



MINISTRY OF TRANSPORTS AND INFRASTRUCTURE  
ROMANIAN RAILWAY AUTHORITY - AFER

ROMANIAN RAILWAY INVESTIGATING BODY



## INVESTIGATION REPORT

of the serious railway accident that occurred on May 10, 2008 to Valea  
Călugărească



Final edition  
May 08 2009

The Romanian Railway Investigating Body performed an investigation action according to the provisions of Law no. 55/2006 on the railway safety as regards the serious railway accident that took place on May 10, 2009 to Valea Calugareasca.

By the investigation action performed were collected and analyzed the information related to the railway accident occurrence, were established the conditions and the causes were determined.

The action of the Romanian Railway Investigating Body didn't had as purpose to establish the guilt or the responsibility.

The Romanian Railway Investigating Body considers that is necessary to be taken into consideration a series of corrective measures in order to improve the railway safety and to prevent the railway events and therefore has issued in the present report a series of safety recommendations.

Bucharest, May 8, 2009

DIRECTOR  
Dragos FLOROIU

<b>I.</b>	<b>Preamble</b>	5
I.1.	Introduction	5
I.2.	The investigating process	5
<b>A.</b>	<b>The railway accident summary</b>	6
<b>A.1.</b>	<b>Short description</b>	6
<b>A.2.</b>	<b>Direct cause, facts that contributed and primary causes</b>	6
A.2.1.	Direct cause	6
A.2.2.	Facts that contributed	6
A.2.3.	Primary causes	7
<b>A.3.</b>	<b>Serious level of the railway accident</b>	7
<b>A.4.</b>	<b>Safety recommendations</b>	7
<b>B.</b>	<b>Investigating report</b>	9
<b>B.1.</b>	<b>The serious railway accident description</b>	9
<b>B.2.</b>	<b>The circumstances of the serious railway accident</b>	10
B.2.1.	The parties involved	10
B.2.2.	The composition and the equipments of the train	11
B.2.3.	The railway equipments	11
B.2.4.	Communication means	12
B.2.5.	Launching the railway emergency plan	12
<b>B.3.</b>	<b>The consequences of the serious railway accident</b>	12
B.3.1.	Fatality and injured people	12
B.3.2.	Material damages	12
B.3.3.	The consequences of the serious railway accident in the railway traffic	13
<b>B.4.</b>	<b>External circumstances</b>	13

<b>B.5.</b>	<b>The investigation performance</b>	14
B.5.1.	The summary of the testimonies of the involved personnel	14
B.5.2.	The safety management system	18
B.5.3.	Norms and regulations. Sources and references for the investigating	18
B.5.4.	The functioning of the technical installations, of the infrastructure and of the rolling stock	19
B.5.4.1.	Data found on the installations	19
B.5.4.2.	Data found out on the tracks	21
B.5.4.3.	Data registered during the operation of the rolling stock and of its technical devices	25
<b>B.6.</b>	<b>Analysis and conclusions</b>	25
<b>B.6.1.</b>	<b>The passing way of the train on the switch</b>	25
<b>B.6.2.</b>	<b>Cause of the lock box detachment from the switch</b>	32
<b>B.6.3.</b>	<b>Cause of the switch half – opening continuance</b>	33
<b>B.6.4.</b>	<b>Cause of getting the control of the operated switch in the conditions of its half-opening</b>	33
B.6.4.1.	Inspection performed to Valea Călugărească	34
B.6.4.2.	Inspection performed to Chiajna	35
B.6.4.3.	Inspection performed to Giurgiu Nord	36
<b>B.6.5.</b>	<b>Cause that lead to the train move order</b>	37
<b>B.6.6.</b>	<b>Remarks concerning the professional training of the employees involved in the subsystems maintenance.</b>	38
<b>B.7.</b>	<b>The causes of the railway event</b>	38
B.7.1.	Direct cause	38
B.7.2.	Facts that contributed	39
B.7.3.	The primary causes	39
<b>D.</b>	<b><u>Safety recommendations</u></b>	39

## **I. Preamble**

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

The Romanian Railway Investigating Body - RRIB launched an investigation action in order to prevent some railway events with similar causes, by establishing the conditions and determining the causes and issuing some safety recommendations.

The RRIB's investigating action didn't had as purpose to establish the guilt or the responsibility, its objective being the improvement of the railway safety and the prevention of the railway events.

### **I.2. The Investigating process**

RRIB performed its activity according to the Law no.55/2006, being informed on the railway accident occurrence, respectively the derailment of a passenger train, going to the place of the railway event and founding the consequences, respectively:

- the decease of a passenger;
- slight injury of the train master;
- slight injury of 3 passengers.

The occurred facts were qualified as serious railway accident according to the provisions of art.3, item of the Law no.55/2006 on the railway safety reason for which the RRIB's director took the decision to perform an investigating action.

By decision no.7 of May 12, 2008 of the RRIB's director was appointed the investigating commission composed of:

- STOIAN Eduard - investigator in charge
- OLARU Mihai - member
- DRĂGHICI Marin - member
- CIOBANU Eugeniu – member
- ZAMFIRACHE Marian – member
- SFÂRLOS Dumitru – member
- TOADER Doru-Cătălin - member

To the place of the railway event were present also the representatives of the Prosecutor's Office of Court of Appeal Ploiesti of the Operative Department of the Railway Transport Police, of the Emergency Mobile Department of Reanimation and Intervention – SMURD, of the Romanian Railway Safety Authority, of the National Railway Company “CFR”- SA and of the National Society of Passenger Railway Transport “CFR CALATORI” – SA.

The activity of removing the consequences of the serious railway accident was coordinated by the members of the investigating commission appointed by the Order of the Minister of Transports according to the provisions of the Instructions for preventing and inquiring the railway events and accidents no. 003/2000 with the approval of the prosecutor in charge of the Prosecutor's Office of Court of Appeal Ploiesti.

## **A. The railway accident summary**

### **A.1. Short description**

On May 10, 2008 hour 16:57, the passenger train no.1661 that was running on Bucuresti Nord - Iasi, at the clear signal from Valea Calugareasca station has derailed on the switching zone from CFR Ploiesti Est railway station. The train had command to enter on the direct track no. 3 from Valea Calugareasca and passed the switch no.9 having a speed of 67 km/hour.

The place where took place the serious railway accident is located between the railway stations CFR Ploiesti Est - h.m Valea Calugareasca at the km 69+990 in the switching zone from the end of X of the halt Valea Calugareasca.

The passenger train no.1661 had in its composition a first class wagon and five double-decker wagons of second class and was hauled by the locomotive EA 872, all this belonging to the railway undertaking SNTFC "CFR Calatori" SA.

The configuration of the railway route is flat (without gradients), with a slight curve to the right in the direction of traffic of the train.

The serious railway accident occurred by the derailment of the locomotive and of the first four wagons from the train composition when passing on the switch no.9.

The consequences of the derailment were:

- the decease of a passenger;
- slight injury of the train master and of other three passengers;
- damages to the locomotive and to the fourth wagons;
- damages to the railway infrastructure ( track, railway installations, energy supplying installations) ;

### **A.2. Direct cause, facts that contributed and primary causes**

**A.2.1. The direct cause** of the railway event was the penetration of the wheel's tyre lip from the right side of the first axle in the direction of the traffic of the locomotive (axle no.6), between the straight points and the curved stock rail of the switch no.9. This took place as result of allowing operating the route in the conditions of half opening the point switch.

#### **A.2.2. Facts that contributed**

The permit of performing the route took place as result of obtaining the control of the switch by a point motor, the control not being obtained properly in the conditions of the absence of the fastening elements of the locking box and of the produced half opening. This was due to the detector slides of the point motor that had the grooves of control widened in comparison with the projected.

The point switch half-opening was possible because of the locking box detaching from the fixing system in the conditions of the absence of the fastening elements ( screws and nuts) that was fixing it by the curved stock rail of the switch no.9, having as consequence the loss of the function of the locking and guidance system of the straight points.

### **A.2.3. Primary causes** of the railway event are:

- a. the absence of the specific regulations ( technical memorandum, working instructions, technological processes) on assembling, maintaining and repairing the point motors no.9 type EM5;
- b. the use of the fastening elements necessary to the locking box fastening of the curved stock rail are not corresponding to the technical documentation of the manufacturer;
- c. using for the point lock of the switch no.9 some constructive alternatives different from the technical documents of reference;
- d. non- assembling the crown nuts of the screws C2 and C4 of the point lock from the switch no. 9;
- e. keeping the screws DA M 22x65 with a fragment of used-up thread corroborated with the modification of the constructive solution designed by using the helical spring in place of the washers , fact that led to the situation that from the thread of the two screws only 4-5 and not all the designed surface;
- f. assembling in reverse position the arrester of the operating bar together with the screw C5 from the point lock of the switch no.9;
- g. non-replacing or non-reconditioning the used-up parts with the occasion of performing the examination tests of the hidden parts of the switch, such as:
  - i. the cotters from the base of the points that is limiting the longitudinal displacement of the points;
  - ii. polishing the chipped corner of the right point of the switch no.9;
- h. widening the cuttings from the detectors slides of the point motor.

### **A.3. The serious level of the railway accident**

According to the provisions of art.3, item m of the Law no.55/2006 on the railway safety, the railway event by its consequences is qualified as serious railway accident.

### **A.4. Safety recommendations**

The beneficiary of the safety recommendations is the National Company of Railways “ CFR” S.A as manager of the public railway infrastructure.

The recommendations are given in order to solve the following aspects:

1. Performing an examination on the entire railway network in order to identify all systems that have not been homologated, with improvisations or modifications in comparison with the technical documents of reference in force used at the subassemblies of the switch fasteners with pincers and to the *detectors* of the point motors of type EM 5. Following these actions, in case of identifying some major nonconformity a safety program for these safety installations shall be elaborated.
2. Elaborating some specific proceedings, technical memorandum, working instructions, technological sheets by which shall be specified the way of assembling, maintaining, repairing

of the point motors of type EM5, including the method of mechanical control adjustment with the occasion of performing these type of works.

