the traction hook was deformed;
  - the front air valve was broken.
- **wagon box**
  - the rail crossing platform deformed due to the contact with the rail crossing of the next wagon that was involved in the derailment;

- **wagon no. 31538762192-5** (the second by locomotive), derailed by both bogies:

wagon features

- wagon series	Iaeghis;
- automatic brake type	KE-GP;
- bogies type	Y25 Cs II;
- automatic wheelhouse regulator type	DRV 3-600;
- wagon wheelbase	15800mm;
- length over buffers	21040mm;
- date of the last scheduled repair (RP)	the 19 <sup>th</sup> of March 2010;
- maximum term for overhaul	6 years

findings after the derailment:

- **the bogie with the wheels 1-4**
  - traces of impact resulting from the derailment on the rolling surface of all wheels;
- **the bogie frame:** slides in full condition and corresponding;
- **the suspension :** no ineffective dampers;
- **the bogie brake:** no damages.
- **chassis:** the pad on the right side of the running direction was pulled from the headstock mounting screws.

b) Findings on the line

In the derailment area (diagonal S10-S18 from Livezeni railway station) is in curve with  $R = 405$  m,  $h = 20$  mm,  $s = 0$  mm,  $L_{r1} = 45$  m,  $L_c = 60$  m,  $L_{r2} = 60$  m, superstructure type 49 on concrete / wood sleepers, gradient (slope in the running direction of the train) to the value of 4.66 ‰.

The first sign of derailment (fall of the wheel 5 within the path - point 1) was observed on the left rail wire path in the running direction of the train, at km 83 + 520 (to the end of the circular curve). The second sign of derailment (in fact fall of the wheel 6 on the upper side of the rail and not escalating the rail - point 0) was observed on the rail wire on the right side of the path, at 2.10 m from the first sign (point 1) in the running direction.



point 1



point 0

- between the measurement points 3 and 4 is a muddy area with water stagnation in the ballast prism;
- between the measurement points 1 and 2 the wood sleepers 2, 3 and 4 were inadequate, catching plate beam being provided with at least 2 coach screws;
- between the measurement points 3 and 4 the wood sleepers 11, 12 and 13 were inadequate, catching plate beam being provided with at least 2 coach screws;

- between the measurement points 8 and 9 the wood sleeper 32 was inadequate, catching plate beam being provided with 4 coach screws;
- between the measurement points 9 and 10 the wood sleeper 39 was inadequate, catching plate beam being provided with minimum 2 coach screws;
- joints made of beams 6 and 7 is muddy with water stagnation in the ballast prism
- measurement from point 0, point situated at 2.10 m from point 1, where the wheel 6 felt on the upper side of the rail, was made on the 31<sup>st</sup> of August 2010 in the presence of the main investigator and the OTF delegate.
- on the 31<sup>st</sup> of August 2010, on the distance of 2.10 m between points 1 and 0 has been established that there aren't lateral movements on the sleepers of the whole rail / mounting plate, even if the coach screws are inclined. Under the metal plate are mechanical wear of the sleeper with plates embedded in the sleeper up to 7-8 mm (see photo above).

Gauge and cross level values measured from 2.5 m to 2.5 m from the first sign of derailment in the opposite direction of running of the train were as follows:

	Measurement point number												
	0	1	2	3	4	5	6	7	8	9	10	11	12
Gauge (E)	24	37	21	25	32	22	17	10	15	15	16	20	20
Cross level (N)	15	14	17	17	10	10	10	8	13	13	10	12	13

## B.2. The accident circumstances

### B.2.1. Involved parties

The running section where the railway accident happened 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 Section L 9 Simeria of CF Timisoara Regional Branch.

Installations signaling, centralization and blocking (SCB) on the running section Subcetate - Livezeni are managed by CNCF “CFR” SA and maintained by the employees from the Section CT 4 Deva, CF Timisoara Regional Branch.

The installation of railway communications between the stations CFR on the running section Subcetate - Livezeni is managed by CNCF “CFR” S.A. and maintained by the employees of SC TELECOMUNICAȚII CFR S.A.

The installation of power and electric traction (IFTE) is managed by CNCF “CFR” SA and maintained by the employees of SC ELECTRIFICARE CFR SA.

The installation of railway communications on the locomotive belongs to the railway undertaking SC SERVTRANS SA and maintained by its employees.

The locomotive and the wagons in the composition of the freight train no. 30471-2 belong to the railway undertaking SC SERVTRANS SA and maintained and overhauled in operation by its employees and the repairs are made by railway undertakings licensed as suppliers.

### B.2.2. Forming and equipments of the train

The freight train no. 30471-2 consisted in: 21 loaded wagons, 128 axles, 2463 gt, 1768 net tons, length 678 m, and was towed by the locomotive EA-766, all belonging to the railway undertaking SC SERVTRANS SA.

