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ENSURING OF THE TRAIN MOVEMENT SAFETY IN THE ERTMS/ETCS

European Rail Traffic Management System (ERTMS) was defined by the first European Commission (2001/260/EC) decision as the combination of the European Train Control System (ETCS) and the Global System for Mobile Communication - Rail (GSM-R). The ETCS as element of ERTMS provides two principal functions: Automatic Train Protection (ATP) and Cab Signalling. Automatic Train Protection is the system that automatically applies the train brakes if a driver does not keep the train's speed below the specific trackside safe limits for the train's current location and operating conditions.

Cab Signalling is the system that displays information inside a train cab about the current status of the track ahead. To do so the ETCS onboard computer must predict the decrease of the train speed in the future, from a mathematical model of the train braking dynamics and of the track characteristics ahead. This prediction of the speed decrease versus distance is called a braking curve.

The ETCS on-board computer calculates in real time braking distances, which will also be used to assist the driver and to allow him to drive comfortably, by maintaining the speed of the train within the appropriate limits.

ETCS is based on an a set of braking curves, computed in real time and depending on different physical parameters (estimated speed of the train, track profile, train acceleration, etc.).

Today the ETCS specifications lay down the basic principles for the braking curves and the associated information displayed to the driver, but there is still no harmonized method to compute them. In the absence of any requirement, the algorithms of the ETCS on-board suppliers lead to different braking distances for a given type of rolling stock. This makes the engineering of the ETCS trackside not only dependent on the pure performance of the rolling stock braking system, but also on the ETCS on-board supplier. For cross border trains, the differences through national rules require the implementation in the ETCS on-board of several national braking curves. It can obviously induce increased costs (software design, cross acceptance tests, software upgrade necessary whenever a national parameter is amended).

The purpose of this article is to present an overview of the ETCS braking curves according to the European specifications, including the following main aspects: basic principle to ensure of the train movement safety, the main types of ETCS braking curves, the input parameters for braking curve calculation, construction of the emergency brake deceleration, and guaranteed emergency brake deceleration.

There have been considered in the work the main ETCS braking curves and the supervision limits of the EBD braking curves, the movement authority, the end of authority, the most restrictive speed profile, the supervised location and others.

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DISTRIBUTION OF THE TRACTION CURRENT HARMONICS IN RAILS

To ensure the electromagnetic compatibility (EMC) of new types of rolling stock with signaling and radio communication systems, they are subjected to an acceptance procedure that includes the EMC tests in accordance with European and national regulatory standards and norms.

The aim of the work is to establish mathematical and computer model for distribution of traction current harmonics in AC direct feeding traction network with multiple vehicles in feeder zone. This model is an evolution and simplification of models represented earlier [1]. The results of the work have been used during tests of new types of trains [2].

A mathematical and computer model of traction current harmonic distribution in traction network with multiple vehicles in feeder zone has been established. The traction network was represented as series-connected multipoles, corresponded to longitudinally uniform network areas which are modeled with MTL equations. The model has been simplified as follows. The lines with equal or close to each other potentials are represented as a single line with equivalent electrical parameters. The disturbing vehicles are modeled as sinusoidal current sources with several set of frequencies that are represented by current vector. Only return current harmonics with frequencies that lie in frequency range of track circuit receiver were considered.

The distribution of the traction return current harmonics was computed for direct feeding traction network 1x25 kV AC electric railway system with twoside ESS and with 1 to 5 vehicles in feeder zone.

The maximum interference from trains is in the areas nearest to trains and near the point of connection of return feeder to rails (at ESS terminals). The traction harmonic current in rails are increased with increasing of train number in feeder zone and with decreasing of the rail-to-earth conductivity. The interference at 25 Hz in the rails area near the ESS for one locomotive in feeder zone don't exceed a limit value of 1 A even in unfavorable operation conditions for the rail-to-earth conductivity equal 0.02 Sm/km. If number of trains are increased (from 1 to 5) the