The COMPACS®-EXPRESS-TR3 comprehensive system for diagnostics of EMU-trains sections

The COMPACS®-EXPRESS-TR3 comprehensive system for diagnostics of EMU-trains sections is designed for a comprehensive automatic health evaluation of the most compound equipment, subjected to operational wear and failures of EMU-trains sections (wheel motor units; pantographs; compressed-air and electric-pneumatic brake system; electric control circuits; high-voltage power circuits; heating and auxiliary electric circuits) within current repairs of a large amount. According to the defined equipment classes, the system includes seven diagnostic subsystems, interacting as one.

The system structure and components together with the adopted layout allow to carry out the comprehensive diagnostics of EMU-trains sections of 15 different AC and DC series on the single software-and-hardware.

The COMPACS®-EXPRESS-TR3 system advantages

- The system has a unique structure due to specially connecting devices network, stationary located in the optimal test area spots, and auxiliary mobile measuring devices, functioning via the wireless network Compacs-Radio-Net®.
- The system automatically generates, archives and transmits technical readiness reports on each EMU train subsystem and a summary report to the Compacs-Net® depot diagnostic network. The data transmission is carried out via the Compacs-Radio-Net® wireless network with no personnel interference.
- During the operation, parameters of physical values and processes, used as diagnostic

"MONITOR" mode of the Wheel motor unit diagnostics subsystem software

"MONITOR" mode of Insulation diagnostics subsystem software
features (vibration parameters, pressure, effort, current, voltage, resistance, impulses, time intervals) are automatically measured and displayed on the screen of the diagnostic station, built on the industrial controller basis, in the form of quantitative and qualitative characteristics, reflecting the equipment and electric sections assemblies health.

- The system provides an objective evaluation of EMU train section health due to a multilevel testing control, an automatic identification of EMU train series, maximization of the diagnosed assemblies and units quantity, elimination of a subjective "human factor" from the processes of testing and drawing a conclusion - diagnosis.
- Duration of the full diagnostic program including preliminary and final operations does not exceed 3,5 hours.
- The system software-and-hardware self-diagnostic function provides a high safety of the whole complex operation.
- The system integrated in 12 multiple unit depots of Moscow, Oktaybrskaya, Privolzhskaya, West Siberian, Northern and Kuibyshevskaya railways.
- The system considerably surpasses all known analogs in structure, functionality and completeness of revealing malfunctions of EMU trains sections equipment.

The COMPACS® EXPRESS-TR3 system economic benefits

- Economy by reducing of expenses for after-repair control.
- Economy by excluding of losses from trains equipment defects and damages along the line.
- Economy by excluding of unscheduled repairs.
- Economy by excluding of EMU trains running tests and relevant expenses.
- Economy by reducing of operation costs due to decrease of unit
man-hours spent on repair works.

As long as the depot repair counts 150 sections per year, the system self-repayment period does not exceed one year.

The system provides a strong social and economic effect, acts as an effective tool of railway transportation safety and operation regularity increase, creates conditions for the repair system accelerated reconstruction on the safe money-saving basis.

**The COMPACS®-EXPRESS-TR3 system structure**

- **WMU** – wheel-motor units diagnostic subsystem;
- **IDS** – power and auxiliary circuits insulation diagnostic subsystem;
- **CDS** – collector diagnostic subsystem;
- **BDS** – compressed-air brake system equipment diagnostic subsystem;
- **ECCDS** – electric control circuits diagnostic subsystem;
- **EPCDS** – electric power circuits diagnostic subsystem;
- **AECDS** – high-voltage auxiliary electric circuits diagnostic subsystem.

The system is being actively operated and has established a reputation for detecting large amounts of various defects, including mounting errors, regulations violation, non-typical elements installation, violation of connections density in an air main and others. Diagnostics credibility is close to 1 and is confirmed by results of revision and disassembling, as well as an after repair adjustment, running and the first operation period of EMU trains.

Engineering solutions, implemented in the system, are protected by the Russian Federation Patents on various objects of intellectual property and Certificates of official registration for computer programs.

The warranty for supplied equipment - 12 months.

