MINISTRY OF TRANSPORTS AND INFRASTRUCTURE
ROMANIAN RAILWAY AUTHORITY - AFER

ROMANIAN RAILWAY INVESTIGATING BODY

INVESTIGATING REPORT

on the railway accident
occurred on the 1st of April 2011, in the railway station CFR Chisineu Cris

FINAL EDITION
The 2nd of November 2011

NOTICE

With reference to the railway accident occurred on the **1st of April 2011**, around **1:55 a.m.**, on the range of activity of **CF Timisoara Regional Branch**, the running section Nadab – Ciumeghiu, consisting of the **derailment and the overturning of 9 wagons in the composition of the freight train no. 50505** (belonging to the railway undertaking SC UNIFERTRANS SA) **passing through the railway station CFR Chisineu Cris on the direct line III** on the area of the switch no. 3 from the end X of the railway station, Romanian Railway Investigating Body carried out an investigation, according to the provisions of the Government Decision no. 117/2010. Through the investigation, the information on the respective accident was gathered and analyzed, the conditions were established and the causes determined.

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

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

Bucharest, *the 2nd of November 2011*

Approved by
Dragoş FLOROIU
Director

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

Chief Investigator
Nicu PĂLĂNGEANU

This approval is part of the Report for the investigation of the accident occurred on the 1st of April 2011, around 1:55a.m., on the range of activity of CF Timisoara Regional Branch, the running section Nadab – Ciumeghiu, consisting of the derailment and the overturning of 9 wagons in the composition of the freight train no. 50505 (belonging to the railway undertaking SC UNIFERTRANS SA) passing through the railway station CFR Chisineu Cris on the area of the switch no. 3 from the end X of the railway station.

CONTENT

I. PREAMBLE

I.1. Introduction

With reference to the railway accident occurred on the **1st of April 2011**, around **1:55 a.m.**, on the range of activity of **CF Timisoara Regional Branch**, the running section Nadab – Ciumeghiu, consisting of the **derailment and the overturning of 9 wagons in the composition of the freight train no. 50505** (belonging to the railway undertaking SC UNIFERTRANS SA) **passing through the railway station CFR Chisineu Cris on the direct line III** on the area of the switch no. 3 from the end X of the railway station, Romanian Railway Investigating Body carried out an investigation, according to the provisions of the Government Decision no. 117/2010, in order to prevent accidents with similar causes, by establishing the conditions and determining the causes.

Romanian Railway Investigating Body investigation did not aim to establish the guilty or the responsibility in this situation, its aim being to improve railway safety and to prevent railway incidents or accidents.

I.2. Investigation process

On the 1st of April 2011 General Inspectorate of Traffic Safety in CNCF "CFR" SA notified Romanian Railway Investigating Body about the accident occurred on the 1st of April 2011, at 1:55a.m., on the range of activity of CF Timisoara Regional Branch, on the running section Nadab - Ciumeghiu, in the railway station CFR Chisineu Cris, in the running of the freight train no. 50505 (belonging to the railway undertaking SC UNIFERTRANS SA) consisting of the derailment and overturning of 9 wagons (from the 5th to the 13th by locomotive), on the area of the switch no. 3 from the X end of the station.

Considering that the occurred facts are defined as accident under the provision of the art. 3, point l of the Law 55/2006 on railway safety and of the art. 7, paragraph 1, point b) of the Regulations for the investigation of the accidents and incidents, for the development and improvement of Romanian railway and subway safety, approved by Government Decision no. 117/2010 and that this accident is relevant for railway system, under the article 19 paragraph (2) of the Law no. 55/2006, corroborated with the art. 48, paragraph 1 of the Regulations for the investigation of the accidents and incidents, for the development and improvement of Romanian railway and subway safety, Romanian Railway Investigating Body decided to start an investigation. So, through the decision no. 54 of the 1st of April 2011, of the OIFR Director, the investigation commission was appointed consisting of:

- Stoian Eduard - main investigator
- Zamfirache Marian - investigator
- Păiș Luca - investigator
- Șipoș Zoltan - territorial inspector in ISF Timisoara - ASFR
- Diță Dumitru - territorial inspector in ISF Timisoara - ASFR
- Nemeș Liviu - regional inspector SC – in CF Timisoara Regional Branch - CNCF "CFR" SA
- Păun Ștefan - regional inspector SC - in CF Timisoara Regional Branch - CNCF "CFR" SA
- Olaru Mihai - Chief operating – SC UNIFERTRANS SA Bucharest

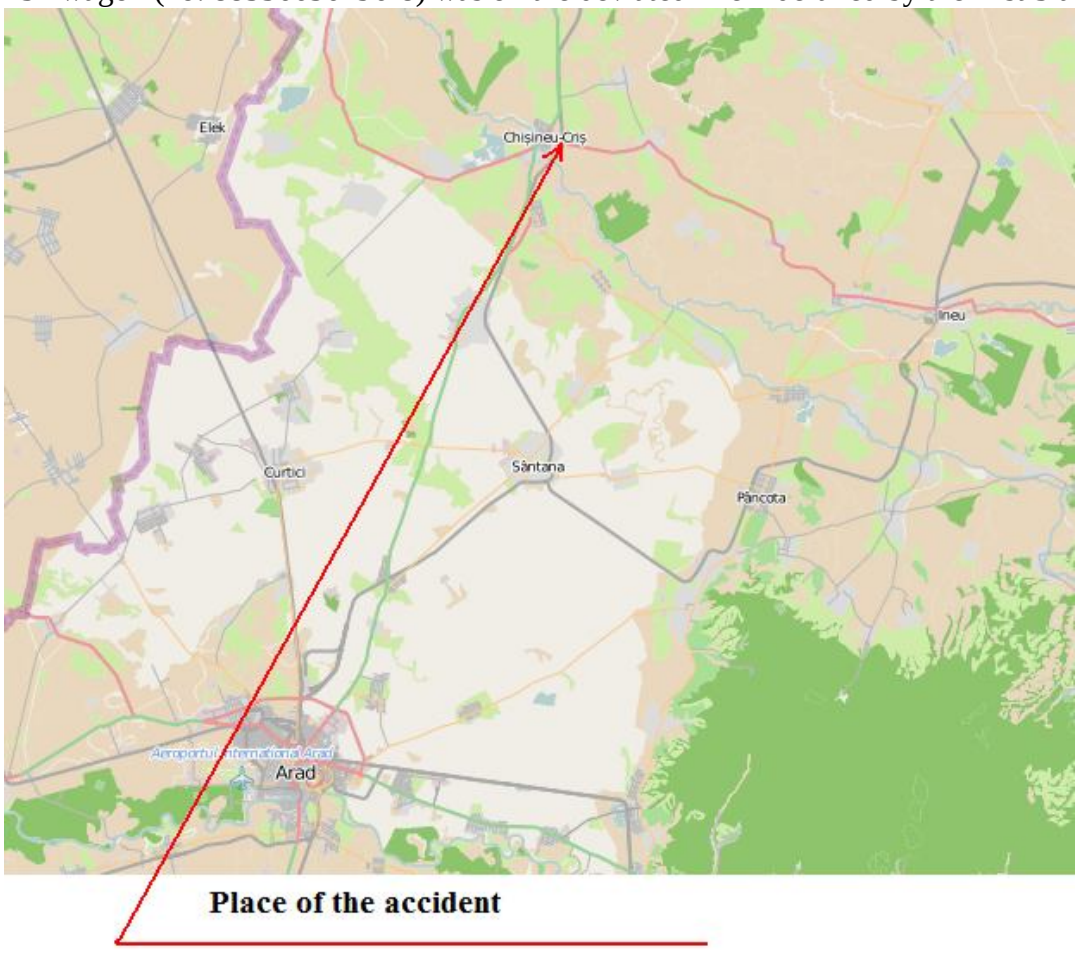
A. BRIEF PRESENTATION OF THE INCIDENT

A.1. Brief presentation

On the 31st of March 2011, at 2:31p.m., the freight train no. 50505, belonging to the freight railway undertaking SC UNIFERTRANS SA Bucharest, was sent from the railway station CFR Plopsoru and ran on the route Targu Jiu – Simeria – Arad – Utvinisu Nou with the destination the railway station CFR Episcopia Bihor.

