

1.10.35. ON-BOARD REAL-TIME CONDITION MONITORING SYSTEM OF ELECTRICAL TRAIN

Kostyukov A.I.V., Aristov V.P., Sizov C.V.,
Kostyukov V.N., Boichenko S.N., Zajcev A.V.,
SPC "DYNAMICS", Omsk, Russia

Improvement of commuter traffic quality is impossible without providing of high level reliability and operational availability of motor driven rolling stock (MDRS). Traditional methods of this problem decision in the second half of XX century were based on extensive factors of development, first of all on significant resources of cheap, highly skilled labour force, and now they are completely exhausted. On the other hand, growth of activity and quality of traffic raises appropriate requirements to a level of MDRS equipment maintenance and repair with reduction of terms and operating costs [1, 2]. Fundamental change of present situation is possible on the base of continuous automated monitoring of MDRS state during operation process. Monitoring is a control of MDRS state for determination and prediction of limiting state by periodic diagnostics during coterminous time intervals which duration is considerably less than interval of critical failure development. Realization of this requirement is possible only due to the On-board real-time condition monitoring system of electrical train. On-board system for electrical train technical state monitoring has a number of contradictory requirements:

- Necessary completeness and reliability of diagnostics;
 - The maximum simplicity for providing of high reliability and low cost;
 - Providing of controllability of electrical train, which doesn't contain regular diagnostic points, and also inadmissibility of changes in design and electroscheme of train;
 - Full automation of all actions in on-board system with the purpose of reduction of communication time with engineman;
 - Simplicity of system equipment assembling on an electrical train in depot;
 - High level of protection and stability, wide range of operating temperatures, selfdiagnostics from sensor up to display;
 - Automatic transfer of diagnostic information from electrical train board to the depot diagnostic net for making a decision on its further operation. Of course, development of on-board monitoring system requires the development of diagnostic net in depot.
- Developed on-board system COMPACS-EXPRESS 3 provides monitoring of electrical train technical state in real-time and allows to detect occurrence and development of faults with information representing on the engineman display in proper time. Estimation of technical state is made on the base of diagnostic parameters analysis in conditions of varying speed and loading mode of electrical train movement. Hardware and software system tools are very reliable in difficult conditions of operation.

System provides metrological characteristics in wide range of temperature from –40 up to +60°C and relative humidity up to 100%. The wireless technologies which allow to transfer information concerning the technical state of some MDRS components and units without electrical train design change, are extensively used in the system. Due to system GPS-navigator the location of train with indication of the nearest station is always evident. At the moment of approaching to a terminal station the information is transferred to diagnostic net server in depot for electrical train diagnostic personnel by means of wireless network.

System allows to receive complete information about equipment technical state during movement, to trace a level and development of defects, and form necessary recommendation for locomotive and repair crews. On-board system ensures a maximum safety for passengers, makes easier efficient maintenance of electrical trains, and also increases run-to-failure and allows to decrease operation costs essentially. State of all controlled units according to the measured parameters and can have one of the following values: “atisfactory” – state of equipment meets the requirements of standards; “attention required” – train or unit have a state when operation is still possible, but there’s a need of additional control, because units parameters are close to limiting; “intolerable” – train or unit have a state when their parameters exceed maximum permissible values.

Result of measured parameters processing is displayed on the diagnostic controller monitor at once, saved in its database, and also transferred to the diagnostic network server in depot. The developed system allows to diagnose automatically defects of such trains and units as wheel-motor units and wheelsets, power electric circuits and traction motors, electrical equipment, auxiliary machines, pneumatic equipment, brake lever and controller of engineman. Besides, system realizes a complete selfdiagnostics of its own hardware, including sensors, electric modules and communication channels.

According to the diagnostic results, system forms in real-time recommendations concerning detected defects elimination for locomotive crew and repair personnel of depot. System controls all basic units and trains of electrical train cars and gives reliable and efficient information about controlled object state to personnel.

In case of need the diagnostic results can be printed in the form of test report. This report comprises numerical values of measured parameters, state of electrical trains units and trains, and diagnostic messages which present specified actions concerning to these units faults elimination to personnel. The developed on-board system for electrical train technical state monitoring ensures control of all electrical train units in real-time corresponding to all requirements of necessary completeness and reliability of diagnostics, maximum simplicity for providing of high efficiency and low costs, full automation of diagnostic and other actions with minimization of human factor influence. System has a high level of protection and stability, small dimensions, vibration tolerance, wide range of operation temperatures ($-40 \dots +60^{\circ}\text{C}$) and humidity; realizes self-diagnostics of all its sensors (from sensor up to display). System provides automatic transfer of diagnostic information from electrical train to diagnostic network in depot for further operation decision making. On-board system allows to replace scheduled repairs of electrical trains by repairs based on actual technical state, that significantly release human and material resources.

References:

1. **Kostyukov V.N.** Monitoring of production safety. Moscow: Mashinostroyenie, 2002. – 224 p.
2. **Kostyukov V.N., Sizov S.V., Aristov V.P., Kostyukov A.V.** Continuous monitoring of motor driven rolling stock // Railway Transport. – 2008. – N 6. – P. 41–42.
3. **Application** 2008139837, MPK G01M17/08; System of electrical trains monitoring [Text]: Kostyukov V.N., Kostyukov A.V., Boichenko S.N., Starikov V.A., Zajtsev A.V., Schelkanov A.V.; Applicant SPC “Dynamics”; Appl. 26.06.2006, Published 20.11.2007, Bull. N 32; priority 26.06.06. – 16 p.