

RESEARCH ON TECHNICAL AND LEGISLATIVE ASPECTS OF THE “INTELLIGENT END OF TRAIN” SYSTEM

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The deployment of digital technologies on the railway, especially the widespread deployment of the ETCS system at the L2 application level, enables direct control of railway vehicles, i.e. vehicles are permanently connected by a radio system with the infrastructure interlocking system. One of the expected benefits of using these technologies, in addition to increasing safety, is the possibility of increasing the capacity and usability of the railway infrastructure, as well as reducing investment costs for technologies (infrastructure occupancy detection devices and signaling) currently installed in the infrastructure. However, to replace these technologies, the information about the position of each train must be available, both its front (today provided by the ETCS mobile part) and its end of the train. The paper presents the main outputs of the TACR project – CK04000156 INTELLIGENT_END4TRAIN, which carried out research into the possibility of detecting the integrity of a freight train based on monitoring pressure conditions in the main brake pipe. The research focused on the implementation and operational verification of the Intelligent Train End measurement system and the examination of operational aspects on the basis of which it would be possible to evaluate information about the integrity of the train.

According to the current specifications of the ETCS system, in addition to information about the length of the train, it is also possible to confirm the integrity of the entire train. This information can be obtained today for most passenger trains (e.g. via UIC cable connection, or via the electro-pneumatic brake control cable). However, it is most difficult to obtain this information for freight train, because freight wagons currently do not have any other connections (electrical, busses) than a continuous pipe for supplying and controlling the train brakes with compressed air from the traction vehicle.

The aim of the project was to explore aspects of the possibility of checking the integrity of a freight train. Main operational aspect under analyze was the examination of pressure conditions in the train brake pipe in all continuous brake states (operational and emergency) with the analysis of the detection of the train rupture state. To ensure the transmission of information from the end of the train via the radio system, it was also necessary to ensure the acquisition of electrical energy from a generator connected to the air pipe of the continuous brake of the train.

The basic architecture of the intelligent train end system is depicted in Figure 1. In order to investigate the operational aspects under real conditions, a functional prototype consisting of two units, HOT (head of train) and EOT (end of train), was constructed.

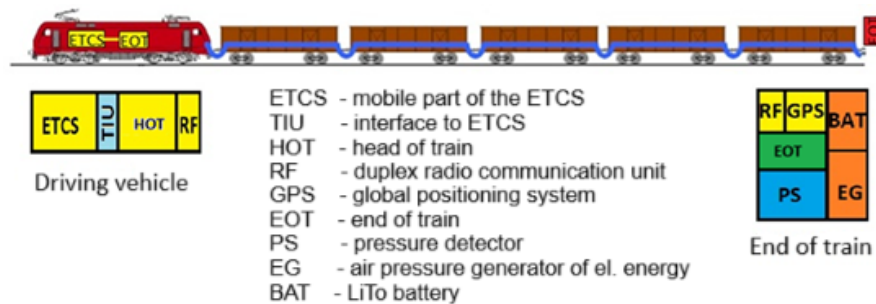


FIGURE 1. Intelligent train end architecture.

Both units communicate with each other via a radio communication system using frequency modulated data transmission in the 450MHz band. The EOT unit is equipped with a pneumatic microturbine with an electric generator that charges the LiTo battery from which the electronic and radio parts of the EOT unit are powered.

The exploration of pressure conditions in the brake pipe was carried out on a static train stand of the 750 m length in the brake system manufacturer DAKO in Třemošná.

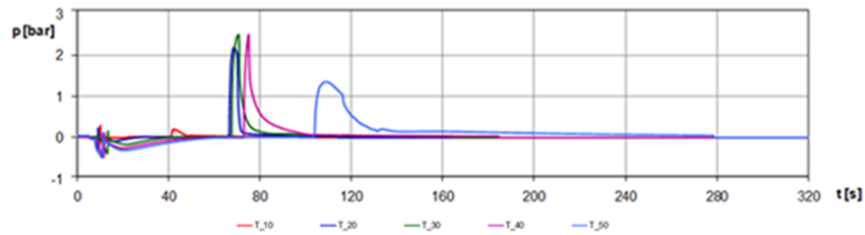


FIGURE 2. Pressure profile in the brake pipe during full operational braking and swing braking and pressure differences at the front and rear of the train depending on its length.