3. Elaborating a normative document promoted through an order of the minister of transports and infrastructure by which shall be prohibited the performance of constructive changes without the approval of the central public authority from the railway transport field by the employees that are ensuring the maintenance of the components of the interlocking installation assemblies.
4. Developing the level of the technical professional knowledge and improving the practical abilities of the personnel that are managing, maintaining and repairing the points and crossings and the point motors by internal courses or in specialized institutions followed by the professional examination of these.
5. Accelerating the implementation of the safety management system at the level of the public railway infrastructure manager as foreseen in the Law no.55/2006 on the railway safety.
6. Starting an examination action at the level of the public railway infrastructure manager of the personnel activity with responsibilities in traffic safety and of those with responsibilities in training and controlling for the nonconformities found with the occasion of this examination action referring to the elements of the switch no.9 of Valea Calugareasca. The conclusions of this action and also the possible disciplinary measures shall be contained in a Report that shall be submitted to the Romanian Railway Investigating Body.

The present report shall be transmitted to the public railway infrastructure manager, the railway undertakings and to the Romanian Railway Safety Authority.

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

## B. INVESTIGATING REPORT

### B.1. The serious railway accident description

On May 10, 2008 the train no.1661 that was put into service on the route Bucuresti Nord –Iasi, left from CFR Ploiesti Sud railway station and passed without stopping, according to the schedule on the track no.6B from CFR Ploiesti Est railway station. When passing through all railway stations, the train was surveyed by the movement's inspector (IDM). According to the schedule after leaving CFR Ploiesti Sud railway station the next stop was supposed to be Mizil railway station (photo no.1).

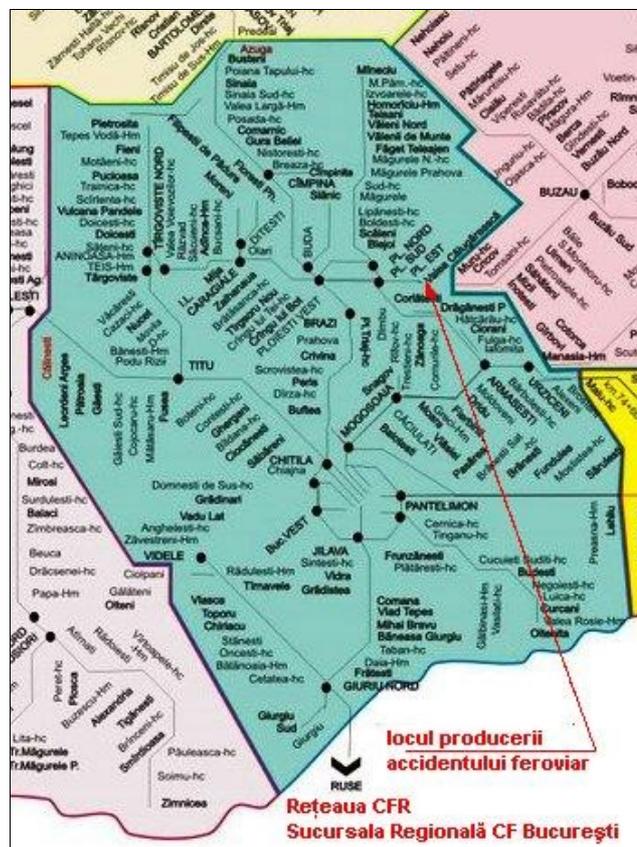
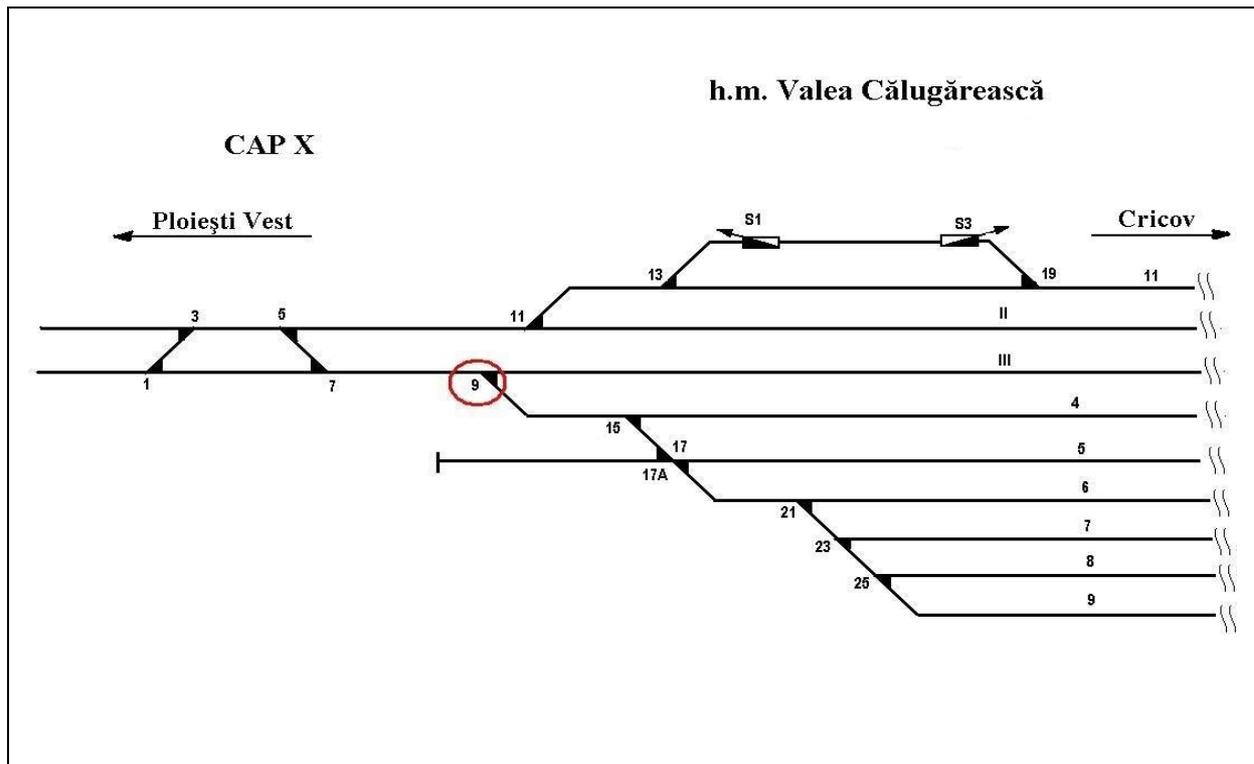


photo 1

After passing through CFR Ploiesti Est railway station, the train was running on the current track corresponding to the first running line to Valea Calugareasca with speeds between 67 and 68 km/hour - according to the bulletin of approving the speed restrictions BAR – available for the period 01-10 of May, 2008 and the charts with speed limitations for the timetable 2007/2008, the maximum running speed was limited to 70 km/hour from the kilometer 63+750 to the km 71+900 until the entrance to Valea Calugareasca where, at the hour 16:57 in the moment of passing over the switch no.9 (photo no.2), the switch being in the position "direct", took place the derailment of all axles of the locomotive EA 872, followed by the derailment of the next four wagons, respectively of the wagons no.50531955029-7, 50532616020-5 and 50532616017-1 of all axles and of the wagon no.50532616021-3 of the first bogie in the direction of running.



After the train no.1661 passed the signal from the end of X of Valea Calugareasca, the movement inspector went out in order to inspect it. While the movement inspector was expecting to inspect the train he heard a strong noise that resulted from the direction of the train and also, simultaneously with the sound made by the bells of trailing the switches. In this situation, the movements inspector returning to the office, observed on the control unit of the halt that the switch no.9 wasn't controlled and the isolated sections 1-7, 9 and 041 were signaling "occupied" on the track diagram. The movements inspector immediately contacted the trains driver by radiotelephone, communicating him that the locomotive and the first two wagons derailed. In these conditions, the movements inspector unsealed the button of the trailing bell in order to interrupt its functioning , after which he informed the traffic controller of Ploiesti, the station manager of Ploiesti Est, the deputy of the station manager and the interlocking system driver on duty concerning the train derailment.

The train was running without stopping in this halt and had a clear signal authorized by the movements inspector on the direct third line. When performing the necessary operations for giving the clear signal, the movements inspector didn't observed any irregularity in the interlocking installation functioning, the track diagram indicators corresponding to the ordered route. Also, the engine driver confirmed the fact that the clear signal X was displaying "green".

Due to the derailment a passenger died, other three passengers and the train master were easily injured.

## **B.2. The circumstances of the serious railway accident**

### **B.2.1. The parties involved**

The running section where the railway event took place is managed by CNCF "CFR" SA and is maintained by its employees.

The railway infrastructure and superstructure is managed by CNCF “CFR” S.A. and is maintained by the employees of the permanent way district no.5 Ploiesti Est within the Section L6, the branch of the district CFR Bucharest.

The terminal of managing the railway traffic and also the interlocking system from Valea Calugareasca are managed by CNCF “CFR” S.A. and maintained by the employees of the permanent way district Ploiesti Est within the Section CT 4 Ploiesti, Branch of the Railway District Bucharest.

The installation of railway communications from Valea Calugareasca is managed by CNCF “CFR” S.A. and is maintained by the employees of SC TELECOMUNICATII CFR SA.

Catenary geometry and power supply voltage is managed by CNCF “CFR” S.A. and is maintained by the employees of SC ELECTRIFICARE CFR SA.

The installation of railway communications from the locomotive is the property of SNTFC “CFR Calatori” SA and is maintained by its employees.

The locomotive and the wagons from the composition of the train that has derailed are the property of SNTFC “CFR Calatori” SA and are maintained and inspected by its employees and the repairs are performed by the economic agents authorized as railway suppliers.

The investigating commission interrogated the employees involved in the management of the railway traffic, the maintenance of the installations and of the tracks and the engine driver.

### **B.2.2 The composition and the equipments of the train**

The train was composed of six passenger wagons, 274 tones, 24 of axles, automatic braked 408 tones, 434 tones braked plus 26 tones in comparison of the timetable, hand braked 54 tones, being in fact 155 tones plus 101 tones , length 175 meters, the train was hauled by the locomotive EA 872 belonging to the Engine Depot CFR Bucuresti Calatori, subunit of the SNTFC “CFR” Calatori S.A.

