



INVESTIGATING REPORT

of the railway accident
occurred on the 08th of May 2013, in the activity of the Branch of the Regional Center for Railway
Operation, Maintenance and Repairs Cluj, between the railway stations Fiad and Telciu, at km
21+300



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A. PREAMBLE

A.1. Introduction

The Romanian Railway Investigating Body, hereinafter referred as OIFR, performed an investigation, according to the provisions of the *Law no. 55/2006 on the railway safety, hereinafter referred as Law for Railway Safety* and the *Regulation for the investigation of accidents and incidents, development and improvement of railway safety on the railway and the metro network in Romania*, approved by the Government Decision no. 117/2010, hereinafter referred as *Investigation Regulation*.

The investigation action of OIFR aim's to improve the railway safety and preventing the railway incidents or accidents.

The investigation is performed independently of any judicial inquiry and does not aim to establish the guilt or the responsibility.

A.2. Investigation process

According to the art. 19, point 2 from the *Railway Safety Law*, corroborated with the art. 48 from the *Regulation for the investigation of accidents and incidents, development and improvement of railway safety on the railway and the metro network in Romania*, OIFR, for the railway accidents and incidents, has to start an investigation and establish investigation commissions for gathering and analyzing the technical information, establishment of the occurrence conditions, including the causes definition and, if case, issuing safety recommendations for the prevention of some similar accidents and for the improvement of the railway safety.

Taking into account the informative note of the Regional Traffic Safety Inspectorate from the CNCF „CFR” SA on the 08th of May 2013, and the informative note from the Branch of the Regional Center for Railway Operation, Maintenance and Repairs Cluj, hereinafter referred as CREIR Cluj, concerning the accident occurred on the 08th of May 2013, at 17,45 o'clock, in the running of the freight train no. 43622, belonging to the freight undertaking SNTFM „CFR Marfa” SA, in the activity of the Branch of the Regional Center for Railway Operation, Maintenance and Repairs Cluj between the railway stations Fiad and Telciu, at km 21+416, where the derailment of a number of 9 wagons occurred, from which 3 were overturned from the viaduct at km 21+347 **and taking into account that the railway event is defined as accident according to the provisions of the art. 7(1), point b.** from the *Regulation for the investigation*, OIFR director decided to start an investigation and to appoint an investigation commission.

Through the Decision no. 115, from the 10th of May 2013 of OIFR director has appointed an investigation commission, made from employees from OIFR, ASFR (ISF Cluj), CREIR Cluj and SNTFM „CFR Marfa” SA, as follows:

▪ Cristian GROZA	OIFR investigator	main investigator;
▪ Nicolae COSTIN	Territorial state inspector ASFR Cluj	member;
▪ Ion SALCA	Territorial state inspector ASFR Cluj	member;
▪ Gabriel PASCU	Head of RRSC CREIR Cluj	member;
▪ Alexandru COTUT	Regional inspector CREIR Cluj	member;
▪ Bogdan NASTASIE	central inspector SNTFM	member;
▪ Stefan GAL BANDI	regional inspector SNTFM	member.

B. INVESTIGATION REPORT BRIEF PRESENTATION

On the 08th of May 2013, at around 17,45 o'clock, in the activity of the Branch of the Regional Center for Railway Operation, Maintenance and Repairs Cluj, the freight train no. 43622 (belonging to the freight undertaking SNTFM „CFR Marfa” SA), between the railway stations Fiad and Telciu, where the trains traffic is made using the telephonic agreement system at station gap, based on free track, happened an railway accident in the area of km 21+416, through the derailment of a number of 9 wagons, from which 3 were overturned from the viaduct at km 21+347. This wagons are owned by the freight undertaking SNTFM „CFR Marfa” SA.

The freight train no. 43622, consist of 37 freight wagons Eacs series, from which 1 was empty, 4 axles, 36 wagons loaded with logs, 144 axles, a total of 148 axles, 1870 tones, having at the rear the locomotive 60-0857-7 inactive and conect at the train and brake, with a total length of 545 m. The train was hauled with locomotive DA 60-0672-0, belonging to SNTFM „CFR Marfa” SA. The locomotives were droved and deserved by employees belonging to SNTFM „CFR Marfa” SA.

After this railway accident, the railway traffic between the railway stations Fiad and Telciu was closed from 08th of May 2013, 17,52 o'clock until 11th of May 2013 at 18,09 o'clock, when after the performed repair works, the train traffic was taken up with a speed of 15 km/h (for 2 trains), after that with 30 km/h.

As consequence for the occurrence of this railway accident, on the section Telciu – Fiad were cancelled a number of 27 passenger trains, were introduced a number of 22 additional passenger trains, were transferred the passengers from 19 trains and 3 passenger trains were had delayed with a total number of 150 minutes.

The accident did not generate casualties or dead.

The direct cause, contributing factors

The direct cause of the occurrence of this accident is the climbing of the flange of the wheel from the right side of the first axle from the second bogie in the running direction of the wagon no. 315354935878 on the head of the track corresponding to the exterior curve rail and the leaving of the track, due to the following combination of factors:

- the existence of the excess of super elevation at the line due the reducing in time of the traffic speed, from 60 km/h at 30 km/h;
- the existence at wagon no. 315354935878 of some values of the load ratio of the wheel from the left beside the one from the right from the same wheel, respective wheel no. 3 beside wheel no. 4 with a value of 1,20 and wheel no. 1 beside wheel no. 2, with a value of 1,13;
- the existence of a tilt of the wagon's body to the interior of the curve, found out at the measuring of the distances between the bogie's frame and the superior guide;
- the existence at wagon no. 315354935878 of an ineffective shock absorber corresponding to wheel no. 4;
- the reactions on the train, caused by the positioning of the train simultaneous on lines with different declivities and in opposite curves and different radiuses, also the existence of a ratio of 2,1:1 between the locomotive's weight from the rear of the train beside the wagon's weight from the train.

Underlying cause

The false understanding and applying of art. 6, paragraph (16) from the Braking and Hauling Regulation no. 006, referring to the remaining at the initial position in the train consist, without being active of the locomotive which were used as banking locomotive.

Root cause

None

Safety recommendations

Taking the necessary measures for the operation employees to understand accurately and unambiguously the applying conditions of the provisions of art. 6, paragraph (16) from the Braking and Hauling Regulation no. 006, referring at remaining at the initial position in the train consist, to continue running as hauled vehicles and without being active in the train hauling, of the locomotives which were used as banking locomotives.

C. INVESTIGATING REPORT

C.1. Accident presentation

On the 08 of May 2013, the freight train no. 43622, was dispatched from the railway station Sacel (in the available train path of the freight train no. 42564), to the railway station Dealul Stefanitei, where it arrived at 16,20 o'clock, being hauled with DA 60-0672-0 and having as banking locomotive DA 60-0857-7. The train was formed from a number of 18 wagons type Eacs loaded with wood, the brut tonnage being of 924 tones.

In the railway station Dealul Stefanitei were attached a number of 109 wagons type Eacs loaded with wood, the brut tonnage rising at 1870 tones. At around 16,30 o'clock was made the change of the traction employees which had to be on duty on the locomotive DA 60-0672-0 (hauling locomotive), after that was performed the complete test of the train brakes, the locomotive personnel receiving the message: „The brake test is over. The automatic brake is alright”.

From the railway station Dealul Stefanitei, the freight train no. 43622, hauled with DA 60-0672-0 and having the banking locomotive DA-60-0857-7 was dispatched at 17,18 o'clock to the railway station Salva using the telephonic agreement system at station gap, based on free track for train traffic.

The freight train no. 43622, belonging to SNTFM CFR Marfa SA, was formed from 37 freight wagons Eacs series, from which 1 was empty, 4 axles, 36 wagons loaded with logs, 144 axles, a total of 148 axles, 1870 tones, having at the rear the locomotive 60-0857-7 inactive and tide at the train and brake, with a total length of 545 m. The train was hauled with locomotive DA 60-0672-0, belonging to SNTFM „CFR Marfa” SA. The locomotives were droved and deserved by employees belonging to SNTFM „CFR Marfa” SA.

After the departure of the train from the railway station Dealul Stefanitei, when the train had a running speed of about 25 km/h, the driver of the hauling locomotive checked the effectiveness of the automatic brake, the braking effect being confirmed through the radio telephone by the banking locomotive personnel. There were none problems recorded in the hauling of the train, the movement inspector from the railway station Fiad which visually inspected the train (the last before the accident occurrence), communicated through the RTF station to the driver from the hauling locomotive the fact that this passed through the stations without problems and that the train was fully signalized.

After passing through the railway station Fiad, the hauling locomotive DA 60-0672-0 driver noticed a not ordered diminishing of the air from the main pipe, after that he took immediately quick braking measures of the train. After moving on the site, in the area of km 21+416 he noticed the derailment of 9 wagons (3 of those were overturned on the viaduct from km 21+347), starting with the 28th wagon from the locomotive to the rear of the train. The place of the accident occurrence is presented in **image no. 1**.

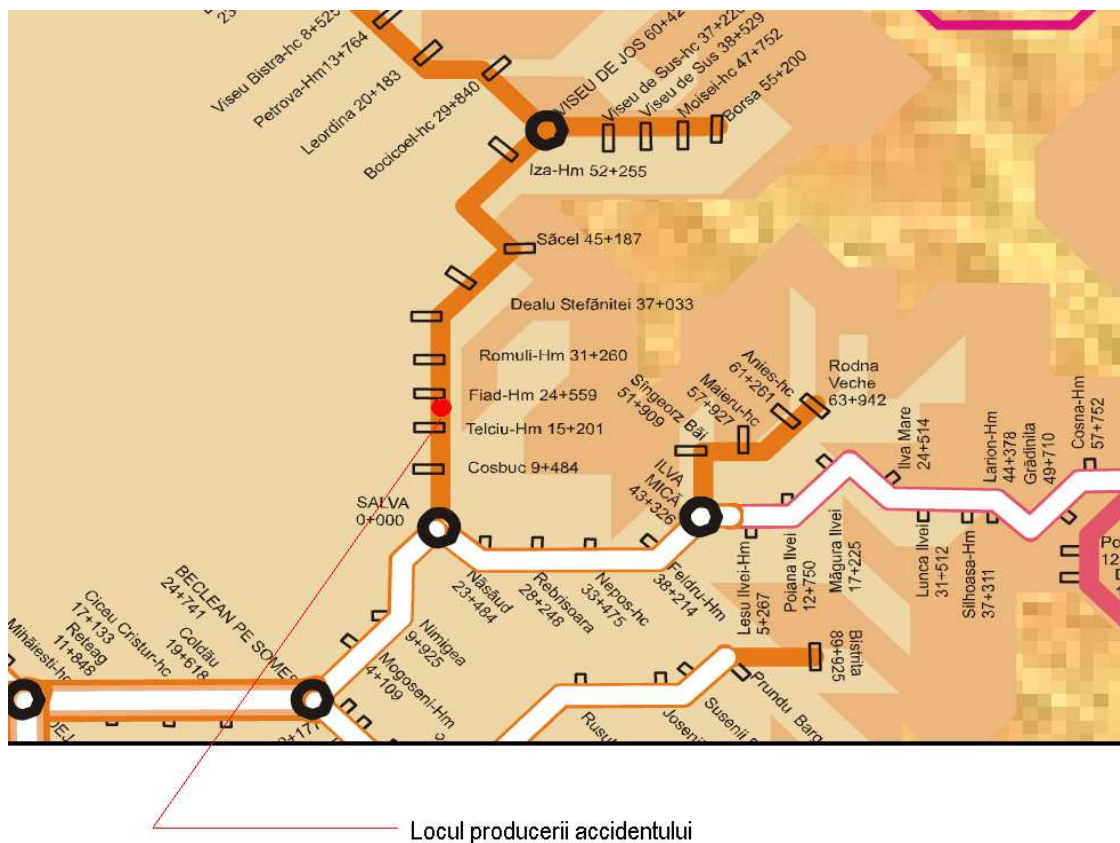


Image no. 1 The place of the accident occurrence

It occurred the derailment of the next wagons:

- the loaded wagon 315354935878, 28th from the train, derailed by the second bogie;
- the loaded wagon 315354722276, 29th from the train, derailed by the first axle of the second bogie;
- the loaded wagon 825354679482, 30th from the train, derailed by both bogies on the viaduct;
- the loaded wagon 825354700221, 31th from the train, derailed and overturned on the viaduct;
- the loaded wagon 315354763270, 32th from the train, derailed and overturned on the viaduct;
- the loaded wagon 315354676696, 33th from the train, derailed and overturned at the end of the viaduct at km 21+400;
- the loaded wagon 315354759104, 34th from the train, derailed by both bogies;
- the loaded wagon 315354791172, 35th from the train, derailed by both bogies;
- the loaded wagon 315354736607, 36th from the train, having derailed the wheel from the right side of the first axle.

