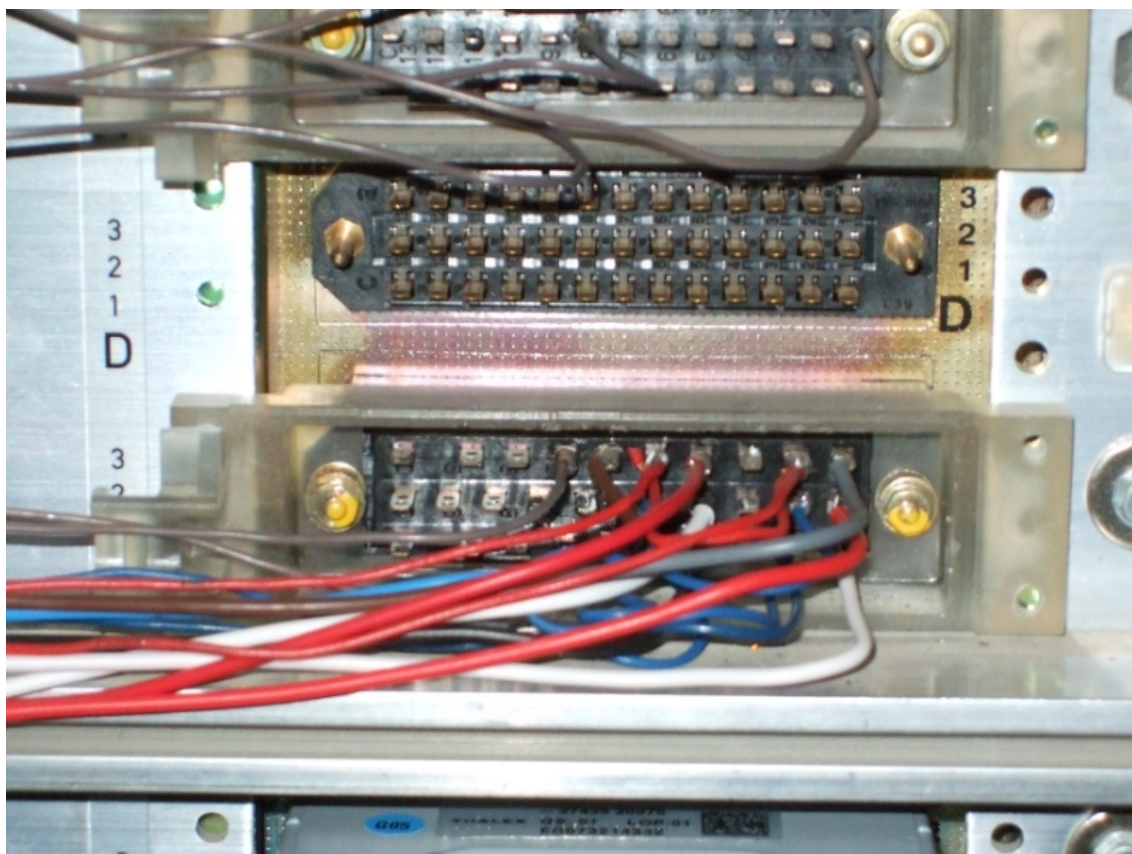




## INVESTIGATING REPORT

on the railway incident

happened on the 16th of December 2008 in the railway station Basarabi



*final edition*

*the 15 th of december 2009*

Romanian Railway Investigating Body performed an investigation of the railway incident, happened on the 16th of December 2008, in the railway station Basarabi, according to the legal provisions.

Through the performed investigation, there were gathered and analyzed information concerning the occurrence of this incident, the conditions were established and the causes determined.

The investigation of Romanian Railway Investigating Body does not aim to establish the guilty or the responsibility in this case.

Romanian Railway Investigating Body considers as necessary to take some corrective measures in order to improve the railway safety and to prevent the incidents, and accordingly it made some recommendations this report.

Bucharest,  
the 15<sup>th</sup> of December 2009

Director  
Dragos FLOROIU

	Page
<b>I. RESUME</b>	
<b>I. Preamble</b>	<b>5</b>
<b>I.1. Introduction</b>	<b>5</b>
<b>I.2. Investigation process</b>	<b>5</b>
—	
<b>A. Incident brief presentation</b>	<b>6</b>
<b>A.1 Brief presentation</b>	<b>6</b>
<b>A.2 Direct cause , underlying and root causes</b>	<b>6</b>
A.2.1 Direct cause	6
A.2.2 Underlying causes	7
A.2.3 Root causes	7
A.3. Strictness of the incident	7
<b>A.4. Safety recommendations</b>	<b>7</b>
<b>B. Investigation report</b>	<b>9</b>
<b>B.1 Incident presentation</b>	<b>9</b>
<b>B.2 The background of the occurrence</b>	<b>11</b>
B.2.1 Parties involved	11

B.2.2 Train forming and equipment	11
B.2.3 Railway equipments	12
B.2.4 Communication facilities	12
B.2.5 Starting of the railway emergency plan	12
<b>B.3 Incident consequences</b>	<b>12</b>
B.3.1 Deads and injuries	12
B.3.2 Material damages	13
B.3.3 Consequences of the railway incident on the railway traffic	13
<b>B.4 External circumstances</b>	<b>13</b>
<b>B.5 Record of investigations</b>	<b>13</b>
B.5.1 Brief presentation of the involved staff testimonies	13
B.5.2 Safety management system	16
B.5.3 Norms and regulations. Sources and references for investigation	16
B.5.4 Operation of the technical equipments, infrastructure and rolling stock	17
B.5.4.1 Data on equipments	17
B.5.4.2 Data on lines	20

B.5.4.3 Data found out at the functioning of the rolling stock and its technical installations	20
B.5.5 Interface man – machine – organization interface (psychological considerations concerning the organizational deficiencies that led to railway incident occurrence)	20
<b>B.6 Analysis and conclusions</b>	<b>21</b>
<b>B.6.1 Interpretation of the data found out by the technical and inquiry commission</b>	<b>21</b>
<b>B.6.2 Interpretation of the data found out by the investigation commission</b>	<b>23</b>
<b>B.6.3 Analysis of the railway incident occurrence</b>	<b>27</b>
B.6.3.1 Analysis of the causes of the wrong switch position in the coupled switch 9/15 and getting of the wrong control	27
B.6.3.2 Analysis of the cause that led to the wrong position of the switches from the coupled switch 9/15 and getting of the wrong control	30
B.6.3.3 Analysis of the cause that led to the return of the coupled switch 9/15 to the right operation	32
<b>B.6.3.4 Tests performed by the investigation commission</b>	<b>32</b>
<b>B.6.4 Cause that allowed the train route order</b>	<b>33</b>
<b>B.6.5 Analysis of the scheme and conclusions</b>	<b>33</b>
<b>B.6.6 Findings on the training of the employees responsible with the system maintenance</b>	<b>34</b>
<b>B.6.7 Analysis of the operation staff intervention</b>	<b>34</b>

<b>B.7 Accident causes</b>	<b>34</b>
B.7.1 Direct cause. Causal factors	34
B.7.2 Underlying causes	35
B.7.3 Root causes	35
<b>C. Safety Recommendations</b>	<b>35</b>

## **1. PREAMBLE**

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

Romanian Railway Investigating Body, hereinafter referred as OIFR, started an investigation in order to prevent incidents or accidents with similar causes, establishing the conditions and the causes and making safety recommendations.

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

### **I.2. Investigation proces**

OIFR being notified about the occurrence of a railway incident in the railway station Basarabi, went to the incident place and found out the wrong entry of a train on an line occupied by a stopped train, although the movement inspector operated right the interlocking system and the signaling on the push-button interlocking frame was suitable.

The happened facts were appointed as railway incidents, according to the provisions of art.3, letter o of the Law 55/2006 concerning the railway safety. Taking into account that this incident under slightly different conditions could lead to a serious accident, OIFR director made the decision, according to the provisions of the art.19, paragraph (2) of the Law 55/2006 to perform an investigation.

Through the decision no. 9 from the 17<sup>th</sup> of December 2008 of OIFR director, there was designated an investigation commission, consisting in :

- OLARU Mihai – investigator in charge
- TOADER Doru Cătălin – investigator
- DOBRE Florin – investigator
- SFÂRLOS Dumitru – investigator

At the railway incident place were immediately present the representatives of Romanian Railway Authority – AFER, National Railway Company “CFR” SA – administrator of the railway infrastructure, National Railway Passenger Company “CFR” Calatori SA – railway undertaking and SC Thales Signalling Solutions SRL Bucuresti - responsible with the modernization of the interlocking system.

The removal of the railway incidents effects was coordinated by the members of the inquiring commission appointed in accordance with the specific regulations in force.

## **A. INCIDENT BRIEF PRESENTATION**

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

On the 16th of December 2008, at 20:24 hour, the passenger train no. 8205, consisting in 7 coaches, 28 axles, 346 t, hauled by the locomotive EC 128, belonging by the Depot Tecuci – Buzau working place, of National Railway Passenger Company “CFR” Calatori SA, that run between Buzau – Constanta, had entry order on the line II from the railway station Basarabi.

The railway incident place is in the railway county Constanta, between the railway stations Dorobantu – Valul lui Traian, at the km 2007+360, in the area of the switches from the end of the railway station Basarabi.

The track is without gradient, with a slight curve to the left of the traffic direction, it running on the left line II.

When the train started to move on the ordered route, on the basis of the open position of the entry signal XF from the railway station Basarabi, the driver found out that the entry route has no access to the direct line II, as it should to be according to the position of the entry signal, but to the deflecting section 1, occupied by the stopped train no. 8018.

The driver stopped the train on the turnout no. 9, in the area of its switch. The turnout no. 9 is coupled with the turnout no. 15, and are operated by the point machines type L700H, constituting the coupled switch no. 9/15.

The movement inspector had performed the entry route on the direct line II from the railway station Basarabi, operating the interlocking system type CR2, adjusted for point machines type L 700H.

The consequences of the wrong performance of the entry route of the train no. 8205, by running of the locomotive on the coupled switch 9/15, in the position in which the turnout no. 9 was with access on the line 1 occupied by the train 8018, were decreased because of the vigilance of the driver who took into account the position of the former entry signal XF and decreased the speed at 5 km/h, running with repeated stops, until he observed that the train is routed to the line 1 instead the line II.

Before the occurrence of the railway incident, the infrastructure administrator started works at the interlocking structural subsystem from the railway station Basarabi, taking out of service the electro-dynamic interlocking system type CR3 with domino desk in order to perform running and shunting and the replacement with an interlocking system type CR2, adjusted for the point machines type L 700H of own design, manufactured and fitted by Thales Rail Signalling Solutions SRL Bucuresti

### **A.2. Direct cause, undelying and root causes**

#### **A.2.1. Direct cause**

**The direct cause** of the railway incident is the wrong answer of the interlocking system type CR2, adjusted for the pint machines type L 700H, that consisted in getting the electric control and the signal on the track diagram of the coupled switch no. 9/15 on the position “direct” when the switch no. 9 was on wrong position with access on the deflecting section 1.

**A.2.2 Underlying causes** of the railway incident that led to the wrong answer of the interlocking system type CR2, adjusted for the point machine type L 700H are:

- Existence of a short circuit in the control scheme of the switch no. 9, situated between the control electromagnetic relays of the position of the switch no. 9 and the coupling B of the switch group, manufactured in Germany, following the wrong performance of the fitting works;
- Loss of the control of the switch 9/15 after passing the passenger train no.1821-2 on the direct line (before giving the entry order for the passenger train no. 8205);
- One pressing of the operation button of the coupled switch 9/15, without operating the lever that was on “plus” position.

