ABS Failure Diagnosis Charts for a Blocked CL

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***Abstract*— The Automatic Block Signal installations (ABS) is a system of powering and receiving circuits that ensure train traffic command, control, and signals between two consecutive train stations. The circuits are usually electronically or electrodynamically synchronized. Because the distance between two stations is at least 4 kilometers, any failure to these installations cause long traffic delays, especially since the maintenance staff must travel on foot to the site of the failure. To fix failures in the operation of BLA installations it is required that the maintenance staff is well acquainted with the system's wiring diagrams and their interrelations. The complexity of the wiring diagrams poses some problems in failure fixes. To ease the decision taking process in failure detection we present here diagnosis charts that lead to a quick and correct remedy decision. The diagnosis charts presented here are to be applied for cases when the current line (CL) is signaled as being occupied by rolling stock, but is in reality empty.**

Keywords— Automatic Block Signal, diagnosis chart, failure detection, open line blocked.

I. INTRODUCTION

Train traffic between two stations, A and B, connected by lines without traffic control installations requires that no second train is sent on the line from one station, say A, to the other before the first train is confirmed to have arrived to the other station, B.

ABS installations placed on open lines ease train traffic congestions, allowing same direction train dispatches [1,2]. To improve the train traffic flow, the running rail between two consecutive train stations is split into series of sections, also called return conductors, which are separated by insulating joints. On one ABS secured running rail exist at least two sections (of minimum 1200m and maximum 2500m), each controlled by both stations [3,4]. When three sections are present, the middle one is controlled by both stations, while the first and the third are controlled by their adjacent stations. In the design of the ABS electric wiring the station closest to the capital (Bucharest for the Romanian Railroad Company, CFR) is called the sending station, or the dispatching station.

In any CFR station, its closest to Bucharest extremity is marked with X, the opposite extremity is marked with Y. The station entry signals are, depending on the direction, X, respectively Y, preceded by precursory signals PrX and PrY respectively (Fig. 1).

Fig. 1 shows four track sections (X1 AD, X2 AD, Y1 AD, Y2 AD) which help control the train position on the ABS controlled section (that is, the distance between the Y entry signal of the dispatch station A and the X entry signal of the receiving station B). Allowing or stopping the traffic train on the 4 sections is done by signal posts Bl 1, Bl 3, Pr X for the direction given by the arrow (Y → X), and Bl 2, Bl 4, Pr Y for the inverse direction.

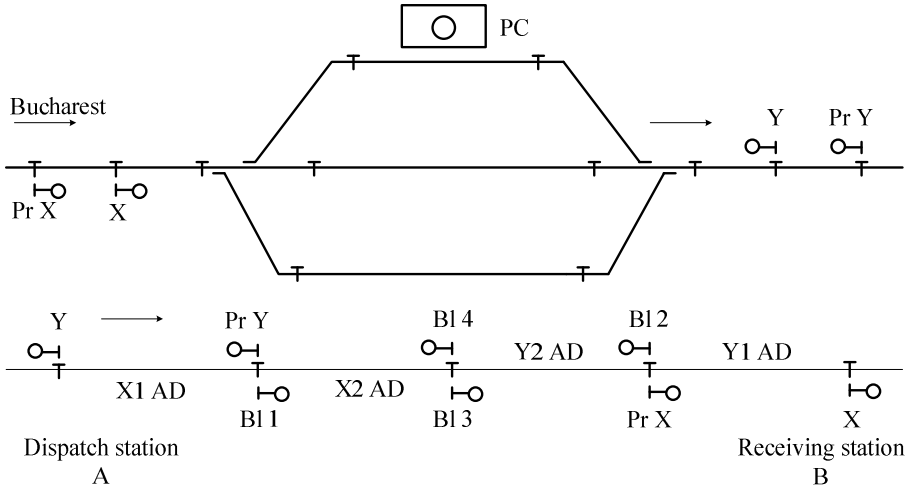

Fig. 1. Simplified station and ABS electric wiring.