The obtained data allowed to create a model of the air duct and subsequently to determine the algorithm for detecting train rupture. The entire system was operationally verified in real operation at the Test Center Velim, where the functionality of the system in real conditions was confirmed.

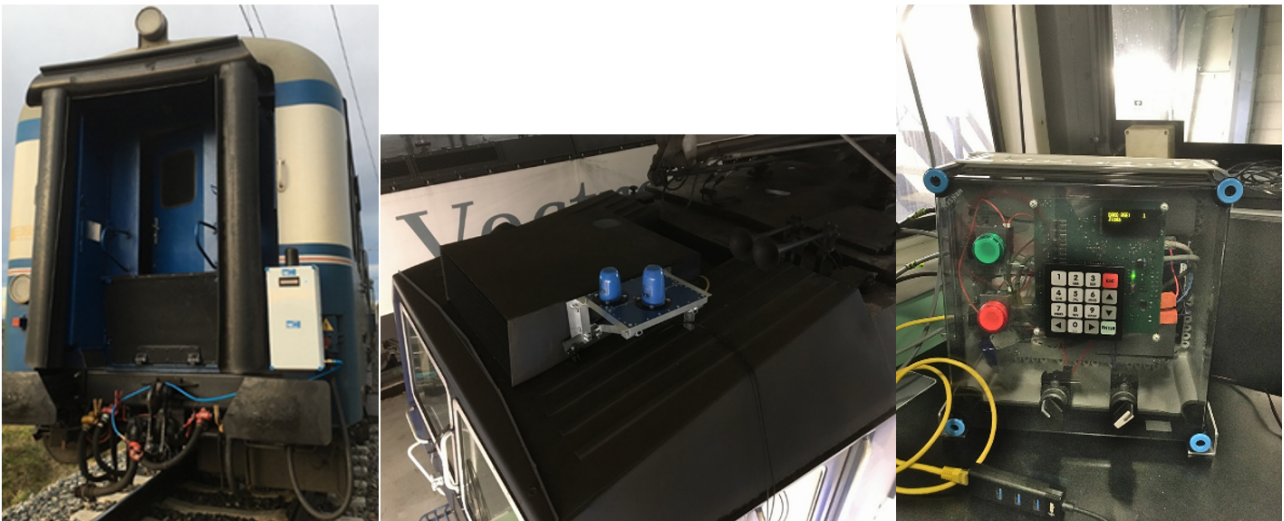


FIGURE 3. From the left – location of the EOT unit, location of the RF and GNSS antennas on the 363.5 series vehicle, installation of the EOT unit on the driver's seat.

The research has shown that the proposed train integrity detection device, which is connected to the main pipeline of the train's brake system, does not have a negative effect on the behavior of the train's brake. The measurements and analyses performed show that the proposed Intelligent Train End system is suitable for train integrity detection in all brake operating states, except for rapid braking, where the state of the train's brake pipeline and thus the confirmation of train integrity cannot be unambiguously determined. The train end detection device can be viewed as a new brake device that ensures continuous monitoring of the train's brake, including automatic evaluation of its condition. As part of the revision of TSI and EN 14198, the basic requirements for such a new brake device can then be added to the aforementioned documents.

The possibilities of introducing the intelligent end of train system are closely linked to the issue of introducing the ETCS system at higher application levels and a possible decision on the date of introducing the DAC automatic coupler at level 5. The implementation and further solutions of the intelligent end of train system for freight trains depend on the ongoing modernization of the railway control and safety subsystem, including the widespread introduction of the ERTMS/ETCS system at application level L2.

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