**A2.3. Root causes** of the railway incident were:

1. lack of homologation/certification of the interlocking system type CR2, adjusted for the point machine type L 700H and its acceptance in operation by the representative of the railway infrastructure administrator, without the preliminary authorization for the putting into service;
2. the designing and achievement of the control scheme of the coupled switch 9/15 from the interlocking system, that do not allow its wrong answer if some short-circuits appear in the inner cabling of the equipments, cumulated with the loss of the switch control and the operation of the button corresponding to the switch in the position in which it lost the control;
3. lack of some principles for the design, clearly regulated, that ensure the unitary design/ application of the electric scheme of railway safety, corresponding to the requirements of the railway infrastructure administrator and accepted by the respective authority;
4. the inadequate monitoring of the infrastructure administrator, during a limited period of time.

### **A.3. Strictness of the incident**

According to the provisions of the art. 3, letter o of the Law no. 55/2006 concerning the railway safety, the event, through its consequences, can be taken as railway incident.

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

The recommendations aim to settle the next issues:

1. Drawing by the railway infrastructure administrator of some technical norms on the principles and the design of the railway safety electric schemes from this type of interlocking systems, in order to meet with the railway safety.
2. The public railway infrastructure administrator will take all the measures for the application of the respective legislation for the putting into service of the structural subsystems and of the interoperability constituents and the homologation/certification of the railway critical products.
3. The administrator of the public railway infrastructure will found out all the cases of equipments used along the track for a limited period of time and that are not homologated/certified, respectively authorized for the putting into service and the meeting with the specific legislation.
4. The administrator of the public railway infrastructure will present monthly to Romanian Railway Investigating Body a copy of each dossier on the failures of the interlocking subsystems with new technology, that generate traffic interruptions.

This Investigating Report, will be sent to the administrator of the railway public infrastructure, Railway National Company “CFR” SA., railway supplier Thales Rail Signaling Solutions SRL Bucuresti, Romanian Railway Notified Body and Romanian Railway Safety Authority.

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

## **B. INVESTIGATING REPORT**

### **B.1. Incident presentation**

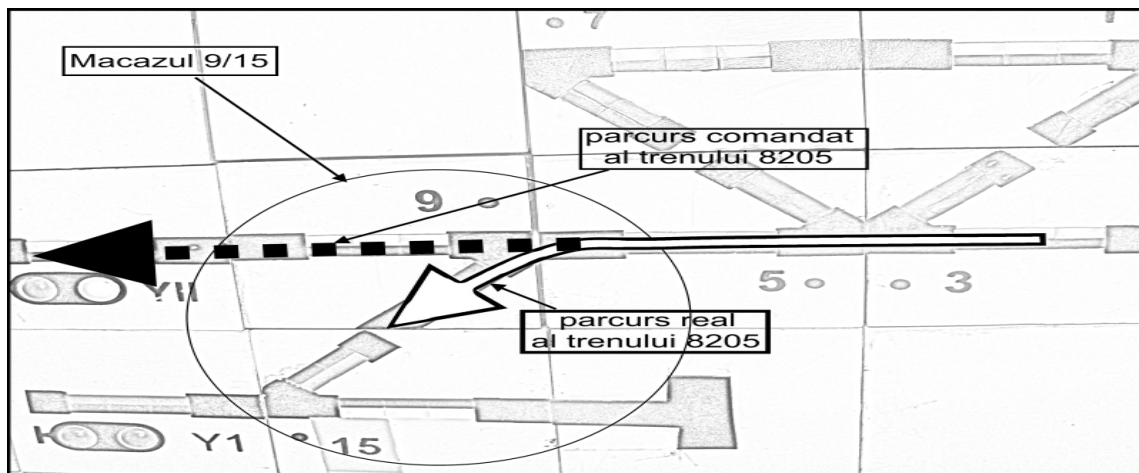
On the 16<sup>th</sup> of December 2008, the passenger train running between Buzau and Constanta left the railway station Dorobantu and run on the open line II Dorobantu – Basarabi, because of the complete closing of the open line I for modernization works of the infrastructure, part of the reconstruction and modernization project of the pan-European corridor IV. According to the train diagram, after leaving the freight halt Poarta Alba, the next stop had to be the railway station Basarabi.



(picture 1).

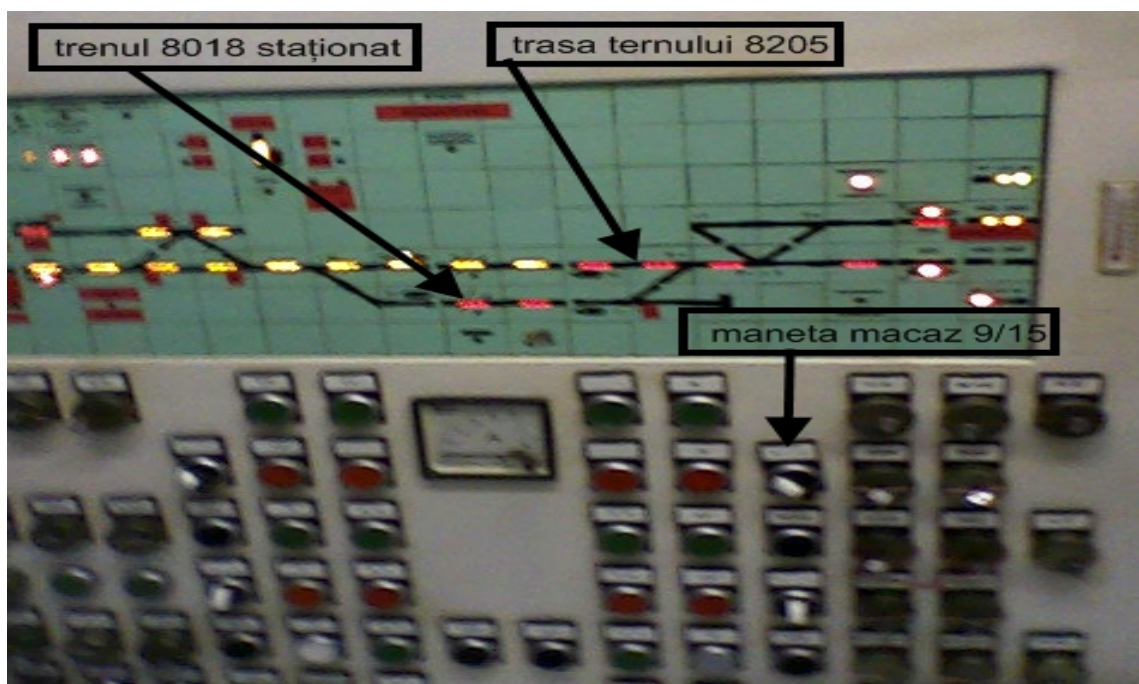
After leaving the passenger halt Poarta Alba ( at 20:13 hour ), the train 8205 run on the open line II to the railway station Basarabi with the speed 60km/h up to the signal PrXF, then the speed decreased at 26 km/h up to the entry signal XF.

After seeing the free passing colour “yellow”, the driver passed the entry signal XF (at 20:20 hour) from the railway station Basarabi and run about 55 m, then stopped the train following seeing a signal on “red”. Accoring to the explanations of the movement inspector about the role of this signal, respectively it is an entry signal XF of the former interlocking system, the driver run the train with a maximum speed of 5 km/h to the line II and found out during the running to the switch no. 9 that this did not permit the access to the direct line II, according to the position of the entry signal, but the access was to the line 1 occupied by the train 8018 (picture 2). At 20:24 hour, the driver broke rapidly on the area of the switch no. 9 of the station, preventing the collision of the trains.



Picture 2

During the operations necessary for the entry order, the movement inspector did not see any failure in the operation of the interlocking system type CR2 adjusted at the point machine type L 700H from the railway station Basarabi, the indicators from the push button interlocking frame correspond to the ordered route (picture 3).



Picture 3

In these conditions, the movement inspector notified the traffic controller Constanta and the station manager about the railway incident occurrence, in accordance with the provisions of the Instructions for the prevention and investigation of the railway accidents and events no. 003/2000.

Because both of the vigilance of the driver and of some contributing factors (former signal XF of the former equipment CED was permanently on the position “red”, although it was out of operation, visibility conditions reduced because of the darkness and the route of the train was in curve) that led to the speed decrease to a very slow speed (maximum 5 km/h), there was avoided the collision of the passenger trains with serious consequences on the railway infrastructure and rolling stock integrity , or the possible victims between the passengers.

## **B.2 The background of the occurrence**

### **B.2.1 Parties involved**

The traffic section where happened the railway accident is managed by CNCF “CFR” SA and maintained by its employees.

The interlocking system for the trains running in the railway station Basarabi was designed and manufactured by SC Thales Rail Signalling Solutions SRL Bucuresti for the adjustment of the point machines L 700H of the equipment CR2. This was managed by CNCF “CFR” SA and maintained by the employees of the District SCB Basarabi from the Track Section CT 1 Constanta, Railway County Constanta. This equipment was fitted for a limited period of time, then it had to be taken out of operation at the completing fit of the interlocking system based on technical computing ESTW L90, manufactured by SC Thales Rail Signalling Solutions SRL Bucuresti.

The work consultant is the consulting company ORICONSLUT, changed in Pacific Consultants Intenational SA Tokyo, Bucharest branch.

The railway communication facilities from the railway station Basarabi is managed by CNCF “CFR” SA and it is maintained by the employees of SC TELECOMUNICATII SA – Constanta branch.

The electrification system is managed by CNCF “CFR” SA and maintained by the employees of SC ELECTRIFICARE CFR SA – Constanta branch.

The Railway communication facility from the locomotive is owned by SNTFC “CFR Calatori” SA and maintained by its employees.

The locomotive and the coaches from the train involved in the railway incident are owned by SNTFC “CFR Calatori” SA and maintained and inspected from the technical point of view in the route by its employees, and the repairs are performed by the economic agents authorized as railway suppliers.

The investigation commission questioned the employees involved in the interlocking system construction, in its maintenance, railway traffic management as well as the driver.

### **B.2.2 Train forming and equipments**

The train consisted in 7 coaches, 346 gross tonnage, 28 axles, automatic braked according to the timetable 249 tonnes, in fact braked 450 tonnes, plus 201 tonnes against the timetable, handbraked according the timetable 35 tonnes, actually 140 tonnes, length 200m and was hauled by the locomotive EC 128 belonging to the Railway Depot Tecuci, Buzau Working Place, SNTFC “CFR” Calatori SA,

The Safety and Warning Devices (DSV), punctual control equipment traffic lights (INDUSI) from the endowment of the motive power were active and operated according to the instruction and with the automatic braking active.

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

The switch no. 9 has the geometrical point (PG) at the km 207+360 and its is coupled with the switch no. 15, that build up the coupled switch 9/15 in the interlocking system type CR2, adjusted for the point machines type L 700H.

The equipments for the achievement of the traffic safety, organization and performance of the trains running is automatic, the switches and signals being in a relay interlocking system (CED) type CR-2 (relay interlocking system), with functions only for the train running, adjusted for the point machines type L 700H, manufactured by SC Thales Rail Signalling Solutions SRL Bucuresti. For it was necessary that the classic electric schemes be changed, so the operation control of the switches be possible through the German equipment (switch block ), technical issues accepted by the work consultant and by its beneficiary ( CNCF “CFR” SA).

The switches no. 3, 5 and 9 area and the lines II and 1 from the railway station Basarabi are without gradient, preceded by a curve.

On the 16<sup>th</sup> of December 2008, in the railway station Basarabi, the place of the railway incident, some works were performed at the subsystem command and control and signalling (equipment for the achievement of the safety, organization and performance of train running and shunting) by taking out of service the electrodynamic interlocking system type CR-3 (of Romanian conception) and putting into operation the electrodynamic interlocking system type CR2 adapted for point motors type L 700H, designed and built by SC Thales Rail Signaling Solutions, subsidiary of the German society THALES and accepted by the work consultant PACIFIC CONSULTANTS INTERNAȚIONAL. This installation ensures the requirements of safety, of organizing and performing the railway traffic only for the line 1 and II, with exits only for the open line II to Dorobanțul and Valul lui Traian railway stations (the other open line being completely closed to the traffic), and was meant to function until the completion of the works to the subsystems infrastructure and energy and to be replaced with an installation type ESTW L90 manufactured by Thales Rail Signaling Solutions Germany.