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II. ABS Command and Control

The ABS installation is commanded by one of the block's adjacent stations, and controlled by both stations. The traffic direction command (towards X or towards Y) or the train dispatch on the ABS sector is issued by the 'proceed' exit signal, which is signaled in both stations. The 'open' or 'blocked' states of the current line (CL) is controlled by both stations, while the ABS's return conductors are controlled by their adjacent stations – each station controls two return conductors.

The main circuits commanded and controlled by the ABS installation are [2]:

1) The d.c. 220V feeding circuit of the ABS boxes (to each pair of insulating joints an apparatus box is placed). Each adjacent station powers half of the boxes placed on the ABS track between them;

2) The Transmitting Relays (TR) feeding circuits, powered at d.c. 110V, by the dispatch station. The relays powered by this circuit are used to command and control the ABS return conductors;

3) The Occupied Line (OL) and Control Line (KL) relay circuits are powered up by the dispatching station at d.c. (60÷80) V. These circuits control and signal, in both stations, the Occupied Current Line (OCL) when the 'proceed' signal is set in one of the stations, as well as the 'occupied' signal of a ABS circuit;

4) The Directing (D) relay circuits fed by c.c. (60÷80)V from the receiving station. This circuit concatenates the D relays in each ABS apparatus box with the D relay in the dispatch station. It is used to power the ABS track and signal circuits;

5) The proximity (close/far) circuit relays (1A2D, 2A3D) powered with ± 24V from the ABS adjacent stations. This relay's terminals send signals about the occupancy of each return conductor of the ABS;

6) The forced reverse circuit, powered as the OL-KL circuit, allows reversing the ABS's orientation when one or more return conductors falsely signals 'blocked', or when the OL-KL circuit is failing.

The ABS signals displayed on the station's controller are:

a) OCL 'blocked', signaled in the receiving station or in both stations by a whitely lit light bulb when an exit signal is set on 'proceed' or when an ABS return conductor is occupied;

b) 'dispatch', signaled by a green light when the station is dispatch oriented, or by a blinking red light (this being a defect) when the D relay circuit is interrupted;

c) 'receive', signaled by a red light when the station is receive oriented, or when the ABS installation operates on the forced reverse circuit;

d) Static Contactor Plug (SCP) feed voltage, feeding c.c. 60÷80V, insured by a d.c. 220V, 75 Hz source, when a white light is continuously on, or insured by the c.c. 24V source, in which case the white light blinks;

e) First and second close sections, signaled by two white lights, one for each section, signaling the occupation of their return conductors;

The main failures of the ABS are:

- power failures (from the 220V source);
- power failures of the return conductors or other failures of the return conductors;
- blocking the current line either in the receiving station of in both stations, with normally orienting the ABS being impossible;
- D circuits failures;
- ABS signal failures.

In this work we look at failures signaled by the Occupied Current Line (OCL) signal.

From the above listings, it is clear that failure fixes for the OCL failures is difficult, expert knowledge and long repair times being required, leading to train traffic delays.

III. The OCL Failure Detection Chart

In train traffic security, the control and signal of either 'proceed' or 'blocked' signals between two ABS adjacent train stations is necessary. The current line allows for the following command and control systems:

- Rail integrity control on the ABS sector;
- Control of the successive occupation of the ABS return conductors and their release;
- Control of wagon detachments and its stationing on an ABS sector;
- ABS train traffic control according to the 'proceed' or 'blocked' return conductor states. If a return conductor is blocked with rolling stock, sending the 'proceed' signal for the station exit signal a) will turn on the green light signals together with the next two ABS signals – if at least the next two sectors are free, or b) will turn on the yellow light – if the first ABS sector is free, but the next one is not or is failing, or c) will turn on the red light – if the immediately next ABS sector is occupied by rolling stock or is failing. When a signal shows a red light, train traffic at normal speed is forbidden beyond this signal;
- Dispatch block command in the neighboring station, following a 'proceed' exit signal towards that station or when maintenance is done on the ABS section.

Because trains must travel with extreme caution and a maximum speed of 20km/h on sections signaled as 'blocked' (red light), any failures of this installation causes train delays. At the same time, when the control system signals the occupation of a ABS return conductor, any train that enters a station must be checked that it is complete, that no wagons were left on the section signaled as occupied. Therefore, this installation must continuously function, satisfying all the security and functionality it was designed for.

