Ministry of Transport and Construction of the Slovak Republic
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National implementation plan for the technical specification for interoperability relating to ”Control-Command and Signalling“ subsystem of the railway system of the European Union

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Legislative Background

In order to achieve a common transport policy in the interests of the interoperability of national railway systems, it is necessary to harmonize technical, administrative and safety rules. In order to ensure the interoperability of the Community railway system and to enable Union citizens, economic operators or competent authorities to take full advantage of the existence of the Single European Railway Area, EU legislative instruments have been developed, including Directive 2016/797 of the European Parliament and of the Council of 11 May 2016 on the interoperability of the rail system within the European Union (hereinafter referred to as the "Interoperability Directive"). In pursuit of the defined objective of interoperability, the level of technical harmonization should be optimized and the improvement and development of international rail transport services should be facilitated and it should be contributed to the progressive establishment of the internal market for equipment and services intended for the construction, renewal, upgrading and operation of the Union rail system. The Interoperability Directive introduced basic subsystems as a basic tool for technical harmonization, as well as the obligation to draw up a technical specification for interoperability (hereinafter referred to as "TSI") for each subsystem. The aim of drawing up the TSIs was indeed to increase the competitiveness of the Union's railway sector without distorting competition between the key players in the Union's railway system. On the basis of that obligation, Commission Regulation (EU) No 2016/919 on the technical specification for interoperability relating to the control-command and signalling subsystems of the rail system in the European Union (hereinafter referred to as "CCS subsystems") was adopted. The CCS subsystems are defined as all the equipment necessary to ensure the safety and traffic management of trains approved to travel on the network and include components such as train protection, voice radio, data radio and train detection. An obligation to use control-command and signalling equipment and signalling procedures and associated procedures is introduced for that TSI in such a way as to enable trains to travel with a level of safety which corresponds to the objectives set for the network. The aim of the TSIs is to ensure the highest possible level of safety and to promote the competitiveness of rail transport in the Union network.

At national level, harmonization has taken place with the Interoperability Directive and the Regulation on control-command and signalling subsystems, in particular with the adoption of Act No. 513/2009 Coll. on Railways and on Amendments to Certain Acts, as amended, and its subsequent amendments. The implementing regulation to the Act is the Decree of the Ministry of Transport, Posts and Telecommunications of the Slovak Republic No. 351/2010 Coll. on the traffic regulations of railways, which regulates the details of the operation of individual types of railways and their components, on the operation of transport on railways, on the type approval of a railway vehicle and its substantial change, on the issuance and withdrawal of a technical license of a railway vehicle, on the operation of railway vehicles, on technical-safety testing of rolling stock, technical inspections of rolling stock and drawing up a timetable.

Basic information

The railway network consists of the sum of all transport routes - tracks. These are lines that serve public rail transport. From a technical point of view, the railway lines that are included in the railway network do not have to have the same gauge and do not have to be electrified by one current system.

In the territory of the Slovak Republic (hereinafter referred to as the "SR"), the Railways of the Slovak Republic (hereinafter referred to as the "ŽSR") are the administrator of the railway infrastructure. ŽSR ensures the operability of railway infrastructure in the sectors of railway lines, structures and buildings, bridges and tunnels, electrical and energy equipment and security equipment. They take care of its maintenance and development in accordance with technical progress and requirements for safety and smoothness of railway traffic.

ŽSR manages and operates railways of national and regional importance in the following parameters:

RAILWAY LINES AND CONSTRUCTIONS	As of 31 Dec 2019	Unit of measure
Construction length of operated lines	3 582	km
Construction length of managed lines	3 629	km
Total construction length of tracks	6 872	km
Number of crossings	2 082	pcs
Number of switches	8 379	pcs
Number of bridges	2 326	pcs
Total length of bridges	52 544	m
Number of tunnels	76	pcs
Total length of tunnels	45 007	m

The data on the "construction length of managed lines" also include lines with suspended operation due to unsatisfactory technical condition. The total length of lines with suspended operation is 46,692 km.

The ŽSR strategy declares intentions to build the GSM-R and ETCS system on the corridors, but each corridor requires an individual approach due to the diversity of existing security devices and the possibility of implementation on the ŽSR network and the modernization process.