Automatic brakes of the train wagons were active, safety and vigilance devices (DSV), installation of speed point control and hitchhiking (INDUSI) of the traction locomotive equipment were operating and instructionally working.

### **B.2.3. Railway equipments**

#### ***Description of the rail path***

The accident occurred on a diagonal line from the station, reflected by the switches no.10 and no.18.

In plan this diagonal is in curve with radius  $R = 405$  m, over-elevation  $h = 20$  mm, over-enlargement  $s = 0$  mm, left deflection in the running direction of the train and in the in long profile, in the running direction of the train, the path is in slope with gradient of 4.66 ‰.

#### ***Description of the rail superstructure***

The rail superstructure in the accident area consists in rail type 49, timber and concrete sleepers T13, indirect fixing K type, with joints.

### **B.2.4. Means of communications**

The communication between the locomotive driver and movement inspectors and between the locomotive driver and the train party was provided by radiotelephone installations.

### **B.2.5. Triggering railway emergency plan**

Immediately after the railway accident, triggering intervention plan to remove damages and restore train traffic was performed in accordance with the Regulations for the investigation of the accidents and incidents, for the development and improvement of Romanian railway and subway safety, approved by Government Decision no. 117/2010, from which there came representatives of the public railway infrastructure manager (CNCF "CFR" SA - CF Timisoara Regional Branch), the railway undertaking SC SERVTRANS SA, the Romanian Railway Authority - AFER and of Rail Transportation Policy Operations.

To restore the derailed rolling stock, was requested and directed the intervention train specialized with hydraulic winches belonging to Section L6 Craiova.



### B.3. Accident consequences

#### B.3.1. Death and injuries

None.

#### B.3.2. Material damages

The amount of material damages in accordance with the estimates prepared by the owner of the rolling stock, of the means of intervention and the public railway infrastructure manager, is as follows:

• <b>at the locomotive EA-766</b>	<b>none</b>
• <b>at the wagons</b> according to the estimate no.188/07.09.2010 from SC CFR IRV CONSTANTA SECTION CURTICI PETROSANI WORKHOUSE	2995.79lei
<b>at the line</b> according to the estimate no.2168/07.09.2010 of Section L 9 Simeria	482.90 lei
• <b>at the installations</b> according to the estimate no. 122/31.08.2010	2507.30 lei
• <b>cost of the means of intervention</b> according to the estimate no. 31/3/54/01/09//2010 of RSC Timisoara	31342.20 lei
according to the estimate no.14-13302/13.10.2010 SC SERVTRANS INVEST SA	70976.00 lei
<b>TOTAL</b>	<b>108304.19 lei</b>

#### B.3.3. Consequences of the accident in the railway traffic

The railway traffic was not affected by the consequences of the accident.

### B.4. External circumstances

On the 30<sup>th</sup> of August 2010, between 05:00-06:00, the visibility of the bright lights indication and of their indications was good.

### B.5. Investigation course

#### B.5.1. The summary of the of the involved railway staff statements

**The foreman** of D8 Iscroni- L9 Simeria stated as follows:

- he inspected the lines from the railway station CFR Livezeni in August, on the distance between S10 and S18 and he didn't find improper wooden sleepers, but he noticed sleepers with coach screws inclined on the outer wire of the curve;
- he checked these coach screws by hitting with a hammer, founding that they were intact and not broken;
- he found joints with loose bolts that were tighten on the spot, and at a joint a missing bolt that could not be completed because the hole in the strap did not fit with the one in the rail.

**The foreman** of D8 Iscroni-E 26-28, L9 Simeria stated as follows:

- made the fortnightly revision on the 27<sup>th</sup> of August 2010 at the lines 4 and 5, respectively at the line in curve between S10 and S1, but he didn't find any problem that may jeopardize SC;
- he considered the gauge evolution according to the measurements from the curves book after the switches, during the period 2008-2009-August2010, based on some rectification works on the gauge carried out during this period;
- he considered that the values measured at the gauge in 2010 were bigger because the mechanical wear of the rail material was higher, due to a more intense traffic on this stretch of line.

**The railway inspector** of D8 Iscroni, Section L9 Simeria, stated as follows:

- he made the last inspection on the lines 4 and 5 from the railway station Livezeni on the 16<sup>th</sup> of August 2010 and respectively on the 18<sup>th</sup> of August 2010;

- he found at these inspections at the diagonal 10-18 from the railway station Livezeni a muddy area close to the switch no.18;
- he found some wooden sleepers with the coach screws inclined outward which were found firmly fixed on the sleepers at checking;
- he considered that these problems couldn't endanger SC.