The diagnosis charts for blocked OCL signals (although unblocked in reality and no exit signal is set on 'proceed') are based on the ABS schematic circuits [1] and concrete ABS instances associated with Electrodynamic Centralized Traffic Control Stations CED-CR4 systems [5,6]. The charts do not show the normal functioning sequence of steps when a train is dispatched on the ABS line, blocking and releasing

consequently all the return conductors, and the traffic manager omits the last executed sector – an almost non existing situation for staff working in traffic security.

The occupied current line failures may be signalled as follows:

- OCL in the receiving station;
- OCL in both stations.

The receiving station OCL failure causes the de-energization of the X KL relay in the receiving station, while the Y OL dispatch station relay is up.

To detect the cause of the failure a maintenance staff may use the diagnosis chart shown in Fig. 2, which requires that he or she checks the state of the X KL relay in the receiving station.

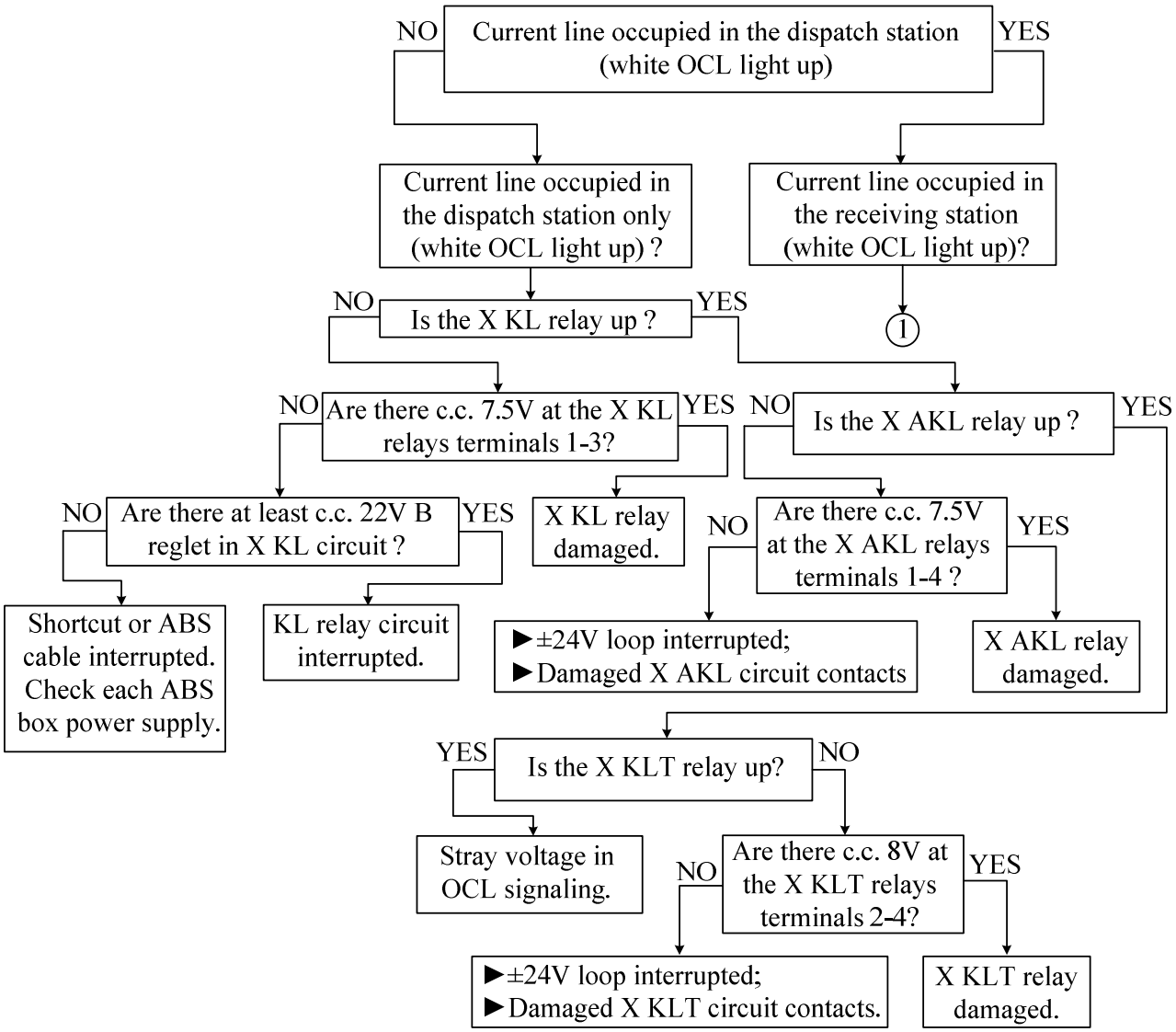

Fig. 2. Failure diagnosis chart for OCL signals in the receiving station only.

If the relay is up, according to the chart, further checks are done at the control transmitting relays that carry out the OCL signals.

If the X KL relay in the receiving station is not up and the B reglet corresponding to the OL-KL circuit is not fed a minimum c.c. 22V the failure cause is a shortcut in the ABS cable, between the wires in the OL-KL circuit. In this case, the maintenance staff must go on site and find the damaged section by ABS box measurements.

If the current line is signaled as occupied in both stations then the Y OL dispatch station relay and the X KL receiving station relay are de-energized. The failure diagnosis chart is shown in Fig. 3 and continued in Fig. 4 and Fig. 5.