At present, the railway infrastructure is equipped with equipment of the following parameters:

SECURITY DEVICES	**As of 31 Dec 2019**	**Unit of measure**
Track-side security equipment		
Automatic block	484	km
Automatic gate	418	km
Semi-automatic block	633	km
Lines with telephone communication	1 785	km
Station security equipment	513	pcs
Remotely controlled equipment - dispatcher	396	km
Train security equipment		
Line train protection device	484	km
ETCS L1	179	km
ETCS L2	30	km
Crossing security devices	2 082	pcs
of which:		
passive crossings - unsecured	1 007	pcs
active crossings - secured	1 075	pcs
of which:		
automatic crossings	926	pcs
manual crossings	149	pcs
Slope security devices	218	pcs
Radio network		
Analogue radio network	817	km
GSM-R	375	km

Current situation

European transport policy results in major efforts to revitalize the railways in Europe and to gain a greater share of the railways in the transport market. One of the ways is to achieve the interoperability of the railways and thus to remove technical and administrative barriers. The unification of the radio communication system for GSM-R railways and train running leading (the ETCS train protection system) makes it possible to create a single ERTMS control system in Europe.

The gradual introduction of a single system requires long-term efforts and strategic planning of the railways for several decades to come. The strategic plans of the Slovak Republic are focused on the development of railway infrastructure. **This is modernization of the remaining sections of the CORE NETWORK TEN-T network by 2030:**

Modernization of the corridor, state border CR/SR - Čadca - Krásno nad Kysucou (excluding), railway line, 3rd stage

The construction in question addresses the 3rd stage of the construction "Modernization of the corridor, state border CR/SR - Čadca - Krásno nad Kysucou (excluding), railway line", which is part of the railway line Žilina - Čadca, included among international transit corridors in the SR, as part of Pan - European Corridor No. VI. Žilina - Zwardoň - Gdynia. The section Čadca – state border CR/SR is the interconnection of this corridor with the corridor No. 3 in the Czech Railways network.

The modernization of the line will ensure an increase in safety and line speed in the line section Čadca - state border CR/SR to a line speed of up to 160 km/h, including so that the speed is achieved in the longest possible sections without restrictive speed jumps.

There is one railway station in the solved section - Svrčinovec. The section Čadca - the state border CR/SR consists of a double-track line with 3 kV unidirectional electric traction. In the section, there are seven crossings secured by an automatic light crossing security device. Of the four proposed variant solutions, the variant No. 3 was recommended to be implemented - modernized line in the section Krásno nad Kysucou - Čadca led through a new railway tunnel "Kýčera" while maintaining the existing line in the original railway body (to preserve regional passenger transport).

Modernization of the line Liptovský Mikuláš – Poprad, section of railway station Lučivná – Poprad (excluding)

The subject of the project is the modernization of the railway line (including the ERTMS system) in the section of Lučivná - Poprad (excluding) to the speed of 160 km/h. It is especially important to increase the maximum speed to 160 km/h, full peronisation of railway stations and stops, including the provision of elevated access (including comprehensive access for the disabled persons and persons with reduced mobility), modern voice and video information systems. Overall, the elimination of level crossings with roads will increase safety of transport, modernize station and track equipment, fixed traction equipment prepared

to the change of traction to 25 kV, 50 Hz, reduce the negative effects of the track on the environment (noise barriers, vibration reduction). Standard 750 m long freight trains will be allowed to run along the route and the overall railway station equipment will be innovated for freight transport.

Modernization of the Bratislava railway junction

The modernization of the Bratislava railway junction is focused on the centralization of long-distance and interregional transport in combination with a partially centralized scenario for regional transport. Long-distance and interregional passenger transport is concentrated in the railway station Bratislava main station, regional and suburban transport is from three directions (Pezinok, Senec, Dunajská Streda) concentrated in the new railway station Bratislava branch, three other directions (Malacky, Rajka and Vienna via Kittsee) to the railway station Bratislava-Petržalka and direction Vienna via Marchegg to the railway station Bratislava main station. In freight transport, the current operating concept is maintained. The technical solution also includes the modernization of the section Devínska Nová Ves (excluding) - Bratislava main station. - Bratislava- Vinohrady from the railway station Bratislava suburbs and construction of a new section Bratislava suburbs - Bratislava branch, other sub-sections will be reconstructed.

Several alternatives have been developed for the needs of the project. The two alternatives have many elements in common and were therefore recommended for further preparation. These are the following common elements:

- from the operational point of view, a distributed operational concept is proposed (with different distribution of individual directions in regional passenger transport),
- in terms of technical solution, most sections and stations are designed identically, the differences are only in the sections Bratislava suburbs - Bratislava branch and Bratislava-Nové Mesto - Podunajské Biskupice,
- from an economic point of view, they achieve very similar parameters.