The safety and vigilance device, the automatic train stop (INDUSI) of the traction vehicle endowment were active and were functioning according to the instructions with the automatic active brake.

### **B.2.3 The railway equipments**

The switch no.9 has the geometric point to km 70+971 and is located in a straight area of 545 meters, situated between km 70+735 and km 71+280.

The rolling stock derailment occurred on a switch type 65 having the tangency 1:9 with the radius of 300 meters, deviation right, flexible points type 49, indirect fastening type K. As consequence of the derailment were affected also the superstructures of the third direct line and the fourth deflecting section.

The railway event occurred on an area where the maximum running speed of the trains on the third direct line was restricted to maximum 70 km/hour from the km 69+720 to the km 71+900.

The terminal of the railway traffic management is foreseen with relay interlocking systems of type CR-3.

The switching area 1,3,5,7,9 and line II, III and four of Valea Calugareasca are flat arranged with fragments of curves bordered by straight lines.

On May 10, 2008 near the place where the railway event took place weren't performed works to the railway installations or tracks.

#### **B.2.4. Communication means**

The method of communication between the engine driver and the movements inspectors and also between the engine driver and the trains staff was ensured by the radiophone installation.

#### **B.2.5. Launching the railway emergency plan**

Immediately after the railway event took place, the launch of the intervention plan for removing the damages, the victims and reestablishing the trains movement had two components:

- The notice of the unique national system by the passengers of the train no.1661 involved in the railway event for emergency calls 112 referring to fires, accidents, medical emergencies, disasters and other events that are involving the quick intervention of the special services, at the place of the railway event being present the representatives of the Emergency Mobile Department of Reanimation and Intervention – SMURD, of the Operative Department of the Railway Transport Police, of the Prosecutor's Office of Court of Appeal Ploiesti and of the Inspectorate for Emergency Situations of Prahova.
- The notice of the railway event by the circuit of the information specified in annex 2 of the Instructions for preventing and inquiring the railway events and accidents – no.003, after which were present the representatives of CNCF "CFR" S.A- the public railway infrastructure manager, of SNTFC "CFR Calatori" SA- the railway undertaking and of the Romanian Railway Authority – AFER.

As result of the cooperation of all representatives present at the site of occurrence, intervention means were directed in order to remove the consequences of the railway event, their action being possible only with the verbal approval of the designed prosecutor of the Prosecutor's Office of Court of Appeal Ploiesti.

In order to re-rail the derailed rolling stock on May 10, 2008 at the hours 17:50 were requested and directed from the CFR Bucuresti Triaj railway station to the place where the railway event took place the intervention trains with cranes type EDK 2000/1 si EDK 750/6 and also the intervention wagon with hydraulic jacks. These operated until May 11, 2008, at hours 19:30.

### **B.3 The consequences of the serious railway accident**

#### **B.3.1. Fatality and injured people**

As consequence of the railway accident it was registrated victims and injured people as follows:

- deceased: 1;
- serious injured: - ;
- slight injured: 4;

#### **B.3.2 Material damages**

The value of the material damages according to the estimates drawn up by the owner of the rolling stock, of the intervention means and the public railway infrastructure manager is the following:

- To the track: according to the works estimation no.1382/2008 of the Section L6 is **372.019,41 lei**;
- To the installations: according to the estimation no.893/2008 of the Section CT4 Ploiesti the value of the works is **4213,73 lei**;
- To the locomotive - according to the estimation 17/134/833/2008 of the SCRL Brasov the value of the works is **456456,39 LEI**;
- To the wagons:
  - to the wagon no.50531955029-7, according to the estimation no.2089/2008 of SC IRVC SIRV Titu SA the value is **68.100,41 lei**;
  - to the wagon no.50532616020-5, according to the estimation no.2117/2008 of SC REMAR SA Pascani the value is **46.500 lei**;
  - to the wagon no.50532616017-1, according to the estimation drawn up by the Multimodal terminal Bucuresti Grivita no.1354/2008 the value is **1081,07 lei** and of the estimate no.1353/2008 the value is **76,67 lei**;
  - to the wagon no.50532616021-3 according to the estimation no.1355/2008 of the Multimodal terminal Bucuresti Grivita the value is **1081,07 lei**;
- **The cost of the intervention means** – according to the estimation no. L4.2/125/16.05.2008 of the Branch of the Railway District Bucuresti the value for using the specialized intervention train with cranes EDK of 250 tf and EDK of 125 tf is **33.074,69 lei**;
  - according to the estimation no.T4/193/13.05.2008 of the Engine Shed CFR Marfa Bucuresti Triaj, the value of the works is **4975,55€ +1261,28 lei**;
- **to the environment** – they weren't;
- **other damages ( trains delays)** – estimate of the minutes of the passenger train delay no.10/51/1/326/2008 of the Traffic Controlling Department within SNTFC “ CFR Calatori” S.A with the value of **2929,27 lei**;

**The total value of the material damages : 1.047.562,53 lei + 4975 €;**

### **B.3.3 The consequences of the serious railway accident in the railway traffic**

The third direct line and the fourth deflecting section were closed to the railway traffic as follows:

- the third direct line closed from May 10,2008, hour 16:55 until May 13, 2008 hour 12:30;
- the fourth deflecting section closed from May 10,2008, hour 16:55 until June 21 ,2008, hour 15:40;

The following trains delayed because of the serious railway accident occurrence:

- 15 passenger trains with a total delay of 1865 minutes;
- 50 freight trains with a total delay of 21.161 minutes;

### **B.4 External circumstances**

On May 10, 2008 between the time period 15:00 -18:00 the visibility was very good, the temperature was approximately of 15°C, clear sky, no wind with maximum luminosity during the day.

In Valea Calugareasca halt were free the line 1, II, III, Magazie, line no. 4 was occupied by the freight train no.81705. The lines 5,6,7,8 and 9 were closed for the trains movement and shunting.

In the area where the railway event took place the line is straight and flat.

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

## **B.5. The investigation performance**

### **B.5.1. The summary of the testimonies of the involved personnel**

**The movements inspector** on duty when the serious railway accident occurred to Valea Calugareasca station stated the following:

- In the day of the serious railway accident occurrence when he began his duty visually examined the switch no.9 and didn't found nothing special;
- In the day of the serious railway accident occurrence weren't registered interruptions to the trains movement and shunting due to the improper functioning of the installations;
- The relay interlocking system functioned in normal parameters;
- The radiophone installation and the phone from the office of the movements inspector functioned normally;
- The entrance in the railway station and parking of the freight train no. 81705 was performed on the basis of the order of the relay interlocking system and was parked to the fourth line at hour 16:52 after which was performed the entrance for the train no.1661;
- The route for the passenger trains no.1661 was performed on the orders of the relay interlocking system according to the provisions of the instructions for its operation;
- After the train passed the clear entry signal he went out for a visual inspection and he heard a big noise from Ploiesti simultaneously with the sound made by the bells of trailing the switches;
- He returned to the office and he observed on the control unit that the switch no.9 wasn't controlled;
- He tried to contact the driver of the train no.1661, who communicated to him after a few minutes that the locomotive and the first two wagons derailed;
- He informed the traffic controller of Ploiesti, the deputy and the station master of Ploiesti Est, and the technician of the interlocking system on duty concerning the train derailment.

**The engine driver** of the locomotive EA 872 that hauled the passenger train no.1661 stated the following:

- Before entering in Valea Calugareasca station he was informed by radiophone that the train has clear signal of passing on the third direct line from Valea Calugareasca without any comments that those foreseen in BAR;
- The indication of the outer distant signal was “ green” and also of the entry signal;
- The trains engine driver didn’t saw any person on the area of the tracks at the entrance in the station in the switching area from the end of X;
- On the switching area at the entrance in the station the speed of the train was of 67 km/hour ( the maximum running speed according to the curves classification and of the speed restrictions was of 70 km/hour);
- When passing on the switch from which ramifies the third direct line and the fourth deflecting section ( the switch no.9), felt a strong shock and trepidations specific to the derailment , moment in which the locomotive moved between the third direct line and the fourth deflecting section. The displacement direction of the locomotive in that moment was with the frontal window to the catenary support, then as result of a lateral shock from the right part, the locomotive moved sharply to the left and with the corner from the right of the locomotive’s cabin touched the catenary support, the locomotive displaced until its stopping parallel with the third direct line;
- After the stop of the train, the engine driver contacted the movements inspector by radiophone communicating the fact that the train no.1661 derailed on the switching area. After examining the situation, the engine driver informed the chief of the Engine Depot Bucuresti Calatori on the railway event.

**The engine driver** of the locomotive that hauled the freight train no.81705 stated the following:

- On May 10,2008 it wasn’t registered any special problems related to the weather and the signals visibility;
- The freight train no.81705 belonging to the railway undertaking SNTFM “CFR Marfa” S.A, was parked to the fourth deflecting section from Valea Calugareasca at the hour 16:22. The trains parking was performed on the basis of the instructional provisions up in front of the signal X4 because, according to the communication by radiophone made by the movements inspector the freight train was going to head to Cricov railway station immediately after the passenger train no.1661 passed and clearing the first sector of automatic electric block system;
- On the entire distance that circulated on the running line 1 Ploiesti Est- Valea Calugareasca until parking the train to the fourth deflecting section from Valea Calugareasca , the engine driver didn’t saw any person on the area of the tracks.