Around 1:55a.m., passing through the railway station CFR Chisineu Cris on the direct line III, over the switch no. 3 located in the X end of the station, occurred the derailment and the overturning of 9 wagons in the composition of the train (from the 5th to the 13th by locomotive), as follows:

- the 5th wagon in the composition of the train (wagon no. 88536656453-6 – first derailed) had the coupling hook towards the 4th wagon broken and was overturned on the right (in the running direction), being linked by coupling to the 6th;
- the 6th wagon (wagon no. 88536656616-8) was placed transversely to the direct line III axis, on the right in the running direction, exceeding the structure gauge of the line 4 deviated;
- the 7th wagon (wagon no. 88536656640-8) was placed parallel to the 6th wagon;
- the wagons the 8th (no. 88536656667-1), the 9th (no. 88536656783-6), the 10th (no. 88536656815-6), the 11th (no. 88536656682-0) and the 12th (no. 88536656517-8) in the composition of the train were derailed on the line 4 deviated, being inclined to the vertical plane;
- the 13th wagon (no. 88536656796-8) was on the deviated line 4 derailed by the first 3 axles.



The freight train no. 50505 was composed of 22 wagons (loaded with coal), 88 axles, 1199 gross tones, length 311 m and was towed with the locomotive DA 003 (belonging to the railway undertaking SC UNIFERTRANS SA).

As consequence of the occurrence of this railway accident damages were registered to the 9 derailed wagons, at the lines III and 4 from the railway station and also at the switch no. 3.

There were no deaths or injuries.

A.2. Causes of the accident

A.2.1. Direct cause

The direct cause of this accident occurrence is the rolling of the axles from the 2nd bogie of the wagon no. 88536656453-6 (the fifth in the composition of the train) together with the axles of the first bogie from the wagon no. 88536656616-8 (the sixth in the composition of the train), with the wheels on the left in the running direction on the right counter-needle of the switch no. 3 and with those on the right on the curved counter-needle of the same switch, followed by the fall of the wheels on the right between the right counter-needle and the curved needle, at about 11 m from the top of the needles.
This was possible given that, when passing the train no. 50505 over the switch no. 3, its switch half-opened, because it was not locked.

Contributing factors to the half-opening of the switch no. 3:
- the incorrect position of the clips end of the switch no. 3 – when passing the 5th wagon in the composition of the train it was in the slot on the operating bar of the top fixator;
- the vibrations transmitted by the component parts of the switch no. 1 to the component parts of the switch no. 3 under the conditions of the rolling stock operation over these switches, corroborated with the fact that the distance between the end of the core check-rail of the switch no. 1 and the needles top of the switch no. 3 was about 1m, between the two switches there was no intermediate panel to mitigate these vibrations (the last joint of the switch no. 1 is top joint for the switch no. 3);
- the stripper tendency of the top of the flexible right needle when passing the rolling stock over the beam area, due to the guidance forces generated by the operating rolling stock.

A.2.2. Underlying causes

None.

A.2.3. Root causes

None.

A.3. Severity level

Under the art. 3, letter l of the Law no. 55/2006 on railway safety, corroborated with the provisions of the art. 7, paragraph (1), letter b of the Regulations for the investigation of the accidents and incidents, for the development and improvement of Romanian railway and subway safety, approved by Government Decision no. 117/2010 the event is categorized as **railway accident**.

A.4. Safety recommendations

The safety recommendations are addressed to the Romanian Railway Safety Authority as an independent body designed to monitor, promote and harmonize the regulatory framework for railway safety, including the national railway safety rules.

The safety recommendations aim to solve the next issues:

1. Identify and implement a technical solution through which at the insurance installation with key locks to control the position of the switches, the lock of the switch and the remove of the key from the lock to be made only after blocking the switch.
2. Identify and implement a technical solution through which to be removed the detachment tendency of the top of the flexible needles of the switches with top fixer with clips from the stations equipped with insurance installations with key locks to control the position of the switches.
3. Eliminate the ambiguity in the regulations on checking the condition of the switches insured with key locks or without block, created by using two different expressions used to define the same condition of a switch, respectively "insured switch" and "locked switch".

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

B. INVESTIGATING REPORT

B.1. Description of the accident

On the 31st of March 2011, at 2:31p.m., the freight train no. 50505, belonging to the freight railway undertaking SC UNIFERTRANS SA Bucharest, was sent from the railway station CFR Plopsoru with the destination the railway station CFR Episcopia Bihor.

The train ran on the route Targu Jiu – Simeria – Arad – Utvinisu Nou where arrived at 0:12a.m. on the 1st of April 2011. After performing the exchange of towing means and the technical inspection in transit the train was sent from the station CFR Utvinisu Nou at 1:00a.m.

Further, the train ran without stopping to the railway station CFR Chisineu Cris where, when entering the railway station, after passing over the switch no. 3 and entering on the direct line III the towing locomotive and the first 4 wagons, there occurred the derailment and the overturning of the following 9 wagons in the composition of the train (from the 5th to the 13th by locomotive). The other 9 wagons in the composition of the train (from the 14th to the 22nd by locomotive) did not derail.

Moving to the place of the accident, the members of the investigation commission found the following:

- the first signs of abnormal rolling of the wagons wheels in the composition of the train were found at a distance of 6 m from the needle top of the switch no. 3, where on the curved counter-needle (wire on the right) were found 4 signs of falling inside the path (between the sleepers no. 11 and no. 13 numbered from the top of the switch);
- at a distance of 11 m from the top of the needle, on the right counter-needle (the wire on the left) were found 4 signs of falling inside the path (between the sleepers no. 39 and no. 21);
- from the place of the first signs of abnormal rolling of the wagons wheels in the composition of the train (km 47+182) and to the stopping

point of the first derailed and overturned wagon (the 5th in the composition) – km 47+260, the train ran a distance of about 76 m. The first part of the train, (the towing locomotive and the first 4 wagons in the composition) stopped with the last wagon at the km 47+457.

- *Regarding the lines and the installations in the railway station CFR Chisineu Cris:*
  - to perform the train crossing on the direct line III the switch no. 3 had been handled to the position "on direct".
  - the members of the investigation commission found the switch no. 3 handled and locked to the position "on deviation", the curved needle having the top stuck on the right counter-needle, the access of the switch being towards the deviated line 4;
  - the joints of the top fixer of the switch no. 3 were found sealed and with intact leads (applied);
  - the locks of the switch no. 3 were found sealed and with intact leads (applied);
  - the connection and the traction bar from the switch no. 3 were found without any sign of impact or deformation;
  - the lock beak of the switch no. 3 on the direct position was pulled from the body of the lock and was hanging down between the sleepers 2 and 3 (numbered from the top joint);
  - the top of the right needle had fresh signs of impact, on a length of 39 mm at the top side, on 3 different plans oriented towards the curved counter-needle;
  - the curved needle, starting from the top, had a compaction on a length of 114 mm with a depth of 3 mm and a width of 5 mm, with burr on both sides of the needle and on the counter-needle was printed the trace of the burr, the surface of this compaction was dark colored in the middle and with metallic luster towards the outside;
  - in the switch lock, from the switch no. 3, was found the key 1+, that had been removed to carry the traffic;
  - the distance between the inner side of the curved counter-needle and the top of the right needle, in the opened position, was of 180 mm.
  - the locking box (the case) on the curved counter-needle (corresponding to the locking of the needle on the position with access at the direct line III) was found with the 2 horizontal screws tighten and the nuts were provided with "H" part and with bent split pin. The case did not show stroke on the counter-needle core;

- *regarding the derailed wagons in the composition of the train:*
  - the 5th wagon in the composition (wagon no. 88536656453-6 – the first derailed) had the coupling hook from the 4th wagon broken and was overturned on the right (in the running direction), being bounded by coupling to the 6th wagon;
  - the 6th wagon (wagon no. 88536656616-8) was placed cross to the direct line III axis, on the right in the running direction, beyond the structure gauge of the deviated line 4;
  - the 7th wagon (wagon no. 88536656640-8) was placed parallel to the 6th wagon;
  - the wagons the 8th (no. 88536656667-1), the 9th (no. 88536656783-6), the 10th (no. 88536656815-6), the 11th (no. 88536656682-0) and the 12th (no. 88536656517-8) in the composition of the train were derailed on the deviated line 4, being inclined to the vertical plane;
  - the 13th wagon (no. 88536656796-8) was on the deviated line 4 derailed by the first 3 axles.