After this railway accident, the railway traffic between the railway stations Fiad and Telciu was closed from 08th of May 2013, 17,52 o'clock until 11th of May 2013 at 18,09 o'clock, when after the performed repair works, the train traffic was taken up with a speed of 15 km/h (for 2 trains), after that with 30 km/h.

As consequence for the occurrence of this railway accident, on the section Telciu – Fiad were cancelled a number of 27 passenger trains, were introduced a number of 22 additional passenger trains, were transferred the passengers from 19 trains and 3 passenger trains were had delayed with a total number of 150 minutes.

The accident did not generate casualties or dead.

Following the notification of this railway accident, made according to the provisions of the specific regulations, at the accident place came the specialists of OIFR, Romanian Railway Safety Authority

(ISF Cluj), railway infrastructure administrator CNCF „CFR” SA and of the freight undertaking SNTFM „CFR Marfa” SA.

According to the accident classifications from the *Regulation for the investigation of accidents and incidents, development and improvement of railway safety on the railway and the metro network in Romania*, approved through HG 117/2010, the derailment of the wagons: 315354935878, 315354722276, 825354679482, 825354700221, 315354763270, 315354676696, 315354759104, 315354791172 and 315354736607 is classified as a **railway accident** and framed at the **art. 7(1), point b**.

C.2. Accident circumstances

C.2.1. Involved parties

The infrastructure and superstructure involved, where the accident took place, are administrated by CNCF „CFR” SA – Branch CREIR Cluj and is maintained by the specialized employees of Line District Telciu – L9 Section Sighetul Marmatiei.

The hauling locomotive DA 60-0672-0, the banking locomotive from the rear of the train DA 60-0857-7 and the wagons from the train no. 43622 are owned by SNTFM „CFR Marfa” SA. The locomotives were drove, respectively deserved by the employees of the freight undertaking SNTFM „CFR Marfa” SA.

The communication equipment from the locomotives belongs to the SNTFM „CFR Marfa” SA and is maintained by its employees.

C.2.2. The consist and the equipment of the train

The freight train no. 43622, belonging to SNTFM CFR Marfa SA, was formed from 37 freight wagons Eacs series, from which 1 was empty, 4 axles, 36 wagons loaded with logs, 144 axles, a total of 148 axles, 1870 tones, automatic braked tonnage after timetable 935 tones, actually 1418 t, hand braked tonnage after timetable 262 t, actually 411 t and the locomotive DA 857 inactive and connected at the rear of the train, with a total length of 545 m, the train being hauled with locomotive DA 672, belonging to SNTFM „CFR Marfa” SA. The locomotive was droved and deserved by employees belonging to SNTFM „CFR Marfa” SA.

The 37 wagons belongs to the freight undertaking SNTFM „CFR Marfa” SA.

The vigilance and safety device (DSV), and the INDUSI installation from the hauling locomotive DA 60-0672-0 were active and functionally instructionally and had the automatic brake active. The vigilance and safety device (DSV), from the banking locomotive 60-0857-7 from the rear of train was active and functionally instructionally and the INDUSI installation was isolated.

C.2.3. Presentation of the railway equipments involved in the accident

C.2.3.1 Lines

Track embankment

The site of the accident occurrence is situated in the activity of the Branch CREIR Cluj, on current line, between the railway stations Fiad and Telciu, at km 21+416. The accident happened in the area of a circular curve with a radius of $R=500$ m.

The curve elements are following:

AR_1 : km 21+300; R_1C_1 : km 21+360; C_1C_2 : km 21+666; C_2R_2 : km 21+757; R_2A : km 21+825.

Curve radiuses: $R_1 = 500$ m; $R_2 = 485$ m; over widening $s = 5$ mm; superelevation $h_{ef} = 60$ mm ; arrow $f = 100$ mm.

The track embankment in the derailment area is in mixt profile, the profile in length of the accident occurrence place is on an area with slope with a gradient of 16,3‰ (slope in the running direction).

The current line between the railway stations Fiad and Telciu is a simple current line, the track embankment being constituted from a succession of alignments and curves, whereby there is a footbridge with flagstones at km 21+418 and a viaduct at km 21+347. The total length of the viaduct is $L_t = 76$ m.

The initial line was built with rail type 40. In the year 1977 was performed a renewal of the track with SB material, and with this occasion was changed the type of the rail from 40 with 49. In the year 1988 were performed periodically repair works with heavy rail machines and the cleaning of the ballast (RPMG + CI) and after 1988 until now were performed only maintenance works.

Track superstructure

The track superstructure afferent to the current line between the railway stations Fiad and Telciu is made with rails type 49, track with joints, wooden sleepers, indirect fastenings type K, built in 1977 with semi-good material (SB), the traffic speed being of 30 km/h.

On the viaduct from km 21+347 the railway superstructure is supported on two beam guide ways with full webs of the girders, tide up between them with cross-bars and horizontally wind bracings. On the lateral parts of the viaduct are mounted in bracket sideways with hand rail, the track on that part being built from metallic bridge covering.

The profile in length of the track embankment has flat areas and areas with declivities, the declivity in the area of the accident occurrence being of 16,3 ‰ (slope in the running direction of the train).

The maximum running speed between the railway stations Fiad and Telciu is performed according to the timetable of the freight trains at CREIR Cluj 2012-2013 is of 30 km/h.

The last RK repair work was performed in 1977 – 1978 with semi-good material and the last work type RPMG with CI was performed in 1988.

On the hectometer between km 21+400 and km 21+500 and in the autumn of the year 2012 were taken out a number of 11 not corresponding wooden sleepers.

On the area between km 21+300 and km 21+500, at the last track geometry check, performed on the 3rd of October 2012 with the testing and recording car (VMC) were 2 failures recorded of 3 degree: an embankment failure (widening – L_3) at km 21+500, failure which was corrected on the 13th of December 2012 and a track torsion failure on the connection curve (on the super elevation gradient) R_3 at km 21+310, failure which was corrected on the 8th of November 2012.

C.2.3.2 Installations

The line section where the railway accident occurred doesn't exist any signaling or communication installations. The train traffic is performed with telephonic agreement system at station gap, based on free track.

C.2.3.3 Rolling Stock

The freight train no. 43622, belonging to SNTFM CFR Marfa SA, was formed from 37 freight wagons Eacs series, from which 1 was empty, 4 axles, 36 wagons loaded with logs, 144 axles, a total of 148 axles, 1870 tones, having at the rear the locomotive 60-0857-7 inactive and connected at the train and brake, with a total length of 545 m. The train was hauled with locomotive DA 60-0672-0, belonging to SNTFM „CFR Marfa” SA. The locomotives were droved and deserved by employees belonging to SNTFM „CFR Marfa” SA.

The 37 wagons belongs to the freight undertaking SNTFM „CFR Marfa” SA.

The derailed wagons are following:

The wagon no. 315354935878

-wagon series: Eacs

-state of the wagon (empty / loaded): loaded with logs;

The wagon no. 315354722276

-wagon series: Eacs

-state of the wagon (empty / loaded): loaded with logs;

The wagon no. 825354679482

-wagon series: Eacs

-state of the wagon (empty / loaded): loaded with logs;

The wagon no. 825354700221

-wagon series: Eacs

-state of the wagon (empty / loaded): loaded with logs;

The wagon no. 315354763270

-wagon series: Eacs

-state of the wagon (empty / loaded): loaded with logs;

The wagon no. 315354676696

-wagon series: Eacs

-state of the wagon (empty / loaded): loaded with logs;

The wagon no. 315354759104

-wagon series: Eacs

-state of the wagon (empty / loaded): loaded with logs;

The wagon no. 315354791172

-wagon series: Eacs

-state of the wagon (empty / loaded): loaded with logs;

The wagon no. 315354736607

-wagon series: Eacs

-state of the wagon (empty / loaded): loaded with logs;

The positioning on the site of the derailed wagons is represented in **Image 2**.

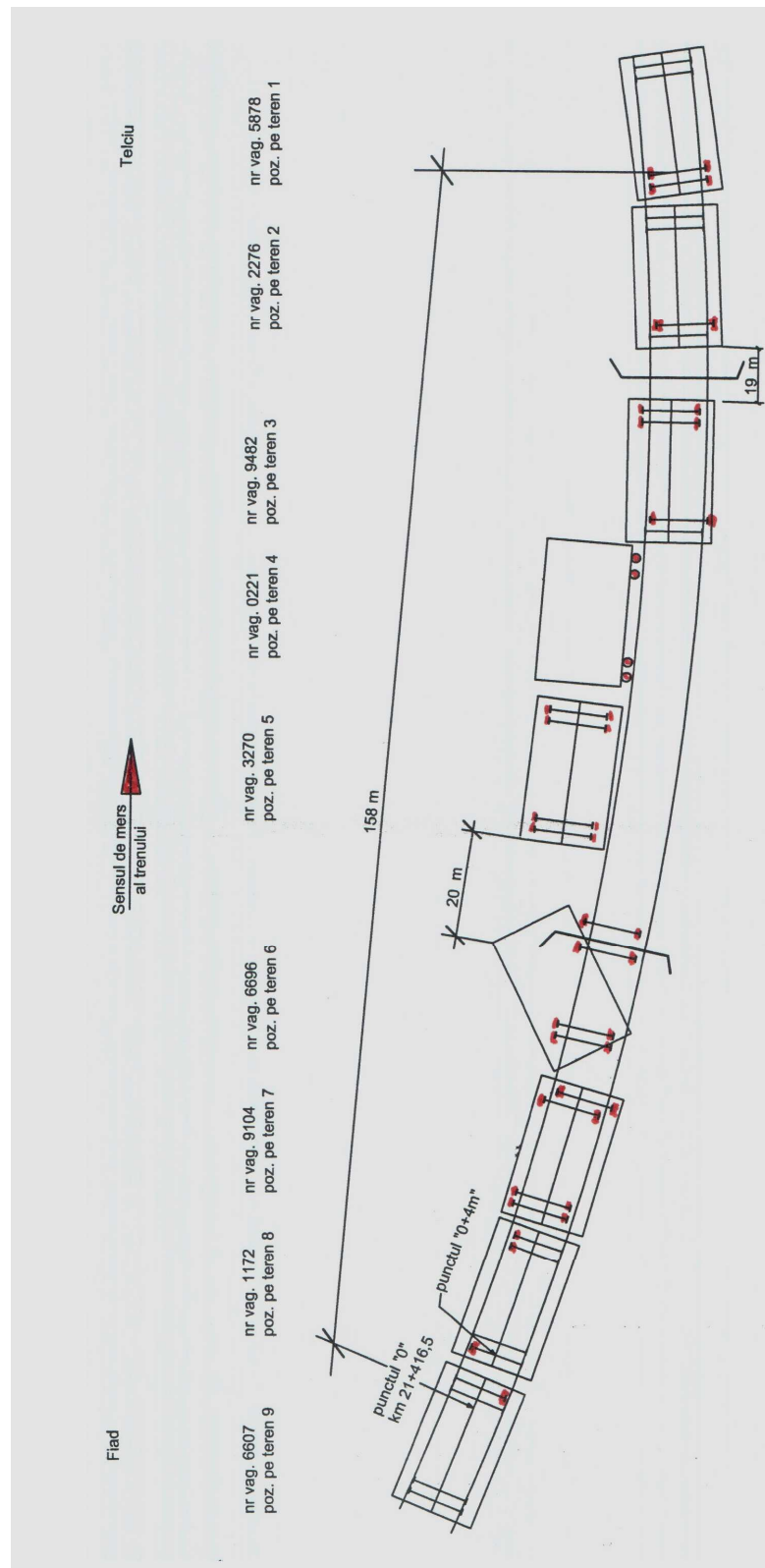


Image no. 2 Positioning on the site of the derailed wagons

The vigilance and safety device (DSV), and the INDUSI installation from the hauling locomotive DA 60-0672-0 were active and functionally instructionally and had the automatic brake active.

The vigilance and safety device (DSV), from the hauling locomotive 60-0857-7 from the rear of train was active and functionally instructionally and the INDUSI installation was isolated.

C.2.4 Communication means

The communication between the driver and the movement inspectors was ensured through radio-telephone equipments.