**The ganger** belonging to the District 5 Ploiesti, that performed the inspection of the line on the area of Valea Calugareasca stated the following:

- On May 10, 2008 didn’t performed works on the switch no.9;
- He never screwed the nuts from the box of the switch no.9 because the fastening was always active ( corresponding);

**The gang foreman** belonging to the District 5 Ploiesti Est in charge with maintaining the tracks of the area of Valea Calugareasca stated the following:

- The last work that he made to the switch no.9 was to verify the hidden parts on March 13, 2008;

- The nuts from the locking box when verifying the hidden parts, were very well fastened and didn't presented marks on it due to the chisel action;
- The switches of Valea Calugareasca and of Ploiesti Est railway stations similar to the switch no.9 don't have the H safety part to the boxes for several years since he participates to the works of verifying the hidden parts;
- He doesn't remembers in what position was assembled the stroke arresting device corresponding to the box from the curved stock rail of the switch no.9;

**The inspector of the district no.5 Ploiesti Est** stated the following:

- The locking box was removed from the curved stock rail of the switch and fallen on the operating bar;
- The nuts and the helical springs were fallen on the prism of the broken stone between the right point and the curved stock rail;
- An horizontal screw was fallen on the prism of broken stone and positioned between the locking box and the bottom of the curved stock of rail;
- The second horizontal screw was fallen on the prism of broken stone and positioned between the locking box and the sleeper after the operating bar;
- The horizontal screws of supporting this locking box on the heart of the curved stock of rail and also the corresponding screws weren't replaced from 2000;
- It weren't registered difficulties to the functioning of the switch no.9 by records in the registers of tracks and installations inspection;
- It was not operated on the right point with metallic parts by striking it at the head in the cross section;
- Within the inspections and the works he didn't observed if the screws from the locking box had marks made with the chisel on the exterior surface;

**The deputy district permanent way inspector** of section L6 Ploiesti stated the following:

- On May 10, 2008 when he arrived at the place of the railway event the elements of fastening the box weren't there;

**The district permanent way inspector** of section L6 Ploiesti stated the following:

- The locking box was removed from the curved stock rail of the switch and fallen on the operating bar;
- Those two horizontal screws that are ensuring the fastening of the locking box by the curved stock of rail were fallen in the exterior of the box in its right side;
- The screws that were ensuring the fastening of the locking box by the curved stock of rail were fallen under the bottom of the curved stock of rail;
- Helical springs were fallen down in the exterior of the curved stock of rail , on the right side;

- Within the inspections he didn't observed if the screws from the locking box had marks made with the chisel on the exterior surface;

**The safety inspector of the Tracks Department stated the following:**

- The locking box was removed from the curved stock rail of the switch and fallen on the operating bar;
- The screws of fastening the box and helical springs were fallen on the broken stone prism, on the right side of the curved stock of rail;
- The nuts of the horizontal screws were fallen on the broken stone prism and were under the bottom of the curved stock of rail;

**The chief of the Tracks Department Bucuresti stated the following:**

- The locking box was removed from the curved stock rail of the switch and fallen on the operating bar;
- The horizontal screws of supporting this locking box on the heart of the curved stock of rail and helical springs of the screws were fallen on the broken stone prism between the bottom of the curved stock of rail and the locking box , the order in which these were starting from the bottom of the curved stock of rail to the locking box being the horizontal screws and then helical springs;
- The nuts of the horizontal screws were fallen on the broken stone prism and being placed under the bottom of the curved stock of rail;

The statements of the personnel of the tracks maintainance that was examined on the position of the horizontal screws of fastening the box fallen on the coupling bar are not corresponding to the first photos made by the penal investigating bodies ( photo no.3).



photo 3

The position of the elements of fastening the box corresponding to the right stock of rail of the switch no.9.

- I- Screws; II - helical springs; III - nuts;

The statements of the personnel examined on the existence of some marks of strokes on the exterior surface of the nuts of fastening the box are not corresponding to the photo made by the penal investigating bodies ( photo no.4).



**The district permanent way inspector of CT4 Ploiesti stated the following :**

- The locking box was removed from the curved stock rail of the switch and fallen on the operating bar;
- The locking bolts of the locking box from the hearth of the curved stock of rail and helical springs of the nuts were fallen on the broken stone prism under the stock of rail;
- The switch no.9 didn't had control for the position „plus” , the peg and the point motor were sealed with control lead;

**The electromecanic II of the interlocking system of the section CT 4 Ploiesti stated the following:**

- The box was fallen and the long control bar of the point corresponding to the position „ plus” was distorted;
- The last exterior inspection of the point motor no.9 was made on May 9,2008 with the occasion of the daily inspection;
- The last monthly inspection to the point motor no.9 was performed on May 7, 2008 and with this occasion it wasn't found any technical deficiencies;
- To the last inspection it weren't found marks on the nuts of the box.

**B.5.2. The safety management system**

In performing its tasks and responsibilities the railway infrastructure administrator CNCF „ CFR” SA didn't established its own safety management system.

In this context, CNCF „ CFR” SA doesn't ensure the control of all risks associated with the activity of managing the railway infrastructure , including supplying the critical railway services and products and also the use of the contractors.

It is not implemented a safety policy at the level of CNCF „ CFR” SA that should express the commitment, the mission and the strategical vision of an organization as regards the railway safety

that must include a statement of intention and to give indications on the global direction and the general objectives of the safety management system.

### **B.5.3. Norms and regulations. Sources and references for investigating**

To the railway accident investigation the following were taken into consideration:

- The investigating file no.7000/135/2008 of the railway event drawn up by the investigating commission appointed through the Order of the Minister of Transports no.611 of May 10, 2008;
- Images that were filmed immediately after the railway event occurrence put at disposal by witnesses, AFER's representatives or posted on the internet;
- A part of the photos taken immediately after the occurrence of the railway event performed for the Prosecutor's Office of Court of Appeal Ploiesti and the Department of the Railway Transport Police;
- Photos taken immediately after the occurrence of the railway event performed by the members of the investigating commission ;
- Documents concerning the maintenance of the tracks and railway installations that were put at the disposal by those responsible with their maintenance;
- Documents concerning the process of train operation and setting up the trains movement;
- The results of the measurements performed to the electric locomotive that hauled the wagons of the train involved in the railway event immediately after the occurrence of the railway event;
- The examination and the interpretation of the technical condition of the elements involved in the railway event: switch, point motor and train;
- The personnel examination on the professional training, professional knowledges and their interpretation;
- The interrogation of the employees involved in maintaining the switches and the point motor no.9;
- Regulations, instructions, technological processes on construction and maintenance of the switches and the point motor no.9 of type EM 5;
- The Technical Regulation of Railway Operation no.002 approved by the Order of the Minister of Public Works, Transports and Lodgings no.1186 of August 29,2001;
- Specification Pr 2060-0 "Switch locks with pincers operated by point motors – EM 4", edition 1995 approved by the management of SNCFR;
- Technical specification no.2/2001 of the point motor of type EM5/EM5R issued by SC SPIACT SA Craiova, approved by AFER through the technical homologation certificate series OT 142/2001;
- Technical specification no.9/2001 of the garnitures of switch bars of type EM5/EM5R issued by SC SPIACT SA Craiova, approved by AFER through the technical homologation certificate series OT 144/2001;
- Instruction concerning the terms setting and of the order in which the track inspections must be performed no.305 approved by the Order of the Minister of Transports no.71 of February 17, 1997;
- The tasks and the responsibilities of the district inspector on inspecting the condition of the switches are foreseen in the Instruction for the district permanent way inspector of maintaining the track no.323/1965 and in the Order of inspecting the hidden parts of the switches no.33/34 -1978 of the Tracks and Installation Direction;
- The Order of inspecting the hidden parts of the switches no.33/34 -1978 of the Tracks and Installation Direction;

- The instruction of norms and tolerances for constructions and maintenance of the track with normal gauge no.314/1989;
- Instructions for speed restrictions, for closing a line and to put out of the tension no.317/2004;
- Instruction for technical maintenance and repairing of the interlocking system no.351/1988 approved by the Order of the Minister's Deputy of Transports and Telecommunications no.1749 of September 23, 1988 with previous modifications;
- The Order of the Minister of Transports no.290/2000 on the technical acceptance of the products and/or the services to be used in the activities of building, modernization, maintenance and repairing of the railway infrastructure and of the rolling stock for the railway and subway transport.

#### **B.5.4. The functioning of the technical installations, of the infrastructure and of the rolling stock**

##### **B.5.4.1. Data found on the installations**

The operation of the route for the passenger train no.1661 was performed with orders of the relay interlocking system with color - light signal having the indication "green" this meaning that the point motor no.9 confirmed the "locking" and placing the points of the switch in the correct position perceived through the bars and the detector slides in the conditions that the glued point wasn't locked by the stock of rail by the system of fastening with clamp and box.

The point motor that operated the switch no.9 is of type EM 5 with electric motor fitted with gearing-down device, critical railway product homologated by AFER and manufactured by SC SPIACT Craiova SA.

The point motor of the switch no.9 is a part of the interlocking structural subsystem of type CR 3 and has the role of operating the points of the switch and to control the displacement and their attaching by the stocks of rail. The point of motor is not directly examining the locking of the points by their stocks of rail.

The control of the points operation in the extreme positions of attaching them to the stocks of rail is made with the help of the fixed bar of soft steel of type OL 37 2K attached to the detector slides that are placed in the point motor specifying the position of the points depending on the bars adjustment. The adjustment of the control bar is made by local heating (hot forcing operation) of it, according to the provisions of art.122, item a) from the "Instruction for maintaining and repairing the interlocking systems" no.351/1988 followed by the operation of stretching and fastening depending on the need on the field.

The point motor of the switch no.9 was assembled on timber sleepers with a length of 4,30 metres placed in the tip of the switch, the fastening of its box to this sleepers being performed with the help of coach screws.

The long fixed blade -detector assembled on the right point was distorted as result of the penetration of the wheel rims between the point and the stock of rail from the direct position, its reduction being directly proportional with the right point displacement as consequence of its forcing by the train's wheels;

Immediately after the representatives of the prosecutor's office presence at their request, the cover of the point motor was opened but without issuing a document from which should result its condition, the seal that was applied and its integrity.

In the presence of the investigating commission it was found that the detector slides had the nicks widened in which is entering the beak of the contacts lever that is verifying the mechanical control of the correct displacement of the points in the position attached to the stocks of rail. This nicks were made with the chisel. ( photo 5).



photo 5

The last date when complex works ( biannual inspection) were done to the point motor of the switch no.9 was in March 13, 2008. At this type of work it's mandatory the dismantling of the subassemblies by examining the integrity of the component parts and replacing of those noncorresponding.”

The last montly inspection, before the serious railway accident occurence was performed on May 7,2008 by a team composed of an interlocking system electromechanic and an interlocking system assembler I . To this inspection no irregularity was found on the switch functioning.