#### **B.2.4. Communications facilities**

The connection between the engine driver and the movement inspectors, also between the engine driver and the train crew was ensured by the radiophone installation.

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

Immediately after the railway incident occurrence it wasn't necessary to start the intervention plan to remove the damages and re-establish the trains movement, the railway incident being notified through the circuit of the information mentioned to annex 2 of the Instructions for preventing and investigating the railway incidents and events – no.003/2000. Following the notification were also present the representatives of the National Company of Railways “ CFR” SA – the railway infrastructure administrator, of the National Society of Passenger Railway Transport “ CFR Calatori” SA – the railway transport operator and of the Romanian Railway Authority-AFER but also of the constructor Thales Rail Signaling Solutions Bucharest.

### **B.3. Incident consequences**

#### **B.3.1. Deads and injuries**

Following the railway incident no victims or injuries persons were registered.

#### **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 by the manager of the public railway infrastructure is the following:

- **To the line** - it weren't;
- **To the installations** - it weren't;
- **To the wagons** - it weren't;
- **The cost of the intervention means** - it weren't;
- **To the environment** - it weren't;
- **Other damages (delays of trains)** -360 lei according to the estimate no.6/4345/2008

### **B.3.3. Consequences of the railway incident on the railway traffic**

The second direct line and the first deflecting line were closed to the railway traffic on December 16, 2008 from 20:24 o'clock to 22:01 o'clock (data recorded in the investigating file no. F 31/42/2008 drawn up by SRCF Constanta and taken over by the management of CNCF "CFR" through the document no.4/k/47A/2009).

Due to the railway accident occurrence the following trains have delayed:

- train no.8205 with 140 minutes;
- train 8018 with 135 minutes;

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

On December 16, 2008 in the interval 20:00-20:30 the visibility was reduced, the temperature was of approximately 15 °C, clear sky, without wind, with reduced luminosity during the night.

In Basarabi railway station the line II was available, the first line being occupied by the passenger train no.8018. The lines III, 4, 5 and 6 were closed to railway traffic and for train's shunting.

In the area of the railway incident occurrence, the line is straight and flat.

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

### **B.5. Record of investigations**

#### **B.5.1. Brief presentation of the involved staff testimonies**

From the statement of the **movement inspector** on duty on December 16, 2008 during the works from Basarabi railway station, we can retain the following:

- on the day of the railway incident occurrence, according to the telegram no.5/1/3130/2008 from RCF Constanta District – the regional commission for closing lines, removal of the voltage and speed restrictions, were foreseen "works of putting into function the temporary installation type CR-2" during which was helped by an external movements inspector;
- at 18:10 o'clock, according to the record from RRILSC no.153, the electrodynamic installation type CR-3 that was operating in the railway station was taken out of service and was put into function the "temporary" electrodynamic installation of type CR-2, reason for which he took his documents from CED building and moved in an office in the building of the railway station where the control panel of the "temporary" installation was installed, continuing to perform the trains movement with the new interlocking system;
- around 19:21 o'clock, after dispatching the train 8343-2 that was on the first line of the railway station, he found that all employees of the constructor and of the beneficiary left,

except the regional examiner that was supervising, the activity being performed without supervising the new interlocking system;

- at 19:25 o'clock, after the train 1821-2 passed on the second line, when returning in the office he noticed "the loss of control" of the switch 9/15 and the isolated sections 1-15 and 023 of the exit distance remained locked, being free without rolling stock on it;
- after he recorded with no.156 in RRILSC, he artificially released the sections that were locked and pushed the switch button 9/15, without operating its handle because it remained on the position "plus" (with access on line II);
- the button operation ended with signalling the control on the position "plus" on the control panel, position that was handed over to the movement inspector on duty (at 20:02 o'clock) on December 16/17, 2008;
- he informed the electromechanic on duty to Dorobantu railway station, communicating to him that he will arrive to Basarabi railway station with train no.8205.

From the statement of the **movements inspector** on duty on December 16/17, 2008, during the railway incident occurrence to Basarabi railway station, we can retain the following:

- on the day of the railway incident occurrence he took over the "temporary" interlocking system to which the signalling of the controlled elements was displayed without showing fault indications in operation;
- he also found that the old electrodynamic installation was taken out of service and to the new temporary installation was an interruption shown by losing control of the conjugate switch;
- he performed the incoming route in station of the train no. 8018 to line 1, after stopping at the line serving a siding he operated the button of the entry signal XF for the route of the train no. 8205 at line II that was available;
- on the control panel he noticed that the route was performed and locked at the direct line II, the repeating entry signal displaying the free position, situation which:
  1. order "permissive passing with the established speed, attention the next signal ordered the stop" according to the Instruction for signalling;
  2. the position and the locking of switches that are a part of the route in the right position, necessary for the route at line II;
  3. the impossibility of the subsequent handling of switches that entered in the route ordered at line II.
- previous to the command of entry of the train no. 8205, he handled twice the switch 9/15 following the disposition of the operator from the traffic controller Constanta to put into service the train no.8018 from the line 1, disposition that afterwards was cancelled;
- after he noticed that the train no. 8205 passed the entry signal XF (being at the control panel) he operated the button of the exit signal X II for dispatching the train, following that after this train, to be dispatched also the train from line 1;
- the engine driver of train no. 8205 communicated to him by radiophone the fact that after passing the entry signal XF he encountered a signal with "red" position and stopped, reason for which he communicated that it is a signal out of order and should be instructional signalled (two crossed slats on the signal) and must continue its route to line II serving a siding;
- after two minutes the engine driver communicated to him the fact that the route gives access to line 1 occupied by the train, not to direct line no. II and stopped the train over the switch no.9;
- he went on the field for findings, as on the control panel the position was displaying the occupation of the isolated section 1-15 with route at line II (photo no.4);

From the statement of the **engine driver** of the locomotive EA 128, that hauled the passenger train no. 8205, we can retain the following:

- before its entry to Basarabi railway station he was informed by radiophone that the train has an entry order on the direct line no. II of the railway station, without other comments as those foreseen in BAR;
- displaying the colour “green” at the caution signal PrXF and at the entry signal XF the colour was “yellow”;
- after the exit from the curve, running almost 100 meters, he noticed a signal that was displaying “red”, reason for which he requested explanations to the movements inspector;
- the movements inspector communicated that it is the old entry signal XF and it should have been taken out of service and signalled according to the instruction by applying some crossed sticks on the signal;
- as approaching at 4-5 meters by the signal that was displaying “red”, he noticed the signalling for taking out of service the signal, reason for which he continued the route with a speed of maximum 5 km/ hour to the line serving a siding;
- during the route to the line II of serving a siding, he noticed that the switch no.9, from which ramifies the direct line no.II and the deflecting section no.1, it is not accordingly to the position necessary to the ordered route by the indication displayed at the entry signal, giving access to the deflecting section no.1 that was occupied by a standstill train. Following this he operated the emergency brake, immobilizing the train with the locomotive over the built-up common crossing of the switch no.9 to the first deflecting section;
- after the train stopped, he contacted by radiophone the movements inspector and communicated the fact that the train no.8205 was routing to the first occupied line. After establishing the situation, the engine driver informed the hierarchical chief of depot Tecuci - working point of Buzau.

From the statement of the **interlocking system electromechanic** that presented to the interruption occurred previous to the incident, we can retain the following:

- it was located to Dorobantu railway station when he was informed by telephone by the occurrence of the interruption, by loosing control of the switch 9/15;
- the shift was done to Dorobantu railway station, following that after taking over the shift to move to Basarabi railway station in order to survey the interlocking system at disposal of the chief of district;
- travelled by train no.8205 to Basarabi railway station where he found that the stop of the train over the conjugate switch 9/15 and also the routing of the train to the occupied line;
- he didn't interfere in the interlocking system functioning till the commission arrival;

From the statement of the **chief of Basarabi interlocking system district**, we can retain the following:

- he noticed that the switch no.9 is not accordingly to the position necessary to the conjugate switch of the switch no.15, this giving access to line 1 occupied by a train (“on diverted position”), while the switch no.15 was located with access to the shunting line (“straight position”);
- the control on the control panel for the conjugate switch was indicating the position “direct line”;
- together with the investigating commission it was taken the decision of unblocking the traffic by:
  - withdrawal of train no.8205 on the same route that it arrived right on the signal XF, followed by the shunting of the point motor no.9 with the handle (manually) on straight position and bringing the train at line II serving a siding of the railway station;
  - the shunting of both point motors with the handle on the “diverted” position necessary to dispatch the train 8018 from the first line of the railway station to Dorobantu railway station;

- while performing the train movement, the signalling of the control panel was showing “conjugate switch 9/15 without control” and after bringing in the position that was found at the moment of the incident, the switch regained control for the “straight” position;
- Functioning tests were performed operating in automatic mode with the conjugate switch 9/15 with its turnouts non-accordingly, the switch being operated with control on both positions “representing the position of the switch 15”;
- During the functional tests “time in which the switches were operated accordingly and with control on the control panel”, without “repeating the situation before the incident occurrence”;
- “when returning to the container I asked the staff of Thales what works they performed in the container, the staff said that they verified the integrity of the wires from the coupling B, the contacts 11 and 21 till the Romanian motorised train, by detachment and sticking them back on the terminals of the coupling B the contacts 11 and 21”.

From the statement of the **deputy head of department CT 1 Constanta**, we can retain the following:

- on December 16, 2008 he performed “the tests of good functioning and conformity to switches 9/15 with the team on the field” composed of employees of department CT 1 Constanta;
- the movements inspector wasn’t present to the control panel during the performed tests.

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

In performing its tasks and responsibilities, the infrastructure administrator CNCF „CFR” SA didn’t establish its own safety management system, but it started the informing on the requirements necessary to draw up the documentation that is going to be submitted to the department within Romanian Railway Safety Authority in order to be approved.

In this context, CNCF „CFR” SA doesn’t ensure the control of all risks associated with the activity of infrastructure management, when using the contracting parties for works of renewal, modernization or repair that are presuming a particular complexity by affecting the safety level of the technological installations used in routing the railway traffic should be a separate approach in the safety management system.

There isn’t implemented a safety policy at the level of CNCF „CFR” SA that should express and reflect the commitment, the obligation (mission) and the strategic vision of an organization as regards the railway safety that should include a statement of intent and to supply indications on global direction and to general objectives of the safety management system.

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

At the railway incident investigation the following were taken in consideration:

- the photos realized immediately after the incident occurrence put at disposal by witnesses or AFER’s representatives;
- the photos realized immediately after the incident occurrence performed by the investigation commission members and the examination commission members ;
- the documents on putting into function the railway installation put at disposal by their responsible;
- the documents on the process of leading and regulating the trains movement;

- the results of the measurements performed to the interlocking system, immediately after the railway incident occurrence;
- examination and interpretation of the technical state of the elements involved in the incident: “temporary “ interlocking system and point motor;
- questioning the employees involved with mounting and maintenance of the conjugate switch no.9/15;
- questioning the personnel relating to professional training, professional knowledges and their interpretation;
- electric schemes of the interlocking system, designed and accepted;
- regulations, instructions, technological processes concerning construction, functioning and maintenance of the” temporary “ interlocking system and point motor of type L 700H;
- technical specification no.2/2001 of the point motor L 700H issued by SC Thales Rail Signalling Solutions SRL Bucuresti, approved by AFER through the certificate of technical homologation series OT 142/2001;
- technical specification no.9/2001 of the interlocking system type ESTW L90, issued by SC Thales Rail Signalling Solutions SRL Bucuresti ( ALCATEL SA Stuttgart) approved by AFER through the certificate of technical homologation series OT 144/2001;
- technical Regulation of Railway Operating no.002, approved by the Order of the Minister of Public Works, Transport and Housing no.1186 of August 29, 2001;
- the Signalling Regulation no.004 approved by the Order of the Minister of Transports, Constructions and Tourism no.1482 of August 4, 2006;
- instruction for technical maintenance and repairing the interlocking systems no.351/1988, approved by the Order of the Minister’s Deputy of Transports and Telecommunications no.1749 of September 23, 1988, with ulterior modifications;
- order of the Minister of Transports no.290/2000 on technical allowance of the products and/or services for the use in the activities of building, upgrading, maintenance and repair of the railway infrastructure and rolling stock, for the railway and subway transport.