C.2.5. Start of the railway emergency plan

Soon after the railway accident, the intervention plan for the removal of the damages and for the restoration of the traffic was made in accordance with the information flow stipulated in the *Investigation Regulation of the accidents and incidents, for the development and improvement of Romanian railway and subway safety*, approved by the Government Decision no. 117/2010, according which, at the accident place came the representatives of the public railway infrastructure manager CNCF „CFR” SA – Branch of CREIR Cluj, of the railway undertaking SNTFM „CFR Marfa” SA – Branch Transylvania. There were also present at the accident place representatives of Police, Prosecutor's Office and the Territorial Labor Inspectorate.

C.3. Accident consequences

C.3.1. Fatalities and injuries

None

C.3.2. Material damages

After the derailment of the 9 wagons were following material damages:

C.3.2.1. Material damages notified by CNCF „CFR” SA – Branch CREIR Cluj

Material damages notified by CNCF „CFR” SA – Branch CREIR Cluj	RON
At the rolling stock: will be established after the repairs done at the wagon at PLD Fetesti, belonging SNTFM „CFR Marfa” SA	-
At the lines	13.869,08
At installations	-
At the environment	-
At the intervention means	51.632,95

C.3.2.2. Material damages notified by SNTFM „CFR Marfa” SA

At the wagons

- repairs at 5 from the 6 derailed wagons, in a total value of 6.049,32 lei, according to the estimations no. 1/8883, 1/1888, 1/1889, 1/18890 and 1/18890 from the workshop for wagons maintenance.
- the check on the wheel lathe of the 14 derailed axles, in a total value of 698,05, according to the estimation no. B2/1445/14.11.2013 from IRLU Section Dej;
- inventory value a the 3 overturned wagons, in a total value of 2587, 24 lei;
- weighting of the derailed wagons at SC Remarul SA, in a value of 3.411,54 lei, according to the tax bill no. 7295072;
- the crane performance and the staff from L3 Section Cluj for recovering the parts from the 3 overturned wagons, also for the partial recovery of the logs from the 3 overturned wagons, in value of 23007,60 lei, according to the tax bill no. 02501 (was paid by SNTFM „CFR Marfa” SA)
- the damages of the loading – 36.525,56 lei;
- the performance of the crane for lifting of the 3 body's from overturned wagons from the bridge , with an estimate value of 20.000 lei.

At the locomotives

None

C.3.2.3. Total damages

The total amount of the estimated damages is of 157.781,34 lei

C.3.3. Consequences of the accident in the traffic

After this railway accident, the railway traffic between the railway stations Fiad and Telciu was closed from 08th of May 2013, 17,52 o'clock until 11th of May 2013 at 18,09 o'clock, when after the performed repair works, the train traffic was taken up with a speed of 15 km/h (for 2 trains), after that with 30 km/h.

For the lifting of the derailed wagons was requested the intervention train with a crane 250 tf EDK from SC Interventii Feroviare SA from the railway station Cluj, arrived in the railway station Telciu at 02,35 o'clock and a crane 20 tf EDK from the railway station Dej Triaj, arrived in the railway station Telciu at 02,02 o'clock. The works for the lifting of the wagons and the gauge issue were finalized at the 11th of May 2013, at 18,09 o'clock.

As consequence for the occurrence of this railway accident, on the section Telciu – Fiad were cancelled a number of 27 passenger trains, were introduced a number of 22 additional passenger trains, were transferred the passengers from 19 trains and 3 passenger trains were had delayed with a total number of 150 minutes.

The accident did not generate casualties or dead.

C.4. External circumstances

On the 18th of May 2013, at around 17,45 o'clock, the visibility was good.

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

C.5 Investigation course

C.5.1 Summary of the involved staff testimonies

The traffic controller from the Dispatch of SNTFM „CFR Marfa” SA stated:

- he requested the entry in traffic of the train no. 43622;
- he requested through the "Coala Program" the stations where the wagons had to be attached at the train no. 43622 and the running of the locomotive with double traction on the distance Sacel – Dej Triaj;
- the running of the locomotive from the rear of the train no. 43622 was made according to art. 6, paragraph 16 from Regulation no. 006, referring to the locomotives which were used as banking locomotives;
- he considered that he just propose the arrangement of the locomotives in the train, but the approval is given by the Programming Controller from the Infrastructure Administrator.

The Programming Controller from CNCF – RC Dej stated:

- he got through the informatics system MEDUSA, on 07th of May 2013 a request from SNTFM for the entry in traffic of the train;
- he considered that the arrangement of the locomotives in the train is the responsibility of the movement inspector and the controller from the Controller Office;
- he considered that the running of the banking locomotive is set out by the controller from the Controller Office.

The controller from the Controller Office stated:

- he set through the Controller Office instruction no. 54 from 8th of May 2013 that the train no. 43622 run with the banking locomotive on the distance Dealul Stefanitei – Dej Triaj;

- he considered that the banking locomotive can run according to art. 6, paragraph 16 from the Regulation no. 006, referring to the locomotives which were used as banking locomotives.

The Head of L9 Section Sighet stated:

- he performed the last revision of the line in March 2013 and in the area of km 21+416 that line correspond for traffic safety with the set speed, without other founding's;
- he knew that after the measurements performed at the line with the VMC on the 03rd of October 2012 on km:21+000 – 22+000 were 4 failure of 3rd degree recorded, of type 2 (L+I), 1V and 1R, for which he ordered the remedial in the terms recorded in the instruction no. 329/1995 – for the using testing and recording car;
- he couldn't appreciate the causes which led to the accident occurrence from the 8th of May 2013 at km: 21+416, because from the data he has of the state of the railway line are none clues that could determine the occurrence.

The Assistant Head of L9 Section Sighet stated:

- he performed the last revision of the line in February 2013 and in the activity area from line district Telciu the line correspond for traffic safety with the set speed, without other founding's after the performed inspections;
- he knew that after the measurements performed at the line with the VMC on the 03rd of October 2012 on km:21+000 – 22+000 were 4 failure of 3rd degree recorded, of type 2 (L+I), 1V and 1R, for which it was ordered the remedial in the terms recorded in the instruction no. 329/1995 – for the using testing and recording car;
- he couldn't appreciate the causes which led to the accident occurrence from the 8th of May 2013 at km: 21+416, because from the data he has of the state of the railway line are none clues that could determine the occurrence.

The Head of the Line District Telciu stated:

- he argued that the line corresponds for the traffic safety with the set speed and at km 21+416 are none special problems;
- he knew about the failures found out at the line after the measurements performed with the VMC on the 03rd of October 2012 on km: 21+000 – 22+000, but those failures were programmed for remedial through fortnightly schedule and have been corrected at the time limits set out;
- he couldn't appreciate the causes which led to the accident occurrence from the 8th of May 2013 at km: 21+416, because from performed measurements at the line at the inspections the line is in good shape and the embankment in that area is stable.

The district permanent way inspector at Line District Telciu stated:

- he performed the fortnightly inspection on the 13th of April 2013 and he didn't found any failures at the track state that could not allow the running with the speed of 30 km/h;
- he knew about the failures found out at the line after the measurements performed with the VMC on the 03rd of October 2012 on km: 21+000 – 22+000, but those were corrected on the 7th and 8th of November 2012;
- he couldn't appreciate the causes which led to the accident occurrence from the 8th of May 2013 and he is mentioning that the last works at the line in that area were performed on the 27th of March 2013 and consisted of levelling of the track through packing of sleepers, manually, in points, from km: 21+300 to km 21+500;
- he appreciate that the state of the track could not be the cause for the railway accident occurrence, because the line was good and there was no clue that could influence the happening of this.

The ganger from the Line District Telciu stated:

- between 07th and 08th of May 2013 he performed the track inspection on the inspection distance between km :25+000 and km: 12+500 and he didn't found any failures at the line;

- he knew about the failures found out at the line after the measurements performed with the VMC on the 03rd of October 2012 on km: 21+000 – 22+000, but those were corrected by the team in November 2012;
- he couldn't explain the causes which led to the accident occurrence, because the line was good and there was no clue that could influence the happening of this.

The ganger at a danger point from the Line District Telciu stated:

- at the time of the occurrence of the railway accident he was guarding the danger point, he assisted at the visual inspection of the train posted at the point set from km: 23+270 and he didn't see anything fishy or particularly at the visual inspection of the freight train no. 43622.

The driver stated:

- he took over the locomotive in the railway station Dealul Stefanitei without observations to its technical and thermo-technical condition;
- together with the V party he performed the complete brake test of the train, which corresponded, fact which he recorded in the route sheet;
- he departure with the train no. 43622 from the railway station Dealul Stefanitei, he performed the effectiveness of the automatic brake, which was corresponding;
- the train no. 43622 run normally in traffic until it passed the railway station Fiad;
- between the railway stations Fiad and Telciu he noticed the sudden decreasing of the air from the main pipe of the train;
- he sent the driver's assistant to find out the cause of the sudden decreasing of the air from the main pipe;
- he was informed, by this, that there are derailed wagons;
- before the derailment occurrence he didn't noticed anything unusual on the line and he didn't felt any reactions in the train running.

The driver's assistant stated:

- he took over the locomotive in the railway station Dealul Stefanitei without observations to its technical and thermo-technical condition;
- he didn't noticed any irregularities at the wagons from the train no. 43622;
- the driver performed the complete brake test of the train, which corresponded, fact which he recorded in the route sheet;
- after passing the railway station Fiad the driver noticed the sudden decreasing of the air from the main pipe of the train;
- he was sent by the driver to find out the cause of the sudden decreasing of the air from the main pipe;
- he found derailed wagons in the area of a bridge;
- in the derailment area he met with the driver's assistant from the locomotive from the rear of the train;
- he called the shed superintendent and the head of the shift communicating those the founding's;
- he couldn't telephonic reach the T controller;
- before the derailment occurrence he didn't noticed anything unusual on the line and he didn't felt any reactions in the train running.

The driver from the locomotive on the rear of the train stated:

- he took over the locomotive in the railway station Viseu de Jos without observations to its technical and thermo-technical condition;
- he hauled the train 42560 from Viseu de Jos until Dealul Stefanitei and then he departure with DA 672, isolated locomotives, to the station Sacel;
- in Sacel he performed de forming shunting of the train no. 43622;

- after the departure from Sacel, the locomotive driver which hauled the train no. 43622 performed the effectiveness of the automatic brake, which corresponded;
- he run in normal conditions until the moment he noticed the sudden decreasing of the air in the main pipe;
- after the sudden stop of the train he noticed derailed wagons;
- after the departure of the train no. 43622 from Dealul Stefanitei and until the moment of the derailment he didn't noticed anything unusual at the train.

The driver's assistant from the locomotive on the rear of the train stated:

- he took over the locomotive in the railway station Viseu de Jos without observations to its technical and thermo-technical condition;
- he hauled the train 42560 from Viseu de Jos until Dealul Stefanitei;
- he departure with isolated locomotive to the station Sacel where it was performed de forming shunting of the train no. 43622;
- he departure with the train to Dealul Stefanitei where it was attached a group of wagons;
- the brake test at the train was performed by the V personnel;
- after the passing the railway station Fiad of the train no. 4362 he noticed the decreasing of the traffic speed and also the sudden decreasing of the air in the main pipe;
- after the train stopped he moved along and he found out derailed and overturned wagons.

The examiner, employee of SNTFM „CFR Marfa” SA stated:

- in the railway station Sacel he participated at the train no. 43622 forming;
- he inspected each of the 18 wagons loaded with wood;
- he recorded in the brake sheet the wagons with defect automatic brake and hand brake;
- after the performing of the complete brake test he went to the railway station Dealul Stefanitei;
- after the forming of the train he performed the complete brake test and made the brake sheet of all wagons being in the train no. 43622;
- he didn't found any irregularities at the loading of the wagons;
- at the departure of the train he supervised the wagons being in the train without to find any irregularities at their technical condition.

The head of the shift, employee of SNTFM „CFR Marfa” SA stated:

- he participated in the railway station Viseu de Jos, at the forming and the performing of the complete brake test of the train no. 43622;
- in Viseu de Jos the train was formed from 5 wagons;
- he didn't found any failures from the technical point of view at the inspected wagons;
- he didn't noticed any irregularities at the loading of the wagons.