The shunting detector slide of the point motor no.9 was complete operated, operation necessary to the position „ direct” and appropriate tied up and sealed to the steering rod of the point motor operation with the operating bar of the point lock.

The illuminated signal from the control panel of type „ domino” , corresponding to the point motor no.9 was signalling „ control missing” ( permanent lighting of the red lamp placed in the center of the element).

The point motor that operates the switch no.9 „on the right” ( seen from the inlet crack handle) located on the left side of the switch as seen from the beak.

The shunting operation of the point motor no.9 from the position „ minus” ( access to the line 4 railway station) to the position „ plus” ( access to line 3 railway station) was completely performed.

The long blade from the position „ minus” ( the short blade) was tied and sealed in the ensuring bolt from the corresponding detector slide.

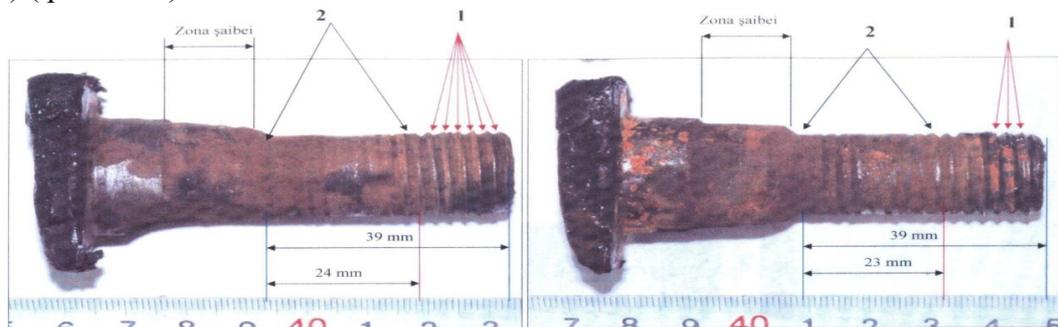
### B.5.4.2. Data found out on the tracks

The odd track 1 and the lines III (direct) and 4 (deflecting section) have a superstructure type 65, concrete sleepers T17, indirect fastening type K.

In the front of the switch was a panel consisting in rail type 65, concrete sleepers T17, indirect fastening type K.

The fastening system of the locking box of the switch no. 9 does not comply with the provisions of the Project 1489-0/R ( from the specification Pr. 2060-0 of the Romanian Railway Company ) the fastening subassembly of the stock-rail box that has to consist in the screw type DA M 22x65 (2 pieces) safety rail clip according to the picture 1350-5 (1 piece), flat washer  $\phi$  60/25x3 (2 pieces), nut type B M 22x22 (2 pieces), splint  $\phi$  6,3x32 (1 piece). Nonobservance of the project consisted in the replacement of the safety clip and of the flat washer with 2 spring rings type B 23.

The nuts type B M 22x22 that ensure the fastening of the locking box on the respective stock rail ensured the maximum fastening without their whole inside tapped surface be on the suitable screw tapped rod, according to the specification (  $\frac{1}{4}$  of their thread being on the outside of the tapped rod of the screw ) ( picture 6 ).



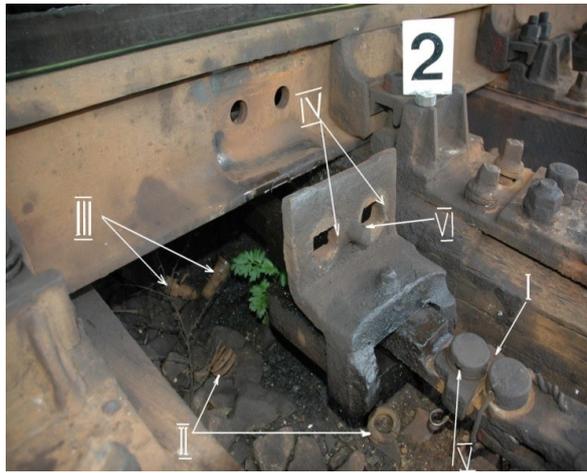
The nuts B M 22x22 had traces of impacts with a metallic object (chisel) with traces in the screwing up direction of the nut (picture 4)

1. Zona filetată activă
2. Zona filetată uzată

The holes from the locking box through are screwed on the horizontal screws that are fastening the box on the curve stock rail crossing were widened with the welding device with oxyacetylene flame, against the provisions of the specification (IV from picture 7), their shape not being square, but trapezoidal .

The stroke-arresting device was unsuitable assembled on the upper side of the operation bar and the screw 5 was reversely fastened without the crenellated nut A M 22 (I and V in picture 7).

The locking box from the right side was dislocated against the curved stock rail and was fallen on the operation bar (picture 7).



picture 7

The right points had indentures on the upper edge on about 260 mm (picture 8)



picture 8

The screws type C2 and C4 were not ensured for fastening with crenellated nuts (I and II from picture 9).

The lock clip of the point lock of the right points was removed from the locking box and was on the base of the curve stock rail (III from picture 9)



picture 9

The lock clip of the middle lock of the right points was out of shape, but locked in the locking box. The right points had in the tip new hitting traces at the upper side and old traces at the lower side, in the cross section (picture 10)



picture 10

After disassembling the parts of the point lock and of the middle one the right points was reversed with the base up in order to see, when were found out:

- The special places in the points base where had to come the bungs, were oval (picture 11);



picture 11

- lack of the bungs that had to prevent the move longways the points - bungs that ensure the connection between the base of the points and the metallic plate of the special sleeper from the points heel ( picture 11);



picture 12

Starting with the 12<sup>th</sup> sleeper with slide chair and until the train stop, the whole switch was affected by the derailment, as well as the direct line 3 and the deflecting section 4, that branched out from the switch on lengths of about 100 m.

The investigation commission performed inspections, with the track gauge, checking the cross level and the gauge on the rail panel in front of the switch no. 9 (between the switches no. 7 and no. 9). The measured values found out were:

	Joint of the switch tip no. 7			Joint of the switch tip no. 9	Points tip of the switch no. 9
Gauge	-2	-1	-1	-4	-2
Level	0	10	10	5	5

During the inspection of the switch no. 9 with wear template for the points wear checking and with the wear template no. 1 for the stock rails wear checking, was found out that they are suitable from ORE point of view.

The derailment occurred on the switch no. 9 that was type 65, tg 1:9, R=300 m, right deviation, flexible points type 49, double locking, assembled on wooden sleepers.

In the minute is registered that the sleepers from the switch no. 9 are wooden sleepers, in a suitable technical situation, excepting the first sleeper from the joint tip of the switch, that was unsuitable, because it had longitudinal cracks in the fastening area of the metallic plates. At this sleeper the fastenings situation was the following:

- the metallic plate fastening from the right side ( switch outside ) had an inactive coach screw;
- the fastening of the metallic plate from the left of the respective sleeper, was ensured only through 2 coach screws from a total of 4 .

The right points had a new hit in the tip, at the upper edge and old traces of hits in the tip in cross section. The minute has no reference concerning the existence and the size of the indenture of the right points of the switch no. 9 (picture 10)

The broken stone bed in the switch no. 9 area is incomplete to the end of the sleepers at the joint between the connection rails and the stock rails heel.

The tampon panel in front of the switch no. 9 was type 65 concrete sleepers type T17, and its end to the switch no. 7 had 2 slimy sleepers, the rest of the panel having the broken stone bed complete and clean.

The operating device for the points movement and for the locking of the middle point lock was assembled on the right side (version B1).

The locking box from the curve stock rail of the switch no. 9 was detached from the fastening place, moved away from the stock rail, fallen and supported by the shunting bar, next to the stroke-arresting device.

The right points of the switch no. 9 was moved away with 38 mm from the curve stock rail, the locking clip of the point lock was supported by the upper part of the curve stock rail base, and the locking clip of the middle lock was out of shape following the passing of the tires lip of the wheels

The curve points was operated until the complete opening, making the minimum opening established by the instruction to remove from the stock rail

The operating bar of the point lock of the switch had the end from the right points out of the locking box and right connected at the connection bar.

#### **B.5.4.3. Data registered during the operation of the rolling stock and of its technical devices.**

The locomotive EA 872 had the equipment “INDUSI” in operation and sealed, the safety and vigilance equipment in operation and sealed, the speed recorder sealed, in the machines house the mechanisms block ( S1 – S8) were sealed, the locomotive brake unit was in operation and sealed, the cock brake type KD2 was in position of quick braking.

The measurements performed during the revision type R1 carried out on the 7<sup>th</sup> of May 2008 by SC CFR SCRL Brasov SA – Locomotive Repairing Section from Ploiesti, unit to which was dispatched the locomotive for repair, are registered in the measurements sheets annexed to the minute of technical observations - piece of the investigation file drawn up by the investigation commission. After the analysis of the measured quotas of the tires from the locomotive axles resulted that these are in the accepted limits of the Regulations for the Railway Technical Operation no. 002/2001.

The minutes for the reading of the equipments IVMS 2001 – piece of the investigation file drawn up by the investigation commission - stipulates that the locomotive speed at the km 69+72 – 71+900 was 68 km/h maximum, under the level of 70 km/h, the speed limit established for this area.

The last measurements and the adjustment of the loads distribution on the axle of the locomotive EA 872, were performed on the 2<sup>nd</sup> of December 2007, without other interventions, until the occurrence of the railway accident. According to the records from the copy of the measurements sheet, the values were in the operating instruction limits.

### **B.6. Analysis and conclusions**

#### **B.6.1. The passing way of the train on the switch**

The axle no. 6 of the locomotive was the first in the running direction of the train 1661. The wheel from the right side of the running direction of the axle no. 6 hit the tip of the right points of the switch no. 9 half-opened, and the lip of the tire of this wheel passed between the right points and the curve stock rail, operating the right points to the centre of the track III, with a force lateral horizontal. (picture 13)



picture 13

The right wheel of the axle 6 continued to run on the deflecting section of the switch no. 9, running on the curve stock rail. The left wheel of the axle 6 continued to run on the direction of the switch no. 9, according to the normal route, running on the right stock rail. So, the wheels of the axle 6 continued to run on those two stock rails, in divergent directions until the end of the distance between the limit lateral surfaces of the wheels tires. Then occurred the left wheel derailment, followed by the right wheel derailment

The first trace of derailment is seen on the 12<sup>th</sup> curve points slide chair, in the place between the curve points and the right stock rail (picture 14) and on the right side of the running direction, at the 18<sup>th</sup> right points slide chair, on the head of a vertical screw and of its nut being between the right points and the curve stock rail (picture 15).