B.2. Circumstances of the accident

B.2.1. Involved parties

The running section where the railway accident took place is managed by CNCF "CFR" SA - CF Timisoara Regional Brancj and is maintained by its employees.

The railway infrastructure and superstructure are managed by CNCF "CFR" S.A. and maintained

by the employees of Section L 8 Arad, District L 11 Chisineu Cris, CF Timisoara Regional Branch.

Installations signaling, centralization and blocking (SCB) from the railway station CFR Chisineu Cris are managed by CNCF "CFR" SA and maintained by the employees of Section CT 2 Arad District SCB 2 Santana, CF Timisoara Regional Branch.

The installation of railway communications on the locomotive is the property of the railway undertaking SC UNIFERTRANS SA Bucharest and is maintained by its employees.

The locomotive DA 003 that towed the freight train no. 50505 is the property of the railway undertaking SC UNIFERTRANS SA Bucharest.

The investigation commission questioned the employees involved in the running of the train and also the driving and serving staff of the towing locomotive of that train, the movement inspector and the switchmen from the railway station CFR Chisineu Cris, the driver and the driver assistant of the locomotive DA 003.

B.2.2. Forming and equipments of the train

The freight train no. 50505 was composed of 22 wagons, 88 axles, 1199 tons, length 311 m, automatically braked under the service book 870 tons, real 1092 tons, (plus 222 tons to the service book), hand braked under the service book 175 tons, real 210 tons (plus 32 tons to the service book).

The train was towed with the locomotive DA 003 – belonging to the railway undertaking SC UNIFERTRANS SA Bucharest, locomotive that was served by staff belonging to the same railway undertaking.

The automatic brake of the train was active, the safety and vigilance equipments (DSV), the equipment for the point control of the speed and hitchhiking (INDUSI) in the equipment of the locomotive that provided the traction were active and instructionally working, being sealed.

B.2.3. Railway equipments

Description of the rail path

The switches in the X end of the railway station CFR Chisineu Cris are placed in embankment cross section, in alignment and gradient (slope) of 6.5 ‰.

The derailment occurred on the switch no. 3, that has the following features: rail type 65, radius R=300 m, tangent tg 1:9, right deviation, with flexible needles type 49, wooden sleepers, indirect clamping type "K", equipped with top fixer with clips.

At the date of the railway accident occurrence the running speed in deviation over the area of the switches in the X end of the railway station CFR Chisineu Cris was of 30 km/h and in direct the established speed for the freight trains was of 70 km/h.

The prism of broken stone was complete, the fixing system of the metallic parts on the sleepers being complete and active.

For the passing of the freight train no. 50505 at the line no. III, the switch no. 3 was handled to the position "in direct", being attacked to the top.

Description of the rail superstructure

In the area of the derailment, the rail superstructure is built of rail type 65, wooden sleepers and indirect clamping type K.

Description of the safety installations to control the railway traffic

The railway station CFR Chisineu Cris is equipped with insurance installation with key lock and block type SBW.

The trains traffic on the running section Nadab – Ciumeghiu is performed under the telephone agreement system – free way.

B.2.4. Means of communication

The communication between the locomotive driver and the movement inspectors and between the locomotive driver and the train party was insured through radio-telephone installations.

B.2.5. Triggering the railway emergency plan

Immediately after the railway accident occurrence, triggering the intervention plan to remove the damages and restore trains traffic was performed according to the provisions of the Regulations for the investigation of the accidents and incidents, for the development and improvement of Romanian railway and subway safety, approved by Government Decision no. 117/2010, following which were present representatives of the public railway infrastructure manager (CNCF "CFR" SA), of the railway undertaking (SC UNIFERTRANS SA Bucharest) and of the Romanian Railway Authority - AFER.

To restore on the rails the derailed wagons was used the intervention train with crane EDK 125 from the railway station CFR Deva. The intervention train arrived in the railway station CFR Chisineu Cris on the 1st of April 2011, around 11:47a.m. and the last derailed wagon was restored on the rails on the 3rd of April 2011, at 4:10a.m.

B.3. Consequences of the accident

B.3.1. Deaths and injuries

None.

B.3.2. Material damages

The value of the material damages according to the estimates submitted by the owner of the rolling stock, of the means of intervention and the manager of the non-interoperable railway infrastructure and by the railway undertaking who handled the intervention means, is the following:

- **at the locomotive -** none;
- **at the environment** – none;
- **means of intervention:**
  - according to the estimate no. 21/3/3/1042/2001 of Timisoara Lines Division 47 559.89 lei
  - according to the estimate no. TS1/1053/2011 of CFR Simeria Depot 46 378.16 lei
- **other damages – train delays:**
  - according to the estimate no. 135/1/2011 of Arad Traffic Controller 502.80 lei

- **at the wagons:**
  - equivalent value of the 9 derailed wagons non-repairable according to the insurance policy OMNIASIG VIENNA INSURANCE GROUP series F no. 1857456 — 586 000.00 lei
- **unrecovered freight from the wagons:**
  - invoice UNICOM TRANZIT SA no. UTENG 18/21.04.2011 — 20 634.79 lei
- **equivalent value of the unrecovered freight transport:** — 12 345.48 lei
- **loading unrecovered freight in the wagons:**
  - invoice TRIO ARDECRIJ SRL no. TRIF 000660/29.04.2011 — 2 827.20 lei
- **at the line:**
  - according to the estimate no. 1217/27.04.2011 of Section L8 Arad — 112 695.53 lei
- **at the installations:**
  - according to the estimate no. 291/27.04.2011 of Section CT2 Arad — 161.32 lei

Total amount of the damages — **829 105.17 lei**

B.3.3. Consequences of the accident in railway traffic

Following the occurrence of this railway accident there were no major perturbations in railway traffic, the traffic being carried out on the line 2 of the railway station CFR Chisineu Cris.

B.4. External circumstances

On the 1st of April 2011, between 0:00a.m. - 2:00a.m. the visibility was good; the air temperature was about $+10^0$ C.

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

B.5. Investigation course

B.5.1. Summary of the involved staff statements

From the statements of the **movement inspector** on duty on the 31st of March/1st of April 2011, in the railway station CFR Chisineu Cris, one can retain the following:

- at the entry on duty, at the inspection of the installations in the railway station he found that these were working normally, the control seals were intact and complete, the lines in the railway station were free, with insured gauge, the inventory of the movements office was complete, inclusively the hand shoes and the staff on duty (the switchmen) was present at the assigned stations;
- the switch no. 3 was handled “on direct”, locked to this position, with the needle stuck to the counter-needle, with the lock beak down, without defects at needles, counter-needles and with the connection and traction bars sealed and without defects;
- since he works in this railway station he had no problems with the switch no. 3;
- the lock beak of the switch no. 3 on the position “on direct” did not show breaks or visible cracks, having a normal position;
- he did not find any indication that could lead to the conclusion that the beak of this lock was abnormally working;
- the inspection of the switch no. 3 was performed only visually, without handling this switch;
- during the traffic breaks the switchmen from the movements cabins did not go to the movements office;

