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The operation of ETCS in high-speed lines – legal requirements

Abstract: This article discusses the national requirements for operating ETCS at speeds above 160 km/h. Particular emphasis is placed on the amendment to the 2023 Traffic and Signalling Regulation, which allows for operation in ETCS without classic semaphore signalling. This change is in line with the European trend to create the so-called ERTMS radio system, as mentioned in the European Commission Regulation of June 2024, which is a system with full detection without the need for trackside signalling. The second part of the article focuses on the experiences of PKP PLK regarding the operation of the ETCS system at speeds above 160 km/h.

Keywords: ETCS; Signalling; Legal requirements; TSI Control; Command and Signalling

Legal Aspect

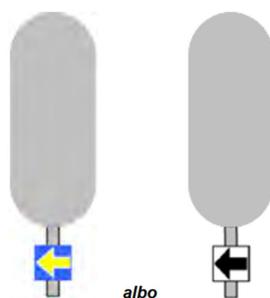
According to the applicable regulation on the general conditions for railway traffic management and signalling, operating at speeds above 160 km/h in Poland is only possible with the ETCS system. This means that installing ETCS on a given railway line is essential for running trains at speeds above 160 km/h, and in the event of a failure of either trackside or onboard ETCS equipment, the maximum permitted speed is reduced to 160 km/h.

One of the most recent amendments to the Regulation on the general conditions for railway traffic management and signalling of 2023 [1] has established a legal framework for improving railway operations using the ETCS system, particularly on high-speed lines and in mixed traffic operations, meaning both ETCS-equipped and non-ETCS-equipped trains. The most significant changes introduced by the amendment include:

- 1) Expansion of the definition of a block section – in addition to the current definition, where a block section starts or ends at a traffic control post or an automatic block signal, the amendment includes a block section that starts or ends at an ETCS indicator (W ETCS 10 or the newly introduced W ETCS 11). A block section without a semaphore at its beginning or end is referred to as an ‘ETCS block section’ (§ 25(7) of the amended regulation). Furthermore:
 - If multiple ETCS block sections exist between a given semaphore and the next one, the proceed signal at the semaphore (applicable to non-ETCS trains) may only be displayed if all those ETCS block sections are unoccupied, meaning without changes to the current traffic management rules,
 - An ETCS-equipped train may receive movement authorisation as soon as one ETCS block section is clear.
- 2) Introduction of the ETCS block section definition – the use of ETCS block sections can increase line capacity by allowing train movements not only within block sections

defined by signals but also based on newly introduced ETCS indicators: W ETCS 10 and W ETCS 11,

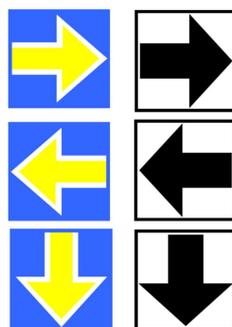
- 3) Clarification of the train dispatching process by the traffic controller;
- 4) Approval of the following configurations for equipping railway lines with ETCS system devices:
 - Trackside signalling and ETCS devices installed in parallel, allowing both systems to operate simultaneously,
 - Trackside signals remain installed, but when ETCS equipment is operational, train movements rely exclusively on ETCS, with signals being turned off (this option requires the trackside equipment to have a function that allows distinguishing between ETCS and non-ETCS-equipped trains),
 - No trackside signalling, with train movements fully managed by the ETCS system;
- 5) Introduction of the SE signal: ‘Proceed according to the indications of the ERTMS/ETCS system’ to facilitate the second of the above configurations;



1. SE signal

Source: Regulation of the Minister of Infrastructure of 20 October 2023 amending the Regulation on the General Conditions for Railway Traffic Management and Signalling (Journal of Laws 2023, item 2474)

- 6) Definition of the W ETCS 11 indicator (‘ETCS Location Marker’), specifying its placement and required driver response. Further clarification of the placement and required response to the W ETCS 10 (‘ETCS Stop Marker’);



2. W ETCS 10 and W ETCS 11 indicators

Source: Regulation of the Minister of Infrastructure of 20 October 2023 amending the Regulation on the General Conditions for Railway Traffic Management and Signalling (Journal of Laws 2023, item 2474)

The discussed amendment to the regulation aligns with the broader European trend—to achieve rail system interoperability, legislative efforts at the European level are aimed at

ensuring that, within the construction of new railway lines (or modernisation of the ‘Control-Command and Signalling’ subsystem), only ETCS Level 2 is installed, without national signalling systems or Class B systems [2].

Given this, national regulations should already be adapted to the objective of achieving rail system interoperability, particularly since the safe implementation of new solutions—both legislatively and technically—is time-consuming, due to complex technical challenges.