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

##### **B.5.4.1. Data on equipments**

The order for the entry route for the passenger train no.8205 was performed with help of the interlocking section adapted for the point motors type L 700H with the light entry signal XF that displayed the indication ” permission of passing with the established speed. Attention! The following signal was ordering the stop”, a yellow colour –light signal for the train.

The interlocking system is the conception of Thales Rail Signalling Solutions SRL Bucuresti and is based on the Romanian concept of the electrodynamic interlocking system with relays type CR-2, adapted for the interconnection with the equipments necessary to operate the point motors of type L 700H.

The point motor that operated the switch no.9 is type L 700 H with electric three-phase motor, the operation of the switch being performed by hydraulic procedure, critical railway product that was granted with an agreement from AFER and manufactured by Thales Rail Signalling Solutions Germany. The point motor no.9 is a part of the structural subsystem command-control-signalling and its role is to operate the points of the switch and to control their displacement and attachment from the stock rail.

The assembling of the interlocking system of Basarabi railway station was limited in time and functionally, its role being to ensure only the centralised orders of the routes on the lines I and II from Basarabi railway station and open line II Dorobantu- Basarabi- Valul lui Traian.

The works of construction and assembling of the interlocking system of type CR2 adapted for point motors type L 700H were performed in the period September – December 2008 according to the technical documentation, approved by the project’s consultant and was put into function by the

beneficiary of the work. The last intervention of the constructor's employees was on December 16, 2008 shortly before putting into function the installation and consisted in mounting a relay to the switch 9/15 (on the field, to the picket with devices).

The putting into function of the interlocking system for point motors type L 700H was performed at 18:10 o'clock according to the record no.153 of the Register of Revision of the Installations and Lines of Traffic Safety on December 16, 2008.

The order performed by the movements inspector for the train 8205 involved in the railway incident it assumes that the centralised installation :

- by its logic schemes with safety relays transmitted the order of operating the conjugate switch 9/15 to the point motor;
- took over the information from the field that the point motors no.9 and no.15 operated the switches and "locked" their points in an extreme position, corresponding to the ordered position;
- it processed the information obtained from the field in the logical schemes of command, operation and control of the conjugate switch no.9/15 and supplied to other parts of the installation the permission to perform the route and displaying the permissive light (yellow).

The inquiry commission gathered according to the provisions of the Instructions for preventing and investigating the railway events and incidents no.003/2000 found that:

1. on the control panel of the interlocking system adapted for point motors type L 700H was correctly signalled :
  - a performed route but unused from the open line II Dorobantu- Basarabi with the signal XF to line II of Basarabi railway station, over which were standing wagons of train no.8205 that was stopped on the sections 023 and 1-15;
  - the signalling of the position of the switch 9/15 was indicating the placing of the switches 9 and 15 on the "direct position" (or access to right);
  - an exit route with signal X II from the line II Basarabi- Valul lui Traian for train no.8205, that was unused;
  - line 1 occupied with train 8018 that was stabling;
  - the lack of any optic or acoustic signalling showing malfunction of any component of the centralized installation.
2. on the field, the components of the conjugate switch 9/15 were:
  - the switch no.9 was on the "diverted position" (access to left), with access from running line II to line 1;
  - the switch no.15 was on "direct position" (access to right), with access from line 1 to the shunting line head X;
  - without visible traces of trailing the switches 9 and 15, that would have consisted of supposed frictions on the attached points from the position had in the moment of the incident.

The technical commission composed of specialists of Direction of Control Command Signalling of CNCF "CFR"SA, of the Departement Control Command Signalling Constanta and with participation of the constructor Thales Rail Signalling Solutions that performed tests and technological examinations on December 17 and 18, 2008 from which resulted the following:

1. the measured value of the di-electric strength of the power sources comparative with the mass was in admissible limits according to the instruction;
2. the circuit of command and control of the point motor no.9 of the inner installation (placed in containers), had the device according to the sheets and execution plans;

3. the inner cabling was according to the technical plans, without finding short-circuits or nonconformities of its integrity and with a value of the di-electric strength bigger than two MOhmi;
4. at the manual operation it was found that on the whole period of operation the switches lost control on the illuminated track-diagram;
5. to the tests performed by trailing and removing the knife to the point motors 9 and 15, those corresponded by signalling, on the control panel the signalling was displaying the lost of control to the conjugate switch 9/15;
6. the values of the electric resistances between the contacts of commutators of the point motors 9 and 15 were in normal limits;
7. the value of the di-electric strength of conductors of the connecting cable between the central point and the point motors 9 and 15 of more than 16 MOhmi also between wires and also as concerns the mass;
8. on the connectors of type B of the metallic frame equipped with German components that connects these equipments with the part of the installation with logical relays of the circuit of operation and control of the position of the point motor no.9, with electric connections between pines and conductors that were inadequately performed (photo..);
9. in the equipment of detecting the position of points (points controller type ELP manufactured by ALCATEL) of the point motor no.9, the terminal A2 was inadequately set up so when pulling it from the conductor permitted its pulling from the set part;

The representatives of Thales Rail Signalling Solutions objected in written, mentioning that “ *the electric connections mentioned were accordingly performed, not finding any contact at reception and also during investigations. The works of assembling to the temporary installation CE CR2 of CFR Basarabi railway station were performed in the period September-December, not in the period April-December 2008.*”

On the period (December 17-18, 2008) of tests and examinations, the investigating commission members weren't convoked and implicitly they weren't present. The results of tests were taken by the investigating commission from the investigating file no. F 31/42/2008 of the railway incident drawn up by the investigating commission named according to the provisions of the Instructions for preventing and investigating the railway events and incidents no.003/2000.

The investigating commission present at the spot, found in addition from the inquiry commission the following aspects:

1. the handle of the conjugate switch no.9/15 placed in the necessary position for “plus” (or switch right access);
2. the handle of the simple switch no.10 placed in the necessary position for “plus” (or switch right access);
3. the throw bar of the point motor no.9 was completely operated, operation necessary for the “diverted position”, correctly attached and sealed to the connexion bar of the point motor with the operating bar of the point lock;
4. the control bars of the “diverted position” were correctly attached and sealed in the insurance bolts of the afferent detector slides;
5. the command scheme of the conjugate switch 9/15 didn't have included the condition of impossibility of initiating the order of operating by a movements inspectors in case of trailing of a switch equipped with a trailed point motor, provided that the equipment doesn't have an internal mechanic condition that should block the electric operation;
6. inside the point motors type L700 H, that were operating the switches 9 and 15, there weren't marks on the vaseline of the throw bar of the sphere from the trailing device, aspect that would have given the certainty of trailing the equipment;
7. to tests performed by electric trailing of the point motor no. 9, the signalling on the control panel was made by flashing red light signal of both cells of the switch 9/15, the signalling being identical as in case of “loosing control”;

8. on the connectors type B of the metallic frame equipped with German components, the electric conductors were:
  - of big section ( of 1 mm), comparative with the conductors used to the installation ESTW L90 of 0,6 mm;
  - of unifilar construction with wires that weren't firmly glued of the pine;
  - without protection on each pine with varnish material that should exclude the possibility of possible contacts of the wires from the electric cable, fact that led to the possibility of loading with material of welding by decreasing the distance between pines and implicitly the distance between the electric connections.
9. the switches block is equipped for each point motor with a set of ten relays (named A, B, D1, D2, WL, WU, Ab, WA, WP and WN) at the level of the telephonic ones that from the point of view of the safety level, when functioning are placed under the level of the electromagnetic relays. The relay WL, used for establishing the control of the position of the switch has a special construction of the armature, so for a position of the point motor it establishes contacts and excludes the contacts necessary to the other position. The switch block as a whole corresponds to the safety level SIL 4.

#### **B.5.4.2. Data on lines**

The open line II Dorobantu – Basarabi and the lines 1 ( deflecting section) respectively II ( direct line) have superstructure type 60, concrete sleepers T17, indirect fastening type K. In front of switch it was a panel composed of rail type 60, concrete sleepers T17, indirect fastening type K.

#### **B.5.4.3 Data found out at the functioning of the rolling stock and its technical installations**

The INDUSI installation was functioning and sealed, the safety and vigilance installation was functioning and sealed, the speed recorder installation was sealed, the blocks of equipments from the machines hall (S1-S8) were sealed, the braking installation of the locomotive was functioning and sealed and the brake cock type KD2 was on the position of total braking.

In the report of reading the records of the installation IVMS 2001 – evidence to the investigating file drawn up by the investigating commission – it is mentioned that the speed of the locomotive that was under the influence of the inductor of 1000Hz of the entry signal XF decreases suddenly to 0, after which it moves with a speed of 1-2 km/h on a distance of approximately 116 metres after which stops again. After a stop of 39 seconds the train runs approximately 612 metres to which the speed increases progressively to 25 km/h after which decreases suddenly to 0.

#### **B.5.5 Interface man – machine – organization interface (psychological considerations concerning the organizational deficiencies that led to railway incident occurrence)**

The railway incident can be included from the human reliability theories point of view in the multiple causes model (of the error generated by the system). It means that the incident has as basis a series of preconditions, as follows: mistakes in the acceptance in operation and designing of some equipments, lack of some working procedures and also a series of causes depending on the involved staff behavior (the insufficiency in taking the responsibilities, lack of the preventive acknowledge and attitudes).

During the investigations one found out, first, a cooperating attitude of some from the investigated persons, and also a defensive attitude and an evident simulated behaviour from the others.

In order to avoid for the future such conducts, that make difficult the investigation, it is necessary to take some measures in order to stimulate the fair and frank attitudes in the true statement of the happened facts.

In the socio-technical system from the railway station Basarabi happened a series of latent deficiencies, persistent in the system, as well as active deficiencies, that led directly to the railway incident.

**The latent deficiencies** are forerunners of the risky acts and consisted in:

- the unsuitable organization of the activities, consisting in the improper order to ensure the permanent surveillance of the equipments by the Control Comand Signalling Departement and the manufacturer Thales Rail Signalling Solution. In this situation there was a under-evaluation of the surveillance and control tasks of the movement staff;
- lack of the preventive tasks of the involved staff.

**The active deficiencies** are consisting in the mistakes appeared in the situation of a potential danger or risk conditions.

The active deficiencies in the railway incident from the railway station Basarabi consisted in:

- the design principles of this equipment were not clearly defined;
- the design and the achievement of the equipment that did not take into account the possible effects of the multiple failures;
- acceptance by the railway administrator of some non-certified equipments in operation.

The active deficiencies led to the removal in time of the possibilities to eliminate the latent deficiencies existent in the system, generating the railway incident.