- at the timetable submitted at 0:00a.m., the operator from the traffic controller ordered the running of the freight train no. 50505 with departure from the railway station CFR Utvinisu Nou at 1:00a.m. and passing through the railway station CFR Chisineu Cris;
- under these conditions he transmitted to the switch stations the order with the trains traffic between 0:00a.m. and 6:00a.m. where he mentioned also the train no. 50505 with passing through the railway station around 1:40a.m.;
- at 1:35a.m. he gave to the railway station CFR Nadab free way for the train no. 50505;
- around 1:40a.m. he gave to the switch stations the order to check the direct line III and the path of input-output for the passing of the train no. 50505, then he supervised the execution of this order;
- after he received from the switchmen in the switch stations the confirmation of execution of the checking of the path and of the direct line III he asked and obtained free way for the train no. 50505 from the flag station Zerind;
- at 1:50a.m. he received from the railway station CFR Nadab the passing approval for the train no. 50505 and under these conditions he gave to the switch stations verbal and in block order for the passing of this train;
- after he ensured that the output-input signals in the railway station were in position of "free" he communicated to the locomotive driver of the train no. 50505 that in this railway station he had passing path on the direct line III;
- after he received the confirmation from the driver of the train that he had received the communication he expected the ring signal from the switchman from the switch station placed in the X end of the railway station;
- after receiving the ring signal from the switch station no. 1, signal announcing that the train no. 50505 passed by the input signal, he gave acoustic signal to the railway station CFR Zerind through he was announcing that the train was going to pass through the station and then he went out from the movements office to supervise the train by scrolling;
- when the train was entering the railway station he saw sparks and flame in the composition of the train and he immediately gave stopping signals to the train with the flashlight in the equipment;
- the train braked by emergency, it passed by the movements office having in its composition only 4 wagons and stopped completely at about 30 meters from the movements office;
- then he entered in the movements office and he communicated to the train driver that he had after the locomotive only 4 wagons in composition and then he called the switch stations so that they report what had happened;
- the switchman from the switch station no. 1 told him there were derailed wagons from the train;
- after this communication he went out from the movements office and went together with the locomotive driver and the driver assistant towards the X end of the railway station;
- at the place of the derailment he found that were 8-9 derailed wagons and some of them were also overturned;
- after he ensured together with the switchman that the train was complete and signaled and that the railway level crossing from the X end of the railway station was not occupied with wagons he ordered the opening of the barrier for the road vehicles traffic;
- after he found there was no injury he communicated to the switchman to pay attention to the preservation of the evidences and of the freight in the wagons;
- he went then to the movements office where he announced about the occurrence of the accident the traffic controller, the station manager, the subunits SCB and of lines and also the TF police, then he waited to arrive the representatives of CF Timisoara Regional Branch and of the railway undertaking;
- after the derailment he noticed that the switch no. 3 was in the position "on deviation" with the curved needle stuck to the right counter-needle and the lock beak of the switch no. 3 on the position "direct" was pulled out from the lock together with its axis and fallen near the lock;
- at that moment he did not notice which was the position of the "swallow tail" and of the counterweight from the switch no. 3;
- he considers that a switch that was locked "on direct" can be handled to the position "on

deviation" only through a handling of the counterweight or through the damage of the traction or connection bars;
- he can't explain how occurred the signs of new impacts on the top of the right needle from the switch no. 3 found by the investigation commission.

From the statements of the **switchman** on duty on the 31st of March/1st of April 2011, in the railway station CFR Chisineu Cris at the switch station no. 1, one can retain the following:
- at the entry on duty, at the inspection of the installations SCB and TTR from his station he found that these were working normally;
- at the entry on duty, the switch no. 3 was handled "on direct";
- he did not perform operational tests with the switch no. 3;
- for the passing of the freight train no. 50505 the movement inspector asked him verbally to check the direct line III and the entry path for this train;
- he checked the direct line III by moving to the safety mark between the line III and 4 and by giving the appropriate signals with the flashlight in the equipment;
- checking the entry path for the train no. 50505, at the switch no. 3 he checked it to be locked, the right needle to be stuck to the curved counter-needle, not to be screws missing from the check rail, not to be breakings at the cross core or at the connection or traction bars;
- he did not handle the switch no. 3 at the entry on duty as provided in the regulations in force, because he did not see any defect, he saw that the right needle was stuck to the curved counter-needle and that the switch was appropriately locked;
- since the entry on duty and until the passing of the train no. 50505 he did not handle the switch no. 3;
- since the entry on duty and until the passing of the train no. 50505 he did not leave the switch station no. 1;
- the first person who came at his station was the movement inspector together with the train driver, then the regional inspector arrived and shortly thereafter the manager of the station CFR Chisineu Cris;
- checking the switches at the entry on duty he did not find anything special at the tops of the needles of these switches;
- supervising by scrolling the train no. 50505 he did not find anything special, but after the passing of 2-3 wagons he heard a "whizzing" and then a strong thud;
- he does not remember if the switchman who gave him over the duty mentioned something about the handling (checking) of the switch no. 3;
- immediately after the derailment occurrence he found that the switch no. 3 was handled and locked to "on deviation" towards the line 4, the curved needle was stuck to the right counter-needle and the lock beak of the switch no. 3 from the position "direct" was pulled out from the lock, but not completely out of the lock body;
- he was convinced that the switch was locked to the position "on direct" because the right needle was stuck to the curved counter-needle, the "swallow tail" was completely out of the slot and handling the switch lock it raised completely and allowed the removal from the lock of the resulting key L III;
- after the derailment occurrence the counterweight of the switch no. 3 was down to the right (towards the switch station no. 1);
- before the passing of the train no. 50505 the counterweight of the switch no. 3 was down to left (towards the railway station building);
- during the supervision of the train passing he remained next to the switch station no. 1, at a distance of about 15 meters from the counterweight of the switch no. 3, but during this supervision he did not notice or hear noises caused by the displacement of the counterweight of this switch;
- he considers that at the passing of a train over a switch locked to the position "on direct" it can't handle to the position "on deviation" and to lock to this position, too;
- he considers that a switch can change from a position to another one without being handled by a

switchman if some parts from the wagons in the composition of the train cling the detached needle. Under these conditions he considers that signs remain only on the concerned needle and the traction/connection bars are not damaged;
- he was theoretically and practically trained about the handling of the switches;
- he does not know which part from the wagons in trains could cling the detached needle of a switch, unlock it, handle it to the opposite position, then to lock it to this position;
- scrolling the first part of the train no. 50505 he did not notice parts of the locomotive or of the wagons to be uninsured;
- checking the entry path for the train no. 50505 and the raising of the lock beak of the switch no. 3 from the position "on direct" it was at about 1 mm to the right needle;
- the last time when he handled the switch no. 3 was on the 30th of March 2011 around 7:15a.m. when he found that it was easy to manipulate being necessary only one hit with the counterweight of the switch.

From the statements of the **switchman** on duty on the 31st of March/1st of April 2011, in the railway station CFR Chisineu Cris at the switch station no. 2, one can retain the following:
- at the entry on duty, at the inspection of the installations SCB and TTR from his station he found that these were working normally;
- for the passing of the freight train no. 50505 the movement inspector asked him verbally to check the direct line III and the exit path for this train;
- for these works he checked the position of the switch no. 2, checking if it was locked, he did the same operations also to the switch no. 4, he locked this switch then he checked the line III going to the safety mark where he gave the signal that the line was free with the flashlight in the equipment;
- after he received the same signals from the switchman in the opposite switch station he entered the cabin and introduced the resulting key from the switch no. 2 in the block and communicated to the movement inspector that exit path for the passing of the train no. 50505 was performed and then he expected the passing order to put the exit signal on free;
- checking this path he did not notice strangers in his area of activity;
- at the entry of the train no. 50505 in the railway station he notices lights by the switch station no. 1 and then strong noises;
- since the entry on duty and until the occurrence of the accident he did not go to the movement office;
- when was on duty at the switch station no. 1 he did not have problems with the switch no. 3;
- at the passing of the freight train no. 50502 from the direction Zerind he did not notice anything special that could affect the lines or the installations in the railway station;
- after the passing of the train no. 50502 he did not hear and did not notice his colleague, the switchman from the switch station no. 1 to move to the movements office;
- he considers that a switch locked to the position "on direct "can not change to the position "on deviation "without being handled by the switchman or without a damage at the switch needles or at the traction/connection bars;
- he does not explain how a switch locked to the position "on direct" to be found locked on the opposite position after the passing of a train and without a damage of the switch needles or of the traction/connection bars;
- he does not know cases when a switch locked to the position "on direct" can be found locked on the opposite position after the passing of a train and without damage of the switch needles or traction/connection bars and he does not believe it possible;
- he considers that, if the switch is not locked and the needle is not perfectly stuck, it's possible that it changes on the opposite position after the passing of a train over it and without damage of the switch needles or of the traction/connection bars.

