1.8.15. ROLLING STOCK VIBRATION DIAGNOSTICS EXPERIENCE ON RUSSIAN RAILWAYS

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The investigation of the railway locomotives running gear diagnostics by vibration was done. The required adaptation of the designed vibration diagnostics techniques is analyzed. The adaptation goal was the significant reduction of the locomotive's wheel-motor cartridges (WMC) failures that often lead to long stopovers of the railway transport.

The reliability of the locomotive's WMC between major repairs is mostly defined by the condition of rolling element bearings – box bearings, transmission and motor bearings. The main condition diagnostics methods for the rolling element bearings operating in the stationary conditions are well known, but application of such methods to the diagnostics of the railway locomotive's WMC does not provide reliability required for practical diagnostics. A special adaptation is required to take into account structural and technological peculiarities of the railway transport as well as organizing special modes of WMC rotation for diagnostic vibration measurements.

The following issues were considered during adaptation process – optimization of the applied diagnostic methods, modification of the measurement instrumentation and diagnostics software, choice and maintenance of WMC rotation modes, centralization of the database storage, training of personnel and work organization in field.

Two peculiarities in the major repair technology of the WMC had significant influence on the condition diagnostics methods choice. These are the usage of reconditioned bearings that require very detailed and complex methods for diagnostics and condition prediction and at the same time no efforts is done to select gear wheels for transmission gear pairs. The quality of gear wheels interaction is the main issue that defines the results of bearings and gear diagnostics of the WMC. As a result four independent methods for bearings vibration diagnostics were selected and well as three for the diagnostics of gears. That in its turn resulted in significant redesign of the expert software used for diagnostics.

Three main options for WMC operation mode during measurements were investigated. These are diagnostics during locomotive motion, measurements in depot on the lifted locomotive while the wheels were rotating from their own motors and measurements while the wheels were rotating from the drive of the special roller stand. From the point cost efficiency the most effective turned out to be the measurements on lifted locomotive, but the required reliability of condition diagnostics and prediction was obtained only after adaptation of measurement instrumentation and software. Also the optimal rotation speed was defined for the wheels. It lies in the interval 250–300 RPM.

The method of wheels rotation from the special roller stand according to investigations can be recommended not for locomotives that have their own motor on WMC, but for railway cars that do not have their own motors.

The next task was to find out the periodicity of measurements and diagnostics based on the optimal condition prediction interval. The investigations proved that on the first stage of diagnostics technology introduction when there is no data on the previous results of condition diagnostics i.e. after the major repairs, it is not possible to provide reliable condition prediction on the intervals more than the one between regular maintenances. Such interval is about 20 thousand km, but may vary with the locomotive type. The reason for it is that more than half of the dangerous defects of the WMC are detected in this

run-in interval after the major repair. But if the detailed WMC condition diagnostics is done just after the major repair and the data have been entered in the central database used for the future periodic diagnostics the reliable condition prediction interval can be prolonged in 2–3 times.

Not of minor importance is the question of diagnostics personnel efficiency optimization. The question is solved by the use of automatic diagnostics software capable of rotating parts analysis by vibration analysis of group of large number (up to 100 and more) of identical machines. Such analysis provides very efficient and reliable separation of good parts (typically more than 80 % of rolling stock) from the ones with some defects. The defects in automatic algorithms are typically significantly overestimated and the operator is responsible for verifying defects using all direct and indirect information he may obtain. For this operators should pass training on regular basis as well as to be able to contact an expert in diagnostics in complicated cases.

As an experiment there was formed and works for two years already a diagnostics center of the Northern railway. If guarantees safe operation of the locomotives by the periodic diagnostics of all WMC operating on the railway. The center is equipped with all needed means of diagnostics and introduces the new corporate diagnostic complex with united database. All personnel working in the 11 depots of the railway passed two weeks training in the North-West educational center in St. Petersburg and three months practice in depot under the guidance of diagnostics experts. The railway has 4 experts and they have a remote access to the database by intranet and internet networks and can shortly assist operators in verification of doubtful defects in any depot. In complicated cases experts from the head center organized in St. Petersburg educational center can assist in case analysis. Each operator, including experts follows up the condition of about 40 locomotives (more than 2000 units for diagnostics). Re diagnosis reliability level can be characterized by less that one false diagnosis, including false alarms, for 10,000 of diagnoses, the number of found defects that require immediate correction actions is close to one percent of the diagnosed units. During the first year of the center operation, the number of WMC bearing failures during locomotives operation due to wrong diagnostics decreased in dozens of times and does not exceed 2–3 cases per year on the whole Northern railway.

The following vibration measurements are done for each diagnostic unit – acceleration autospectrum up to 1–2 kHz, high frequency vibration envelope spectrum selected by a bandpass filter with center frequency 6–8 kHz and high frequency vibration level in the 15 – 30 kHz band. For each diagnostic unit only one measurement location and one radial direction is used. The levels for defects are automatically calculated based on more than 100 previously diagnosed bearings.