Picture 14



picture 15

The traces of the derailment are seen both on the tire and on the lip of the tire of the right wheel of the axle no. 6 (picture 16).



Picture 16



picture 17 (wheel no. 1 is the wheel from the right of the axle no. 6)

Running of the maximum distance between the outside surfaces of the tires is seen also on the outside surface of the tire of the right wheel no. 6 which rubbed on the lateral surface of the right points from the curve stock rail (pictures 13 and 17)

The right wheel of the axle 6, at the moment of the derailment fell between the right points and the curve stock rail, and the left wheel fell between the curve points and the right stock rail. The route of the axle 6 is then followed by the wheels of the axles no. 5 and 4 of the bogie no. 2 of the locomotive.

On the length of the switch no. 9, the wheels of the bogie axles no. 2 and 1 of the locomotive run on the slide chairs, beams, vertical screws and metallic plates (picture 18).



picture 18

The left wheel of the axle 6 cut the horizontal bolts of the glued insulated joint and of the normal joint from the right stock rail heel (picture 19).



picture 19

Then this run on sleepers on the direction of the centre of the direct line of the switch no. 9, and the right wheel of the axle 6 on the sleepers of the deflecting section to the switch heel (picture 20).



picture 20

On the running surface of the right points and of the connection rail from the heel of this points there are no traces of wheel climbing.

After the heel of the crossing of the switch no. 9 from the right wheel came into lateral contact with the rail from the left side of the deflecting section (line 4), and the left wheel came into

lateral contact with the rail from the right side of the direct line (line III) through the lateral surfaces of the tires from the longitudinal axle of the locomotive (picture 199). All this route was run by the bogie no. 1 of the locomotive (the second in the running direction) and by the bogies of the four derailed wagons.

After the axle no. 6 came out of the area with special wooden sleepers that connect and join the two directions of the switch no. 9, begin the distortion of the longitudinal axles of the two lines (III and 4) generated by the action of the lateral forces transmitted by the left wheels and by those right of the bogie 2 of the locomotive EA 782.

This distortion happened on a distance of 14 m from the heel of the switch no. 9, when the horizontal lateral forces transmitted by the wheels exceeded the resistance of the fish-plates and of the first rail section type 65 from the glued insulated joint of the line 4, left stretch of rails. Because of it in this area were cut the connections to the normal joints of the glued insulated joints type 65 from the line III, as well as a rail from the right side was broken and from the line 4 was broken a rail from the left side. The first rail section type 65 from the glued insulated joint of the line 4 left stretch rails was broken at 2,5 m from the gap of the glued insulated joint and also were cut the connections of the special fish plates from the glued insulated joint type 65 from the line 4, the left side (picture 21).



picture 21

From this point the distortion force to the right, that acted on the line III decreased having as result the decreasing of the line III distortion to the right ( inside the curve ) and the line 4 is not affected by the lateral forces of the wheels from the right of the bogie no. 2.

The bogie no. 2 of the locomotive continued to run with the left wheels on the sleepers between the rails of the line III, and with the right wheels between the right rail of the line III and the left rail of the line 4, on the broken stone bed.

Because the action of this rail section of 7 m on the bogie no. 1 ( the second in the direction of running ) this changes advance direction against that of the bogie no. 2, running on between the lines III and 4.

The bogie no. 2 of the locomotive, after about 10 m, hit with the right wheel the foundation of a shunting signal, reason for which the running direction of the locomotive changed suddenly to the centre of the line III ( left), so a telegraph pole was hit by the locomotive with the right end of the cabin no. 2, and the metallic anchors for the support of the two telegraph poles between the lines III and 4 acting as support points for the locomotive and the first wagon (picture on the cover).

The locomotive ran derailed on about 97 m. During this running the locomotive hung also the rail section that in its relative move against it hit with the end from the railway station the track sleepers, and with the other end hit and deteriorated the subassemblies under the locomotive (the triangle axles, drum of gears, pair of wheels) – picture no. 22



picture 22

The rail section exited under the locomotive hitting and deteriorating the locomotive plough at the end from the first wagon of the train. (picture no. 23).



picture 23

The wagon no. 50531955092-7 (first after the locomotive) followed the same direction, running with the both bogies derailed until the rail section belonging to the glued insulated joint from the left side of the line no. 4, when the first bogie in the direction of running came in the broken stone bed. In the same time the opposite end of the rail section stopped in one of the sleepers of the line III.

Following this situation, the end of the rail section from the wagon bogie raised, hit the centre of the first axle in the running direction from this bogie, this changed the rail section direction up, to the wagon deck, holing it in front of the centre casting pin, between the two central solebars of the wagon frame.

After holing the wagon deck, the rail section penetrated under an angle of  $45^{\circ}$  in the fixed wall between the compartments no. 8 and no. 9 (first compartments in the wagon running direction), devastating the seats 91, 93 and 95 from the compartment no. 9 and the seats 82, 84 and 86, stopping at the moment of train stop in the upper part above the seat 85 of the fixed wall between the compartments no. 7 and no. 8 (picture 24).



picture 24

This rail section in its movement, injuring the master train who was in the compartment no. 9, as well as killed a traveler and injured slightly 3 travelers.

Following the running of the derailed locomotive and of the first wagon, all the axles of the wagons no. 2 and 3 derailed, as well as the first bogie of the wagon 4 in the running direction.

**CONCLUSION:** From the analysis of the derailment of the axle no. 6, first in the locomotive running direction, of the train wagons, colligated with traces from the tip of the points of the switch no. 9 (picture 9), the indenture from the tip of its points (picture 7), as well as with the switch position after the derailment (picture 12), was concluded that the derailment occurred because the running of the lip of the right wheel tire of the first axle (no.6) between the right points and the curve stock rail from the switch no. 9, this leading to the running of the right wheels of the first axle (no. 6) on the deflecting section (to the line 4) instead of the direct line (to the line III) of the switch. This running of the wheels needed that the points of the switch no. 9 be half-opened with at least 10 – 12 mm, before to be passed over by the locomotive of the train no. 1661.

#### **B.6.2. Cause of the lock box detachment from the switch**

1. The measurements performed after the derailment by the investigation commission on the 11<sup>th</sup> of May 2008 indicate an exceeding of the tolerances limits for the track torsion for the panel between the top joints of the switches no. 7 and 9 that is 10 mm suitable to a declivity of 1/250 of the defect over the maximum running speed is 50 km/h, according to the provisions of the art. 7, A point 4 from the Instructions of norms and tolerances for the track construction and maintenance no. 314/1989.

2. During the measurement performed after the derailment by the investigation commission on the 11<sup>th</sup> of May 2008, in the point top joint at the switch no. 9 the gauge was 1431 mm (accepted value 1432 mm), this indicates an exceeding of the tolerances limits at the gauge with 1 mm.

The provisions of the art. 19, point 2 from the table no. 17 from the Instruction of norms and tolerances for the track construction and maintenance no. 314/1998 were not fulfilled.

3. The investigation commission found out the existence of hit traces in the lower part of the end section of the right points (picture 17), of bungs holes wear (picture 18) from the right points base and of the holes of the locking box widened with the oxyacetylene flame (picture 14). All of these indicate that during the operation the right points moved longitudinally, this needing the reposition works in order to prevent the lock of the locking system of the point lock.

4. The investigation commission, on the 11<sup>th</sup> of May 2008 found out that the first sleeper from the top joint of the switch no. 9 was unsuitable, this being against the provisions of the art. 15, point 11 from the Instruction of norms and tolerances for the track construction and maintenance no. 314/1989 that impose that “in the switches are not accepted unsuitable sleepers, curved or wry”.

5. The investigation commission, on the 11<sup>th</sup> of May 2008 found out that the fastening system of the locking box existing before the accident occurrence did not comply with the homologated type, having the safety clip replaced, and the flat washers were replaced with spring rings type B 23.

#### **CONCLUSION:**

- The change of the fastening system (homologated) used at the fastening of the locking box of the curve stock rail from the switch no. 9, by taking off the safety clip “H” and the pin and flat washers, as well as the use instead of them only of the spring rings, does not permit to the investigation commission to state certainly, if the nuts detachment was voluntary ( by human intervention ) or by self-detachment because the vibrations generated by the railway traffic. The homologated system for safety and fastening of the locking box on the respective stock rails, as was designed by the manufacturer, has the role to prevent the nuts detachment from the horizontal screws, including to prevent self-unthreading, inclusively the detachment and falling of the locking boxes from the stock rails;
- Appearance of a half – opening, followed by the running of the tyre lip between the right points and the curve stock rail was possible because the detachment of the locking box from the fastening system, that fastened it on the curve stock rail of the switch no. 9 and had as direct consequence the disappearance of the guidance system for the operation bar and of the locking system through the fastening clip of the right points.

#### **B.6.3. Cause of the switch half – opening continuance**

The detachment of the fastening parts and the falling of the locking box from the curve stock rail of the switch no. 9, on the operating bar of the point lock, following the changes of the fastening and safety system of the locking box contributed to the half – opening of the right points against the curve stock rail over the operation accepted limits.