From the statements of the **locomotive driver** who drove the train no. 50505 on the 1st of April 2011, one can retain the following:

- in the railway station CFR Chisineu Cris he had passing path on the direct line III with signals on free, which was communicated to him through the radio-telephone station by the movement inspector of the railway station;
- after passing with the locomotive by the switch station no. 1 he felt a hard jolt in the train and he noticed that the air pressure in the general pipe of the train drops suddenly;
- under these circumstances he performed an emergency braking and he stopped the train near the movements office;
- he went down from the locomotive and he noticed he had only 4 wagons after the locomotive;
- then he met the movements inspector and he went together with him towards the switches station no. 1 where he saw that 9 wagons from the train were derailed and overturned;
- the running speed of the train at the moment of the derailment occurrence was of about 45-50 km/h.

From the statements of the **driver assistant** who served the towing locomotive of the train no. 50505 on the 1st of April 2011, one can retain the following:
- he served the towing locomotive of the train no. 50505 on the 1st of April 2011 on the distance Utvinisu Nou – Episcopia Bihor;
- in the railway station CFR Chisineu Cris he had passing path on the direct line III with signals on free, which was communicated to him through the radio-telephone station by the movement inspector of the railway station;
- after passing with the locomotive by the switch station no. 1 he felt a hard jolt in the train, he noticed that the air pressure in the general pipe of the train drops suddenly, then the train stopped by emergency near the movements office;
- he went down from the locomotive and he noticed he had only 4 wagons after the locomotive;
- he met the movements inspector and he went together with him and with the locomotive driver towards the switches station no. 1 where he saw that 9 wagons from the train were derailed and overturned;
- the running speed of the train at the moment of the derailment occurrence was of about 45-50 km/h.

B.5.2. Safety management system

At the moment of the railway accident occurrence, CNCF "CFR" SA as manager of the railway infrastructure had implemented its own railway safety management system, according to the provisions of the Directive 2004/49/CE regarding the safety on the community railways, of the Law no. 55/2006 regarding the railway safety and of the Order of the Minister of Transport no.101/2008 on granting the security authorization to the administrator / management of railway infrastructure in Romania, being in possession of:
- Safety Authorization – Part A with the identification no. ASA09002 delivered on the 21st of December 2009 – through which the Romanian Railway Safety Authority from AFER confirms the acceptance of the safety management system of railway infrastructure manager;
- Safety Authorization - with the identification no. ASB9007 delivered on the 21st of December 2009 – through which the Romanian Railway Safety Authority from AFER confirmed the acceptance of the provisions adopted by the railway infrastructure manager to meet specific requirements necessary to ensure safety of rail infrastructure, in the design, maintenance and operation, including where appropriate, maintenance and operation of traffic control and signaling system.

At the moment of the railway accident occurrence, SC UNIFERTRANS SA Bucharest as railway undertaking had implemented its own railway safety management system, according to the provisions of the Directive 2004/49/CE regarding the safety on the community railways, of the Law no. 55/2006 regarding the railway safety and of the Order of the Minister of Transport no. 535/2007 on granting the security authorization to perform railway transport services on Romanian railways,

being in possession of the following documents regarding its own railway safety management system:

- Safety Certificate – Part A with the identification no. CSA 0016 delivered on the 21st of April 2010 – through which the Romanian Railway Safety Authority from AFER confirms the acceptance of the safety management system of the railway undertaking
- Safety Certificate – Part B with the identification no. CSB 0053 delivered on the 21st of March 2011 – through which the Romanian Railway Safety Authority from AFER confirms the acceptance of the provisions adopted by the railway undertaking to meet specific requirements necessary the safe operation on the relevant network in accordance with the Directive 2004/49/CE and with the applicable national legislation.

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

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

- Railway Technical Operations Regulations no. 002/2001
- Instructions on technical inspection and maintenance for wagons in operation no. 250/2005;
- Instruction for setting terms and order for the rail inspections no. 305 approved by OMT no. 71 on the 17th of February 1997;
- Instruction for the lineman head of district for the rail maintenance no. 323/1965;
- Instruction for the activity of the foreman for the maintenance of the line no. 322/1972;
- Instruction for the flagmen and rail or dangerous points inspectors no. 321/1972;
- Instruction of standards and tolerances for the construction and maintenance of the rail - standard gauge lines no. 314/1989;
- Instruction for the use of rail measuring wagons no. 329/1995;
- Description of the installations signaling, centralization and blocking used at CFR by Marius Maris, 1949 edition;
- Instruction for handling the SBW installation – Station Chisineu Cris.

sources and references:

- photos taken immediately after the railway accident by the members of the investigation commission;
- results of measurements and tests made immediately after the railway accident occurrence at the rail superstructure, at the railway installations and at the derailed wagons;
- inspection and interpretation of the technical condition of the elements involved in the accident: infrastructure, rail facilities and railway vehicles;
- measurements and inspections performed at the elements of the switch no. 3 (top fixer, lock on the curved counter-needle) in the railway station CFR Chisineu Cris on the 3rd of May 2011;
- measurements performed at the axles from the wagons involved in the railway accident at SC UNIFERTRANS SA Bucharest – The working point Fetesti;
- measurements and inspections performed at the first 4 wagons (non-derailed) in the composition of the train no. 50505/01.04.2011, measurements that were performed at the railway station CFR Plopsoru;
- documents on the lines maintenance provided by the responsible with their maintenance;
- documents on the railway installations maintenance provided by the responsible with their maintenance;
- questioning of the staff involved in the accident;
- copies of documents submitted as annexes to the investigation file.

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

B.5.4.1. Data found on the line

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

The lines and the rail devices in the area of the railway accident occurrence are built of rail type 65, wooden sleepers, indirect clamping type K, path with joints, embankment transverse profile.

The switches in the X end of the railway station CFR Chisineu Cris are placed in alignment and gradient (slope) of 6.5 ‰.

The switch no. 3 on which occurred the derailment has the following features: rail type 65, radius R=300 m, tangent tg 1:9, right deviation, with flexible needles type 49, wooden sleepers, indirect clamping type. The switch is equipped with top fixer with clips, made in 1987, released into path in 1988.

The fixing elements of the rails and of the metallic parts of the switches on the sleepers were active, providing their fixing.

The prism of broken stone was complete, the fixing system of the metallic parts on the sleepers being complete and active.

Before the occurrence of this railway accident, the last biannual works of checking the hidden parts at the switch no. 3 were performed on the 29th of September 2010.

The next work of checking the hidden parts at this switch was going to be performed on the 6th of May 2011.

The last monthly control of the technical condition of the switches, of the lines and of the traffic safety installations in the railway station CFR Chisineu Cris, performed before the occurrence of the railway accident, in commission composed of the station manager together with the heads of the subunits of lines and installations maintenance, was on the 15th of March 2011. At this control were not found defects at the switches, lines and traffic safety installations in the railway station.

Findings and measurements performed at the line, after the occurrence of the derailment

The first signs of abnormal rolling of the wheels of the wagons in the composition of the train were found at a distance of 6 m from the needle top of the switch no. 3, where the curved counter-needle (wire on the right) were found 4 signs of falling inside the path (between the sleepers no. 11 and no. 13 numbered from the top of the switch). Also, at a distance of 11m from the top of the needle, on the right counter-needle (wire on the left) were found 4 signs of falling inside the path (between the sleepers no. 39 and no. 21).

