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Railway standards in the standardisation and legal railway environment

Abstract: The requirements of the CPK Railway Standards in selected technical areas were presented during the International Scientific and Technical Conference 'High-Speed Railway Development' in Poland. These standards comprise thirty-two volumes. Most users read them as a set of requirements relevant to their specific area of interest. However, it is worth considering them from a broader perspective. This is precisely what this article aims to explore.

Keywords: High-speed rail (HSR); HSR legal regulations; Standardisation; HSR technical standards

Introduction

From the very beginnings of railways, due to the technical characteristics of this mode of transport, railway companies—and soon after, national railways—adopted documents that meticulously regulated their operations. The strict adherence by employees of various departments (such as track maintenance, signalling, and operations) to clearly and precisely formulated instructions ensured the necessary relationships and interdependencies between different solutions, such as the interaction between the rail's running surface and the wheel's tread and flange.

It should be noted, however, that national railways in Europe have not existed for many years. Numerous passenger operators have emerged, along with an even greater number of freight operators and infrastructure managers who provide track access to trains. Freight transport, in particular, now frequently crosses borders on a large scale, moving beyond the boundaries of former national railway networks.

From operators' and infrastructure managers' instructions to the concept of a common market

Both railway operators and infrastructure managers have their own instructions regulating numerous aspects of railway operations. These cover a broad spectrum of activities, from detailed procedures for staff under normal and degraded operating conditions, maintenance rules for specific groups and types of technical solutions, and safety protocols for track and rolling stock work, to the principles of collecting, storing, and analysing operational and maintenance data.

There was a time when national authorities were formally obliged to review and approve the instructions issued by railway operators and infrastructure managers to ensure the coherence of the railway system. However, the sheer volume of such documents and the authorities' lack of hands-on operational experience led to the delegation of this responsibility to infrastructure managers and operators themselves. In most cases, infrastructure managers, through network regulations or contractual obligations, require operators to strictly comply with the instructions in force on a given network. Naturally, this does not eliminate operators' own instructions, nor does it override local or temporary regulations. The large number of applicable documents necessitates not only initial staff training before they are permitted to

work but also continuous updates and improvement of their knowledge and skills. Among the tools used for this purpose are so-called periodic briefings.

In a few countries, infrastructure managers and operators have established joint organisations responsible for drafting, adopting, and improving regulations applicable to all entities, as well as for analysing the impact of their implementation. However, even such an approach does not ensure the level of railway consistency required for seamless cross-border operations. Since the nineteenth century and throughout much of the twentieth century, national railways were deliberately designed with technical differences to create barriers that would prevent neighbouring countries from using rail networks for military purposes. As a result, various elements of railway infrastructure and operations developed divergently, including different track gauges, loading gauges, traction power systems, pantograph geometries and materials, signalling systems (including signal aspects), and electromagnetic interference and immunity requirements. Another significant factor contributing to these differences was the long-standing practice of supporting domestic industries. Railway procurement constitutes a major sector, significantly impacting national economies, including GDP and employment. However, this localised approach to railway technical solutions has become an obstacle to the European vision of a single market for railway products and services, as well as the broader implementation of the four fundamental freedoms across Europe. It was recognised that ensuring the following aspects for railways was essential:

- free movement of goods, meaning that the same technical solutions should be applicable across different countries, without the need for separate approvals in each nation,
- free movement of services, allowing projects and work related to railway construction, modernisation, and operation to be carried out in any country without restrictions,
- free movement of people, reducing or eliminating barriers to recognising professional qualifications and authorisations obtained in one country for work in another,
- free movement of capital, removing financial and tax-related barriers between countries.

These principles were introduced to facilitate a unified railway market covering the entire European Union, as well as other European Economic Area countries and Switzerland, which have adopted EU railway regulations.

CEN, CENELEC, ETSI, and PKN Standards and UIC and OSJD Regulations

The European standards system, embedded in EU law, serves as a solution for harmonising technical regulations under the common market principles. Standards had existed before but were largely national in scope. Last year, the Polish Committee for Standardisation (PKN) celebrated its centenary. However, for over two decades, the work and documents adopted by standardisation committees have had an international character.

European standardisation organisations include CEN, responsible mainly for standards in mechanics, materials, and testing; CENELEC, focusing on electrotechnical and electronic standards; and ETSI, covering telecommunications. These organisations receive mandates from the European Commission to develop and agree on standards, which are then published in the EU's Official Journal as harmonised standards for the common market. In the railway sector, standards are developed by CEN TC 256, CENELEC TC 9X, and ETSI RP.