The considered alternatives include invariant solutions, i.e. technical solutions identical for all evaluated alternatives. Range of invariant solutions:

- establishment of a new traffic management centre for the entire Bratislava railway junction,
- replacement of current obsolete station and track security devices with modern, electronic equipment and implementation of ERTMS system (ETCS L2 + GSM-R).

To ensure the required capacity of the railway infrastructure, all alternatives include:

- 2nd track in the section Bratislava-Nové Mesto - Bratislava main station. (including track modifications at the Bratislava-Nové Mesto station),
- a new branch Ružinov situated in the inter-station section Podunajské Biskupice - Bratislava-Nové Mesto,

- 3rd track in the section Bratislava-Lamač - Bratislava main station. (including track modifications at the Bratislava-Lamač station, which are different in individual alternatives),
- modernization of the railway station Bratislava main station. (station capacity is different in each alternative),

The solution also includes:

- modernization of the Bratislava-Vinohrady railway station and implementation of new Bratislava-Bory, Bratislava-Železná studienka/Patrónka, Bratislava-Ružinov and Bratislava-Vrakuňa railway stations,
- implementation of selected level crossings with roads (a total of 6 crossings)

Modernization of the Žilina railway junction

The modernization of the "Žilina junction" consists of the reconstruction of the existing railway line in order to increase its technical equipment and usability of the most modern and progressive elements, and thus ensure the improvement and enhancement of its technical parameters, safety and indicators as a whole.

The construction must fully create a north-south transit railway corridor that meets the requirements of Europe's conventional rail systems. The modernization of the section in question is a necessary milestone in the transition of operation to a more economically advantageous AC traction with a single-phase system of 25 kV, 50Hz and for a full-fledged transition to dispatch control of modernized line sections.

The modernization criteria are:

- speed increase to 160 km/h, or to 120 km/h,
- the passability of vehicles to the UIC C vehicle kinematic gauge and UIC GC through cross-section,
- the load-bearing capacity of the railway superstructure and the corresponding load-bearing capacity of the railway substructure for load class D4 UIC (axle weight 22.5 t),
- reconstruction of railway bridge constructions for load train UIC -71 and spatial modification,
- reconstruction of railway stations to achieve useful track lengths. Platforms with edges 550 mm above the top of the rail of the required length. Peronization with level access for passengers and with the modification of roads for pedestrians in the areas of stations and stops for people with reduced mobility,
- elimination of level crossings on the main line, i.e. the construction of new structures of overpasses, underpasses and underpasses with related roads,
- comprehensive reconstruction of traction lines, reconstruction of heavy-current distribution systems, new electric lighting and electric heating of switches,
- new track and station security device,

- new communication and telecommunication technology,

Modernization IV. Pan - European railway corridor state border CR/SR - Kúty - Bratislava - Nové Zámky - Štúrovo/Komárno - state border SR/Hungary

The line section state border CR/SR - Kúty - Bratislava - Nove Zámky - Štúrovo/Komárno - state border SR/Hungary is included among the priority corridor E, which was selected from the basic network of ETCS corridors identified in the CCS TSI by the railway associations for the purpose of equipping with the system ERTMS.

At present, there is no complete section of the line equipped with the ERTMS system on the ŽSR network in question. As part of the pilot project, the Bratislava node and the line section Bratislava - Nové Zámky are partially equipped with the GSM-R system. The technical level of railway infrastructure on the line sections of Corridor E in the territory of the Slovak Republic was assessed by the elaborated "Technical-economic study for preparation and implementation of ERTMS on Corridor E", the purpose of which was to propose possible comprehensive solutions for the preparation and subsequent implementation of ERTMS on line sections on Corridor E, based on the evaluation of the current state of station and line security devices. The study showed that the technical condition of the railway infrastructure in the corridor in question lags far behind the standard technical level on the corridors in developed European countries. Among main shortcomings in the corridor the study included its moral and physical obsolescence, the number of level crossings with the road network, insufficient bearing capacity of the undercarriage, low line speeds and also the absence of platforms with level access for passengers at railway stations and railway stops. In an effort to contribute to the achievement of railway interoperability and thus to the streamlining of railway operations and to the improvement of the quality of services provided on Corridor E, the technical and economic study proposed the implementation of ETCS and GSM-R track systems on track sections of the corridor. Implementation of the ETCS protection system:

- ensure the connection between the control and the operation of trains,
- reduce the costs of maintenance and operation of the track section,
- eliminate the number of national protection systems,
- enable the interoperability of vehicles on European railways,
- increase track capacity,
- increase line speeds,
- will replace 20 different national train protection systems.