**The head of district** at D8 Isroni, Section L9 Simeria, stated as follows:

- made the fortnightly revision on the 27<sup>th</sup> of August 2010 and the line measurement between the switches 10-18 to gauge, level and arrow on the 7<sup>th</sup> of September 2009;
- he recorded these values in the curves inspection book, values that fell within the tolerances of the instruction nr.314 / 1989 so as to gauge and level;
- at the sleepers census in the autumn of 2009 he found a number of 37 improper wooden sleepers second-class on the distance between the switches 10-18, that didn't require immediate replacement;
- he explained the inclination to outside the path of the coaches screws providing plates clamping to the wooden sleepers to groups of 2-3 sleepers through the rectify works to the gauge made in 2008 after which they have replaced a number of inadequate wooden sleepers with SB sleepers;
- he explained the value of 1472(+37)mm of the gauge in the falling point of the wheel on the inside rail by the fact that the measurement was made after the derailment, being its consequence.

**The technical inspector of wagons** who technically inspected in transit the train no.30471-2 stated as follows:

- he didn't find defects or deficiencies at the wagons of this train, or at the wagon no.31538762206-3;
- he was equipped with  $q_R$  pattern that he used to the technical preparation of the train;
- he couldn't find at the wagon no. 31538762206-3 the tire rim under the limit and the rate  $q_R$  consumed because in the railway station Simeria Calatori at the lines no.3, 4, 5 and 6 are holes, bumps, material left between the lines, large weeds that obscure;
- he didn't communicate to the railway undertaking management to which he belongs the difficulties encountered at the technical inspection in transit.

**The technical inspector of wagons** who prepared and technically inspected at composition the train no. 30471-2 on the 29<sup>th</sup> of August 2010 stated as follows:

- he made the technical inspection at composition to this train in the railway station CFR Sudrigiu;
- at the technical inspection he didn't find to the train defects to worry;
- he was equipped with  $q_R$  pattern that he didn't use for this train;
- the reason for which he could not detect defects at the train is the presence of a ditch to the line no.3 of technical preparation of the trains from this station.

**M.R. officer** who is responsible for the training of the technical inspectors of wagons stated as follows:

- he did the regular professional check of the employees in the position of technical inspector of wagons on 2010;
- during regular professional checking on 2010, the technical inspector of wagons who technically prepared at composition the train no. 30471-2 obtained the overall average 6.64 and the technical inspector of wagons who technically inspected in transit this train obtained the overall average 6.85;
- he found the activity of the two technical inspectors of wagons until the preparation of this train as being good;
- he considered that the two technical inspector of wagons who prepared and inspected the train no. 30471-2 at composition and respectively in transit didn't find the tire rim and respectively the rate  $q_R$  consumed at wheel no.5 of the wagon no. 31538762206-3 because they didn't pay a proper attention.

### **B.5.2. Safety management system**

At the time of the accident CNCF "CFR" SA as manager of the railway infrastructure, had implemented their own system of management of railway safety in accordance with Law no. 55/2006 on rail safety and the Order of the Minister of Transport (OMT) no.101/2008 on granting

the security authorization to the administrator / management of railway infrastructure in Romania, being in possession of:

- Safety Authorization - Part A with the identification no. ASA09002 – through which the Romanian Railway Safety Authority from AFER confirms the acceptance of the safety management system of railway infrastructure manager;
- Safety Authorization - with the identification no. ASB9007 – through which the Romanian Railway Safety Authority from AFER confirmed the acceptance of the provisions adopted by the railway infrastructure manager to meet specific requirements necessary to ensure safety of rail infrastructure, in the design, maintenance and operation, including where appropriate, maintenance and operation of traffic control and signaling system.

At the time of the accident, SC SERVTRANS INVEST SA as railway undertaking had implemented their own system of management of railway safety in accordance with Law no. 55/2006 on rail safety and the OMT no. 535/2007 regarding the approval of the licensing of railway and safety certificates in order to make rail services on the railways in Romania and had:

- Safety certificate - Part A with the identification no. RO1120100011 through which the Romanian Railway Safety Authority from AFER confirms the acceptance of the safety management system of the railway undertaking according to the national legislation;
- Safety certificate - Part B with the identification no. RO1220100147 through which the Romanian Railway Safety Authority from AFER confirmed the acceptance of the provisions adopted by the railway undertaking to accomplish the necessary specific requirements for safe operation on the relevant network in accordance with national legislation.

### **B.5.3. Norms and regulations. Sources and references for the investigation**

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

#### norms and regulations

- Instructions for technical inspection and maintenance of wagons in operation no. 250 approved by the Order of the Minister of Transport, Constructions and Tourism no. 1817 on the 26<sup>th</sup> of October 2005;
- Instruction for setting terms and order for the rail revisions no. 305 approved by OMT no. 71 on the 17<sup>th</sup> of February 1997;
- Instruction for the lineman head of district for the rail maintenance no. 323/1965;
- Instruction for the activity of the foreman for the maintenance of the line no.322/1972;
- Instruction for the flagmen and rail or dangerous points inspectors no. 321/1972;
- Instruction of standards and tolerances for the construction and maintenance of the rail - standard gauge lines no. 314/1989;
- Instruction for the use of rail measuring wagons no.329/1995
- How-to for using the wagon and carts for rail measuring – Instruction no. 329/1966.