A prerequisite for joining the EU is full membership in CEN, CENELEC, and ETSI, which requires the adoption of EN standards into national collections through translation or recognition. For instance, Poland became a full member of CEN, CENELEC, and ETSI on 1 January 2004, ahead of its accession to the European Communities, later transformed into the European Union, on 1 May 2004.

Cross-border railway transport had, of course, existed earlier. At least three international/intergovernmental organisations have regulated technical, operational, formal, and legal aspects of railway transport:

1. The International Union of Railways (UIC) – A global organisation established in 1922 through cooperation among national railways. UIC developed hundreds of UIC leaflets (fiches). Today, these are no longer binding in Europe. Instead, European standardisation organisations (CEN, CENELEC, ETSI) hold the right to incorporate them into standards. However, UIC continues to share technical knowledge and develop documents under the International Railway Solutions (UIC IRS) framework, providing best practice reviews. UIC also serves as a research and development platform for emerging railway technologies.
2. The Organisation for Co-operation between Railways (OSJD) – A technical railway organisation originally formed as a legacy of the Warsaw Pact. It primarily represents railways operating on the 1520 mm gauge, such as Russia's, but also includes China, where the standard gauge is 1435 mm, like in most of Europe. OSJD maintains and continues to develop OSJD leaflets, which are essential for cross-border operations in Eastern Europe and Asia. Some UIC/OSJD leaflets have been harmonised, such as those governing consignment notes. Unlike UIC, which does not impose legal obligations on governments, OSJD is both an international and intergovernmental organisation, meaning that it can establish binding legal regulations for its members.
3. The Convention concerning International Carriage by Rail (COTIF) – An intergovernmental organisation covering not only all EU countries but also Eastern European, Middle Eastern, and North African states. COTIF regulates international railway transport through a series of extensive annexes to the convention. One example is the RID regulations, which classify dangerous goods transported by rail and set out stringent requirements for their securing and labelling.

The European Commission is a COTIF member and closely collaborates with UIC. Discussions on cooperation with OSJD have been ongoing for years, although some of OSJD's responsibilities have been transferred to the Council for Railway Transport of the Commonwealth of Independent States (CIS) following decisions by the Russian authorities.

Technical Interoperability Speci! cations TSI

The common market for many types of products relies on linking European Parliament legislation with harmonised standards, such as those for toys regulated by CEN and CENELEC standards. However, due to the complexity of railway transport, this approach was deemed impractical. It was also recognised that achieving a fully integrated railway market, allowing for the free movement of goods, services, people, and capital within the EU, required the development, adoption, and continuous improvement of Technical Specifications for Interoperability (TSI). This concept was first introduced for high-speed railways and later extended to conventional rail in 2004.

There are currently eleven extensive TSI specifications adopted by the European Commission. These regulations define requirements for five structural and three operational subsystems that collectively form the EU railway system. Structural subsystems include infrastructure, energy, and trackside control-command (INF, ENE, CCT), managed by infrastructure operators, while rolling stock and onboard control-command (RST, CCO) constitute railway vehicles.

The TSI specifications define many detailed requirements; however, in many aspects, they refer to the provisions of CEN, CENELEC, and ETSI standards, making them mandatory. Few standards are referenced in their entirety in this manner. Most provisions in the standards form the basis for meeting the essential requirements specified in the annex to the directive on railway interoperability. At present, one hundred and ninety-seven European standards have been harmonised with the TSI specifications. The TSI specifications are also supplemented by specifications adopted by the European Union Agency for Railways and

NBRail recommendations, jointly adopted by Notified Bodies (NoBos), which are formally authorised to confirm the compliance of technical solutions with European requirements.

Certain national requirements remain in force within narrow scopes. It is also necessary to verify the compliance of new interoperable rolling stock with existing non-interoperable railway lines. All of this falls within the remit of Designated Bodies (DeBos), which receive their authorisation from the relevant authorities of individual states. The retention of certain, increasingly fewer, national requirements results from the need to maintain the coherence of networks and rolling stock at the national level, given the long operational lifespan of railway lines—one hundred years or more—and rolling stock—thirty years or more. Such national coherence is sometimes referred to as intraoperability, by analogy with interoperability. It is akin to global coherence—such as the internet—and coherence at the corporate or company level—such as an intranet. Both have their role and are necessary.