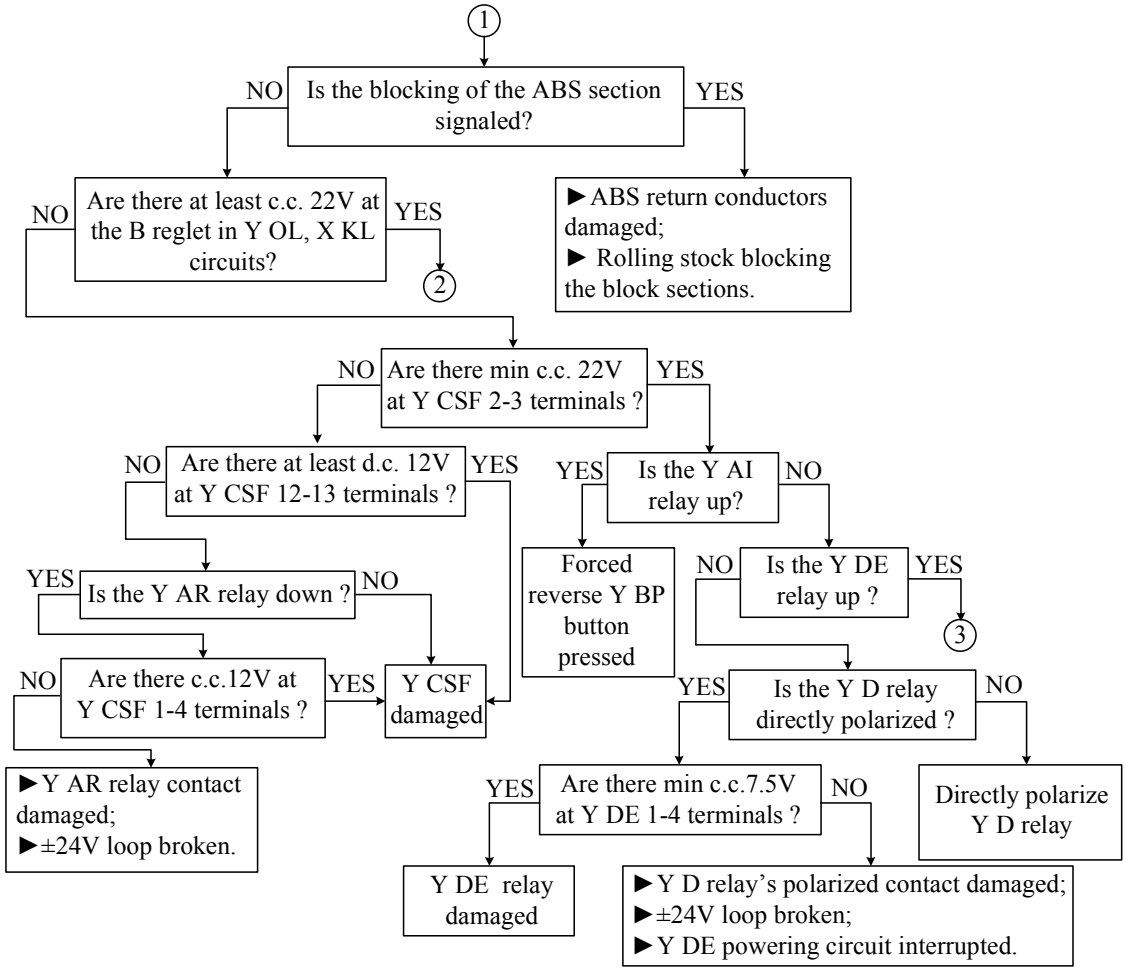

Fig. 3. Failure diagnosis chart for OCL signals in both stations.