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

### **B.6.1 Interpretation of the data found out by the technical and inquiry commission**

According to the minute from the inquiry file, the inquiry commission, together with the technical commission concluded as follows:

1. “because of the unsuitable connections by soldering at the coupling terminals *there was the possibility of touch between the adjacent terminals and the cut of the electrical contact because of the cold junctions*, generating the loss of the switches control, as well as the possibility of the appearance of the false control”;
2. “*by the performance of the following operations, that is: contact loss of the wire from the terminal N23 of the switch no. 9, short-circuit of the terminals B11 and B12, repeated operation from the push-button interlocking frame of the switches 9/15, re-establishment of the connection on the terminal N23, the operation of the switches from the push-button interlocking frame, was possible to restore the situation found out in the railway event happened on the 16th of December 2008 in the railway station Basarabi*”;

According to the statements of the inquiry commission members, the inadequate performance consist in performing some large soldering, non-uniform, due to the type of the conductor used (solid conductor) and also big sections of it (of minimum 1 mm<sup>2</sup>), fact that would lead to the decreasing of the distance between pines and to possibility of a contact between them, aspect that the members of the investigating commission didn't agree with it.

The members of the investigating commission didn't agree the idea that at the passing of the train no.1821-2, the control lost of the conjugate switch 9/15 would be the cause of an imperfect contact placed inside the installation's equipment, supported by the idea that:

- the members of the inquiry commission didn't found any soldering to the circuits of the conjugate switch 9/15, the conductor being firmly glued (“cold soldering”), that would lead to the conclusion of an imperfect contact;
- the lost of control occurred because some vibrations from the track that influenced the exterior equipment (distributor, point motor and/or points controller) when passing over the switch no.9 of at least the first railway vehicle (locomotive);

- a possible lost of control of the switch due to the inner equipment would be produced before the railway incident and also during the tests and examinations performed by the inquiry commission;
- if the moment of control lost would have been when the train would have been situated before the exit signal YII, it have been annulled and the train would have been braked by emergency;
- the extremely low probability of the existence of a possible imperfect contact located to the inner equipment so that when the train passes over the switch no.9, the conjugate switch 9/15 to lose control.

As we shall explain to paragraph B.6.3 – **Analysis of the railway incident occurrence**, the investigating commission agrees that only a firm contact (or short-circuit according to the definition of the technical commission) placed inside the equipment created the premises of the appearance of a false answer but in no case the control lost of the conjugate switch 9/15. This possible contact isn't detectable to tests and examinations performed when putting into function except an examination very careful of the cabling, due to the method of conceiving the electric schemes of control of the switch.

Conclusion no.2 of the technical commission doesn't approach the technical explanation of the method of how was made "the reproduction of the found state to the railway event", limiting only to the mention that the wire from the terminal N23 of the switch no.9 was interrupted and the terminals B11 and B121 were short-circuited and as result of repeated operations from the control panel it was obtained the result mentioned in the minute. Either in the conditions of the short-circuit existence, an interruption of the connection of the terminal N23 from the control circuit of the point motor no.9 situated in the coupling of the switch block would have led to the impossibility of supplying the relay WU and implicitly to obtain the control of the conjugate switch 9/15, , no matter the number of its automatic operations even if the switches would have been operated completely and correctly. The control getting would have been performed only if the interrupted contact would have been recovered and would have been repeated in order for the same desired position.

The technical commission didn't mention in the documents drawn up the logic of choosing this type of defect (cold soldering that puts into contact and cuts off the contact aleatory) that leads to the conclusion that the interruption that occurred previously to the railway incident wasn't taken into consideration. In addition, this interruption corresponds to any possible interruption of the circuit of control of the point motor no.9 and doesn't explain the return of the control of the conjugate switch.

The investigation commission believes that the firm contact existed before the control lost of the conjugate switch 9/15 and that the investigation performed by the technical commission was improper performed due to the lack of information that should have been obtained from the movements inspector. The fact that after the movements inspector operated the button of the switch 9/15 the switch obtained control on the illuminated track-diagram on the anterior position doesn't explain only the changed conditions for attracting the relay of general control WU from its electric circuit that can only be a possible defect to the exterior equipment. This would consist in a cause with high level of probability of mechanic origin possible in the detector of the positions of the switch's points, supported by:

- passing the train over the point of the switch would have produced the widening of the track in the area of the device with arc where is mounted the detector of the position of the switch's points and notifying on its deficiency;
- operating the button of the switch changes the conditions necessary to attract the relay WU and cannot be only the result of the operation of the switch no.9 and establishing other contacts in the point motor and/or detector of the points position.

### **B.6.2 Interpretation of the data found out by the investigating commission**

Following the investigations made by the members of the commission it was found the following facts occurred with certainty:

1. the conjugate switch 9/15 is composed of the switches 9 and 15 being operated by point motors type L 700H. The conjugation is controlled by logic electric circuits with contacts and relays;
2. the movements inspector performed on the control panel an entry route to line II of the railway station, that was and remained signaled according to the operation from the control panel (photo 3);
3. when finishing the entry route, the engine driver of the train no. 8205 found that the switch no.9 was on the “diverted” position (left access) allowing the traffic to line 1, instead to be on “straight” position for the train to have access to line II (right access), according to the route ordered by the signal XF signaled by “yellow colour”;
4. when the inquiry commission presented, its members stated that the switch no.9 was on “diverted” position and its conjugate no.15 was on the “straight” position, the switch 9/15 didn’t accomplish the condition of conjugation;
5. the members of the inquiry commission noticed that the inside equipment corresponding to the switch 9/15 has a group of relays of code type (or telephonic) for each switch, placed in a switch block and the relays WL of special construction were placed corresponding to the position from the field of the point motor:
  - the relay 9WL of the switch no.9 was on “diverted” position;
  - the relay 15WL of the switch no.15 was on “straight” position;
6. the members of the inquiry commission operated the switch 9/15 automatic on the “diverted” position by operating accordingly the command button and the lever, after which the switch was operated with control being signaled on the control panel the “diverted” position according only to the position of the switch no.15 although the position of the point motor no.9 was on “straight” position (right access);
7. the members of the inquiry commission noticed that in the conditions found at item 4, when performing the manual operation of the point motor no.9 (by lever) from the “diverted” position to “straight” position, the signaling of the conjugate switch 9/15 from the control panel was showing “lack of control”;
8. the members of the technical and inquiry commission didn’t find marks of friction of the wheels on the switches 9 and 15 that should suppose a trailing.

Also, the members of the investigating commission found the following facts:

1. after putting into service the “temporary” interlocking system, the first train that circulated on the conjugate switch 9/15 was train no. 8343-2 (dispatched at 19:05 o’clock) which required the switch 9/15 in the “diverted” position and at the completion of the exit route from line 1 on the running line II Dorobantu- Basarabi found that the switches 9 and 15 were on “diverted” position;
2. the passing of the train 1821-2 (at 19:25 o’clock) on the second direct line to the open line II Dorobantu- Basarabi (behind the train that left from line 1) required the conjugate switch 9/15 on the “straight” position, the train’s locomotive passing over the switch no.9, that was correctly situated;
3. after the train no.1821-2 passed the conjugate switch 9/15, the movements inspector noticed on the control panel the indication of loosing control of the switch and the locking of the isolated sections 1-15 and 023;
4. after the interruption to the interlocking system took place, the movements inspector operated:
  - the button of artificial unlocking of the isolated sections and after three minutes they were unlocked;

- the button of operating the switch 9/15 in the conditions that the coupling handle remained on the last position meaning the “straight position”. Following this operation, after few seconds (8-10 seconds), the switch 9/15 regained control on the position that it had previously to the control lost (on plus);
5. after taking over the shift, the movements inspector operated the conjugate switch 9/15 on “diverted” position and then on “straight” position in order to prepare the entry route to line II of the train no.8205 that was involved in the railway incident.

The interlocking system assembled in Basarabi railway station is type CR-2 (centralised with relays) to which the structure of the logic electric schemes is conceived only for the traffic movements without shunting operation in the railway station, only for the lines I and II with exits to the open line II Dorobantu- Basarabi and Basarabi – Valul lui Traian, adapted for point motors type L 700H built by the German manufacturer, that is based on the following functioning principles:

1. power supply with alternative three-phase power due to the construction of the equipment;
2. the need of individual handling of each point motor imposed by the constructive way of the operating mechanism type L 700 H and the equipment and its associated equipment necessary for operating;
3. requiring simultaneous operation of the two point motors due to the concept of individualisation of each point motor;
4. assembling a switch block of German construction with relays of special construction (of code type) which has incorporated a set of relays A, B, D1, D2, WL (control of the switch position), WU (general control), Ab, WP, WN and WA for each point motor. A group of four point motors are composing a “switch block”.
5. logic schemes with contacts and relays for the command and control of the conjugate switch, specially designed to adapt the switch block to installation CR-2 that from the constructive point of view are composed of contacts of the electromagnetic relays of high safety level supplied with continuous power (of combined type KF 1-1000, NF 1L 400, etc.) and are not part of the usual schemes commonly used to the installation of type CR-2.

The investigating commission analyzed the functioning of the logic electric schemes with contacts and relays of the interlocking system of type CR2 adapted for the point motors of type L 700H for the switch 9/15, deepening the study of four schemes of performing its centralization:

1. the command scheme for the switch 9/15;
2. the operating scheme of the switches 9 and 15;
3. the control scheme of the switch 9/15 and
4. the optic signalling scheme of the switch’s condition 9/15.

1. The command scheme for the switch 9/15 is logically built (photo 4) so it offers a high safety level that is based on a safety relay PM (starting a switch type KF 1-1000) for each switch, on the handle with three positions (right –switch “plus”, left- switch ”minus”, at centre – pause) and a single button that is operated when initialising the desired command. As the scheme is designed, any short-circuits downstream from the relays supply PM would lead to the lack of the possibility of beginning the command but an interruption of it would lead to a different result.



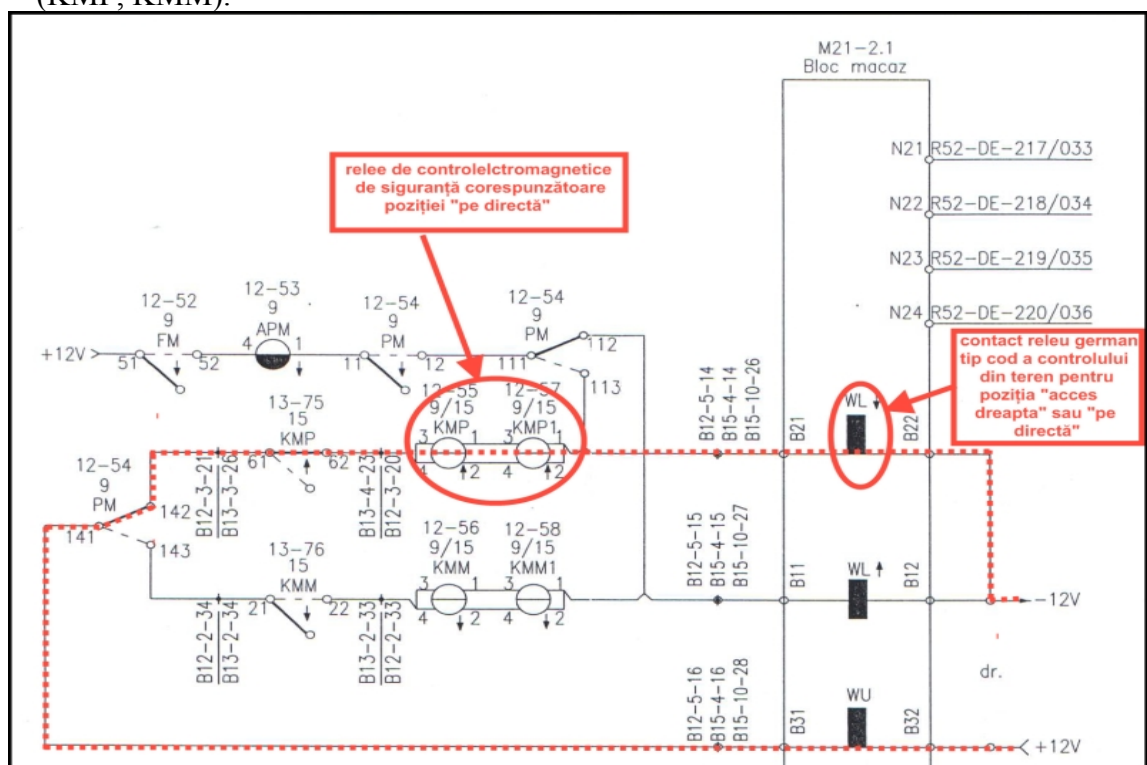
The power supply of the two channels (of the direction and command relays) generates the operation of the switch block which requires the unconditional operation of the L700H point motor, up to the end of the opening and getting of the control in its switch functional block, and can not be return by order during the operation, but only after its end. After operating each point motor from the switch 9/15 composition, each switch block corresponding to the point motors 9 and 15, through the relay WL group – control position “direct access” (or “diverted position”) and WU – general control, one gets the control of their situation on the ground.