The MC regional instructor, employee of SNTFM „CFR Marfa” SA stated:

- he considered that the running of the train no. 43622 with a banking locomotive on the line section Dealul Stefanitei – Salva has been done with another hauling mode then that foreseen in Annex I from the timetable for the freight trains on the Branch CREIR Cluj, with the approval from CNCF „CFR” SA through the informative note RC 54/8th of May 2013;
- he consider that the locomotive which was used as banking can remain in the same position in the train, without being active, even if the train is changing on the route, because the art. 6, paragraph (16) from the Braking and Hauling Regulation no. 006 doesn't specify the changing of the consist of the train;
- he consider that art. 6, paragraph (16) from Regulation no. 006, referring to the locomotives that have been used as banking locomotives, allows the dispatch of a banking locomotive, but only as an hauled vehicle and without being active;
- he consider that art. 6, paragraph (16) from Regulation no. 006, referring to the locomotives that have been used as banking locomotives is clear.

The MC regional instructor, employee of CREIR CF Cluj stated:

- he considered that the running of the train no. 43622 with a banking locomotive on the line section Dealul Stefanitei – Salva was not permitted by the Annex I from the timetable for the freight trains on the Branch CREIR Cluj, edition 2012 – 2013;
- he consider that the locomotive which was used as banking can remain in the same position in the train, without being active, even if the train is changing on the route, because the art. 6, paragraph (16) from the Braking and Hauling Regulation no. 006 doesn't specify the changing of the consist of the train;
- he consider that in the moment of issuing of art. 6, paragraph (16) from the Braking and Hauling Regulation no. 006, referring to he remaining in the initial position in the train without being active of the locomotives which has been used as banking locomotives, was intended the applying of that only to the trains which didn't change the train consist;
- he consider that it should be précised in art. 6, paragraph (16) from Regulation no. 006, referring to the locomotives that have been used as banking locomotive, when the train consist is changed, the banking locomotive could not be remain in the initial position in the train without being active.

C.5.2. Safety management system

At the moment of the accident, CNCF “CFR” S.A., as manager of the railway infrastructure, had implemented its own railway safety management system, according to the provisions of the Law for railway safety and the Minister of Transports' Order no. 101/2008 on the granting of the safety authorization to Romanian railway infrastructure administrator/manager, getting:

- Safety Authorization – Part A, identification number ASA 09002 – by which Romanian Railway Safety Authority, from Romanian Railway Authority – AFER agrees the acceptance of the safety management system of the railway infrastructure manager;
- Safety Authorization – Part B, identification number ASB 09007 – by which Romanian Railway Safety Authority, from Romanian Railway Authority – AFER agrees the acceptance of the dispositions taken by railway infrastructure manager in order to comply with the specific requirements necessary to ensure the railway infrastructure safety, in the designing, maintenance and operation, including if case, maintenance and operation of the system for the traffic control and signaling.

At the moment of the accident, SNTFM „CFR Marfa” SA, as railway undertaking had implemented its own railway safety management, according to the provisions of the Law for Railway Safety and of the Minister of Transports' Order no. 535/2007 for the approval of the norms for the granting of the railway transport licenses and the safety certificates in order to perform railway transport on Romanian railways, got:

- License for freight and passengers railway transport services no. 12/2007, revised and approved (10th of November 2013);
- Safety Certificate – Part A, no. RO1120110024, valid from 10th of November 2012, revised and approved (10th of November 2013) – by which Romanian Railway Safety Authority, from Romanian Railway Authority – AFER agrees the acceptance of safety management system of the railway undertaking, in accordance with the national legislation;
- Safety Certificate – Part B, no. RO1220110187, valid from 10th of November 2012, revised and approved (10th of November 2013) – by which Romanian Railway Safety Authority, from Romanian Railway Authority – AFER agrees the acceptance of the dispositions taken by the railway company in order to comply with the specific requirements necessary for the safety operation on the relevant network, in accordance with the national legislation.

C.5.3 Norms and regulations. Sources and references for the investigation

In the investigation of the railway accident one took into account the next *norms and regulations*:

- Regulations for technical operation no. 002, approved by Minister of Transports, Constructions and Tourism's Order no. 1186 from the 29th of August 2005;
- Regulations for the train running and railway vehicle shunting no. 005, approved by Minister of Transports, Constructions and Tourism's Order no. 1816 from the 26th of October 2005;
- Regulations for Braking and Hauling no. 006, approved by Minister of Transports, Constructions and Tourism's Order no. 1815 from the 26th of October 2005;
- Instructions for the technical inspection and the maintenance of the wagons in operation no. 250, approved by Minister of Transports, Constructions and Tourism's Order no. 1817 from the 26th of October 2005;
- Annex II RIV – Loading prescriptions;
- Instructions for the activity of the locomotive staff no. 201, approved by the Minister of Transports, Constructions and Tourism's Order no. 2229 from the 23th of November 2006;
- Instruction of norms and tolerances for the track construction and maintenance – lines with standard gauge no. 314/1989;
- Instructions for the fixing of terms and order in which must be done the revisions of the railways no. 305, approved by the OMT no. 71 from 17th of February 1997;
- “Technical prescriptions for lateral and vertical wear measuring of the railway rails” approved through Order no. 30/1298/1987 of DLI Bucuresti;
- Instructions for the district permanent way inspector for the track maintenance no. 323/1965;
- Instructions to use the testing and recording cars no. 329/1995.

Sources ad references for investigation

- copies of the documents enclosed to the investigation file;
- photos taken soon after the railway accident by the members of the investigation commission;
- documents on the maintenance of the lines, provided by the persons in charge with their maintenance;
- results of the measurements made soon after the accident at the superstructure and at the derailed wagons;
- examination and interpretation of the technical condition of the elements involved in the accident: infrastructure, installations and train;
- questionnaires of the employees involved in the accident;
- Recordings and Reading Minutes for IVMS and ICL installations from the locomotives;
- „The railway vehicles dynamics”, Ed. Tehnica 1995, author Prof. Dr. ing. Ioan Sebesan.

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

C.5.4.1 Data found out on the lines

Technical statement of the line before the occurrence of the railway accident

The derailment occurred on the line 422, between the railway stations Fiad and Telciu, on current line, at km: 21+416.

At the date of the accident occurrence the track superstructure was made from rails type 49, on wooden sleepers, track with joints, indirect fastenings type K, in active and complete state. The ballast prism, made from broken stone, is complete and chocked in 20%.

The maximum running speed of the line has a restriction of 30 km/h for passenger and freight trains, due the not corresponding state of the track for a higher running speed.

The renewal of the track works had to be done in 1995, but were not performed until the day of the railway accident occurrence.

Findings and measurements at the line, after the derailment

After the derailment of the 9 wagons (from which 3 wagons did overturned on the viaduct from km: 21+347) following damages were found at the line on the embankment and at the viaduct from km 21+347: the track on the embankment and the bridge was deteriorated on a total length of about 119 m;

the embankment

- the track embankment was deteriorated on a length of about 39 m;

on the viaduct from km 21+347

- the track on the bridge was deteriorated on a length of about 80 m;
- the check rails towards Fiad were snatched from the fastening elements;
- the ends of the sleepers towards the interior curve rail were deteriorated;
- the rails which constituted the interior curve rail (the one on the left part in the running direction) and the afferent check rail were snatched from the fastening elements and bended;
- the pavement from the left side was deteriorated.

The Lines specialist members from the investigation commission identified on the field the place where it was the first climbing trace on the head of the rail. This climbing trace on the rail corresponding to the interior curve rail at km 21+416, was marked with "0".

It could not be done the relevant measurements to determinate the geometrical elements of the track on the line between point "0" and to the end toward Fiad of the guideway beam, in the running direction of the train, because of the deformations caused at the line by the wagons in the derailment – **Photo 1**.



Photo no. 3 Deformations caused on the line by the wagons during the derailment

Checks have been performed on the track state in the opposite direction of the running direction of the train starting with point "0" on a 30 m distance.

Following were found:

- the small fixing material of the plates on the sleepers was active on the checked distance isolating vertical bolts were missing from the rail clips type K;
- the broken stone prism had the dimensions according to the instructionally provisions;
- the checked area had 53 normal wooden sleepers. In this area were 5 wooden sleepers identified which were not corresponding and no sequentially (isolated);
- no expansion joints were found closed nor runaway in length of the rails.

The curve where the derailment occurred had a radius of $R = 500$ m, over widening $s = 5$ mm and an effective superelevation $h = 60$ mm, according to the provisions from the *Instruction of norms and tolerances for the lines, switches, bridges and tunnels no. 314/1964*, in force at that moment.

In the year 1989 was issued the *Instruction of norms and tolerances for the track construction and maintenance – lines with standard gauge no. 314/1989*. Therein were introduced new provisions relating to the calculation of the geometric elements of the track in curves. According to them, the analysis of the geometric elements of curves, must be made taking into account the definition of new terms, their formulas, respectively: the line, speed of movement, the average speed of freight trains (V_m) the daily intensity of the freight trains (T_z), the grouping of curves.

According to the provisions of this instruction, bringing the parameters of the track geometry in curves must necessarily performed during execution of the first renewal works (RK) and / or periodic repair of the track with heavy track machines (RPMG + CI).

The last renewal work (RK) between the railway stations Fiad - Telciu was executed during 1977 to 1978 and the last regular repair work with heavy track machines (RPMG + CI) was executed in

1988. During these works were complied the regulations aimed of the geometry elements of the track in curve from the. *Instruction of norms and tolerances for the track construction and maintenance – lines with standard gauge no. 314/1989.*

The renewal works at the line had to be made in 1995, but they were not performed until the date of the accident occurrence, so that the geometrical elements of the line have been not modified.

The measured parameters of the track geometry which were analyzed

In order to verify the gauge and the transversal level of the track, the line was lateral track displacement monitored from 2.5 m to 2.5 m from the peg "0" in the reverse of the running direction of the train.

The values obtained by measuring in three pegs were not analyzed because were on the line section which was deformed due the derailments of the wagons and can't give reliable information about the *track conditions before the accident.*

The track gauge

In all the monitored points which were analyzed, the values of the gauge fit in the provisions of art. 1, point 13 from the Instruction 314/1989.

The gauge tolerances fit in every point monitored analyzed according the provisions of article 1, point 14, paragraph 1, letter c from the Instruction of norms and tolerances for the track construction and maintenance – lines with standard gauge no. 314/1989.

Variation of the gauge between all the points measured fit in the provisions of the Article 1 point 14 letter c paragraph 2 of the Instruction of norms and tolerances for the track construction and maintenance – lines with standard gauge no. 314/1989.

Analyzing the measured values of the gauge and comparing them with accepted values, it was found that admitted tolerances were not overcome before the derailment of the train.

The cross level

In all monitored points analyzed the values of the prescribed cross level of a rail beside the other one is fitting in the provisions of art, point 2 from the Instruction 314/1989.

The value of the track twist fits between all monitored points analyzed in the provisions of art. 7, letter A, point 4 from the Instruction no. 314/1989.

Rail wear

There were performed checks with the thickness gauge to measure the rail wear at four rails removed from the track after the accident.

After analyzing the measured rails wear data it was found that the vertical wear " U_v " and the lateral wear " U_l " of the rail fits between the limits admitted by the Instruction of norms and tolerances for the track construction and maintenance – lines with standard gauge no. 314/1989, at table 24, respectively table 25 and the "Technical prescriptions for the lateral and vertical wear measuring of the rails", approved by the Order no. 30/1298/1987 from DLI Bucuresti.

Data resulted from analyzing the documents requested from the railway infrastructure administrator

The last check of the open line between the railway stations Fiad and Telciu with the testing and recording car (VMC) was performed on the 03rd of October 2012. After the check on the area km: 21+000 – 22+000) resulted a score of 400 points/km, value which fits in the quality score "B2" (according to the provisions of the instruction no. 329/1995).

The track defects which determined this score were 2 failure of the cross level of the track which were recorded in the area of km:21+310 and 21+550, respectively 2 failures of the gauge which registered in the area of km:21+350 and 21+500.

The last current maintenance works in the derailment area were performed on the 27th of March 2013 and consisted from the renewal of the transversal level through manually tamping of sleepers works, in points, on the area from km:21+300 to km 21+500, respectively on the 03rd of April 2013 rectification works of the expansion joints from km:21+300 at km 21+600.

At the last census at the bad sleepers from the track performed in the autumn of the year 2012 by the management of the Line District Telciu on the area km: 21+000 to km: 22+000 were reviewed 11 not corresponding wooden sleepers from which 6 pieces (1,95%) were framed as sleepers to be replaced in emergency I. Percentage, the number of these sleepers doesn't exceed the admitted the instructionally percent according to art. 25, point 4 from the instruction no. 314/1989.