#### sources and references

- copies of documents submitted as annexes to the investigation file;
- photos taken immediately after the railway accident by the members of the investigation commission;
- photos of the involved wagons in the railway station CFR Petrosani, as well as at the Section IRV Petrosani;
- documents on the lines maintenance provided by the persons in charge with the maintenance;

- results of measurements made immediately after the railway accident at the rail superstructure and derailed wagons;
- inspection and interpretation of the technical condition of the elements involved in the accident: infrastructure, rail facilities and train;
- questioning of the staff involved in the accident;

#### B.5.4. Work of the technical installations, infrastructure and rolling stock

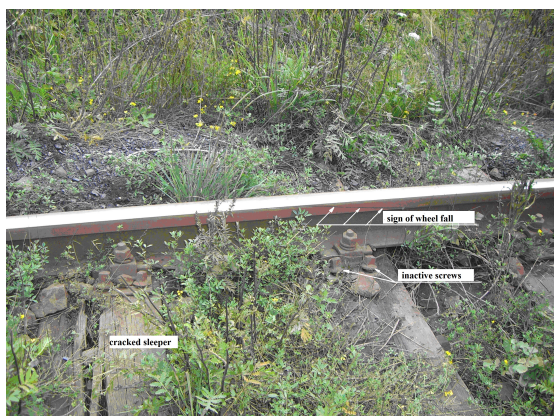
##### B.5.4.1. Data found on the line

###### *Observations and measurements made at the line, after the derailment and lift of the wagons*

From the first sign of derailment (point no. 1) in the opposite of the running direction checks were performed with the pattern to measure the path to the gauge and to the cross level of the rail from 2.5 m to 2.5 m measured values are:

	Number of measurement point												
	0	1	2	3	4	5	6	7	8	9	10	11	12
Gauge (E)	24	37	21	25	32	22	17	10	15	15	16	20	20
Cross level (N)	15	14	17	17	10	10	10	8	13	13	10	12	13

At the request of the railway undertaking there was made a further examination of the gauge and of the cross level on the derailed area at the point "0" at a distance of 2.10 m after point "1". From this point begin visible traces of fall on the rail upper side of the right side wheel.



On the areas between the measurement points no. 1-2 and no. 3-4 were found were found by 3 consecutive improper sleepers.

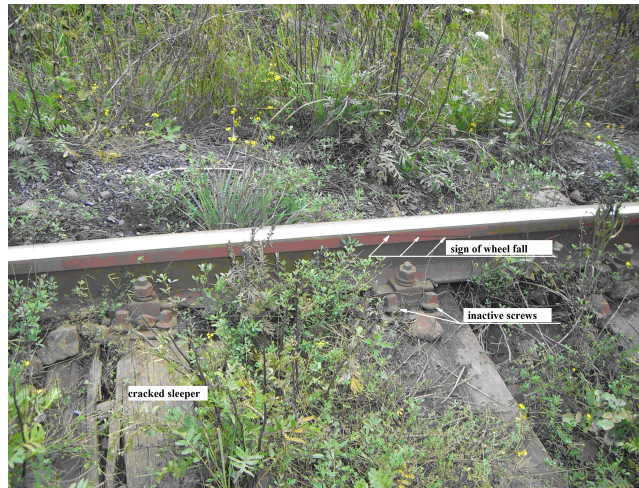
According to the provisions of the art. 1 point 13 from the Instruction of standards and tolerances for the construction and maintenance of the rail, the maximum admitted value of the gauge no. 314/1989 is of 1470 mm (corresponding to the value of + 35 mm indicated by the pattern for measuring the rail). This value is exceeded at the point of measurement no. 1

The values of the cross level don't exceed the values admitted by the How-to for using the wagon and carts for rail measuring – Instruction no. 329/1966.

In the areas between the points no. 3 and 4 the prism of crushed stone was clogged. In this area were checked the gauge and the cross level under load in 2 points, resulting the following values:

E/N: 25/16; 31/12

In these points the gauge values don't exceed the maximum value admitted by the Instruction no. 314/1989, and the values of the cross level fit with the values admitted by How-to for using the wagon and carts for rail measuring – Instruction no. 329/1966.



*clogged area with inappropriate sleepers and fastening*

The first sign of derailment (fall of the wheel 6 within the path - point 1) was observed on the rail wire on the left of the path in the running direction of the train, at km 83 + 520 (to the end of the circular curve). The second sign of derailment (in fact the fall of the wheel 6 on the upper side of the rail and not escalating the rail - point 0) was observed on the tail wire on the right of the path. At 2.10 m from the first sign (point 1) in the running direction was found a trace of rolling of the tire rim of wheel no.5 (appeal wheel) on the upper side of the rail, on the right (outside wire of the curve) from axis to outside.