The switch block has the operation principles of a switch equipped with a L700H point motor, in several stages, from which three are essential:

- coupling of two windings (coils) of the three phase electric motor at 380V AC, which will give the order through the transformer circuit, preparation order for the third winding connection to null;
  - coupling of the third coil of the electric motor, supplied to null, which will start with low power of the point motor, until the reposition and establishing of some of its interior contacts;
  - connection of the three phase electric motor coils “in star” that will give it’s nominal power.
- The point motor will start the operation with nominal power until the end of the opening, followed by the switch and establishment of some inside contacts of the point motor which cut the power supply of the electric motor at the point locking.

The point switch 9/15 control scheme sends its position to the push-button interlocking frame, after getting the control from the train of the point motors no. 9 and 15 state, through the KMP and KMM relay contacts, as follows:

- for the point motor no. 15, the position repeater relay KMP, respectively KMM is attracted through the WL contact corresponding to the position on the spot and relay PM polarized armature (the condition for the checking of the order performed with the results gotten from the ground)
- for the point motor no. 9, the KMP and KMM relays are attracting each other in the similar way as at the switch no.15, **under the additional condition of checking the switch 15 position**, through which the switch 9/15 conjugation condition is obtained, it being the reason for which the designer named the relays 9/15 (KMP, KMM) and not simply 9 (KMP, KMM).



picture 6

**Conclusion:** the point motors no. 9 and 15 conjugation condition is done by checking in the logic scheme with contacts and relays of the point motor no.9 control, of point motor no.15 state position, by putting in connection the relays 15 KMP respectively 15 KMM with the relays 9/15KMP and 9/15KMM and not by direct checking of the fixed contacts state and of electric motor windings within the point motors, method used now in CED schemes. The fixed contacts and electromotor winding inspection is made through the switch group from the functional block.

### B.6.3 Analysis of the railway incident occurrence

As there was stated in the paragraph “**B.5.4.1 Data found out concerning the equipments**” the switches position found by the inquiry commission members as well as the proves and technical inspection of the technical commission require the analysis of the following aspects of the interlocking system scheme operation:

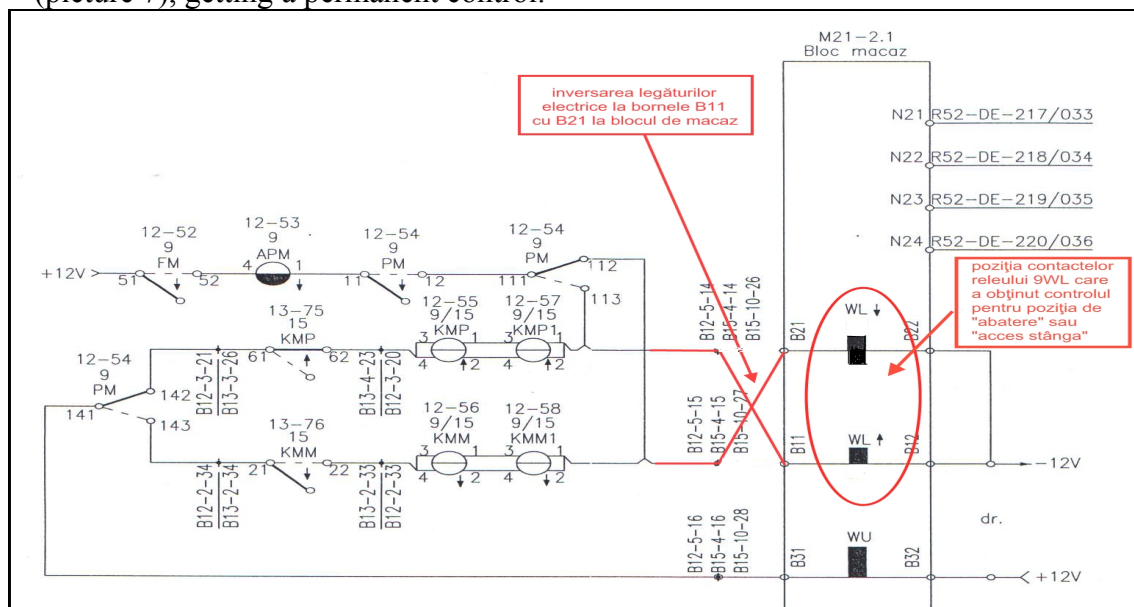
- A. what generated the unsuitable positioning of the switches in the coupled point 9/15 composition;
- B. what allowed the switch 9/15 operation and getting the control according only to the point motor no.15 position;
- C. what could lead to the proper functioning of coupled point 9/15.

#### B.6.3.1 Analysis of the cause that led to the operation of the coupled switch 9/15 with wrong control

In order to answer all the questions, the investigation commission started with the second question “**what allowed the point switch 9/15 operation and getting the control according only to the point motor no.15 position**”. Thus, the investigation commission studied and analyzed electric the scheme operation options when the possible failures (short circuit and/or cut of contact) corroborate with the lack of safety provisions observance (technological tests, operational conformity, etc) should lead to the operation similar to that found by the inquiry commission.

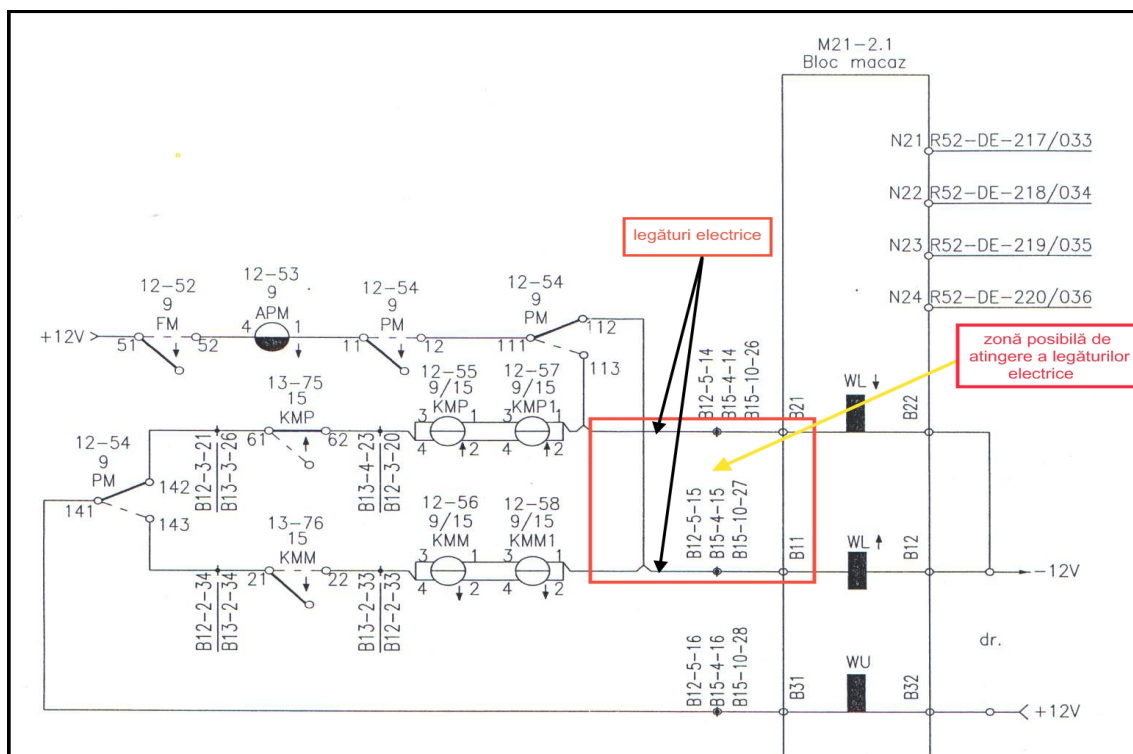
During the analysis of the control scheme with the coupled point 9/15 logical relays, the investigation commission concluded that the reproduction of the coupled point 9/15 operation with the unsuitable point motors, as it is stipulated at the point **B.5.4.1. Data on equipments**, is possible only if:

1. electrical connections from the frames B12 or B15 at B11 and B21 terminals were reversed (picture 7), getting a permanent control.



picture 7 – point machine no.9 control scheme with the electrical connections reversed

2. One took out of the scheme the conditions of the relay 9-WL contacts control switch position (picture 8)



picture 8 – point motor no.9 control scheme with the connection contact area

Following the above mentions and taking into account:

- a. the facility of finding the reversal of electric connections at the inspection of the electric cabling by the inquiry commission members.
- b. the relative large time for the tests and inspections performance by the commission, through coupled point 9/15 operation, which appeared as being controlled on the push-button interlocking frame, when the point motors 9 and 15 were in positions opposite to the conjugation.
- c. return to the correct operation of coupled point 9/15 interlocking system during technological tests (operational), performed by the inquiry commission without a major intervention in the control electric circuit;
- d. the manufacturer and beneficiary employees statements in which they state that the point switch 9/15 conformity tests were performed several times, including the day when the interlocking system was put into operation.
- e. the lack of the distinguishing marks of trailing the point motor and the switch no.9, which should be visible after passing of the trains no. 8343-2 and no. 1821-2, in the electric connection reversal case,

the investigation commission members concluded that the point switch 9/15 malfunction, consisting in the controlled operation of the point motors 9 and 15 that were in position opposite to the conjugation, **was due to the removal of the condition concerning the getting of the position control of the point motor no.9 from the train, achieved through the relay 9WL contacts from the control scheme with the safety relays of the coupled point 9/15.**

The relay 9WL contacts exclusion was possible only under the conditions of short-circuiting the conductor electric contacts which were solder to the pines B11 and B21 of the switch group coupler M21-2.1 and are linked at the contacts 112 and 113 of the relay 9PM and at the relay 9/15

KMP1 and 9/15 KMM1 terminals (possible connection contact area), from the switch no.9 control scheme.

The investigation commission statement concerning the existence of a “complete contact” (short-circuit) is supported by the fact that during an imperfect contact, due to a cold soldering:

- a) coupled point 9/15 operation with false control would have been achieved with difficulty during the tests and inspections by the commission, because, during the point switch repeated operation could exist a control loss case;
- b) during the control of the interior cables, performed by the inquiry commission members and manufacturer employees, the switch could lose the control;
- c) the manual putting of point motor no.9 in conjugate state with no.15 would have ended with the getting of at least one correct control case.

As from the statements of the employees present on the ground, at the coupled point 9/15 functional tests with false control (due to the lack of conjugation condition), the point motors were permanently operated without losing the control and at the point motor no.9 manual operation (on the ground with the crank handle) in order to achieve the switch 9/15 conjugation condition, necessary for running, one could never get the right control, the investigation commission concluded that only a “complete contact” (short-circuit) is the correct answer of the equipment and the right way of the investigation, although it was not found in the investigations performed by the inquiry commission members in the inspected electric schemes.