On the 22th of March 2013 was issued the Minutes no. 59 following the inspection of the line in commission, performed according to the provisions of art. 10 and 11, the sheet No. 4 of the Instruction No. 305/1997 -

On 03.22.2013 was issued minutes No: 59 Revision following line in committee carried out according to Art. 10:11, - "on the deadlines and the order in which the revisions of the track must be performed" in which at position 17 is recorded, referring to the bridge km: 21+347 that " the sleepers are appropriate, the fastening of the sleepers is incomplete, horizontal bolts are partially missing, the support of the sleepers on the guideway beam is good, the fastening material of the sleepers line is completely." On the sheet of the bridge at km 21 +347 the last recording before de occurrence of the railway accident is made on 11th of September 2012 by the assistant head of the section from L9 Section Sighet which is mentioning: "good for SC (safety) with the specifications from 2011" which consist of the following: "Revised ATM Cluj-mobile articulation are +15 mm, missing metallic parts covering between the track rails and the sleepers fastening by TSGP is 50% assured".

The annual measurement of the curve, on which occurred the derailment was performed on the 22th of March 2013, on the distance km:21+300 to km: 21+825, the measured values of the arrows, over widening, superelevation and the lateral and vertical wear are not exceeding the instructionally limits for the value of the curve radius and the traffic speed of 30 km/h.

The line 422, between the railway stations Salva – Telciu – Fiad, km: 0+340-24+560 is made of rails type 49, wooden sleepers / BA T13, the last RK work being performed in the period of 1977/1978, with semi-good material, respectively the last RPMG with CI work in 1988.

The projected speed of line is of 60 km/h, in present the line speed on the section km: 0+340 to km: 9+485 is of 50 km/h and on the area from km: 9+485 at km: 24+560 is of 30 km/h.

The running speed of the railway line:

- a) 60 km/h until 1990 on the section Salva – Telciu – Fiad – Viseu de Jos;
- b) 50 km/h from 1990 until 1998, on the section Salva – Telciu – Fiad – Viseu de Jos;
- c) 30 km/h from 1998 on the section Salva – Telciu – Fiad – Viseu de Jos, because of the state of the not corresponding track – sleepers the track fasteners used (metal plate / sleeper / respectively rail / metal plate), used / defect rails, choked broken stone prism (50 – 70% on section).

On the section from km:12+000 (*Cosbuc - Telciu*) at the railway station Fiad, the running speed remain at 30 km/h and in 2010 this speed restriction extended until the axe of the station Cosbuc (km: 9+484 and km: 24+250) becoming 30 km/h on the section Cosbuc-Telciu-Fiad (between km: 9+484 and km: 24+250) where were current maintenance works performed at the line, necessary to maintain the running speed.

The renewal works at the line should be performed in the year 1995, but those haven't been performed until the occurrence of the railway accident, so that the geometrical elements of the line

hasn't been modified and from the analyze of the curve grouping, performed according to the Instruction no. 314/1989 resulted a maximum admitted superelevation of $h_{\max} = 95$ mm.

Other clues and traces identified at the line

Analyzing the evidences from the site it was found that at the end of the bridge toward the railway station Fiad it was identified on the sleepers, fastening material and embankment traces of derailment to the exterior of the curve, continuing to the railway station Fiad to a distance of 8 sleepers from the point "0". The mentioned derailment trace to the exterior, situated to a distance of 8 sleepers from point "0", was identified in the front of the last axle of the 8th derailed wagon (1172) and is presented in the form of a hitting trace on a vertical bolt.

The mentioned derailment trace was called point "o+4m" and is presented in **Photo 2**.



Photo no. 4 The derailment trace called Point "0+4m"

In the area of the point "0+4m" were identified a number 3 derailment traces on the right side in the running direction (the falling of the wheel from the head of the rail), presented in **Photo no. 5** and **Photo no. 6**.



Photo no. 5 - A derailment trace on the right side



Photo no. 6 - 2 derailment traces on the right side



Photo no. 7 – The four derailment traces from the left part

Also it was identified in the area of point “0” a number of 4 derailment traces on the left part in the running direction (the falling of the wheel from the head of the rail) **Photo no. 7**.

C.5.4.2. Data found out on the installations

On the line section on which the accident occurred are none signaling or communication installations. The train traffic is made using the free track system.

C.5.4.3. Data found out on the rolling stock and its technical equipment

C.5.4.3.1.

Findings performed at the locomotive:

The locomotive DA 60-0672-0 was equipped with speed recorders type IVMS, version with vigilance and safety device (DSV), and the INDUSI installation included.

The vigilance and safety device (DSV), and the INDUSI installation from the hauling locomotive DA 60-0672-0 were functionally and sealed.

The driver's valve KD2 was in emergency position.

The locomotive attached at the rear of the train DA 60-0857-7 was equipped with speed recorders type IVMS, version with vigilance and safety device (DSV), and the INDUSI installation included. The locomotive had the diesel motor stopped.

The vigilance and safety device (DSV), from the locomotive was active and sealed.

C.5.4.3.2.

Findings performed at the not derailed wagons:

- the train consist of a number of 37 wagons with 148 axles;
- the connecting between the not derailed wagons was corresponding;
- no uninsured parts were found, which could endanger traffic safety at the not derailed wagons;
- the not derailed wagons had the automatic brakes and hand brakes active, in conformity with the brake sheet;
- the changeovers and the load were in corresponding position at the not derailed wagons;
- the train connection and brake were corresponding at the not derailed wagons.

C.5.4.3.3. Findings performed at the derailed and not overturned wagons:

- coupled air hoses were disconnected between the wagons 28 and 29 in the running direction;
- the train was broken in two parts: between the wagons 29 and 30 through the plucking of the traction gear from the wagon 30 and between the wagons 32 and 33 through the plucking of the fastening gear from wagon 33.

Wagon no. 315354935878

Wagon series: Eacs loaded with logs;

I. Constructive characteristics wagon number:										3	1	5	3	5	4	9	3	5	8	7	-	8	
Inspections and repairs performed at the wagon from the date of the last performed periodical repair until the derailment							R	P	6	R	E	V	3	1	0	7	2	0	0	9	S	I	M
							R	R							0	9	2	0	1	2	L	B	V
							R	I	F						0	9	2	0	1	2	L	B	V
							D	A					1	7	0	9	2	0	1	2	L	B	V
Wheel base		wagon		9	0	0	0	Bogie's type: Y25 Cs		wheels with tires			Buffers: of great capacity			autom. brake: KE-GP							
		bogie		1	8	0	0																
Wagon's length			1	4	5	4	0	Traction gear type: discontinuous													Hand brake		
Automatic beam adjuster: DRV 2 AT 600							Wagon's loading: 34160						C= 58.3			Telciu		Fiad					

The dimensions measured at the wheelset fits in the admitted limits from the regulations in force.

The height of the center of the buffers from the level of the head of the rail fits in the admitted limits from the regulations in force.

Bogie 1: ineffective shock absorber in the front of wheel R4.

With the occasion of the wagon's weighting it was found that at wagon no. 315354935878 that the load report between wheel no. 3 (left) and wheel no. 4 (right) of the same pair of wheelset is of 1,20 and between wheel no. 1 (left) and wheel no. 2 (right) is of 1,13, closed to the maximum ratio admitted by the Annex II RIV, respectively of the value of 1,25.

This ratio is influenced also by the bending of the wagon's body to the interior of the curve, found out at the distances measuring between the bogie's frame and the upper slide bar, from where it resulted the value of 20,5 mm (obtained as difference between the measured value of 30,7 mm on the left side in front of wheels 2-4 beside 10,2 mm on the right side in the front of wheels 1-3), these being closed to the maximum value of 24 mm admitted by the "Instructions for the technical inspection and the maintenance of the wagons in operation no. 250".

The wagon is foreseen from construction with coil springs at the side bearer blocks and the side bearers blocks are in permanent contact with the upper slide bar.

Wagon no. 315354722276

Wagon series: Eacs: loaded with logs;

I. Constructive characteristics wagon number:										3	1	5	3	5	4	7	2	2	2	7	-	6				
Inspections and repairs performed at the wagon from the date of the last performed periodical repair until the derailment										R	P	6	R	E	V	2	9	0	8	2	0	0	8	C	T	F
										R	R					3	1	0	8	2	0	1	1	L	P	O
										R	I	F				3	1	0	8	2	0	1	2	L	P	O
										D	A					2	8	0	1	2	0	1	3	L	B	V
Wheel base		wagon	9	0	0	0	Bogie's type: Y25 Cs		Solid wheels			Buffers: cylinder type			autom. brake: KE-GP											
		bogie	1	8	0	0																				
Wagon's length			1	4	5	0	0	Traction gear type: discontinuous												Hand brake						
Automatic beam adjuster: DRV 2 AT 600							Wagon's loading: 35975						C= 58.7			Telciu	Fiad									

Findings:

The dimensions measured at the pair of wheelset fits in the admitted limits from the regulations in force.

The height of the center of the buffers from the level of the head of the rail fits in the admitted limits from the regulations in force.

- Measured clearance with the caliper gauge at the side bearer blocks:

Bogie no. 1 (not derailed bogie): - in front of wheels 1-3: 0 mm;

- in front of wheels 2-4: 0 mm;

Bogie no. 2 (derailed wagon): - in front of wheels 5-7: 7,5 mm;

- in front of wheels 6-8: 0 mm;

Observation: With the occasion of the inspection of the total clearance between the side bearer blocks from both sides of the bogie it was found a clearance with not instructional values between the fractioning stones from both sides of the bogie.

At all other not overturned wagons (less in the case of wagon no. 315354935878 which is foreseen from construction with coil springs at the side bearer blocks) it was found that the clearance between the side bearer blocks from both sides of the bogie have instructionally values.

Wagon no. 825354679482

Wagon series: Eacs; wagon loaded with logs;

I. Constructive characteristics wagon number:											8	2	5	3	5	4	6	7	9	4	8	-	2
Inspections and repairs performed at the wagon from the date of the last performed periodical repair until the derailment						R	P	6	R	E	V	3	1	0	8	2	0	0	8	C	T	F	
						R	R					0	9	0	5	2	0	1	1	S	S	V	
						R	I	F				0	9	0	5	2	0	1	1	S	S	V	
						D	A					2	6	0	3	2	0	1	3	S	O	R	
Wheel base	wagon	9	0	0	0	Bogie's type: H		wheels with tires		Buffers: cylinder type		autom. brake: KE-GP											
	bogie	1	8	0	0																		
Wagon's length		1	4	5	4	0	Traction gear type: discontinuous											Hand brake					
Automatic beam adjuster: DRV 2 AT 600						Wagon's loading: 34240						C= 58.6		Telciu	Fiad								

Foundings:

The dimensions measured at the wheelset fits in the admitted limits from the regulations in force.
The height of the center of the buffers from the level of the head of the rail fits in the admitted limits from the regulations in force.

The wagon had the hand brake from construction, but the component parts dismantled being unusable.

Bogie I:

the frame of the bogie present hitting traces, being deformed to the interior, approximately 25 mm in the axle guards at wheels R1 and R3 following the derailment;
the axle guards of wheels 1 and 3 are hit and deformed following the derailment;
wheels 1, 2, 3 and 4 present traces of friction on the exterior side with the interior side of the bogie's frame due the derailment;
there are hitting traces with depths between 5 and 7 mm, on the bogie's frame at the interior, from the contact with the support of the spring for returning the flap following the derailment;
the crossed frame in the area of wheel R1 present traces of friction with the wheel following the derailment;
the fastening end of the main brake pipe in the area of wheel R4 is deformed with ca. 50 mm.

Bogie II:

the frame of the bogie present hitting traces, being deformed in the area of wheel 7 following the derailment, the cross over being deformed at wheel 7 for about 20 mm;
there are trace of friction in the interior at the interior of the bogie's frame due the friction with wheels 5 and 7 after the derailment;
the crossed frame present pronounced friction traces made by the corresponding wheels after the derailment;
the headstock is deformed inside due to the derailment.

Vagonul nr.315354759104

Wagon series: Eacs; wagon loaded with logs;

I. Constructive characteristics wagon number:										3	1	5	3	5	4	7	5	9	1	0	-	4				
Inspections and repairs performed at the wagon from the date of the last performed periodical repair until the derailment										R	P	6	R	E	V	3	1	0	7	2	0	0	7	R	V	
										R	R							0	8	2	0	1	0	L	S	I
										R	I	F						0	8	2	0	1	0	L	S	I
										D	A					1	8	0	2	2	0	1	3	S	S	B
Wheel base	wagon	9	0	0	0	Bogie's type: Y25Cs		Wheels with tires				Buffers: cylinder type				autom. brake: KE-GP										
	bogie	1	8	0	0																					
Wagon's length			4	0	4	0	Traction gear type: discontinuous															Hand brake				
Automatic beam adjuster: DRV 2 AT 600							Wagon's loading: 33225								C= 60.2				Telciu	Fiad						

The dimensions measured at the pair of wheelset fits in the admitted limits from the regulations in force.