Introduction of the GSM-R system focused on the maximum availability and reliability of voice and data transmission in the area representing the line of the railway line:

- ensure the necessary interoperability and compatibility in the field of radio railway communications,
- achieve compatibility in international rail traffic,
- make it possible to ensure, speed up and streamline the organization of communication in railway traffic.

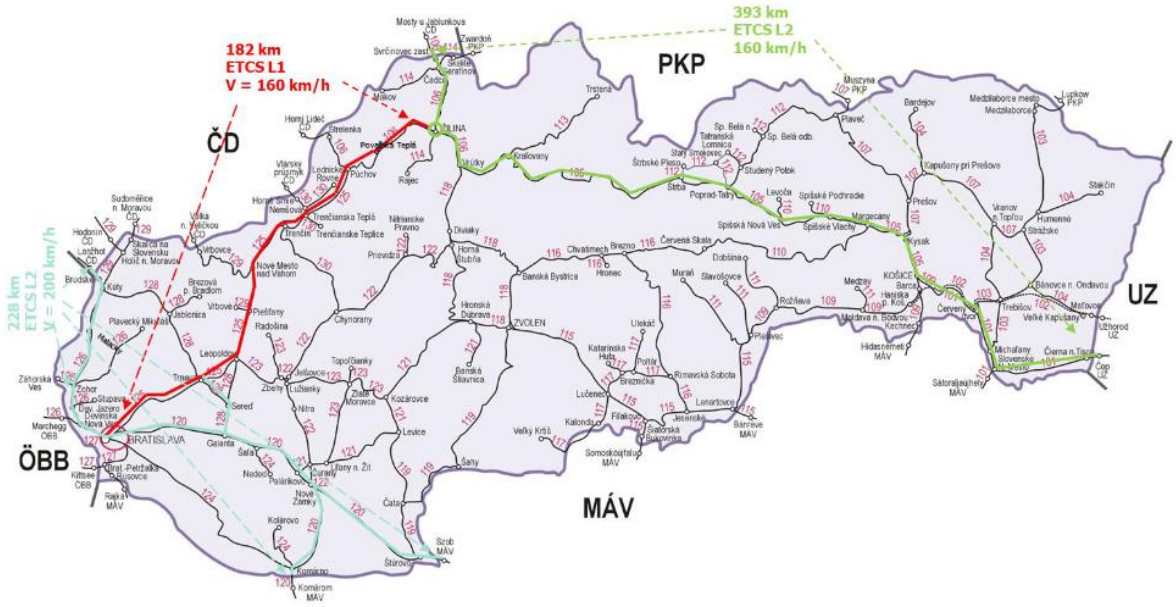

Figure 1: Plan for the implementation of ETCS on the ŽSR railway network

Plan for the implementation of ETCS on the ŽSR railway network. After the upgrade, approximately 830 km of lines will be equipped with ETCS. The following lines are currently equipped with ETCS:

- Bratislava Rača – Púchov (159 km),
- Púchov – Považská Teplá (20 km) and
- Žilina – Čadca (30 km).

<u>Projects that are at an advance stage of construction:</u>

Modernization of the Púchov - Žilina railway line

The project of modernization of the Púchov - Žilina railway line, for the line speed of up to 160 km/h was divided into two stages. The first stage is at the line section Púchov - Považská Teplá and the second stage Považská Teplá (excluding) - Žilina (excluding), 2nd phase the section Dolný Hričov - Žilina.

In the first stage of the construction of the modernization of the section Púchov - Žilina - the section Púchov - Považská Teplá, the modernization of the railway station Považská Bystrica as well as the cancellation of the railway station Považská Teplá are taking place. The subject of the second stage of construction is the modernization of railway station Bytča and the railway station Dolný Hričov and the construction of a new Plevník - Drienové turnout. In terms of implementation, the second stage will precede the first stage.

The modernized section Považská Bystrica - Plevník-Drienové will be in its final state. In the line section Považská Bystrica - Plevník-Drienové, an electronic two-way automatic gate will be created, with the control of the freedom of the line sections by axis computers. As the mutual distance of the section signals is greater than 100 m, this gate will be recorded as two one-way AH Považská Teplá and Podhradie in terms of calculations of permissible track performance, creation of a chart and records of its fulfilment. Automatic gates will be integrated into the electronic security device of the railway station Považská Bystrica. In the future, the entire Púchov - Žilina section will be managed from the railway station Púchov.