The inquiry commission decided to restore all the contacts of the coupler B of the switch block, that contains the coupled point 9/15 and SC Thales Rail Signalig Solutions SRL București staff implemented this provision, in the conditions under which the temporary interlocking system came back to the right functioning situation.

The temporary interlocking system was not used at all in the railway traffic.

This fact in connection with the movement inspector statements allowed to the investigation commission to examine the “temporary” interlocking system operation in the complete contact conditions, to find out the situations presented at the paragraph 2 (taking out of the scheme the 9-WL relay contacts conditions, control switch position) **and to remove the option of an electric contacts reverse execution in the control circuit** of the coupled point 9/15.

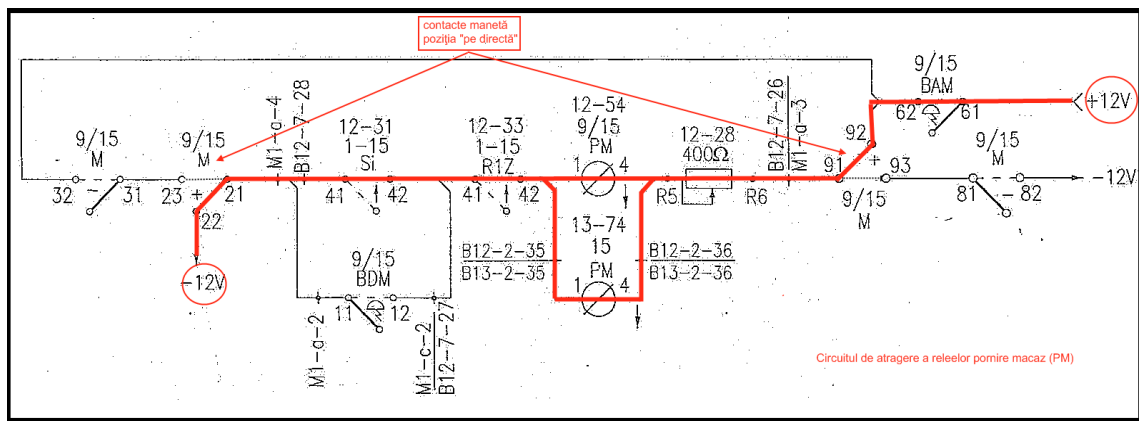
#### **B.6.3.2 Analysis of the cause of the wrong switch position in the coupled switch 9/15 and getting of the wrong control**

When there is a “complete contact” (short-circuit) in the switch no.9 control scheme, in the circuit electric contacts (conductors) between the B11 and B21 pines of switch group coupler and the 112 and 113 contact laminations of the relay 9PM plug, including also the conductor soldering on them, the investigation commission examined the logic scheme operation with relays and contacts, in the conditions stated by the movement inspector:

- i. the switch 9/15 signaled on the push-button interlocking frame the control loss at the passing of the train 1821-2;
- ii. pressing of the switch 9/15 push-button when the lever had remained in the “straight position” (right access).

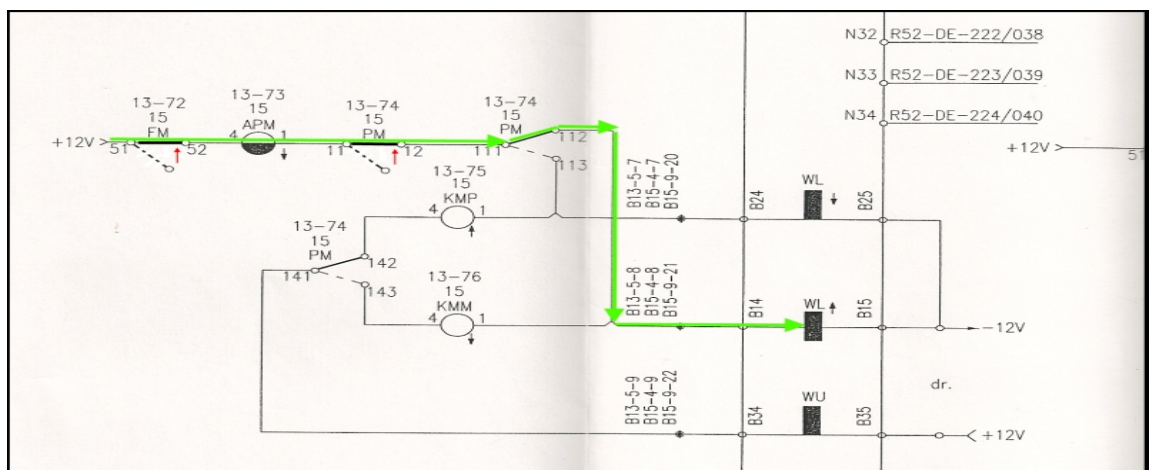
After un-locking the isolated section, at the (9/15 BAM) pressing of the button for the operation of the coupled point 9/15 by the movement inspector; the command scheme worked as follows:

- a. the relays 9/15PM and 15PM were powered with a DC voltage and its neutral armatures were attracted (picture 10);



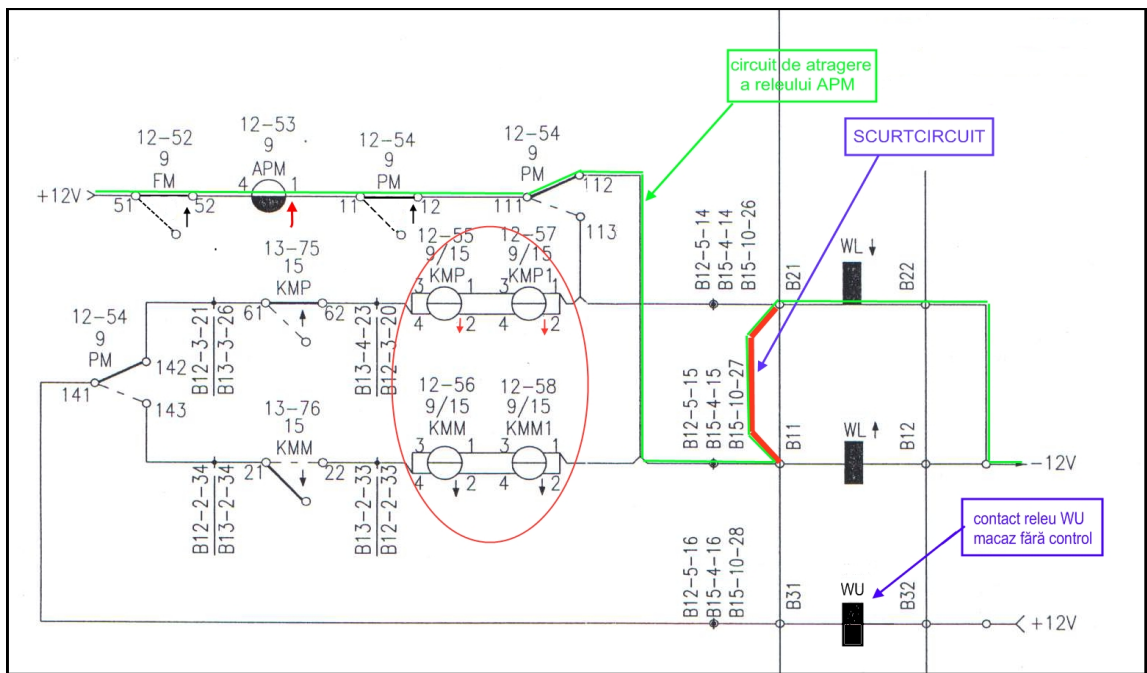
Picture 10

- b. the armatures of the relays 9/15PM and 15PM rested in the previous position because of the their CC power supply similarly as the last command , performed before the lose of the control;
- c. attraction of the relay 15FM, but the impossibilityof the attraction of the relej 15APM because of cutting its power supply through the contact 111-112 of the relay armature 15PM ( picture 11), leading to the impossibility of starting the operation of the switch motor no. 15 and the keeping of the control on the position „direct”;



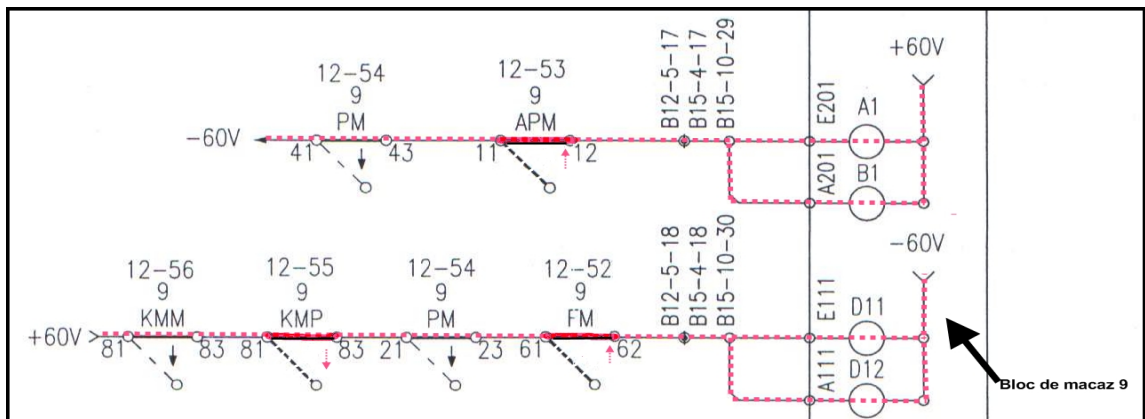
picture 11 – the command scheme of the relay APM of the point motor no.15

- d. the relay 9FM attraction (with 10 second controlled drop-out) and the allowing of the relay 9APM attraction (with 0,8 second controlled drop-out) due to “complete contact” (short-circuit in red in the photo 12) explained in the previous chapter (green circuit picture 12);



picture 12 – the command scheme of the relay 9APM in the short-circuit conditions

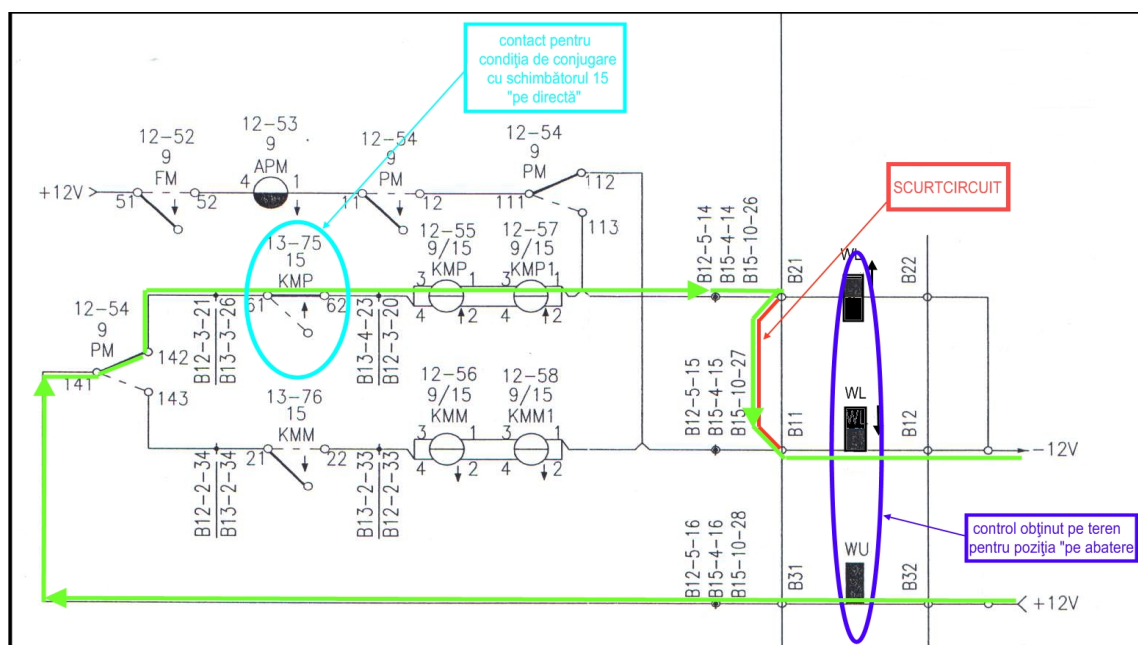
- e. at the release of the operation button, the relay 9PM neutral armature falls and in the conditions of control loss for the “straight” position (with the 9KMP and 9KMM contacts on) occurs the initialization of the point motor no.9 first channel operation by power supplying of 60V DC of the dynamic relays D11 and D12 from the switch operation scheme (picture 12). Once the relays are supplied, they self-energize in the switch block schemes;
- f. after the release of operation button the neutral relay 9PM drop and start the operation of the first channel of the point motor no.9 by the attraction of the relays A1 and B1 from the switch operation scheme, due to the keeping of the 9APM relay armature in the attracted position (controlled drop-out) for about 0.8 seconds (picture 13).