The height of the center of the buffers from the level of the head of the rail fits in the admitted limits from the regulations in force.

Wagon no. 315354791172

Wagon series: Eacs; wagon loaded with logs;

I. Constructive characteristics wagon number:										3	1	5	3	5	4	7	9	1	1	7	-	2				
Inspections and repairs performed at the wagon from the date of the last performed periodical repair until the derailment										R	P	6	R	E	V	2	3	0	7	2	0	0	9	C	T	F
										R	R					1	8	0	1	2	0	1	3	S	P	L
										R	I	F				1	8	0	1	2	0	1	3	S	P	L
										R	C					1	8	0	1	2	0	1	3	S	P	L
Wheel base	wagon	9	0	0	0	Bogie's type: Y25Cs		Wheels with tires		Buffers: cylinder type		autom. brake: KE-GP														
	bogie	1	8	0	0																					
Wagon's length			4	5	4	0	Traction gear type: discontinuous										Hand brake									
Automatic beam adjuster: DRV 2 AT 600						Wagon's loading: 31890						C= 58.9		Telciu	Fiad											

Findings:

The dimensions measured at the wheelset fits in the admitted limits from the regulations in force.
The height of the center of the buffers from the level of the head of the rail fits in the admitted limits from the regulations in craft.

Wagon no. 315354736607

Wagon series: Eacs; wagon loaded with logs;

I. Constructive characteristics wagon number:										3	1	5	3	5	4	7	3	6	6	0	-	7				
Inspections and repairs performed at the wagon from the date of the last performed periodical repair until the derailment										R	P	6	R	E	V	2	9	0	8	2	0	0	8	C	T	F
										R	R					0	1	0	9	2	0	1	1	L	P	O
										R	I	F				0	1	0	9	2	0	1	1	L	P	O
										D	A					0	4	0	4	2	0	1	3	S	S	V
Wheel base		wagon		9	0	0	0	Bogie's type: Y25Cs		wheels with tires			Buffers: cylinder type			autom. brake: KE-GP										
		bogie		1	8	0	0																			
Wagon's length				4	5	4	0	Traction gear type: discontinuous												Hand brake						
Automatic beam adjuster: DRV 2 AT 600								Wagon's loading: 33160						C= 58.3			Telciu	Fiad								

Findings:

The dimensions measured at the wheelset fits in the admitted limits from the regulations in force.
The height of the center of the buffers from the level of the head of the rail fits in the admitted limits from the regulations in craft.

C.5.4.3.4 Findings performed at the derailed and overturned wagons:

Wagon no. 825354700221

Wagon series: Eacs; wagon loaded with logs;

I. Constructive characteristics wagon number:										8	2	5	3	5	4	7	0	0	2	2	-	1
Inspections and repairs performed at the wagon from the date of the last performed periodical repair until the derailment						R	P	6	R	E	V	1	0	0	4	2	0	0	8	P	C	
						R	R					2	0	0	5	2	0	1	1	L	P	O
						R	I	F				2	0	0	5	2	0	1	1	L	P	O
						D	A															
Wheel base	wagon	9	0	0	0	Bogie's type: H		wheels with tires			Buffers: cylinder type			autom. brake: KE-GP								
	bogie	1	8	0	0																	
Wagon's length			4	5	4	0	Traction gear type: discontinuous													Hand brake		
Automatic beam adjuster: DRV 2 AT 600						Wagon's loading:						C= 58.7			Telciu		Fiad					

Findings:

The dimensions measured at the wheelset fits in the admitted limits from the regulations in force. There are deformations and damages due the overturning of the wagon.

Wagon no. 315354763270

Wagon series: Eacs; wagon loaded with logs;

I. Constructive characteristics wagon number:										3	1	5	3	5	4	7	6	3	2	7	-	0				
Inspections and repairs performed at the wagon from the date of the last performed periodical repair until the derailment										R	P	6	R	E	V	1	7	0	5	2	0	0	7	P	C	
										R	R							0	6	2	0	1	0	L	B	V
										R	I	F						0	6	2	0	1	0	L	B	V
										D	A					2	1	0	2	2	0	1	3	S	S	V
Wheel base	wagon	9	0	0	0	Bogie's type: Y25Cs		wheels with tires			Buffers: cylinder type			autom. brake: KE-GP												
	bogie	1	8	0	0																					
Wagon's length						Traction gear type: discontinuous															Hand brake					
Automatic beam adjuster: DRV 2 AT 600						Wagon's loading:						C= 60.3			Telciu		Fiad									

Findings:

The dimensions measured at the wheelset fits in the admitted limits from the regulations in force. There are deformations and damages due the overturning of the wagon.

Wagon no. 315354676696

Wagon series: Eacs; wagon loaded with logs;

I. Constructive characteristics wagon number:										3	1	5	3	5	4	6	7	6	6	9	-	6				
Inspections and repairs performed at the wagon from the date of the last performed periodical repair until the derailment										R	P	6	R	E	V	3	1	0	7	2	0	0	7	P	C	
										R	R					0	1	0	9	2	0	1	0	L	B	T
										R	I	F				0	1	0	9	2	0	1	0	L	B	T

						D	A					0	1	0	8	2	0	1	2	L	B	V
Wheel base	wagon	9	0	0	0	Bogie's type: Y25Cs	wheels with tires		Buffers: of great capacity		autom. brake: KE-GP											
	bogie	1	8	0	0																	
Wagon's length						Traction gear type: discontinuous												Hand brake				
Automatic beam adjuster: DRV 2 AT 600						Wagon's loading:				C=		Telciu		Fiad								

Findings:

The dimensions measured at the wheelset fits in the admitted limits from the regulations in force with the exception of a crooked axle which was deformed by his collision with the armed concrete structure of the bridgehead.

There are deformations and damages due the overturning of the wagon.

C.5.4.4. Data found out at the loading

According to the Minutes no. 1/1156 from 27th of June 2013 for the checking the state of the load and of the findings performed with the occasion the downloading the logs from the derailed wagons, recorded in the Minutes no. 680 / 12th of August 2013, no. 757 / 29th of August 2013, no. 770 / 04th of September 2013, FN / 10th of September 2013, no. 787 / 18th of September 2013 and no. 800/20th of September 2013 it was found out that the loading is made out of brut wood (whitewood logs), laid on four rows with approximatively 3 m length in some cases and on 3 rows of approximatively 4 m length in other cases. After the load verification and also the way of the arrangement of the wood resulted that it was laid and evenly distributed in the wagon, respecting the provisions of Annex II RIV referring to the loading method 1.11.2.

C.5.5. Anterior events with similar character

On 02nd of December 2011, in the running of the freight train no. 43632, which run on the running section Dealu Ștefăniței – Salva, closed to the entry signal of the railway station Salva, occurred the derailment of both bogies of wagon no. 31535475910-4, 32nd after the locomotive, with the wheels from the right in the running direction outside the track, to the track exterior , the line being in curve to the left with the Radius R = 360 m.

The freight train no. 43632 belonging to SNTFM „CFR Marfa” SA was comprising of 38 freight wagons, Eacs series, loaded with logs, 152 axles, 1939 tones, automatic braked tonnage after timetable 970 t, actually 1594 t, hand braked tonnage after timetable 272 t, actually 452 t, with a length of 599 m, being hauled with locomotive DA 1086 in the front of the train and DA 1111 as banking, both belonging to SNTFM „CFR Marfa” SA. The locomotives were driven and deserved by SNTFM „CFR Marfa” SA employees.

The direct cause of the accident occurrence from the 2nd of December 2011 was the reducing of the guidance capacity of the rail corresponding to the exterior curve rail, (curve with left deviation in the running direction of the train) and the climbing of the head of the rail on the exterior curve rail at km 0+937 by the flange of the wheel from the right side of the first axle of the first bogie from wagon no. 31535475910-4, the running of that on the head of the rail on a distance of 4,7 m, followed by the falling of this wheel in the exterior of the track and the falling of the corresponding wheel from the same axle between the rails of the track.

The factors that contributed:

- the exceeding of the tolerance at the track position in plan between the arrow from points "0" and the neighbor arrow, with 25 mm;
- the exceeding variation of the deviations at the embankments with 0,8 mm/m;
- the appearance, in time, of a wear of 2 mm, in operation of the superior frictioning stone, fact which led to the increasing of the resistance to rotation of the bogie and the tilt of the wagon's body;
- the reactions in the train at the running on a slope with a declivity of 4,8 ‰ while the hauling locomotive remains without current from the group of motors, asking the banking locomotive for help.

The wagon derailment occurred through the aggregation of all presented factors, none of those couldn't alone cause the derailment of the wagon.

C.6 Analysis and conclusions

C.6.1 Conclusions on the technical condition of the track superstructure

Due the reducing of the train speed to 30 km / h and the maintaining of the same superelevation of the track afferent to the speed of 60 km/h, the trains run under superelevation excess, being inclined inward of the curve.

The tolerance values of the cross on the adjacent track of the derailment site were within acceptable limits but close to the maximum allowed value, which is an indication that in the derailment place the conditions were similar.

In these conditions, the trains run inwardly to the curve interior and it was producing a load transfer from the wheels from the exterior rail to the wheels from the interior rail of the track, *having as effect the discharge of the load from the exterior rail.*

Given the mentioned issues, one can concluded that the technical condition of the lines produced the accident not direct, but in conjunction with speed and the track route geometry, could be a contributing factor in discharge of the load from the wheels from the exterior rail of the curve.

C.6.2 Analysis and conclusions on the technical state of the wagon's

At wagon no. 315354935878 following were identified:

- the values of the load ratio of the left wheel toward the right of the same axle toward the superior limit of the permissible values, this being a hint that the wheel from one side of the wagon was more discharged of the load then the other from the opposite side;
- the wagon's body tilting in the admissible limits, that leading to the discharging of the leading wheels at running with small speeds in curve;
- an ineffective shock absorber corresponding wheel no. 4 (admitter by the regulations in force), that being a hint the wagon's suspension could not take over optimal the level deviations and the usual twist of the track. This fact led to the appearance of additional load discharging of the wheel in dynamic regime.

Should also be noted that the center of gravity of the load low density (whitewood) was higher than other types of loads with high density (ex. ingots or steel billets). In the situation of the running of the wagon with a small speed in curve with over heightening, the load with a more pronounced higher center of gravity and a more pronounced discharge of a load with a lower center of gravity.

Given the findings, one can conclude that the technical condition of the wagon did not caused directly the accident but the mentioned technical issues could be a factor that could contribute to the derailment, by the load discharge of the leading wheel to the curve exterior.

C.6.3 Analysis and conclusions on the technical state of the locomotives from the train

The technical state of the locomotives was corresponding and could not produce the accident.

C.6.3 Analysis and conclusions on the train's tonnage and forming, the hauling type and the arrangement of the locomotives in the train.

The train no. 43622 was dispatched from the railway station Dealu Stefanitei having the locomotive 60-0857-7 positioned at the rear of the train, being active. The locomotive 60-0857-7 participated at the starting of the train 43622 from the station Dealu Stefanitei, then the diesel motor of the locomotive has been stopped, the locomotive becoming inactive. In the moment of the accident occurrence, the locomotive 60-0857-7 was **inactive**, with the engine off.

In the next paragraphs is presented the analysis and conclusions for this situation.

C.6.4.1. Analysis and conclusions for the arrangement on the rear of the train no. 43622 of a banking locomotive

The train no. 43622 was dispatched from the railway station Dealu Stefanitei, having the banking locomotive 60-0857-7, as written in the order RC Dej no. 54 from 08th of May 2014.

The regulations for the line sections on which the train is hauled with a banking locomotive are following.

art. 6 paragraph (4) from Regulation no. 006 – “(4) the line sections from the hauling sections on which the train is hauled with intercalated or banking locomotives are **foreseen in the route timetables**”,

corroborated with

art. 6 paragraph (14) from Regulation no. 006 – “(14) the provisions for the freight train composition hauled with electric or diesel banking locomotive are **foreseen in the general orders** from the route timetables”,

corroborated with

“General orders” from the ”Timetable with the running of the freight trains on Branch CREIR Cluj, point 2.3. – Annex I / maximum tonnages and the hauling type of the trains ...”,

corroborated with

Annex 1 from the Freight trains timetable – Cluj, where is foreseen that at the descent on the line section Dealu Stefanitei – Salva, **the hauling type** of the train is only with a locomotive in front of the train.