According to the new Regulation (EU) 2024/1679 of the European Parliament and the Council of 13 June 2024, concerning EU guidelines for the development of the trans-European transport network (TEN-T) and repealing Regulation (EU) No 1315/2013, the ERTMS radio system must be implemented across the core and comprehensive TEN-T network [3].

This refers to an ETCS Level 2 system with full or limited detection, which does not require trackside signals and uses a Class A radio communication system (GSM-R/FRMCS) for data transmission between trackside and onboard equipment.

The European regulation mandates the deployment of the ERTMS radio system on new TEN-T lines from 2030, on existing TEN-T lines from 2040, and requires that the entire TEN-T network be equipped with ERTMS radio by 2050.

The solutions introduced in the amendment are intended to enable the construction of high-speed railway lines operating at 250–350 km/h and to enhance interoperability by allowing ERTMS/ETCS Level 2 to be used in a configuration without trackside signals.

Operation of the ETCS System at speeds above 160 km/h on the PKP Polskie Linie Kolejowe S.A. network

Currently, train operations at speeds up to 200 km/h are conducted on the PKP Polskie Linie Kolejowe S.A. (PKP PLK) network, using both ETCS Level 1 and ETCS Level 2. The first implementation of ETCS for speeds exceeding 160 km/h on the PKP PLK network was the deployment of ETCS Level 1 on the Central Railway Main Line (CMK, line no. 4, Grodzisk Mazowiecki – Zawiercie section), allowing for speeds of up to 200 km/h.

ETCS Level 1 enabled train operations above 160 km/h while being a more cost-effective installation solution compared to ETCS Level 2. However, the implementation of ETCS on the CMK posed significant challenges due to the mixed traffic operations on the PKP PLK network. The system had to be installed as an ‘overlay’ on the existing basic railway traffic control equipment, which was originally designed for a maximum speed of 160 km/h for conventional (non-ETCS) trains.

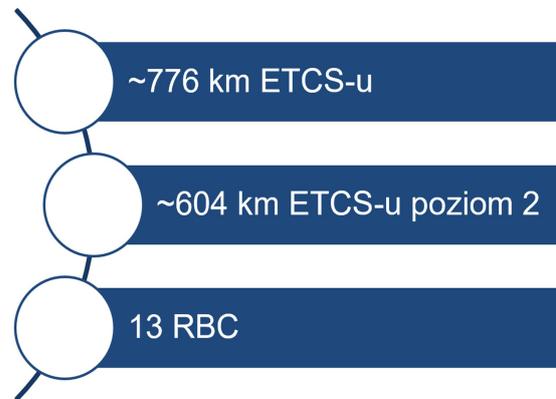
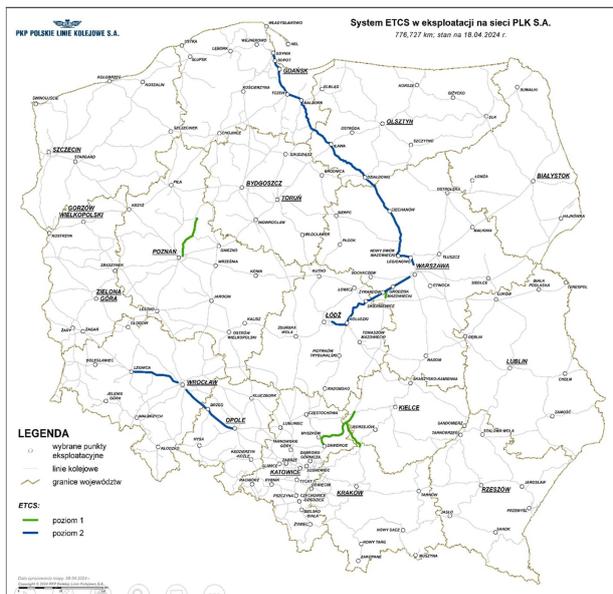
Based on analyses considering spot transmission of data in ETCS Level 1, block section lengths, and line block capacity, the maximum speed for the installed ETCS system was set at 200 km/h.

At the time of ETCS installation on the CMK, the only rail vehicle in Poland technically and formally capable of operating at speeds of up to 200 km/h was the ED250 (maximum operating speed of 250 km/h; currently, this includes the EU200, capable of 200 km/h, and Siemens Vectron).

During ETCS testing on the CMK, it was found that the onboard ETCS system in the ED250 train calculated braking curves in an excessively restrictive manner. Additionally, the braking curve calculation method in the onboard ETCS system—which followed Baseline 2, Model 2—was not harmonised at the European level.