#### **B.6.4. Cause of getting the control of the operated switch in the conditions of its half-opening**

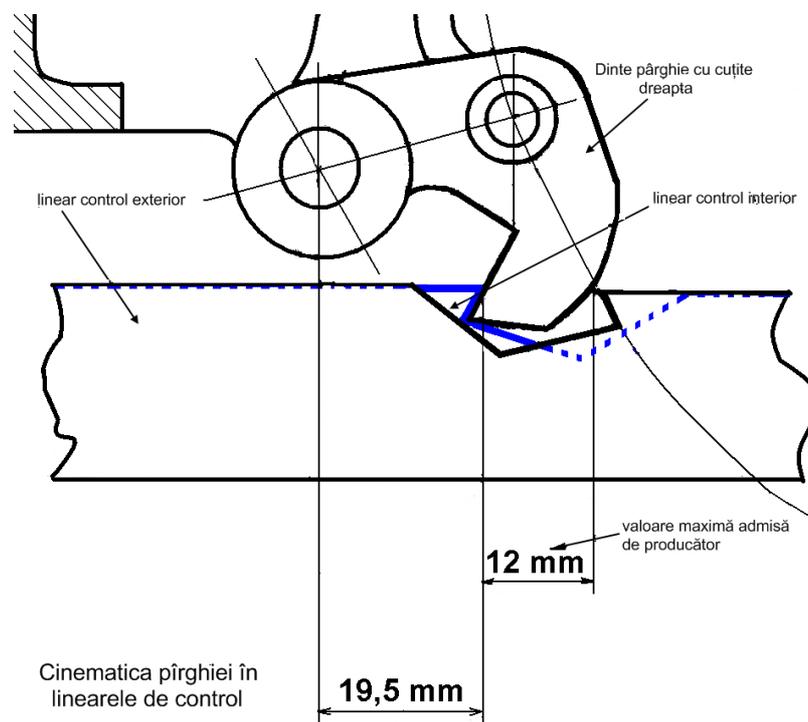
The operation control of the switch no. 9 points was performed through the control bars of the point motor. These are rigidly connected at the switch points through ensuring bolts, to which are not permitted clearances over 2 mm. During the checks of the investigation commission was found out that the control bars had no clearances in the fastening system with the ensuring bolts. The long control bar of the glued points corresponding to the switch position „ plus” was adjusted by forging ( cracks heating and hammering ), as was ensured the mechanic control of the point motor. The adjustment of the control bar is made by heating locally its cracks ( forging operation ) followed by the adjustment of the distance between the fastening bolts, according to the provisions of the art.

122, point a from the Instruction for the maintenance and repair of the signalling, centralization and block equipments (SCB) no. 315/1998.

Sendig the information concerning points stick or its unglue to the point motor is performed by the detector slides that have a special construction (to see the picture 25) and rigidly connected on the control bars by some pieces called linear bolt. At this assemble are not accepted clearances over 2 mm. During the investigation commission checks was found out:

- The inner detector slide, connected to the control long bar that controls the position of the point necessary to the switch for the position „on direct (plus)”, with the groove where enters the right lever with knives was artisanally changed on a length of 38 mm (picture 27)
- The out detector side, connected to the control short bar that controls the position of the point necessary to the switch for the position „on deflecting section (minus)”, with the groove where enters the left lever with knives was artisanally changed on a length of 38 mm (picture 27)
- The measured clearance to the end of the detector slides at the point motor no. 9 was 32,3 mm, much over the value of 12 mm accepted by the manufacturer (picture 27)

**The profile of the levers of the automatic switch during the notmal operation of the assemble** (or the automatic circuit-breaker of the point motor) is based on the in and out detector slides movement by the control bars, at their turn, they are moved by the switch points. The control of each of these two positions of the switch points is gotten when the claw of the lever with knives can move along in the same time in the grooves of the two detector slides, which maximum accepted value is 12 mm (picture 25).



picture 25

In order to identify the assembles that have an important role in getting the control of the switch no. 9 in the conditions of its half-opening, was performed a series of checks and simulations.

**B 6.4.1.** On the 11<sup>th</sup> of May 2008, in the halt Valea Calugareasca was performed the next tests and checks at the switch no. 9:

- With the box assembled with the fastening screws without be assembled the fasteing nuts, the switch was operated “on friction” because the detachment of the lock box from the fastening screws in the same time with the operation bar. The fastening screws did not fall at the moment of the switch operation, and the right points rested half-opened 40 mm. At the second operation the switch opening was complete, without having mechanic and electric control but when the blade detector-long was not straightened;
- With the blade detector-long straightened, the assembled box fastened with screws and the removal of the locking clip ( out of shape ) from the middle lock, the switch was operated with control on the both positions;
- With the box assembled without screws fastened, the switch was operated “on friction” because the detachment of the lock box from the fastening place in the same time with the operation bar.

**B.6.4.2.** On the 2<sup>nd</sup> of September 2008 in the railway station CFR Chiajna, on the switch no. 32 of the same type with the switch no. 9 from the halt Valea Calugareasca, electrical jointed with the switch no. 36 in the presence of the public railway infrastructure manager specialists, were performed the following checks in order to simulate the assemble conditions of the control bars. The point motor was provided with adjustable bars and detector slides of the point motor involved in the railway accident, in order to simulate the adjustments performed by the employees who ensured the maintenance of the interlocking devices. The simulation was performed by adjusting the bar of the points glued on the position “plus” as its detector slide be in the proper position with the groove edge at about 1/3 from its length resulted the following:

- At the first check performed with the locking box assembled on the switch was found out that during the check with an object of 4 mm, the switch was operated “on friction” , refuting the assumption of the public railway infrastructure manager specialists that “ a wrong assembly of the linear bolt artisanal worked could be found out during the check with the object of 4 mm”
- At the second check performed with the locking box released on the switch (a fastening nut disassembled and one released (the switch was operated “on friction” because the aleatory movement of the box.
- At the third check that was performed with the locking box detached from the switch ( the both nuts disassembled ), at the second operation, the switch was operated with control in the conditions of half-opening of 7 mm between the points and the stock rail, because the exit of the locking clip from the box following its movement and exit from the assembled place ( picture 26)

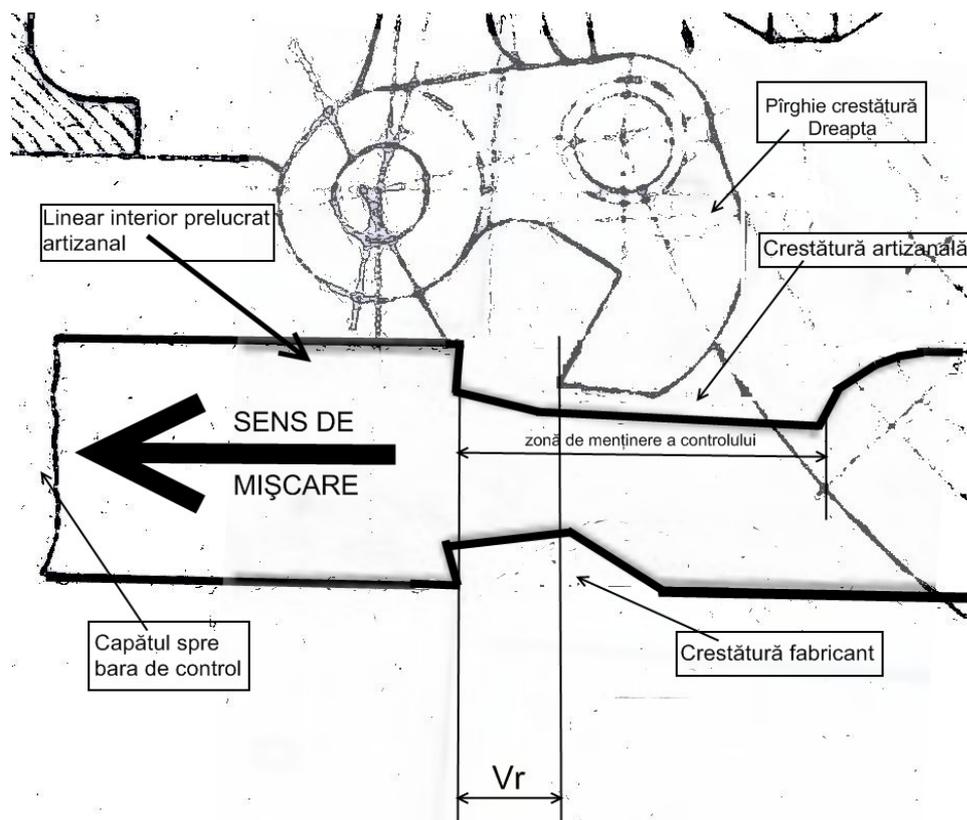


picture 26

Following the simulations in the railway station Chiajna, the investigation commission *concluded that in the conditions given by a detector slide to which was changed the groove on a length 3 times higher than this accepted by the manufacturer (38mm), the profile of the automatic switch rods in this operation of the assembly ( or the automatic circuit-breaker of the point machine ), can lead to a controlled operation of the switch, in the conditions of remaining a half-opening conditioned on the points positioning against the stock rail.*

This can be explained that, during the operation the inside detector slide moved to the connection with the blade detector-long ( arrow direction in the picture 27 ) from the nul value of the distance  $V_r$  to the value of 32 mm found out by the investigation commission. The movement condition to the bar of the inside detector slide is given by the decrease of the distance between its connection bolts in profile, that can be made:

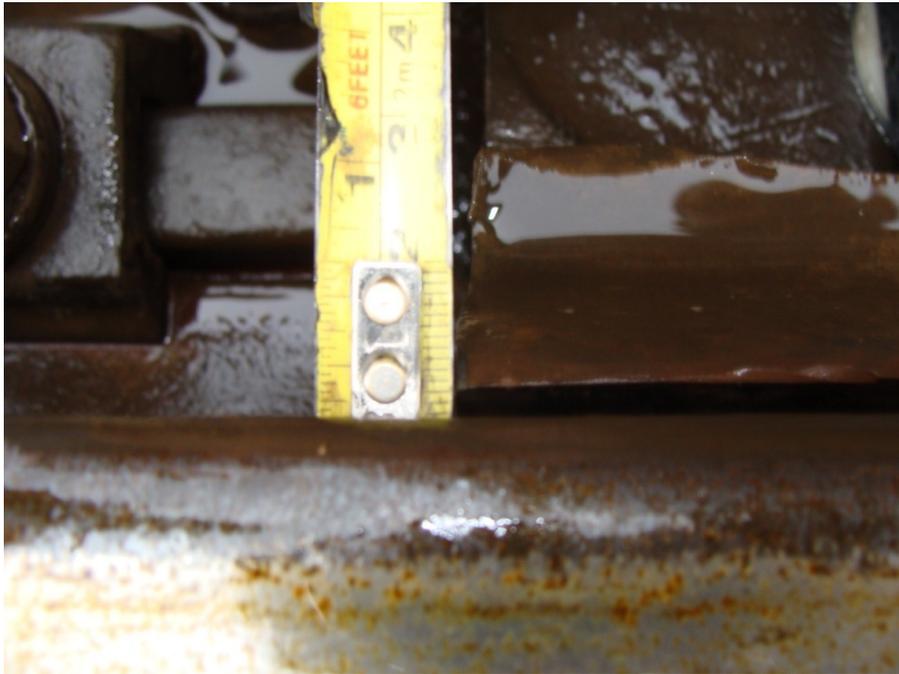
- By an unsuitable adjustment imposed by the forging at the control log rod adjustment, issue for which the execution staff is not responsible because the lack of the visibility of the claw in the grooves of the inner detector slider;
- by applying a force on the middle of the control long bar because of a adult person weight, distortion that could be increased also by the rolling stock ageing in time, in the conditions of a proper adjustment of the lever claw in the detector slide groove
- combination of the above cases, the most probable situation, taking into account the mixture of the malefactors present in the area



picture 27

**B.6.4.3.** On the 23<sup>rd</sup> of September 2008, in the railway station Giurgiu Nord, on the switch no. 24 were performed tests with a switch that complied with the conditions from the switch no. 9 of the halt Valea Calugareasca (ordinary switch with electric scheme on two stretch rails) and on which the public railway infrastructure manager specialists assembled adjusted bars for the point motor type EM 5, and detector slides with the manufacturer grooves. During the repeated simulations by

screwing off the nuts of the fastening screws of the locking box from the points on the position “plus” with a half-opening of the points of 2mm, the switch did not receive control (picture 28)



picture 28

Following the simulations in the railway station Giurgiu Nord, the investigation commission concluded that, at a linear with a groove that complies with the designing quotas, colligated with a assembly and an accuracy adjustment of the adjusting rods (a complete turning round of the screw correspond to variation of 0,5 mm), if the assemble locking box-clip could damaged (by detaching or breaking from its fastening ), the point motor does not received electric control at the moment of the locking box detachment from the stock rail if there is a half –opening accepted be the instructions in force (the obtained half –opening of 2 mm complies with the accepted instruction values).

**CONCLUSION:** Obtaining an electric control of the switch no. 9 for the position involved in the railway accident occurrence on the 10<sup>th</sup> of May 2008, with a half-opening between the right points and the curve stock rail, generated by the detachment of the locking box, was possible because the increase of the grooves from the control linear of the point motor from the manufacturing value to the value of 38 mm and of their intermediary position against the claw of the right lever with knives.. The size of the control linear grooves is consequence of the infrastructure manager non-drawing of some procedures and/or accurate technological instructions concerning the adjustment way of the control fixed gods, this operation being submitted to the professional training of the performer.

#### **B.6.5. Cause that lead to the train move order**

The establishment of the control electric circuit of the switch position was generated by the obtaining of the mechanic control in the conditions of a half-opening between the right points and the curve stock rail of the switch 9, colligated with the fact that the claw of the right contact lever had a free entrance in the grooves artisanal performed, though the control linear did not make a complete move.

As soon as was established the switch position control for the position “plus” by logical contacts of the electric schemes of the equipments CED, was given the permission to command the passing of the train no. 1661 that run on the 10<sup>th</sup> of May 2008, by posting the light “green”

#### **B.6.6. Remarks concerning the professional training of the employees involved in the subsystems maintenance.**

1. to prevent the possible situations when the switch crew fastening that could be released by self - screwing off is stipulated in the Instruction no. 323 for the head of the district permanent way inspector for the track maintenance, chapter 6, art. 26: ”The permanent way inspector will especially check: the situation of all switch parts, how strong are connections between them, especially between the draft bar and the points, pins fastening, screws fastening etc.”
2. on the 13<sup>th</sup> of March 2008, during the hidden parts check were not performed polishing works of the switch no. 9 points , so on the right points at the moment of the accident was a groove of 260 mm non-grinded. The provisions of the table 23, point 3a from the Instruction for norms and tolerances in track construction and maintenance no. 314/1989, that requires the polishing of the grooves over 200 mm, were not fulfilled.
3. the last 4 gauge measurements performed before the derailment and registered in the inspection book of the district switches, in the points from the right points heel (1), deflecting section points heel (2) and the middle curve (3) indicated that the gauge tolerance limit of 5 mm is systematically exceeded with values between 4 mm and 7 mm and these deviations were put in evidence by circle in the inspection note book. The provisions of the art. 19, point 2 and the values of the table no. 17 from the Instruction for norms and tolerances in track construction and maintenance no. 314/1989 were not fulfilled.
4. During the last inspection of the hidden parts (VPA), performed on the 13<sup>th</sup> of March 2008, according to the records from the inspection note book of the switches at the end of the works, 3 values of the gauge measurements and one of the level measurement performed in the characteristic points exceed the accepted tolerances with 4-7 mm at the gauge and 5 mm at the cross level. The technological process from the annex 2 of the Equipments and Tracks Direction Order 33/34-1978 concerning the inspection of the hidden parts of the switches, that at the preparing works stipulates the adjustment of the position in the plan and
5. the distortion of the right point end indicates that sometimes the repositioning works were performed through a brutal method of hitting the points end ( sledge hammer, drop hammer, etc ) in order do not release completely the fastenings of the locking box. One also found out that the technological process imposed by the Equipments and Tracks Directions through the annex 2 of the Order 33/34/1978 concerning the hidden parts of the switches, that stipulates the examination, in the basic works, of the holes in the points base and of the gudgeons against the displacement from the base plates ;

### **B.7. Accident causes**

#### **B.7.1. Direct cause**

**The direct cause** of the railway event was the penetration of the wheel’s tire lip from the right side of the first axle in the direction of the traffic of the locomotive (axle no.6), between the straight points and the curved stock rail of the switch no.9. This took place as result of allowing to operate the route in the conditions of half opening the point switch.

### **B.7.2. Facts that contributed**

The permit of performing the route took place as result of obtaining the control of the switch by a point motor, the control not being obtained properly in the conditions of the absence of the fastening elements of the locking box and of the produced half opening. This was due to the detector slides of the point motor that had the grooves of control widened in comparison with the projected.

The point switch half-opening was possible because of the locking box detaching from the fixing system in the conditions of the absence of the fastening elements ( screws and nuts) that was fixing it by the curved stock rail of the switch no.9, having as consequence the loss of the function of the locking and guidance system of the straight points.

### **B.7.3. Primary causes**

**Primary causes** of the railway event are:

- a. the absence of the specific regulations ( technical memorandum, working instructions, technological processes) on assembling, maintaining and repairing the point motors no.9 type EM5;
- b. the use of the fastening elements necessary to the locking box fastening of the curved stock rail are not corresponding to the technical documentation of the manufacturer;
- c. using for the point lock of the switch no.9 some constructive alternatives different from the technical documents of reference;
- d. non- assembling the crown nuts of the screws C2 and C4 of the point lock from the switch no. 9;
- e. keeping the screws DA M 22x65 with a fragment of used-up thread corroborated with the modification of the constructive solution designed by using the helical spring in place of the washers , fact that led to the situation that from the thread of the two screws only 4-5 and not all the designed surface;
- f. assembling in reverse position the arrester of the operating bar together with the screw C5 from the point lock of the switch no.9;
- g. non-replacing or non-reconditioning the used-up parts with the occasion of performing the examination tests of of the hidden parts of the switch, such as:
  - i. the cotters from the base of the points that is limiting the longitudinal displacement of the points;
  - ii. polishing the chipped corner of the right point of the switch no.9;
- h. widening the cuttings from the detectors slides of the point motor.

## **C. SAFETY RECOMMENDATIONS**

The beneficiary of the safety recommendations is the National Company of Railways “ CFR” S.A as manager of the public railway infrastructure.

The recommendations are given in order to solve the following aspects:

1. Performing an examination on the entire railway network in order to identify all systems that have not been homologated, with improvisations or modifications in comparison with the technical documents of reference in force used at the subassemblies of the switch fasteners with pincers and to the *detectors* of the point motors of type EM 5. Following these actions,

in case of identifying some major nonconformities a safety program for these safety installations shall be elaborated.

2. Elaborating some specific proceedings, technical memorandum, working instructions, technological sheets by which shall be specified the way of assembling, maintaining, repairing of the point motors of type EM5, including the method of mechanical control adjustment with the occasion of performing these type of works.
3. Elaborating a normative document promoted through an order of the minister of transports and infrastructure by which shall be prohibited the performance of constructive changes without the approval of the central public authority from the railway transport field by the employees that are ensuring the maintenance of the components of the interlocking installation assemblies.
4. Developing the level of the technical professional knowledges and improving the practical abilities of the personnel that are managing, maintaining and repairing the points and crossings and the point motors by internal courses or in specialized institutions followed by the professional examination of these.
5. Accelerating the implementation of the safety management system at the level of the public railway infrastructure manager as foreseen in the Law no.55/2006 on the railway safety.
6. Starting an examination action at the level of the public railway infrastructure manager of the personnel activity with responsibilities in traffic safety and of those with responsibilities in training and controlling for the nonconformities found with the occasion of this examination action referring to the elements of the switch no. 9 of Valea Calugareasca. The conclusions of this action and also the possible disciplinary measures shall be contained in a Report that shall be submitted to the Romanian Railway Investigating Body.

This Investigation Report will be sent to the public railway infrastructure manager/administrator, railway undertakings and Romanian Railway Safety Authority.

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

Investigation commission members:

- STOIAN Eduard - investigator in charge \_\_\_\_\_
- OLARU Mihai - member \_\_\_\_\_
- DRĂGHICI Marin - member \_\_\_\_\_
- CIOBANU Eugeniu - member \_\_\_\_\_
- ZAMFIRACHE Marian - member \_\_\_\_\_
- SFÂRLOS Dumitru - member \_\_\_\_\_
- TOADER Doru-Cătălin - member \_\_\_\_\_