Other findings on the line:

- between the measurement points 3 and 4 is a muddy area with water stagnation in the ballast prism;
- between the measurement points 1 and 2 the wooden sleepers 2, 3 and 4 were inadequate, clamping plate sleeper being ensured with at least 2 coach screws;
- between the measurement points 3 and 4 the wooden sleepers 11, 12 and 13 were inadequate, clamping plate sleeper being ensured with at least 2 coach screws;
- between the measurement points 8 and 9 the wooden sleeper 32 was inadequate, clamping plate sleeper being ensured with at least 4 coach screws;
- between the measurement points 9 and 10 the wooden sleeper 39 was inadequate, clamping plate sleeper being ensured with at least 3 coach screws;
- joint made of the sleepers 6 and 7 is muddy with water stagnation in the ballast prism;
- according to the provisions of the Instruction 329/1972 – for the use of rail measuring wagons, Annex I Table 2 NOTE stipulates “...It is considered a defect in one or more exceedings of the degree of deviation respectively, a length of 40 m for defects  $L_2$  (40 m on field 1:4000) and a length of 10 m (2.5 mm on tape) for  $L_3$  to  $L_6$  defects”.

#### **B.5.4.2. Data found on the work of the rolling stock and its technical installations**

##### ***Findings on the wagons in the composition of the train***

- regime exchangers “Freight – Passengers” and “Empty – Loaded” were in proper position for the load condition of the wagons, respectively on the positions “Freight” and “Loaded”.
- binding wagons between them was done properly;
- running coupling of the traction device tighten properly for freight trains;
- no uninsured parts were found to jeopardize traffic safety.



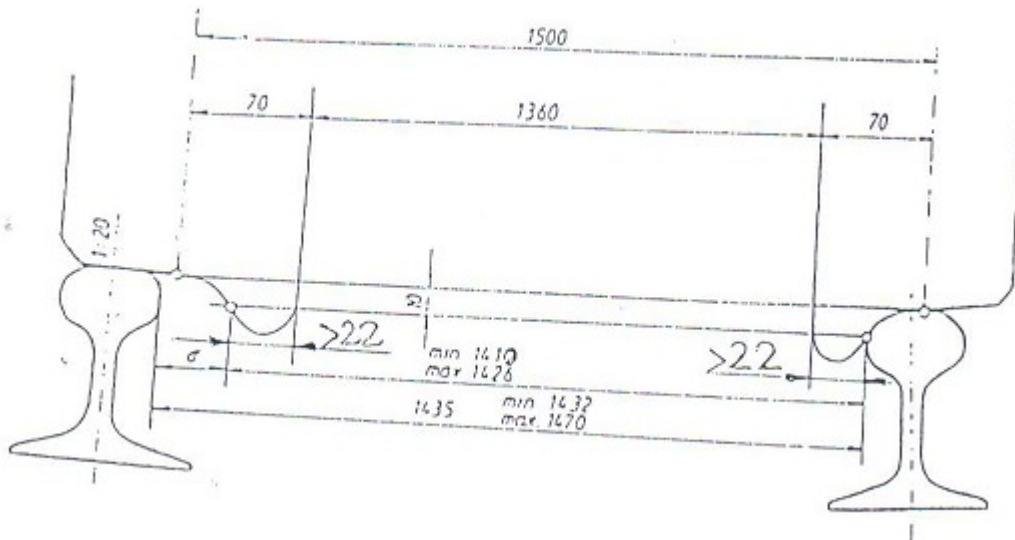
## B.6. Analysis and Conclusions

### B.6.1. Analysis and conclusions on how occurred the train derailment

From the analysis of the findings at the railway accident, of the technical condition of the wagons in the composition of the train, of the photos taken at the derailment and of the statements of the involved staff it can be concluded that the dynamics of the derailment was as follows:

For the situation in point no. 1 where the first sign of derailment was found and where it's registered an exceeding of the rail gauge, measured with the rail measuring pattern, of 37 mm, results a value of the gauge  $E=1435+37=1472$  mm, over the maximum value of 1470 mm admitted by the Instruction for standards and tolerances for the construction and maintenance of the rail no. 314/1989.

In terms of guidance, putting the vehicle with the wheels rims between the two wires of the rail is ensured by the width of the guidance channel, that is by the existence of the total stroke  $\sigma$  between the wheel rim and the inner side of the rail, defined as the difference between the rail gauge and the axle gauge, as in drawing no.1.



drawing no.1

The **minimum** admitted stroke of the axle in rail, corresponding to the situation when the rail gauge is of 1435 mm and the distance between the outer sides of the wheels rims is of maximum 1426 mm (rail and wheels with the running profile unused) is:  $\sigma = 1435 - 1426 = 9$  mm, plus the value of the rail over-enlarging in curves. For constructive reasons for this stroke is taken the value of **10 mm**.