picture 13 – initialization schemes of the point motor no.9 operation

- g. the power supply of the two channels (the direction and control relays attraction) generates the switch block operation which operates the point motor no.9, up to the end of the opening and the getting of its control for the “diverted” position, correctly received by the relay WL by the switch functional block;
- h. although the information about the point motor no.9 position was correctly received by the switch block (picture 14 – signaled in blue) due to “complete contact” (short-circuit symbolized in red) from the control logic circuit with contacts and relays that excluded the analysis of the information provided by the relay 9WL, allowed the power supply of the relays 9/15KMP and 9/15KMP1 (picture 14 – green circuit) by relay 15KMP attract

contact, because the coupled point motor no. 15 could not be operated. The neutral armature attraction of these relays, whose contacts enter into the switch 9/15 position signaling schemes, allows to the relay logic schemes to initialize and execute the route of entry on line II of the railway station.



picture 14 – control circuit scheme of the point motor no.9 in the short-circuit conditions

#### B.6.3.3 Analysis of the cause that led to the return of the coupled switch 9/15 to the right operation

Because, during the railway event investigation, the inquiry commission didn't find "complete contacts" in the point motor no.9 control circuit, does not justify another cause that generated the railway incident.

The removal of the "complete contact" cause was possible because of the lack of organization in the inquiry in order to find out the wrong operation of the electric schemes and can not be determined by the investigation commission.

The cause of the point switch 9/15 control loss, as it was previously examined, could not be than at the external equipment, that most likely, as presented, has a mechanical cause due to point switch controller correct operation afferent to the switch no.9, issue that the investigation commission didn't take into account.

#### B.6.3.4. Tests performed by the investigation commission

In order to have no doubts and interpretations on the completion of the relays supply circuit type A1 and B1 from the command dual channel scheme, imposed by the time of 0,8 seconds APM relay drop and by the relays PM and APM contacts clearances, the investigation commission together with the manufacturer and beneficiary have made an assembly (picture 15) which reproduces in a simplified way the schemes used and the conditions existing on 16.12.2008 in the railway station Basarabi, namely:

- existence of a complete contact (short circuit) as it was presented above;
- switch without control;
- the coupling handle on "straight position" the same with the switch position on the spot at the moment of losing the control;
- the switch operation button was pressed once and released;

- the use of a switch block identical with that one from the interlocking system.

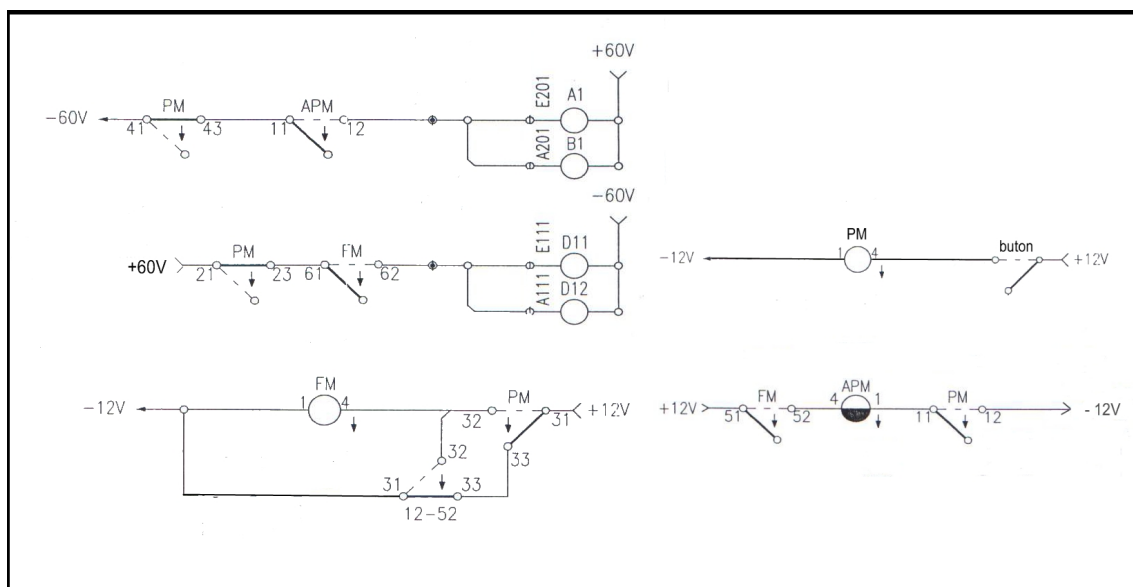


photo 15 – simplified schemes used and the conditions existing at the railway incident

During all the performed after releasing the button for the switch operation happened the operation of the dynamic relays D11 and D12 and of command A1 and B1, starting the two command ways of switch operation from the switch block. Thus, the point motor no.9 operation was simulated on the other independent position of the point motor no.15.

#### B.6.4 Cause that allowed the train route order

Once the relays 9/15KMP and 9/15KMP1 were supplied with voltage and their neutral armature attraction achieved, there are established the electric contacts which confirm the coupled point 9/15 position in “straight” position, that are included in the logical schemes with relays in the establishment of the course that the movement inspector carry out for the train 8205.

#### B.6.5 Analysis of the scheme and conclusions

1. The electric scheme of the interlocking system type CR2, adjusted to the point motors type L 700H allows a false answer in the short-circuit case in the interior cable lay-up, corroborated with the appearance of another interruption to train movement consisting in the switch control loss and pressing the button without handling the lever.
2. The “complete contact” (short-circuit) could not be detected during the technological tests and checks performed by the beneficiary, only by a special test that generates the coupled point control loss and the simulation of the switch operation.
3. For a simple point switch, the incident result would have been the same at the operation simulation on the prior position in the “complete contact” (short-circuit) in the same area presented in the investigation.
4. The new principle provided by the manufacturer and accepted by the railway infrastructure manager, based on the use of point motors supplied with AC with switch block for operation, must be used with caution because the equipment designer of this type didn't take into account the possible short-circuits in the control logical schemes which can give false answers.

#### B.6.6 Findings on the training of the employees responsible with the system maintenance

Because this type of equipments are recently introduced in the Romanian infrastructure patrimony, the experience of employees responsible with their maintenance is reduced, is necessary a training

of this staff by which to be established the involvement level of each one, depending on its training.

### **B.6.7 Analysis of the operation staff intervention**

After the train 1821-2 passing the line 2 remain open and the switch 9/15 remain without control (section 1-5 and 023 remain locked). The movement inspector on duty from the Basarabi station wrote the interruption to train movements in the RRISC register at 19:30 and notified the SCB electromechanic from the Dorobanțu station, because at that time there was only the SC regional inspector at monitoring in the Basarabi station.

According to the 41/64/1986 order, the movement inspector on duty from the Basarabi station had to move on field to determine if the turn out and the coupled one doesn't present one of the defects referred to in Article 21 of the Regulation trains movement and railway vehicle operation no.005, or any foreign body between point switch and stock rail throughout their length, but didn't do so and not even the SC regional inspector present in station didn't asked to go there. On the field the switches no.9 and no.15 were in coupled position, the switch no.9 was with access to line II, and the switch no.15 was with access to the shunting neck.

At 19:32 the movement inspector on duty from Basarabi station wrote in the RRISC register the breaking of control seals from sections 1-5 and 023 for artificial unlocking. After the artificial unlock the movement inspector on duty from the Basarabi station pressed once the coupled point 9/15 that was on „plus” position and the switch received control on „plus”. At 19:40 the movement inspector on duty from the Basarabi station wrote in the RRISC register that the switch 9/15 has control.

Conclusion: The casual movement on field by the movement inspector immediately after the establishment of coupled point 9/15 control loss, to comply with the procedure in the event of an interruption to train movements, would not allow the movement inspector to prevent the railway incident, whereas the discrepancy position between the centralized turnouts no.9 and no.15 it had occurred after the operation of the operation switch 9/15 button, which would have been done at his return from the field.

### **B.7 Accident cause**

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

**The direct cause** of the railway incident is the wrong answer of the interlocking system type CR2, adjusted for the point machines type L 700H, that consisted in getting the electric control and the signal on the track diagram of the coupled switch no. 9/15 on the position “direct” when the switch no. 9 was on wrong position with access on the deflecting line 1.

#### **B.7.2 Underlying causes**

**Underlying causes** of the railway incident that led to the wrong answer of the interlocking system type CR2, adjusted for the point machine type L 700H are:

- existence of a short circuit in the control scheme of the switch no. 9, situated between the control electromagnetic relays of the position of the switch no. 9 and the coupling B of the switch group, manufactured in Germany, following the wrong performance of the fitting works;

- loss of the control of the switch 9/15 after passing the passenger train no.1821-2 on the direct line (before giving the entry order for the passenger train no. 8205);
- one pressing of the operation button of the coupled switch 9/15, without operating the lever that was on “plus” position.

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

**Root causes** of the railway incident were:

1. lack of homologation/certification of the interlocking system type CR2, adjusted for the point machine type L 700H and its acceptance in operation by the representative of the railway infrastructure administrator, without the preliminary authorization for the putting into service;
2. the designing and achievement of the control scheme of the coupled switch 9/15 from the interlocking system, that do not allow its wrong answer if some short-circuits appear in the inner cabling of the equipments, cumulated with the loss of the switch control and the operation of the button corresponding to the switch in the position in which it lost the control;
3. lack of some principles for the design, clearly regulated, that ensure the unitary design/ application of the electric scheme of railway safety, corresponding to the requirements of the railway infrastructure administrator and accepted by the respective authority;
4. the inadequate monitoring of the infrastructure administrator, during a limited period of time.

### **C. Safety Recommendations**

The recommendations aim to settle the next issues:

1. Drawing by the railway infrastructure administrator of some technical norms on the principles and the design of the railway safety electric schemes from this type of interlocking systems, in order to meet with the railway safety.
2. The public railway infrastructure administrator will take all the measures for the application of the respective legislation for the putting into service of the structural subsystems and of the interoperability constituents and the homologation/certification of the railway critical products.
3. The administrator of the public railway infrastructure will found out all the cases of equipments used along the track for a limited period of time and that are not homologated/certified, respectively authorized for the putting into service and the meeting with the specific legislation.
4. The administrator of the public railway infrastructure will present monthly to Romanian Railway Investigating Body a copy of each dossier on the failures of the interlocking subsystems with new technology, that generate traffic interruptions.\_

This Investigating Report, will be sent to the administrator of the railway public infrastructure, Railway National Company “CFR” SA., railway supplier Thales Rail Signaling Solutions SRL Bucuresti, Romanian Railway Notified Body and Romanian Railway Safety Authority.

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

Investigation commission members:

- OLARU Mihai - investigator in charge \_\_\_\_\_
- TOADER Doru-Cătălin - investigator \_\_\_\_\_
- DOBRE Florin - investigator \_\_\_\_\_
- SFÂRLOS Dumitru - investigator \_\_\_\_\_