From the place of the first signs of abnormal rolling of the wheels of the wagons in the composition of the train (km 47+182) and to the stopping point of the first derailed and overturned wagon (the 5th in the composition) – km 47+260, the train ran a distance of about 76 m. The first part of the train (the locomotive and the first 4 wagons in the composition) stopped with the last wagon at the km 47+457.

All the joints from the switch no. 3 were found sealed and with intact leads.

On the surface of the connection bar and of the traction one from the switch no. 3 were not found signs of impact or deformation.

The top of the right needle had fresh signs of impact on a length of 39 mm at the top side, on 3

different plan oriented towards the curved counter-needle.

The curved needle, starting from the top had a compaction on a length of 114 mm with a depth of 3 mm and a width of 5 mm, with burr on both sides of the needle and on the counter-needle was marked the sign of the burr, the surface of this compaction was dark colored in the middle and with metallic luster towards the outside.

The distance between the inner side of the curved counter-needle and the top of the right needle, in its opened position, was of 180 mm.

The case corresponding to the needle lock on the position with access at the direct line III was found with the 2 horizontal screws tighten and the nuts were insured with the H part and bent splint. Also, the case did not show stroke on the counter-needle core.

On the fixing elements of the checkrail corresponding to the right counter-needle from the crossing core of the switch no. 3 were noticed signs of strong impact, came from the contact in the bottom of the axle box corresponding to the wheel on the left of the third axle in the running direction of the train from the wagon no. 88536656453-6.

Measurements of the gauge and of the cross level were performed in the characteristic points of the switch no. 3. The measured values on the area not affected by the wagons derailment were within the tolerances admitted by the Instruction of standards and tolerances for the construction and maintenance of the rail - standard gauge lines no. 314/1989.

On the 2nd of April 2011 were performed the following simulation of half-opening of the switch no. 3, by producing vibrations, after the grinding of the burr of 39 mm from the top of the right needle (occurred during the derailment), performed under the following circumstances:

- needle stuck to the counter-needle, locked, with the lock beak up and the counterweight in appropriate position — the half-opening of the needle did not occur;
- needle stuck to the counter-needle, unlocked, with the lock beak up and the counterweight in

appropriate position — the half-opening of the needle did not occur;
- needle stuck to the counter-needle, unlocked, with the lock beak up and the counterweight in almost vertical position — the half-opening of the needle did not occur;
- needle stuck to the counter-needle, unlocked, with the lock beak down and the counterweight in appropriate position — the half-opening of the needle did not occur;
- needle stuck to the counter-needle, unlocked, with the lock beak down and the counterweight in almost vertical position – the half-opening of the needle occurred with a distance between the needle and the counter-needle of 52 mm between the right needle and the curved counter-needle, respectively 68 mm between the curved needle and the right counter-needle;
- with the right needle stuck to the curved counter-needle and the switch unlocked, the lock beak could raise and so the key went out from the lock;
- the joints of the handling bar of the top fixator with clips did not show strokes.

The simulation of the vibrations was made by successive collisions with a lever of the clamping plate of the sliding on the sleeper no. 3 corresponding to the right needle.

Findings and measurements performed at the switch no. 3 on the 3rd of May 2011

There were repeated the 5 simulations performed on the 2nd of April 2011 on the possibilities of half-opening of the switch no. 3 by using induced vibrations in the path by the stuffing machine BNRI 4694 belonging to L 3 Timisoara, having the operation group of the stuffing hammers turned on and up. In all the 5 cases the switch did not unlock.

At the last test performed, respectively needle stuck to the counter-needle, unlocked, with the lock beak down and the counter width in approximately vertical position, were simulated vibrations by kicking with a pole the sliding on the sleeper no. 3. While performing this test a displacement of 22 mm occurred towards the axis of the path of the right needle by the curved counter-needle simultaneously with a displacement of 90 mm of the curved needle towards the right counter-needle.

There was dismantled the top fixer with clips (the locking boxes, the clips and the operation bar) with the identification number 296.

After cleaning the component parts of the top fixer, was performed the dimensional check of the rates in direct connection with the locking (the operation bar, the fixing clips and the locking box). The values of the measured rates did not highlight wears to influence negatively the switch locking.

In the path was mounted a new top fixer. After adjustments, the simulations since the 2nd of April 2011 were repeated, the results being the same with those of the mentioned date.

Additionally was performed a simulation which consisted of handling and locking the switch in the position on direct, bringing the counterweight in an approximately vertical position (with tendency to unlock), then were simulated vibrations by kicking with the pole the fixing plate of the sliding on the sleeper no. 3. Under these conditions was found the unlock of the switch and the detachment of the needle from the counter-needle with 22 mm.

B.5.4.2. Data found on the installations

The railway station CFR Chisineu Cris is equipped with insurance installation with keyed locks and block type SBW.

At the inspection performed immediately after the railway accident occurrence were found the following:

- *in the movement office:*
  - the control device was completely sealed with seals CT;
  - lever to ensure the paths in the direction Nadab at the line III inclined towards "entry", the unlocking field of the paths from and to Nadab of white color;
  - lever to ensure the paths in the direction Zerind at the line III inclined towards "exit"; the unlocking field of the paths from and to Zerind of white color;
- *in the switches station no. 1:*
  - the shunting device was completely sealed with seals CT;
  - the lever to ensure the paths inclined towards "entry";
  - the lever to close the barrier on the position "opened";
  - in the locks of the shunting device were the keys: switch 7+, shoe M1P, path key from line III;
  - the field to ensure the paths from Nadab of white color;
  - the lights levers of entry A1/2 and exit B in the position "stop";
- *at the switches from the switches station no. 1:*
  - the locks from the switch no. 1 were intact and sealed with seals CT. The lock corresponding to the key 1+ locked with the beak up. The lock corresponding to the key 1- unlocked and with the beak down;
  - the locks from the switch no. 3 were intact and sealed with seals CT;
  - the lock corresponding to the key 3- intact and with seals CT. In the lock was blocked the key L4 and with the beak down;
  - the beak together with the lock axis corresponding to the key 3+ from the direct position was pulled out from the lock body and was hanging between the sleepers 2 and 3 numbered from the top joint.

In the switch lock was found the key 1+ that got up for the traffic performance.

Before the occurrence of this railway accident the last revision work of the locks from the switch no. 3 was performed on the 29th of March 2011.

The last handling of the switch no. 3 from the position "on direct" to the position "on deviation" was performed on the 30th of March 2011, around 7:15a.m. for passing on the line 4 of the train no. 732-1.

Findings at the lock on the curved counter-needle (3 +) on the 3rd of May 2011

The lock on the curved counter-needle (3 +) was dismantled, its subassemblies were dismantled and viewed. At the component subassemblies were not found nonconformities.

Also was checked the beak, the axis and the sleeve in the lock on the date of the railway accident occurrence – 1st of April 2011. With this occasion was found that the axis of the lock had pronounced wears of the thread, especially in the area opposite to the lock beak (from the total of 30, a number of 11 threads were worn and 7 were deformed).

B.5.4.3. Data found on the work of the rolling stock and of its technical installations

Findings at the wagons in the composition of the train

The freight train no. 50505 was composed of 22 wagons type Fals, wagons loaded with coal.

According to the documents accompanying the train (the forms "Description of the wagons" and "Brake note"), the automatic brakes of the wagons in the train were active excepting the wagon no. 88536656667-1 placed the 8th by the locomotive in the composition of the train.

Findings on the 2nd of the April 2011 at the axles of the derailed wagons

On the 2nd of April 2011 were performed measurements and checkings at 16 axles mounted, came from the wagons no. 88536656453-6 (the 5th by locomotive, in the running direction, the first derailed), 88536656616-8 (the 6th by locomotive, in the running direction, the second derailed), 88536656640-8 (the 7th by locomotive, in the running direction, the third derailed), 88536656667-1 (the 8th by locomotive, in the running direction, the fourth derailed), respectively:

$\hat{I}_b$ – the height of the bandage rim,
G_b – the thick of the bandage rim,
q_r – rate qr,
D_{fi} – the distance between the inner sides of the wheels,
D_{fe} – the distance between the outer sides of the wheels.