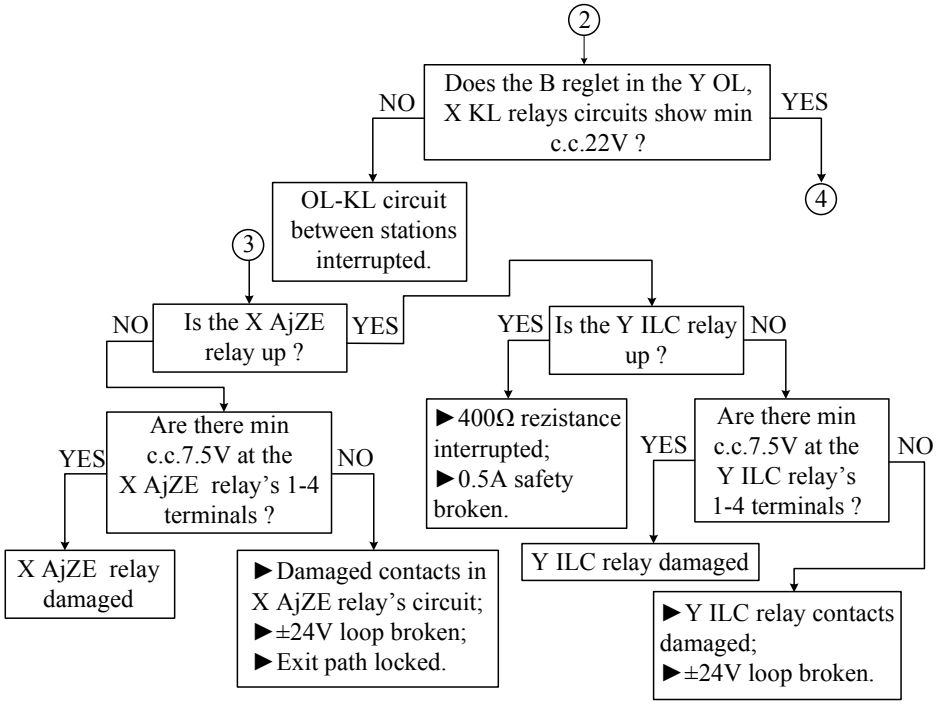

Fig. 4. Failure diagnosis chart for OCL signals in both stations – continued.