The new line speed will be 160 km/h. The braking distance for trains up to 120 km/h will be 1000 m. The preludes of the section lights are located at a minimum braking distance of 1000 m. Since the distance between the compartment lights is 831 m, there will be a separate counting section between the compartment lights. The relevant axis sensors will be located at the level of the compartment lights and the compartment sensors will be at a distance of 55 m behind the compartment lights. The length of the interstation section Považská Bystrica - Plevník-Drienové will be 5902 m. Both tracks will be operated in both directions. The control of the freedom of the tracks will be by the axis computers. In the line section Považská Bystrica - Plevník-Drienové, one stop will be created, namely Považská Teplá.

Trains travelling at speeds above 120 km/h will follow the information from the ETCS information points. This information points will give information about the signal on the section signal at a distance of min. 1,700 m in front of this signal. Trains without ETCS mobile equipment will be able to run on the line max. at a speed of 120 km/h, for which a braking distance of 1,000 m is suitable.

The type of electric traction will be changed, in the final state the traction in the section Púchov - Žilina will be alternating 25 kV/50 Hz. Activation of the electronic automatic gate with partition signals will be possible only after activation of the electronic security device in the railway station Považská Bystrica, from where the automatic gate will be controlled.

Equipment of the section Púchov - Žilina ETCS

The subject of the solution is the construction of the ETCS L1 system in the section Považská Teplá - Púchov. Simultaneously with the installation of the external elements of the ETCS 1 system, it will be necessary to supplement the software of the new electronic interlocking frame of the railway station Považská Bystrica. There will be some modification of the software in the railway stations Púchov and Bytča, as at the time of building the ETCS L1 system in the section Považská Teplá - Púchov, the system ETCS L1 will be terminated in the direction from Bratislava and in the Plevník-Drienová turnout, remotely controlled from the railway station Bytča, the ETCS L1 system in the direction from Žilina will be terminated.

In the direction from Púchov, it will be a smooth continuation of the ETCS L1 system solved within the modernization of railway station Púchov. Infill balises of entrance lights 1L, 2L of the railway station Púchov will be completed. The balises located at the entrance signal will be reassembled, as in this section the directional solution of track No. 1, 2 will be

changed within the modernization. In the railway station Púchov balises terminating the ETCS L1 system in the direction from Žilina will be dismantled. In the direction from the Plevník - Drienové turnout, it will be a smooth continuation of the ETCS L1 system solved within the modernization of the Žilina - Považská Bystrica section. Infill balises of entrance lights 1S, 2S turnout Plevník - Drienové will be added. The balises terminating the ETCS L1 system in the direction from Púchov will be dismantled in the turnout.

GSM-R radio network

As part of this construction, a GSM-R mobile radio network will be built, which is intended exclusively for railway traffic. This network provides mobile telecommunications and data communications for the needs of railway operations. In addition to communication, GSM-R will provide communication with incoming trains and possible future data connections for railway security applications for the ETCS L2 system. The construction of the GSM-R network consists of the construction of individual basic radio stations (BTS - Basic Transceiver Station), which provide the signal in their cell - circuit. The cells are oriented in a directional direction with a narrow horizontal angle of about 35 ° so as to cover the railway line and its immediate surroundings. The base radio station system will cover the track in open terrain.

Conclusion

Interoperability is an essential prerequisite for the functioning of the integrated trans-European rail system. Interoperability means the ability of this system to allow the safe and uninterrupted movement of trains of different carriers that meet the basic parameters established for these selected tracks. To achieve this goal, all regulatory, technical and operational conditions set out in the relevant EU directives and regulations must be met.

The reasons why interoperability is needed are mainly of a security, economic and commercial nature. The competitiveness of the rail system currently depends on differences between Member States in terms of material, technology, signals, safety rules, braking systems, traction current and speed limits. International trains that cross many states are forced to stop at the border crossing points of neighbouring states in this situation where there are systemic differences.

Interoperability is one of the absolutely essential factors for the revival of rail transport and the consistent balancing of the transport market. Thanks to the interoperability and construction of the rail sector, which is legally and technically integrated and commercially competitive, the objective of reducing road congestion, while reducing pollution and clear environmental benefits, becomes real.

The Slovak Republic intensively deals with the issue of interoperability and emphasizes it in the modernization of rail transport, but also its transposition and implementation into national legislation. The fulfilment of the requirements resulting from the TSI is the basis for enhancing the quality, availability and unification of the European rail system.

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