Technical standards developed by the Railway Institute

Even broader, yet still highly detailed, are the multi-volume railway standards developed by the Railway Institute. The first standards, prepared in 2001–2002, concerned increasing speed on the Central Railway Mainline. The subsequent standards, which are still referenced in many tenders for railway investments by PKP Polskie Linie Kolejowe, were developed in 2008–2009 and are dedicated to the modernisation of railway lines for speeds of up to 200 km/h. These standards comprise sixteen volumes:

Volume I – Track infrastructure
Volume II – Railway line clearance gauge
Volume III – Railway engineering structures
Volume IV – Electric traction equipment
Volume V – Non-traction power engineering
Volume VI – Signalling, control, and traffic management
Volume VII – Telecommunications
Volume VIII – Detection of rolling stock emergency conditions
Volume IX – Electromagnetic compatibility
Volume X – Level crossings, parallel roads
Volume XI – Structures
Volume XII – Small architecture, identification systems
Volume XIII – Buildings
Volume XIV – Crossings and railway line protection
Volume XV – Environmental protection
Volume XVI – Rolling stock requirements

Most recently, in the years 2021–2023, the *Technical Standards – Detailed technical conditions for the construction of the railway infrastructure of the CPK* were developed. These standards are referenced in the tender documents of CPK. They are broader in scope, dedicated to the construction of new infrastructure rather than the modernisation of existing railway lines, and comprise thirty-two volumes:

Volume A – Introduction to CPK Railway Standards
Volume I.1 – Railway track – geometrical layouts
Volume I.2 – Railway track – construction of civil structures
Volume I.3 – Railway track – drainage of the track layout
Volume I.4 – Railway track – structure gauge
Volume I.5 – Railway track – geotechnical investigations and design
Volume II.1 – Overhead catenary system and traction power supply
Volume II.2 – 3 kV DC overhead catenary and traction power supply

Volume III.1 – Engineering structures
Volume III.2 – Tunnels
Volume IV – Non-traction power engineering
Volume V.1 – Non-public roads
Volume V.2 – Public roads
Volume VI.1 – Control command and signalling – basic equipment
Volume VI.2 – Control command and signalling – European Train Control System (ETCS)
Volume VII.1 – Fixed and wireless communication systems and data transmission
Volume VII.2 – Telecommunication systems and telematics
Volume VII.3 – Devices for the detection of rolling stock failure conditions (DSAT)
Volume VIII.1 – Station and railway station buildings
Volume VIII.2 – Technical buildings
Volume VIII.3 – Structures
Volume VIII.4 – Structural landscaping
Volume IX – Measures to minimise environmental impact
Volume X – Conflicts with external networks
Volume XI – Electromagnetic compatibility (EMC)
Volume XII – Railway line guard
Volume XIII – Technical support facilities
Volume XIV – Health and safety support systems for people and property
Volume XV – Survey control
Volume XVI – Rolling stock
Volume XVII – Automatic baggage check-in systems
Volume XVIII – Consistency requirements: security, protection, and cybersecurity

Both the standards used by PKP PLK S.A. and those applied by CPK sp. z o.o. are fully publicly available.

The CPK railway standards have been defined in a structure similar to that of the Technical Specifications for Interoperability. In defining and referencing the requirements, reference was therefore made to the essential requirements set out in the European directive on railway interoperability, as well as to the basic requirements defined in the European regulation on construction products. Additionally, following the same patterns, ‘four general requirements additionally defined for CPK railway infrastructure’ have been specified as follows:

1. Focus on the needs of the economy
1.1. The infrastructure should include track layouts dedicated to freight transport, adapted for vehicles with a clearance gauge appropriate for both European and Asian tracks.
1.2. Freight transport service systems must be adapted to the needs of specific types of transport (e.g. container transhipment, pumping of tanker contents, handling of non-standard intermodal units).
2. Focus on passenger needs
2.1. Railway stations, stops, and terminals should have a standardised system for providing passengers with all information related to the use of both railway and other interconnected transport services. This system should ensure the correct dissemination of all essential information both under normal operating conditions and in disrupted situations (e.g. service disruptions, railway incidents, and accidents).
2.2. Railway stations, stops, and terminals should be equipped with devices and systems for detecting and monitoring threats to passengers (e.g. emergency

telephones, CCTV monitoring, systems for detecting passengers near the platform edge when trains approach).