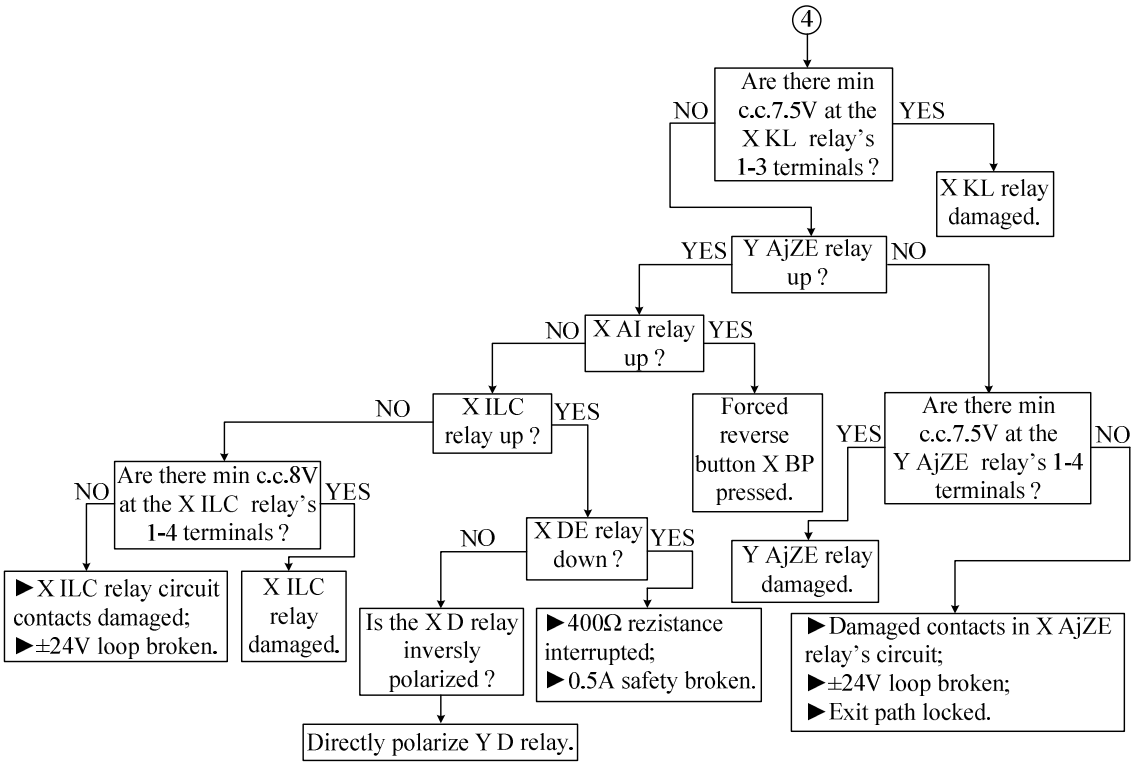

Fig. 5. Failure diagnosis chart for OCL signals in both stations – continued

This circuit does not include the G and X 1AD (Y 1AD) relay terminals which control the free or blocked state of each ABS return conductor, the ABS orientation and the cable circuits integrity.

The chart includes the situation where an exit signal is issued from the dispatch station in order to block the receiving station from issuing incompatible signals (like another exit signal on the same ABS). Thus, issuing a train dispatch command from either the dispatching or receiving stations (after the path is locked by powering down the 'lock dispatch' relay, ZE), the X AjZE and Y AjZE (exit bolt aid) are powered down. This interrupts the OL and KL relays circuits, blocking the neighboring station to issue a dispatch signal towards the station that first issued an exit command. Placing the AjZE relay contacts after the AI contacts eliminates the possibility to reverse the ABS orientation, on the forced reverse circuit, after a train dispatch command was issued.

The OL-KL circuits are guarded against short-circuits by 0.5A safeties, one for each station.

The current in the OL and KL relay circuits must be within (60÷80) mA, and is tuned by the 400 Ω resistances, one for each station. This ensures safe power up and safe relay commutes of the D relays in each ABS apparatus box.

Where works using running line equipments (e.g. draisine works on the line, on the contact cable) both stations must be blocked from dispatching stations on the line where maintenance work is on going. This is done by the OL-KL relays by the X ILC or Y ILC relay contacts (close current line). For making the maintenance works safe, the traffic manager unseals and actives the 'currently closed' button (BILC) which causes the de-energization of the X ILC, Y ILC, Y OL and X KL, or X OL and Y KL relays as needed, which leads to signaling the current line as occupied and to blocking both stations from issuing dispatch commands towards the working site.

OL-KL relay circuits provide a double cut by adding two additional contacts per relay, on the turn and return cables, such that traffic safety is ensured even in the worst situations.

IV. CONCLUSIONS

The designed diagnosis charts help the maintenance staff to redress block signal failures of an unoccupied ABS line.

These diagrams may be a basis for specialised assistance software which will allow a quick and reliable diagnosis of these types of failures. They also contribute to establishing a high competitiveness of the maintenance staff by providing them with new horizons with respect to structured and applied diagnosis.

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