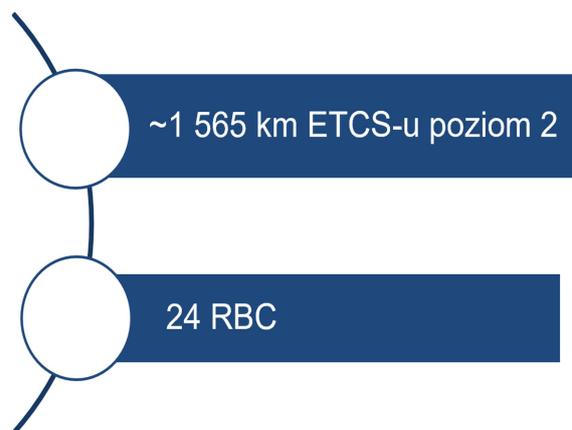
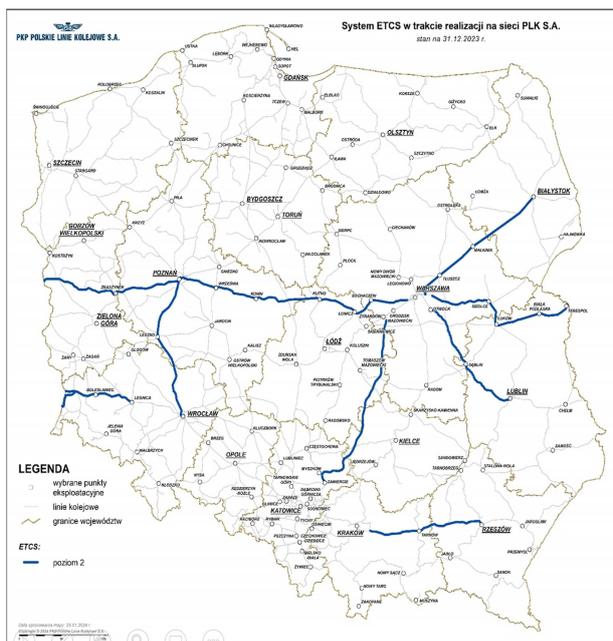
To avoid unnecessary braking interventions caused by the onboard ETCS system's braking curve calculations, speed limits at certain locations on the CMK ETCS system were set below 200 km/h.

The ETCS Level 1 system on the Central Railway Main Line has been in operation at speeds of up to 200 km/h since December 2014.



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3. Lines currently operating the ETCS system, both Level 1 and Level 2
Source: Author’s own materials



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4. Lines currently undergoing the installation of the ETCS Level 2 system
Source: Author’s own materials

Currently, a project for the installation of ETCS Level 2 is underway on the Central Railway Main Line (CMK), which will result in the decommissioning of ETCS Level 1 and an increase in the operational speed to 250 km/h. The project includes the centralisation of traffic control, where a more than 200-kilometre section of the line will be managed by a single local control centre along with a single Radio Block Centre (RBC).

Another railway line where ETCS is in operation at speeds above 160 km/h is line no. 9 (E 65 corridor, Warsaw – Gdynia section), where ETCS Level 2 has been implemented.

Train operations on line No 9 are conducted at speeds of up to 200 km/h, determined by the infrastructure parameters. As a system that provides continuous transmission of Movement Authorities (MA) to onboard equipment, ETCS Level 2 minimises the impact of the existing traffic control system configuration (such as block section length and line block capacity) on the maximum operational speed.

However, the installation of ETCS on line no. 9, taking into account experience from the operation of ED250 trains, required adjustments in the configuration of level crossing systems. The ETCS Level 2 system on line no. 9 has been in operation at speeds of up to 200 km/h since December 2020.

Based on PKP Polskie Linie Kolejowe S.A.'s experience, when operating trains above 160 km/h with ETCS Level 1, the key challenge is finding the right balance between maximum speed and line capacity, particularly in cases of mixed traffic operations on a given railway line.

Source materials

- [1] Regulation of the Minister of Infrastructure of 20 October 2023, amending the regulation on the general conditions for railway traffic management and signalling, *Dz. U.* [Journal of Laws] of 2023, item 2474.
- [2] Commission Implementing Regulation (EU) 2023/1695 of 10 August 2023 on the technical specification for interoperability relating to the control-command and signalling subsystems of the rail system in the European Union and repealing Regulation (EU) 2016/919.
- [3] Regulation (EU) 2024/1679 of the European Parliament and of the Council of 13 June 2024 on Union guidelines for the development of the trans-European transport network, amending Regulations (EU) 2021/1153 and (EU) No 913/2010 and repealing Regulation (EU) No 1315/2013 (Text with EEA relevance).