The dispatch of the freight train no. 43622 with a banking locomotive was **against the provisions** from the “Freight trains timetable on the Branch CREIR Cluj”, valid for 2012-2013, which foresee at **Annex 1** that at a descent from the line section Dealu Sefanitei – Salva the **hauling mode** is done only with a locomotive in the front of the train.

The provisions for the train hauling type must be applied according to **Annex I**, and the using of other hauling types could be done only with the approval of CNCF “CFR” SA, as prescribed at point 5 from “General orders” from the “Freight trains timetable on Branch CREIR Cluj”, valid for 2012 – 2013.

In conclusion it is forbidden the positioning of a banking locomotive at the rear of the train no. 43622, at his dispatch from the railway station Dealu Stefanitei to run down to the railway station Salva.

C.6.4.2. Analysis and conclusions for influence of the running of a LED locomotive at the rear of a train no. 43622

C.6.4.2.1. Analysis for the composition of the train no. 43622

The Regulation no. 002 foresee at art. 157 (1):

“It’s called train **a group** of railway vehicles, regular coupled between them and to the railway traction vehicle, signalized with front and rear signals and deserved by at least 2 agents, from which one is the driver of the railway traction vehicle.”

Applying the definition at the analyzed case, it was found out that in the railway station Dealu Stefanitei arrived a train with the number 43622, comprising of **a group of 18** wagons. Subsequently, from the railway station Dealul Stefanitei was dispatched a train with the same number 43622, but comprising of a **group of 38** wagons.

Comparing the two vehicle groups which formed the two trains, it is clear that the **two trains were different technical**, but had the same identification number, situation occurred trough the technological operations of reforming at arrival of the train.

C.6.4.2.2. Analysis for the running of the inactive locomotive DA 60-0857-7 at the rear of the train no. 43622 in the conditions of changing the train consist

To keep the risks under control, there are general ruled for putting the inactive locomotives at the rear of the trains. So, it is forbidden to put at the rear of the passenger and mixed trains of the inactive locomotives with a weight bigger than 70 tones. Also, it is forbidden to put at the rear of the freight trains of inactive locomotives.

These general rules are set out through the following regulations:

“At the mixed and passenger trains are not admitted:

b) inactive locomotive at the rear of the train, excepting the locomotives which have a weight of 70 t or smaller ...”, according to the Regulation no. 006, art. 6(8)b)

“The locomotives which are not active will be put in this way in the train:

a) in the passenger trains no more than two locomotives, putted right after the hauling locomotive...

b) in the freight trains only in first half of the train...”

according to the Regulation no. 006, art. 36(1) letter a) and b).

But at **the general provisions is an exception:**

“The diesel and electric locomotives which have been used as banking locomotives at the freight trains can remain in the initial position at the forming of the train, coupled at the train and brake, to continue running, but only as hauled vehicles and without being active in the hauling of the train...”, according to the Regulation no. 006, art. 6(16).

From the expressions “...*can remain in the initial position at the forming of the train... to continue running...*”, results that art. 6(16) applies only when it is the same train. In the situation when the initial train, through technological operations is turning in another train, this article does not apply.

Because at paragraph C.6.4.2.1. it was found that the train 43622 was dispatched from the railway station Dealu Stefanitei was another then the train from arrival, results that was **not admitted the applying** of art. 6(16) from Regulation no. 006 in the analyzed case and **was not admitted the remaining** of the inactive locomotive DA 60-0857-7 to continue running **at the rear of the train** no. 43622.

C.6.4.2.3. Analysis for the running of the inactive locomotive DA 60-0857-7 at the rear of the train no. 43622 in the conditions of NOT changing the train composition

If in the railway station Dealu Stefanitei **hadn't change the consist** of the train 43622, then the tonnage of the dispatched train to the railway station Salva had a **maximum of 1000 tones**, this being the maximum tonnage admitted at arrival toward the railway station Viseu de Jos.

The maximum tonnage at arrival of the train toward the railway station Viseu de Jos was set out by:

art. 6 paragraph (4) from Regulation no. 006 – “(4) the line sections from the hauling sections on which the train is hauled with intercalated or banking locomotives are **foreseen in the route timetables**”,

corroborated with

art. 6 paragraph (14) from Regulation no. 006 – “(14) the provisions for the freight train consist hauled with electric or diesel banking locomotive are **foreseen in the general orders** from the route timetables”,

corroborated with

“*General orders*” from the “Timetable with the running of the freight trains on Branch CREIR Cluj, point 2.3. – Annex I / maximum tonnages and the hauling type of the trains ...”,

corroborated with

Annex 1 from the Freight trains timetable – Cluj, where is foreseen that **the maximum tonnage is maximum 1000 tones** to at the uphill climbing on the track Viseu de Jos - Dealu Stefanitei.

In the situation in which the train forming **wouldn't change**, the **train tonnage** would be of **maximum 1000 tones** and could be admitted the remaining in the initial position of the locomotive DA 60-0857-7, situation regulated by Regulation no. 006, art. 6(16):

“The diesel and electric locomotives which have been used as banking locomotives at the freight trains can remain in the initial position at the forming of the train, coupled at the train and brake, to continue running, but only as hauled vehicles and without being active in the hauling of the train...”

C.6.4.2.4. Conclusions for the consequences of the existence of the inactive banking locomotive DA 60-0857-7 at the rear of the train no. 43622 on the section line Dealu Stefanitei – Salva.

On the track Dealu Stefanitei – Salva, **was admitted the remaining of a locomotive LDA – DA** in the initial position in the train consist to continue running, but only if the train fulfill the following conditions:

- the maximum tonnage of the train at dispatch should be of maximum 1000 tones, equal with that at arrival. For wagons loaded with logs, the train resulted should be comprise from approximatively of 20 wagons, should had a length of approximatively 350 m and at had the rear a inactive locomotive;
- should not be done technological operations of wagon's attaching / detaching.

The real situation was different from the admissible one and the train 43622 run with the following consist:

- the tonnage of the train at dispatch had 1870 tones;
- the train comprises of 37 loaded with logs wagons;
- the train had a length of 595 m and had at the rear an inactive locomotive.

From the comparison of the 2 situations, it can be observed that the train 43622 run with a tonnage and a length bigger than the admissible situation, having at the rear an inactive situation. As result, at the train 43622, the running of the wagon's rack and the perturbations from the train were different than those from the admissible situation and were accentuated by the inactive locomotive.

Taking into account the following:

- the inactive locomotive should be aligned only in the first half of a train with a bigger tonnage than 1000 tones in the mentioned conditions;
- there was a ratio of 2,1:1 between the locomotive weight from the rear of the train towards the weights of the train wagons, because the medium weight of the loaded wagons from the train 43622 was of 53 tones / wagon and the weight of a LDE – DDA locomotive is of 117 tones;
- the train 43622 run with the inactive locomotive at the rear, having a tonnage and a length bigger than it would had in running in the admissible situation;
- the running of the train and the perturbation from the train were different towards those of the admissible situation

it can be concluded that the running of the running of inactive locomotive DA 60-0857-7 at the rear of the train no. 43622 was a factor which contributed at the amplifications of the reactions in the train's body and in the dynamic regime constituted a favoring factor for rails climbing from the exterior of the curve by the wagon's wheels from the train no. 43622.

C.6.4.3. The way in which should be understood and applied, by the operation employees, the provisions of art. 6(16) from Regulation no. 006

Regarding **to the position of the inactive locomotive** from the train it was found out that it can be applied 2 articles from Regulation 006:

“The locomotives which are not in action will be arranged in the trains as follows:

- c) in freight trains only in the first half of the train...”

according to the Regulation no. 006, art. 36(1) letter b)

and

“The diesel and electric locomotives which have been used as banking locomotives at the freight trains can remain in the initial position at the forming of the train, coupled at the train and brake, to continue running, but only as hauled vehicles and without being active in the hauling of the train...”

according to the Regulation no. 006, art. 6 paragraph (16).

The two provisions were not understood and were not correctly applied by the employees M/C, in the sense in the railway stations Dealu Stefanitei was composed a new train through the attachment of new wagons, which was dispatched to the railway station Salva, applying it wrongly the provision of art. 6, paragraph (16) from Regulation no. 006, which were apply able only in the case of a train with not modified consist.

In the case of the analyzed case should be applied the provisions of Regulation no. 006, art 36 (1) letter b) through the positioning of the inactive locomotive in the first half of the freight train to which it has been modified the consist through the attachment of the wagons.

Having regard to those presented the investigation commission consider necessary the issuing of a **Safety Recommendation**, as follows:

Taking the necessary steps for operating personnel to understand precisely and unambiguously the conditions for the application of Article 6 paragraph (16) of the Braking and Hauling Regulation

no.006, referring at the remaining on the original position in the train to continue running, as hauled vehicles and without being active in the train hauling of the locomotives that were used as banking locomotives;

C.6.4.4. Conclusions regarding the tonnage and the train consist, the hauling way and the arrangement in the train

Taking in account those mentioned before in the paragraph C.6.4. one can conclude that the running of the inactive locomotive DA 60-0857-7 at the rear of the train no. 43622 did not occurred in a direct mode the accident, but was a factor which in an unfavorable dynamic regime contributed at the additional discharge of the wheels from the curve exterior.

C.6.5. Analysis and conclusions regarding on how the accident occurred

C.6.5.1. Determination of the succession of the 2 train breakings

To establish the succession of the train breakings after the train derailment were analyzed recordings of the locomotives and the clues found at the wagons and infrastructure. With this in mind it was concluded that the succession of 2 train breakings between the derailed wagons occurred first between the wagons 5 and the 6 and later between position 2 and position 3. Graphical representation of these train breakings is presented in Figure. 3.

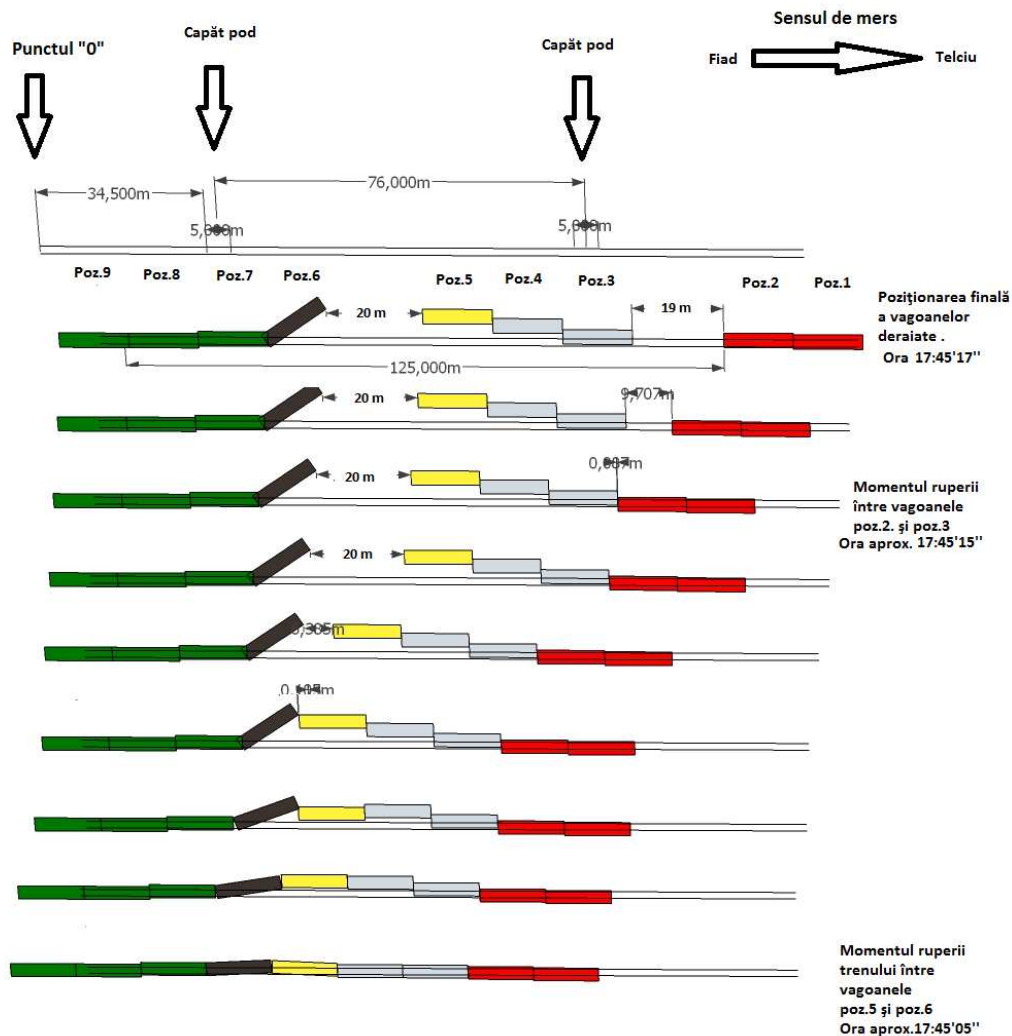


Image no. 8 The succession of the train breakings with the representation of the 9 derailed wagons

C.6.5.2. Determination of the succession of the 2 train breakings

On the bridge passing of the derailed wagons, those let more traces sets printed on the sleepers, on the fastening elements of type K and on the check rails shown on Photo no. 9.