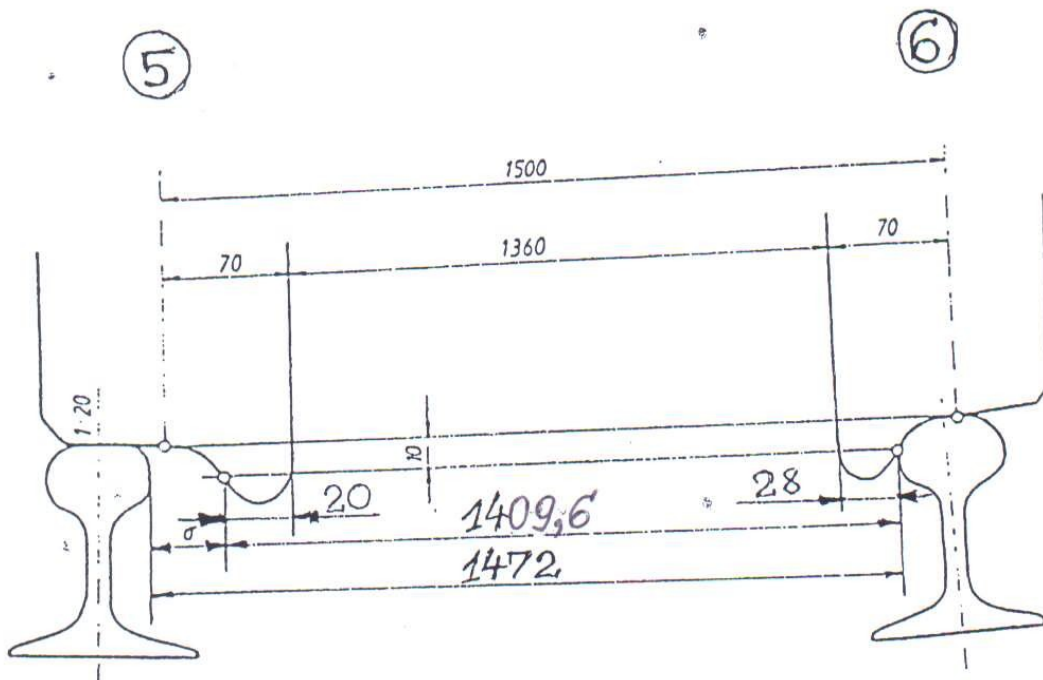
The **maximum** admitted stroke of the axle in rail, corresponding to the situation when the rail gauge is the maximum admitted of 1470 mm and the distance between the outer sides of the wheels rims has the minimum admitted value of 1410 mm (rail and wheels with the running profile used at maximum) is:  $\sigma = 1470 - 1410 = 60$  mm.

The wagon no. 31538762206-3 derailed by the second bogie in the running direction had for the derailed axle (with wheels no. 5 and no. 6) the following elements:

- rim width of 20 mm of the appeal wheel no. 5 under the admitted limit of 22 mm provided by the Instruction no.250/2005;
- variable value of the rate  $q_R$  at the appeal wheel no.5, in three points shifted to  $120^\circ$  from each other, the rate measured in the three points having the values of: 6 mm; 6.2 mm; 6.5 mm, (under the minimum limit of 6.5 mm provided by the Instruction no. 250/2005), values that show an uneven wear of the running profile of the wheel;
- rim width of the wheel no.6 of 28 mm;
- distance between the inner sides of the bandages measured in three points shifted to  $120^\circ$  from each other is of: 1360.9 mm; 1361.2 mm; 1362.9 mm;

- distance between the outer sides of the wheels rims of the axle 5-6 measured with the device in three points shifted to  $120^\circ$  from each other is of: 1409.6 mm; 1410 mm; 1411.1 mm.

Reducing the dimension of the axle gauge previously calculated with the value of the rail gauge measured with the rail measuring pattern, results that the axle with the wheels no.5-6, crossing over the point no. 1, had a total stroke in rail  $\sigma = 1472 - 1409.6 = 62.4 \text{ mm}$ , stroke due to the serious wear of the outside active flank of the rim of the appeal wheel no. 5 (groove tore of the rim of the appeal wheel no.5) and to the gauge in this point, according to drawing no.2.

