The COMPACS®-EXPRESS-3 on-board system for electric multiple-unit trains equipment health monitoring

The COMPACS®-EXPRESS-3 system is designed for electric multiple-unit train equipment real-time health monitoring and allows to detect timely occurrence and development of malfunctions with data issuing on the display located in the driver’s cabin.

On-board monitoring system allows to obtain the full information on the health of bearing assemblies, compressed-air brake system and electric multiple-unit train electrical circuits during the motion, as well as observe defects level and development, form recommendations for locomotive and repair crews on the required maintenance and actions to be taken.

The system measures vibration, temperature, pressure, traction current and auxiliary electrical circuits current, motion speed, current geographical coordinates of the train and command units location. All the information from the sensors is transmitted to the on-board diagnostic station.

The system forms and archives technical state reports for each car and the whole train, issues them on the diagnostic controller display, which is located in the driver’s cabin, and transmits the reports to the Compacs-Net® diagnostic network for the personnel in charge for diagnostics, the depot heads and all the interested subdivisions.

The COMPACS®-EXPRESS-3 system advantages

- Health monitoring is carried out on the basis of diagnostic parameters analysis in conditions of a variable high-speed and load modes of an electric multiple unit train motion.
- The system software and hardware are reliable in severe operation conditions.
- The system provides metrological characteristics in a wide temperature range from -40°C to +60°C and a relative humidity up to 100%.
- The system uses wireless technologies, which allow to transmit effectively the data on particular assemblies and units health without interference in the train construction.

The system contains GPS-navigator, constantly detecting the train location and indicating the nearest station. As the train getting closer o the terminal station, the data are transmitting to the depot server for the personnel in charge of the electric multiple-unit train diagnostics.

The on-board system for electric multiple-units trains monitoring COMPACS®-EXPRESS-3 provides maximum safety for passengers (prevent accidents and crashes), increases effectiveness of the train maintenance, allows to extend run-to-failure and consequently decreases substantially the operation costs.

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 COMPACS®-EXPRESS-3 system components

- on-board diagnostic station (diagnostic controller);
- intellectual interface modules PIM™;
- the Compacs-Radio-Net® wireless net module;
- the CORNET® communications hub;
- impulse counter;
- voltage control device;
- vibration sensors;
- temperature sensors;
- direct current sensors;
The COMPACS®-EXPRESS-3 system scheme

Electric multiple-unit train malfunctions, automatically detected and issued to personnel by the COMPACS®-EXPRESS-3 expert system

- **axle equipment:**
  - bearing defects;
  - low-quality and poor lubrication;
  - balancing, centering and fastening defects.

- **traction reducers:**
  - engagement defects;
  - bearing defects;
  - low-quality and poor lubrication.

- **solid-rolled wheels, wheelsets tyres:**
  - roll surface defects.

- **traction motors:**
  - bearing defects;
  - low-quality and poor lubrication;
  - commutator-and-brush assembly defects;
  - balancing, centering and fastening defects.

- **compressed-air brake system:**
  - malfunctions in a driver’s brake valve;
  - leakage in a brake line;
  - leakage in a feed line;
  - pressure controller malfunctions;

- **compressor:**
  - operation modes violation;
  - phase short circuit;
  - loss of phase.

- **transducer:**
  - generator phases misalignment.

- **electrical control circuits:**
  - malfunctions of a driver’s brake valve circuits and driver’s controller;
  - malfunctions in compressor control circuits.

- **power electrical circuits:**
  - electric circuit malfunctions in traction motors;
  - short circuit in a power chain in various states of a driver’s controller.

- **auxiliary electrical circuits:**
  - short circuits and breakage in auxiliary machines chains.
- leakage in a brake cylinder;
- air distributor malfunctions.

**Characteristics of electric multiple-unit train diagnostics carried out by the COMPACS®-EXPRESS-3 monitoring system**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMU-trains under monitoring</td>
<td>91</td>
</tr>
<tr>
<td>Units of EMU-trains under monitoring</td>
<td>429</td>
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<tr>
<td>Operation malfunctions detected, including:</td>
<td></td>
</tr>
<tr>
<td>mechanical</td>
<td>26</td>
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<tr>
<td>traction electric engines</td>
<td>31</td>
</tr>
<tr>
<td>auxiliary electric machines</td>
<td>25</td>
</tr>
<tr>
<td>electrical equipment and control circuits</td>
<td>43</td>
</tr>
<tr>
<td>compressed-air brake system malfunctions</td>
<td>29</td>
</tr>
<tr>
<td>malfunctions confirmation percent, %</td>
<td>100</td>
</tr>
</tbody>
</table>