At the checks with the pattern performed at the bandage rim rates (height bandage rim, thick bandage rim, rate q_r) was found that these geometric elements were within the limits admitted by the Instructions no. 250/2005.

At the axles with no. 3528656, 3522262 and 3438427 the difference between the measured rates between the inner sides of the bandages rims, measured in three points placed at 120^0, are higher than 2 mm and are not within the limits admitted by the Instructions no. 250/2005, because after the derailment, they had major deformations. This is not a cause of the derailment, but a consequence of it.

After the derailment of the wagon no. 88536656453-6, at the axle no. 377658 (the third in the running direction), on the inner surface of the axle box, left side, in the running direction, were noticed signs of impact, came from the contact with the clamping elements of the check rail from the cross core of the switch no. 3. We mention that from the place of the derailment to the concerned check rail are 15 m and this impact occurred after the derailment of the wagon.

Findings on the 27th of April 2011 at SC UNIFERTRANS SA – Work point Fetesti at the axles of the derailed wagons

On the 22nd of April 2011 were performed measurements and checks at 35 of the 36 mounted axles came from the 9 wagons involved in the railway accident, occasion with which were measured the geometric elements of the wheels from these wagons, respectively:

$\hat{I}_b$ – the height of the bandage rim,
G_b – the thick of the bandage rim,
q_r – rate qr,
D_{fi} – the distance between the inner sides of the wheels,
D_{fe} – the distance between the outer sides of the wheels.

After the measurements was found that the geometric elements (height of the bandage rim, thick of the bandage rim, rate q_r) of the wheels from all the 35 axles were within the limits admitted by the Instructions no. 250/2005.

In the case of 4 mounted axles from the 36 measured could not be identified the wagons at which were mounted.

Findings at the wagons that did not derail

On the 2nd of April 2011 the 13 wagons that did not derail in the composition of the train no. 50505 were weighed on the electronic scales of SC ELECTROCENTRALE ORADEA SA, occasion with which was found that two of these wagons, respectively the wagon no. 88536656699-4 (the first by locomotive) and the wagon no. 88536656816-4 (the last wagon in the train) had the load on axle exceeded with 350 kg/axle and respectively with 150 kg/axle.

On the 19th of May 2011 in the railway station CFR Plopsoru were performed measurements and checks at the 4 wagons (not derailed) that ran in the composition of the train no. 50505 on the 1st of April 2011, respectively:

$\hat{I}_b$ – the height of the bandage rim,
G_b – the thick of the bandage rim,
q_r – rate qr,

D_{fi} – the distance between the inner sides of the wheels,
$\mathbf{J_{pf}}$ – the stroke amounted between the friction stones on both sides of the bogie.

After the measurement was found that the geometric elements of the wheels (height of the bandage rim, thick of the bandage rim, rate q_r) and the stroke amounted between the friction stones on both sides of the bogie were within the limits admitted by the Instructions no. 250/2005.

Findings at the towing locomotive of the train (DA 003)

The locomotive DA 003 had the last current repair type RT on the 1st of March 2011, at SC CFR SCRL Brasov SA – Repairs Section Arad.

On the 2nd of April 2011, the locomotive DA 003 was checked in the locomotives depot Arad, occasion with which were found the following:
- the locomotive did not have missing or dismantled parts at the bottom side;
- the locomotive did not have parts to exceed the locomotive gauge;
- the bandages were in proper condition, without flats;
- the values of the geometric elements of the wheels bandages were within the limits admitted by the Railway Technical Operation Regulations no. 002/2001.

On the 1st of April 2011, in the locomotives depot Arad was performed the reading and interpretation of the IVMS installation records of the locomotive DA 003, occasion with which were found the following:
- on the distance Nadab – Chisineu Cris the train ran with speeds within 65 and 55 km/h;
- at the entry in the railway station CFR Chisineu Cris, at the moment of the derailment occurrence the train speed was of 55 km/h;

B.5.5. Observations regarding the regulations specific to the running of the trains and to the shunting of the railway vehicles

In the Regulations for the running of the trains and the shunting of the railway vehicles no. 005/2005, at the part III "The running of the trains", chapter I, section 7 "Commands and provisions regarding the running of the trains and the shunting performance", art. 139, paragraph (1), letter b is provided that "in the railway stations with switches provided with key locks with blocks, the switchman withdraws and stops the shunting, handles the switches from the ordered path and those of backup, *locks and reviews these switches*, no mather if he handles them or not, raises the path key and checks if the line and the path of entry/exit are free". Also in the part I "General Provisions", chapter II, section 7 "Switches review", art. 30, paragraph (2) it is mentioned that "The review of the switches in a path and of the switches and derailment shoes that cover a path, consists of visual checking of the following: a) if the switches and the derailment shoes were handled in appropriate position for the path and if for each switch the needle is stuck to the counter-needle and *the switch is ensured*; ....", without clear specification if it is necessary to be checked the locking condition of the switch.

The term of "insured switch" is ambiguous, given that, in the same regulation, at part II "The performance of shunting and the composition of the trains", chapter I, section 5 "Handling of the switches and of the derailment shoes at shunting", art. 63, paragraph (3) is provided more clearly that "The non-centralized switches attacked to the top, that enter into the shunting path, are checked on spot by the agent who has the task of handling them to convince that the top of the needle is stuck to the counter-needle, that *it is locked and the counterweight performed the complete stroke*....".

In conclusion, the specific regulation regarding the running of the trains and the shunting of the railway vehicles, respectively the Regulations for the running of the trains and the shunting of the railway vehicles no. 005/2005 has ambiguous formulations regarding the checking of the condition of the switches provided with key locks with block, using two different terms to define the same condition of a switch ("insured switch" and "locked switch"), but this has nothing to do with the causes of this railway accident occurrence.

B.6. Analysis and conclusions

B.6.1. Conclusions on the technical condition of the switch no. 3

From the findings performed immediately after the occurrence of the accident, from the handling tests and from the measurements and checks performed at the switch no. 3, one could conclude the following:

- this type of installation allows to obtain the position control of the switch by sticking the needle to the counter-needle, moving up the lock beak and removing the key from the lock for the situation when the switch is locked and also for the situation when it is not locked;
- the rates values measured at the elements of the top fixer with clips from this switch did not highlight wears to influence negatively its locking;
- the technical condition of the switch subassemblies (needles, counter-needles, top fixer with clips, action bar, connection bar, clamping elements, sleepers, fixing system of the metallic parts on the sleepers, etc) was proper, appropriate for the maximum admitted running speed on the area of this switch;
- the technical condition of the beak and of the axis from the lock on the curved counter-needle (3+) of this switch (pronounced wears of the thread on the side towards the lock sleeve) and also the position in which these were found lead to the conclusion that, during the period between the last handling of the switch and the accident occurrence, this subassembly was permanently subjected to progressive forces strong enough to seriously deform the axis thread (the 7 deformed threads) and, finally, pull it out from the lock. Also, these forces were not as strong as in the shocks produced by the side forces transmitted to the needle not stuck to the wheels of a railway vehicle in the case of attacking in false a locked switch (couponing), case when, according to the projection principles of such lock (mentioned in the work "Description of the installations signaling, centralizing and blocking used at CFR" by Marius Maris, edition 1949), there should have break the beak, the pin or its sleeve;
- this leads to the conclusion that, at the last handling of the switch no. 3, its switch was not locked (the end of the fixing clip – dovetail shaped – had to get out of the slot on the operating bar of the top fixer and to support with one of the sides to the oblique shoulder of the locking case and with the other side on the full side of the bar. This meant that, during the trains traffic over this switch, the vibrations induced by the running of the vehicles in the composition of the trains, produce the displacement of the fixing clips together with the right needle and the operating bar of the top fixer in the locking case of the switch;
- from this displacement, after the stroke of locking (60 mm) the right needle started to hit the lock beak on the curved counter-needle (3+), lock that, under these circumstances, additional to its role of controlling the position of the right needle took temporary also the role of keeping the right needle stuck to the curved counter-needle;
- under these circumstances, as the lock is not designed to resist at these forces, the axis thread of the lock on the curved counter-needle started to sag, which led to the displacement of the axis towards inside the path, which increased the force of the hits transmitted by the right needle to the lock beak and, finally, led to the pulling out of the axis from the lock.