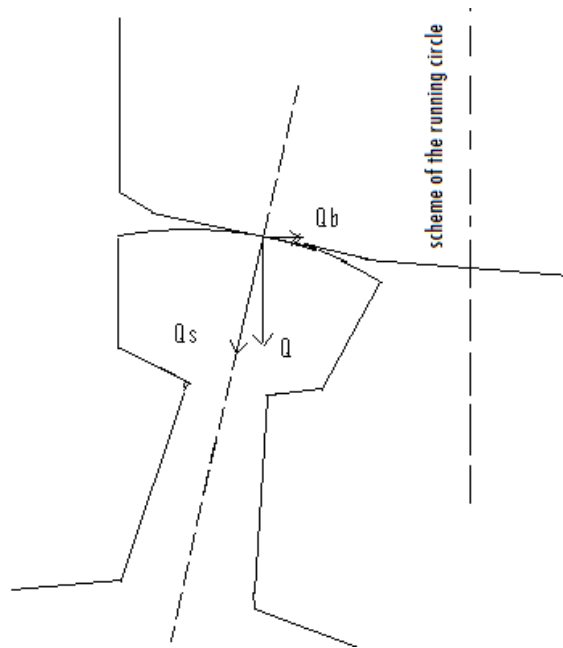


drawing no.2

In this case, the consumption of this total rail stroke of the axle – result of the inherent flexuosity movement of the axle while running led to a monocontact between the inner flank of the upper side of the rail on the left in the running direction and the wheel no. 6, on the one hand and a bicontact (situation characterized by the existence, in addition to the contact point on the running surface, of a contact point on the rim) between the inner flank of the upper side of the rail on the right in the running direction and the appeal wheel no. 5, on the other hand, as in the drawing no. 2, which made that the wheel no. 6 run on the surface on the outer running profile, characterized by maximum taper ( $< 1:15$ ).

Considering Q load on wheel no. 6 applied in point A located in the vertical axle of the rail and breaking up this load into two components as two directions, one horizontal (Qb) and the other in the vertical symmetry axle of the rail (Qs) according to the drawing no.3, we see that the force Qs is compensated by the rail and the horizontal force Qb remains uncompensated and gives to the wheel no.6 (and hence to the axle) a translational movement to the right in the running direction.

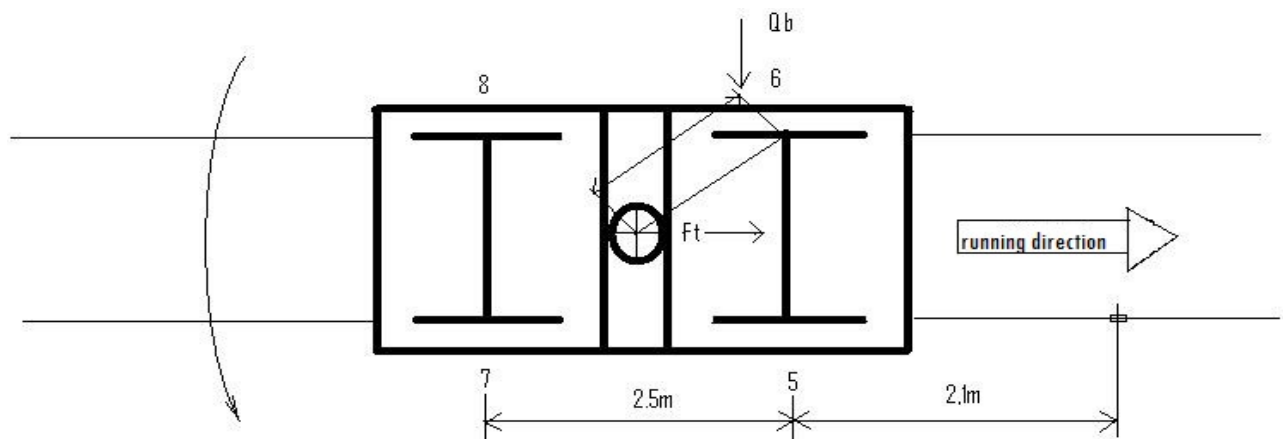
The running of the wheel no. 6 on the maximum taper surface of the running profile – possible due to the conjugated wears of the wheel rim and of the rail gauge – allowed the development of the horizontal force Qb at a level that exceeded the guidance capacity of the rail on the right in the running direction, practically canceling the recovery tendency of the axle in the rail and so causing the slip of the wheel no.6 from the rail on the left in the running direction, concluded by its fall in the inside of the path.



*drawing no. 3*

After the fall inside the rail of the wheel no. 6 and the train running, was imprinted on the surface of this rail the sign from the photo in point 0, sign distanced with 2.1 m from the first derailment sign on the left rail.