Photo no. 9 The traces left on the bridge by the derailed wagons

After the trace identification, the estimation of the distances between the trace sets and in correlation with other technical elements, one can conclude:

The wagon position 5 run derailed on the bridge on the left part of the track and let printed the traces of 2 wheels on the right part. The wagon run with the wheels from the right between the check rails and with the wheels from the left in the left part of the track outside the sleepers. The wagon run in this way until it tilt on the left part and overturned. From the printed traces on the sleepers resulted that it can't be excluded the running of a third wheel from wagon no. 5, which run in the same conditions.

The wagon position 4 run derailed on the bridge by the rear bogie, on the right side of the track. The wagon left printed the traces of 2 wheels from the left on the check rail from the left. The wagon run in this way until overturned due the action of the wagon from behind.

The wagon position 3 run derailed on the bridge by the leading bogie from on the left part of the track and derailed by one axle from the rear bogie on the right side of the track.

The leading bogie left printed the traces of 2 wheels from left side on the end from left of the sleepers and the traces of 2 wheels from the right on the area between the check rails. Following the trajectory of the traces it can be found that before the stop with approximatively 30 m, the leading bogie moved to the right, the wheels from the right climbed the check rail from the right and then fell off between the check rail and the rail from the right, where they run until the stop.

At the rear bogie, the derailed axle on the right left traces with the wheel from the right on the fastening type K, in the exterior of the rail. The derailed wheel from the left, left traces on the fastenings type K, between the interior check rail and the left rail.

The wagon position 2 run derailed on the bridge by axle 3 in the running direction, which was derailed on the right. The derailed wheel from the right left traces on the fastening type K, in the exterior of the rail. The derailed wheel from the left, left traces on the fastenings type K, between the interior check rail and the rail from the left.

The wagon position 1 run derailed on the bridge by 2 axles from the rear bogie from in the running direction, derailed on the right. The derailed wheel from the right left traces on the fastening type K, in the field side of the rail. The derailed wheel from the left, left traces on the fastenings type K, between the interior check rail and the rail from the left.

*C.6.5.3. The wagon identification which **didn't caused** the accident*

From the analyze of the spaces run by the locomotive, from the moments of the stabilization and the decreasing of the speed and until the stop, taking in account the delayed action of the braking installation, corroborated with the distances run by the derailed wagons and with the traces from the site, has been determinate that in the moment of the train speed decreasing due the derailment, were on the derailment area only the wagons from **positions 1, 2 and 3** and the leading bogie of wagon from **position 4**. This are the wagons with numbers 5878, 2276, 9482 and 0221.

Taking into account those mentioned it was concluded that the wagons from **positions 5, 6, 7, 8 and 9 which didn't caused the accident** because they derailed after the wagons from **positions 1, 2, 3 and 4** have been already derailed.

Taking into account that the wheels from the leading bogie from the wagon from **position 4** doesn't present running traces in derailment traces on the embankment and corroborated with the hints from the site it was concluded that the wagon from **position 4 did not caused the accident**, the wagon derailed only after the wagons from **positions 1, 2 and 3 derailed** already.

*C.6.5.4. The wagon identification which **caused** the accident*

The climbing and/or falling traces of the wheels have been found only between point "0" and the end of the bridge, on a distance of approximatively 35 m. There were not identified climbing and/or falling or climbing of the wheels on the bridge or after the exit of the bridge from the bridge.

The longest derailment trace is on the right side in the running direction, starts from point "0+4 m", crossed the bridge and it is ending after the bridge at the wheel of wagon position 1. This trace has a total length of approximatively 154 m. Through comparison, the longest derailment trace on the left side starts with point "0" it's ending on the bridge and has a length of approximatively 120 m. In conclusion, the derailment trace which appeared earlier is that on the right side.

Wagon from position 1 had derailed all the wheels from the rear bogie to the right side and behind him was a not derailed bogie from the wagon position 2. This fact indicates that the wagon from position 1 could not be actioned in derailment by wagon from position 2.

Wagon from position 2 had 1 derailed the rear axle of the bogie to the right and behind it was a derailed bogie to the left from wagon from position 3. This indicates the fact that wagon from position 2 couldn't be actioned in derailment by wagon from position 3.

Wagon from position 3 had all wheels from the leading bogie to the left side and 1 axle from the rear bogie to the right side, being stopped in this position by the rear wagons it which were overturned.

Taking in account that the longest derailment trace was on the right side, and of the clues from the site, of all technical observations and eliminating the implausible assumptions, it is concluded that the **wagon from position 1 with no. 315354935878 run the longest distances in a derailment state, has derailed on the right side and derailed before the derailment of the other wagons.**

The accident started in point “0+4m”, through the climbing of the rail from the exterior curve by the first wheel from the right of the rear bogie in the running direction of the wagon from position 1 with no. 315354935878.

C.6.5.5. The establishment of the causes which produced the derailment of wagon no. 315354935878

From the analyze of the speed recording (Image 4) it was found out that before the derailment there were reactions in the train shown by the speed differences of 2 km/h between the speed of the hauling locomotive and the speed of the banking locomotive from the rear of the train, which run with the engine off.

Run distances, until the stop (m)	50	50	50	50	50	50	50	50	50	50	50	75
The speed of the hauling locomotive DA 672 (km/h)	29	27	24	22	20	22	23	26	28	30	30	0
The speed of the locomotive from the rear of the train DA 857(km/h)	31	29	27	24	21	21	22	24	26	28	31	0
Speed differences: Speed of the hauling locomotive – Speed of the locomotive from the rear of the train (km/h)	-2	-2	-3	-2	-1	+1	+1	+2	+2	+2	-1	0

The reactions manifested through compressions or stretches along the train were given by the track with slope in the running direction, also by the positioning of the train simultaneous on different declivity's, on curves with different radiuses and opposite directions and also by the inertial mass disproportioned of the locomotive LDE from the rear of the train. The compression of the train was exercised specially on the buffers from the interior curve rail and were discharging transversal to the wheels from the curve exterior, constituting in that way a favoring fact for the climbing of rails on the right by the wheels.

The running of the inactive locomotive DA 60-0857-7 at the rear of the train no. 43622 was a factor which contributed to the amplification of the reactions from the train and in the dynamic regime constituted a favoring factor for the rail climbing from the exterior of the curve by the wagon's wheels from the composition of the train no. 43622.

The running of the train in superelevation excess at the line following the decreasing in time of the running speed from 60 km/h to 30 km/h produced a tilt to the interior of the curve of wagon no. 315354935878 and a tendency of load discharging of the wheels to the curve exterior, constituting an favoring factor to the climbing of the right rail by the wheel.

The existence at wagon no. 3153544935878 of some values of the load ratio of the wheel from the left toward the right one from the same axle, respectively the wheel no. 3 toward the wheel no. 4 with a value of 1,20 and wheel no. 1 toward wheel no. 2 with a value of 1,13 was a load discharge manifestation of the wheels from the curve exterior, constituting a favoring factor for the right rail climbing by the wheel.

The center of gravity of the load with a small density was higher than that of other load types with a bigger density and favored a load transfer and a more pronounced load discharge of the leading wheel at the running of the wagon with a small speed in a curve with over heightening.

The tilting of the wagon's body no. 315354935878 to the curve interior (found at the measuring of the distances between the bogie frame and the upper slider), produced a tendency of load discharge of the wheels to the curve exterior constituting an favoring factor for the right rail climbing by the wheel.

The existence at wagon no. 3153544935878 of an ineffective shock absorber corresponding to wheel no. 4 caused a not favorable behavior of the wheels at the meeting with some twist at level variations (normal in exploitation) of the line, constituting a favoring factor for the right rail climbing by the wheel.

In the work “Railway vehicles dynamic”, in the chapter with the safety against derailment are following mentioned:

“The guiding capacity of the axle is decreasing with the decreasing of the load on the leading wheel, also the bigger is the load transfer from the leading wheel on the one behind it. The limit situation for the discharging of the leading wheel can happen at the running with a small speed of the curves with maximum superelvation of the track. The negative load transfers come from the tilt to the curve interior of the bogie’s body, being amplified by the flexibility coefficient and the track torsions, which are overtaken by the vehicle suspension.”

Taking into account the before mentioned facts, the investigations commission concluded that after the apparition of the not favorable dynamic regime in which cumulated simultaneous all favoring factors, happened an excessive load discharge of the wheel from the exterior curve rail from wagon no. 315354935878, which led to the climbing of the leading wheel on the lateral of the wheel and after that to the leaving of the running track by the wheel.

The derailment of wagon no. 315354935878 happened through the climbing of the head of the rail from the exterior curve rail by the flange of the wheel from the right side of the first axle from the second bogie, followed by the falling of this wheel in the track exterior and the falling of the correspondent wheel of the same axle between the track rails.

Immediately after the derailment of wagon no. 315354935878 happened the decoupling of the couples from the air hose from his behind and the damaging of the running track by the derailed wheels. The decoupling of the air hose from the wagons caused the loss of the air from the main air pipe and determined the entry of the brakes from the wagons in quick braking regime. The additional reactions from the train caused by the quick braking together with the damages arise at the running track determinate the ulterior derailment of the other wagons which followed after wagon no. 315354935878.

C.6.5.6. Taken measures

For the safety improvement, CREIR Cluj restriction the running with inactive locomotive at the rear of the train on the line section Dealu Stefanitei – Salva.

D. ACCIDENT CAUSES

D.1. Direct cause, contributing factors

The direct cause of the occurrence of this accident is the climbing of the flange of the wheel from the right side of the first axle from the second bogie in the running direction of the wagon no. 315354935878 on the head of the track corresponding to the exterior curve rail and the leaving of the track, due to the following combination of factors:

- the existence of the excess of super elevation at the line due the reducing in time of the traffic speed, from 60 km/h at 30 km/h;
- the existence at wagon no. 315354935878 of some values of the load ratio of the wheel from the left beside the one from the right from the same wheel, respective wheel no. 3 beside wheel no. 4 with a value of 1,20 and wheel no. 1 beside wheel no. 2, with a value of 1,13;
- the existence of a tilt of the wagon’s body to the interior of the curve, found out at the measuring of the distances between the bogie’s frame and the superior guide;

- the existence at wagon no. 315354935878 of an ineffective shock absorber corresponding to wheel no. 4;
- the reactions on the train, caused by the positioning of the train simultaneous on lines with different declivities and in opposite curves and different radiuses, also the existence of a ratio of 2,1:1 between the locomotive's weight from the rear of the train beside the wagon's weight from the train.

D.2. Underlying cause

The false understanding and applying of art. 6, paragraph (16) from the Braking and Hauling Regulation no. 006, referring to the remaining at the initial position in the train consist, without being active of the locomotive which were used as banking locomotive.

D.3. Root causes

None

E. SAFETY RECOMMENDATIONS

Taking into account the conclusions foreseen at paragraph C.6.4.3 of the present report, referring to the way in which were understood and applied the regulations in force by the operation employees, the investigation commission consider necessary the issuing of the following safety recommendation:

Taking the necessary measures for the operation employees to understand accurately and unambiguously the applying conditions of the provisions of art. 6, paragraph (16) from the Braking and Hauling Regulation no. 006, referring at remaining at the initial position in the train consist, to continue running as hauled vehicles and without being active in the train hauling, of the locomotives which were used as banking locomotives.

This Investigating Report will be transmitted to Romanian Railway Safety Authority, to the public railway infrastructure administrator CNCF „CFR” SA and to the railway freight undertaking SNTFM „CFR Marfa” SA.

Cluj-Napoca, 28th of March 2013

Members of the investigation commission

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▪ Ion SALCA	Territorial state inspector ASFR Cluj	member;
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