B.6.2. Conclusions on the technical condition of the wagons in the composition of the train

After the measurements performed at the derailed wagons and at the first 4 wagons in the

composition of the train no. 50505 (wagons not derailed) was found that the geometric elements (height bandage rim, thick bandage rim, rate q_r) of the wheels of all these wagons were within the limits admitted by the Instructions no. 250/2005.

As at the switch on which occurred the derailment were not find signs of hit or deformations of the top fixer elements by the parts or subassemblies of the wagons in the composition of the train no. 50505 and also, were not find signs of escalation of the wheels on the needles or the counter-needles of the switch it can be concluded that the technical condition of the wagons in the composition of the train could not led to or favors the derailment of the 9 wagons.

B.6.3. Analysis and conclusions on the train derailment occurrence

From the analysis of the findings performed at the place of the railway accident, the technical condition of the wagons in the composition of the train, the photos taken at the place of the derailment, the tests and the inspections performed and also from the involved employees statements it can be concluded that the dynamic of this derailment occurrence was the following:

- at the last handling of the switch no. 3 its switch was not locked, which led to that, during the trains running over this switch, the vibrations induced by the running of the vehicles in their composition to produce the displacement of the fixing clips together with the right needle and with the auctioning bar of the top fixer in the locking case of the switch;
- during the time passed since the last handling of the switch and to the accident occurrence, the beak and the axis from the lock on the curved counter-needle (3+) was permanently submitted to continuous forces strong enough to seriously deform the axis thread and finally to pull it out from the lock. Also, these forces were not as strong as in the case of the shocks produced by the side forces transmitted to the needle not stuck to the wheels of a railway vehicle in the case of attacking in false of a locked switch (couponing), case in which the beak, the pin or its sleeve should have broken;
- at the inspection of the entry path for the train no. 50505, the switchman on duty at the switches station no. 1 from the railway station CFR Chisineu Cris reviewed and locked the switch no. 3;
- as the switch no. 3 was not locked, so that the end of the fixing clips (dovetail shaped) was not on the slot on the operating bar of the top fixer to support with one of the sides to the oblique shoulder of the locking box (case) and with the other side on the full side of the bar (the locking surface), at the passing of the train no. 50505, the fixing clips was displaced together with the right needle and, after the stroke of locking, the right needle started to hit the lock beak on the curved counter-needle, lock that, under these circumstances, additional to its role of controlling the position of the right needle took temporary also the role of keeping the right needle stuck to the curved counter-needle;
- further, as the lock is not designed to resist at these forces, the axis thread of the lock on the curved counter-needle started to sag, which led to the displacement of the axis towards inside the path, which increased the force of the hits transmitted by the right needle to the lock beak and, finally, led to the pulling out of the axis from the lock;
- so, after the locomotive and the first 4 wagons in the composition of the train no. 50505 passed over the area of the switch needles, the top of the right needle of the switch moved enough from the curved counter-needle (getting out from under the counter-needle), so that the wheels on the right in the running direction from the second bogie of the wagon no. 88536656453-6 (the 5^{th} in the composition of the train), together with the wheels on the same right side from the first bogie of the wagon no. 88536656616-8 (the 6^{th} in the composition of the train) to hit in the top side top the right needle top then to come between the needle and the counter-needle;
- from the penetration of these wheels between the right needle and the curved counter-needle these 4 axles rolled with the wheels on the left in the running direction on the right counter-needle and with the one on the right on the curved counter-needle;
- the four axles rolled like this to the place where the gauge between the 2 counter-needles exceeded the distance between the inner sides of the wheels on the left and the outer sides of the

wheels on the right (place located at about 6 m from the top of the needle), moment when the 4 wheels placed on the right in the running direction fell inside the path (between the sleepers no. 11 and no. 13 numbered from the top of the switch);
- the 4 axles rolled further with the wheels on the left on the right counter-needle and with these on the right between the right needle and the curved counter-needle to about 11 m from the top of the needle, moment when the wheels on the left also fall from the right counter-needle;
- the 4 axles roll further derailed, hitting the metallic clamping elements of the rail and also the clamping elements of the checkrail from the crossing core of the switch no. 3;
- after the half opening of the switch and the shocks produced by the fall of the wheels on the right between the right needle and the curved counter-needle, the switch needles perform the entire shunting stroke (100 mm) and the curved needle is stuck to the curved counter-needle;
- under these circumstances, the axles of the wagons on the positions 6 – 15 in the composition of the train that followed the 4 derailed axles rolled on the curved needle and the curved counter-needle going to the deviated direction of the switch towards the line 4 of the railway station;
- as consequence of rolling under these circumstances, as the force transmitted by the connecting device between the wagon 4 and the wagon 5 was on the direction of the direct line III and the wagons placed on the positions 6 – 15 in the composition of the train were rolling on the direction of the line 4, occurred the derailment by all the axles of the wagons placed in the positions 6 – 12 and also the derailment by the first 3 axles of the 13th wagon in the train;
- under these circumstances the resistance force occurred as a result of the rolling in derailed condition of the 9 wagons led to the breaking of the traction hook from this 5th wagon in the composition and the decoupling of the air half couplings between the wagons 4 and 5;
- after the decoupling of the air half couplings occurred the quick emptying of the general air pipe and by default the emergency braking of the train.

B.7. Causes of the accident

B.7.1. Direct cause

The direct cause of this accident occurrence is the rolling of the axles from the 2nd bogie of the wagon no. 88536656453-6 (the fifth in the composition of the train) together with the axles of the first bogie from the wagon no. 88536656616-8 (the sixth in the composition of the train), with the wheels on the left in the running direction on the right counter-needle of the switch no. 3 and with those on the right on the curved counter-needle of the same switch, followed by the fall of the wheels on the right between the right counter-needle and the curved needle, at about 11 m from the top of the needles.
This was possible given that, when passing the train no. 50505 over the switch no. 3, its switch half-opened, because it was not locked.

Contributing factors to the half-opening of the switch no. 3:
- the incorrect position of the clips end of the switch no. 3 – when passing the 5th wagon in the composition of the train it was in the slot on the operating bar of the top fixator;
- the vibrations transmitted by the component parts of the switch no. 1 to the component parts of the switch no. 3 under the conditions of the rolling stock operation over these switches, corroborated with the fact that the distance between the end of the core check-rail of the switch no. 1 and the needles top of the switch no. 3 was about 1m, between the two switches there was no intermediate panel to mitigate these vibrations (the last joint of the switch no. 1 is top joint for the switch no. 3);
- the stripper tendency of the top of the flexible right needle when passing the rolling stock over the beam area, due to the guidance forces generated by the operating rolling stock.

B.7.2. Underlying causes

None.

B.7.3. Root causes

None.

C. Safety recommendations

The safety recommendations are addressed to the Romanian Railway Safety Authority as an independent body designed to monitor, promote and harmonize the regulatory framework for railway safety, including the national railway safety rules.

The safety recommendations aim to solve the next issues:

1. Identify and implement a technical solution through which at the insurance installation with key locks to control the position of the switches, the lock of the switch and the remove of the key from the lock to be made only after blocking the switch.
2. Identify and implement a technical solution through which to be removed the detachment tendency of the top of the flexible needles of the switches with top fixer with clips from the stations equipped with insurance installations with key locks to control the position of the switches.
3. Eliminate the ambiguity in the regulations on checking the condition of the switches insured with key locks or without block, created by using two different expressions used to define the same condition of a switch, respectively “insured switch” and “locked switch”.

This investigation report will be sent to Romanian Railway Safety Authority, to the public railway infrastructure manager CNCF “CFR” SA and to the freight railway undertaking SC UNIFERTRANS SA Bucharest.

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