Because the wheel no. 6 lost the contact with the rail and it came into contact with the sleepers, running over these, it put a strong resistance to forward, currently playing as a fix point, around which the traction force  $F_t$  transmitted through the pallet bolt created a pivoting moment, giving to the bogie a counterclockwise rotation movement, according to the drawing no.4

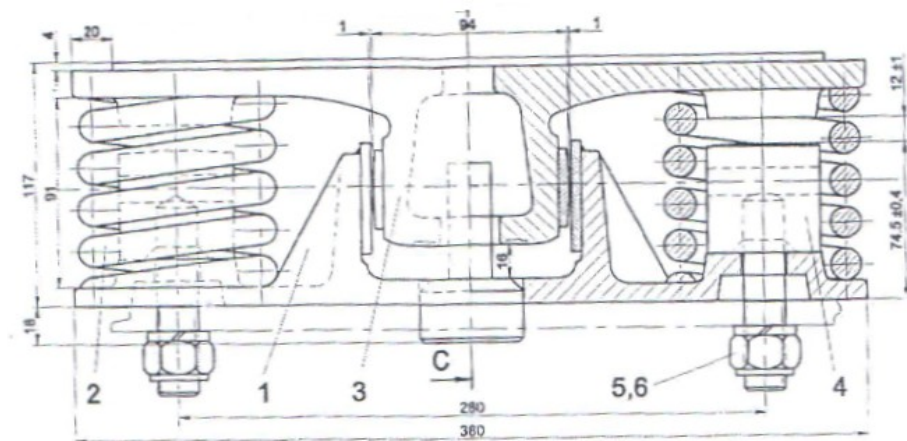


*drawing no.4*

When the wheel no. 6 fell from the rail, the steady state of the bogie was damaged suddenly, from its four boundary points on the rail (materialized by the contact points with the rail of the wheels 5, 6, 7 and 8) remaining only 3 (the appeal wheel no.5 that was running with the bandage rim on the rail and the wheels no. 7 and 8), that determined a down movement of the bogie next to the disappeared support point (wheel no.6) which made that the slide holder on the bogie frame also move down and so to allow the upper slide holder to come out of its slot and the two springs to

become free (removed from under the load).

In this case the upper slide holder, being out of the slot, is subjected to a crush between the pallet cross on the wagon chassis and the bogie frame, which creates a strong vertical deformation thereof and the spring located to the end of the wagon is bent by the rubbing stone on the chassis, causing a distortion of it in the running direction and the printing of the circular traces left by the top of this spring on the rubbing stone of the pallet cross of the chassis, as attached photos taken in the spot and the drawing no. 5.



*drawing no. 5*

Due to the twisting motion to which the bogie was subjected and to the fall of the wheel no. 6 between the rails, the central strut lower flange of the chassis came into contact with the bogie headstock in the area of the hanging support, contact after which the central strut lower flange gets a deformation on about 200 mm, the bogie – and therefore the wagon – running so derailed for about 60 m, moment when it's involved in the derailment also the next wagon, no. 31538762192-5, that derailed by both bogies on the switch no. 18.

When the second wagon was involved in the derailment, the left pad in the running direction of the first derailed wagon hits the right side pad pan of the wagon in the running direction, causing the pulling of the mounting bolts on the headstock and its fall, and the breaking of the train between these two derailed wagons by forcing and detachment of the active coupling noose of the second from the two nut caps of the binding device.

The breaking of the train resulted:

- movement of the first wagon by locomotive, by the end with the derailed bogie, to the right in the running direction about 2 m from the right rail;
- deformation of the headstock of this wagon about 10 mm vertically in the area of fixing the left pad, in the running direction;

- creating a distance between the two derailed wagons of about 4m.

## **7. The accident causes**

**B.7.1. Direct cause:** of the occurrence of this railway accident is the movement of the contact point wheel – rail beyond the rolling surface of the wheel no. 6 as consequence of the difference between the point  $A_{q0}$  of the wheel no. 5 and the outer side of the wheel no. 6 on the one hand and the distance between the inner flanks of the rails.

**Contributing factors** to the occurrence of this accident were:

- wear of the rim, of the wheel no. 5, that had the width of 20 mm, to 22 mm;
- wear of the construction elements of the rail superstructure, that led to a value of the gauge of 1472 mm;

**B.7.2. Underlying cause:** rim width of the wheel no. 5, measured at 10 mm above the rolling circle, of 20 mm to the value of 22 mm admitted by the Instructions for technical inspection and maintenance of wagons in operation no. 250/2005, table 1, point no.8. This was possible under the failing to ensure by the technical inspector of wagons of the mandatory works and checks that he had to provide at the technical inspection at composition, as a result of human error occurring during the technological process of preparation and technical inspection of the train no. 30471-2.

## **B.7.3. Root causes**

None.

## **C. Safety recommendations**

None.

This investigation report will be sent to Romanian Railway Safety Authority, to the public railway infrastructure manager CNCF "CFR" SA, to the freight railway undertaking SC SERVTRANS INVEST SA Bucharest.

Members of the investigation commission:

- |                    |                     |
|--------------------|---------------------|
| ▪ Eduard STOIAN    | - main investigator |
| ▪ Țena LUCIAN      | - investigator      |
| ▪ Păiș LUCA        | - investigator      |
| ▪ Mircea NICOLESCU | - investigator      |