**The COMPACS®-EXPRESS-TR3 system detects the following malfunctions of motor-driven rolling stock sections**
• **Wheel-motor units malfunctions:**
  - bearing defects;
  - lack of lubrication and poor lubrication;
  - misalignment of a bearing mounting in a bearing box case;
  - misalignment of bearings mounting in end shields of traction motors;
  - fastening defects;
  - rotating parts imbalance;
  - reducer defects.
• **Power and auxiliary circuits insulation defects:**
  - insulation features deterioration;
  - humidification;
  - ageing;
  - breakdown.
• **Collectors malfunctions:**
  - defects of moving frames, tie-rods and levers, pin joints of the collector;
  - incorrect adjustment of a reducing valve;
  - incorrect adjustment of lowering and lifting springs effort;
  - incorrect adjustment of tie-rods.
• **Compressed-air and electric air brake system malfunctions:**
  - leakage of feed and brake lines;
  - driver’s brake valve malfunctions;
  - malfunctions of air distributors and electric air distributors;
  - brake cylinders malfunctions;
  - malfunctions of feed, balance and spare tanks;
  - compressor malfunctions;
  - incorrect adjustment of reducers;
  - malfunctions of electric air brake control circuits.
• **Control circuits malfunctions:**
  - breakage of train and section wires;
  - body contact of circuit wires, short circuit on negative wires and line-to-line short circuit;
  - units, relays and contactors malfunctions, including mechanical jam, defects of coils and contacts;
  - violation of units response sequence;
  - malfunctions of control elements and driver’s controllers (contact pairs malfunctions);
  - violation of a power controller adjustment (acceleration regulation unit);
  - units electric pneumatic valves and doors cylinders leakage.
• **Electric power circuits malfunctions:**
  - power units failure;
  - clogging of power units junctions;
  - malfunctions of traction motors circuits;
  - violation of contactors response sequence;
  - malfunctions of starting resistors, actuation weakening resistors, grounding relays and inductive shunts resistors;
  - violation of high-voltage wiring works;
  - violation of a power controller operation.
• **Electric auxiliary circuits malfunctions:**
  - malfunctions of furnace and calorific heating circuits (breakage, lack of furnace and radiator groups, short circuit);
  - auxiliary contactors malfunctions (no response, sticking);
  - breakage of intercar high-voltage connection;
  - malfunctions in damper resistors of voltage dividers and compressor;
  - malfunctions of transducer starting resistors;
  - actuation sequence violation in auxiliary circuits contactors;
  - malfunctions of voltage divider circuit, transducer and compressor motor;
  - malfunctions in control circuits of auxiliary circuits (heating control, phase splitter starting control, battery contactor control).

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**Readings of EMU-train equipment diagnostics by the COMPACS®-EXPRESS-TR3 comprehensive monitoring system**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of diagnosed units of EMU-trains</td>
<td>3 727</td>
</tr>
<tr>
<td>Number of tests carried out</td>
<td>27 207</td>
</tr>
<tr>
<td>Operation malfunctions detected, including¹:</td>
<td>5 810</td>
</tr>
<tr>
<td>wheel-motor units</td>
<td>218</td>
</tr>
<tr>
<td>compressed-air brake system</td>
<td>1 280</td>
</tr>
<tr>
<td>collectors</td>
<td>295</td>
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<tr>
<td>electric circuits</td>
<td>4 017</td>
</tr>
<tr>
<td>Number of confirmed malfunctions²:</td>
<td>5 629</td>
</tr>
<tr>
<td>Component</td>
<td>Count</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>wheel-motor units</td>
<td>209</td>
</tr>
<tr>
<td>compressed-air brake system</td>
<td>1271</td>
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<tr>
<td>collectors</td>
<td>282</td>
</tr>
<tr>
<td>electric circuits</td>
<td>3867</td>
</tr>
<tr>
<td>malfunction confirmation percentage, %</td>
<td>93...97</td>
</tr>
</tbody>
</table>

1. according to the information from operating personnel, test reports and systems databases;
2. according to the information from operating personnel, logs of TU-152 and TU-28 forms, and test reports (within one assembly being tested for several times) and systems databases.