2.3. Railway stations, stops, and terminals should be equipped with passenger health support devices and systems, particularly AED systems.

2.4. Adequate evacuation measures and systems to prevent panic (e.g. public address systems) must be ensured.

2.5. Railway stations, stops, and terminals should provide a suitable level of both basic services (e.g. ticket sales) and complementary services (e.g. the availability of food, newspapers, books, or the possibility of having a meal before or after the journey).

3. Focus on the needs of railway operators

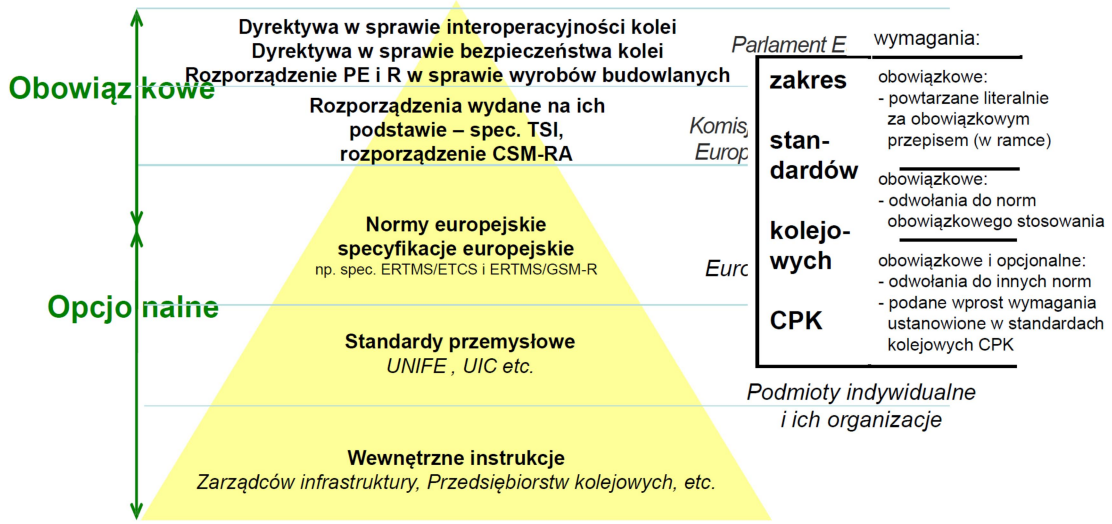
3.1. Rolling stock service systems should be adapted to the needs of various operators under normal operating conditions (e.g. toilet emptying, water refilling, replenishment of sand in sanding systems).

3.2. Adequate measures must be in place for emergency support services for operators in disrupted conditions (e.g. communication facilities, emergency semi-couplers).

4. Compatibility with railway infrastructure connected to the CPK railway infrastructure

4.1. It is essential to ensure the compatibility of the CPK railway infrastructure with other railway infrastructure to which it will be connected (e.g. through appropriate sections separating traction power supply systems).

At the same time, it has been noted that documents defining technical conditions for the construction (as well as modernisation, reconstruction, or operational safety) of railway infrastructure have different legal statuses. Typically, five levels of regulation are distinguished, ranging from directive provisions to infrastructure manager instructions. These documents are usually presented in a pyramid format. This pyramid representation also marks the scope covered by the individual sectoral volumes of the CPK railway standards, as shown in the diagram **1**.



1. Scope of the Technical Standards and Detailed Technical Conditions for the Construction of the Railway Infrastructure of the CPK
Source: Volume A, CPK Standards

It has been noted that, concerning the different levels, the CPK railway standards are structured as follows:

LEVEL I – Railway directives, regulation on construction products
Volume A – repeats the essential and basic requirements and supplements them with general requirements for CPK.
Sectoral volumes – contain tables indicating the relationship to specific requirements.
LEVEL II – TSI specifications and CSM-RA regulation
Sectoral volumes – repeat the requirements of individual TSI specifications.
LEVEL III – European standards and European specifications
Sectoral volumes – indicate both the standards and specifications that are legally mandatory and those whose application remains voluntary under the law but is imposed by CPK railway standards.
LEVEL IV – Industry standards
Sectoral volumes – cite or reference selected requirements only if they are necessary to ensure compliance with both essential and/or supplementary general requirements for CPK infrastructure.
LEVEL V – Internal instructions
Sectoral volumes – generally do not include internal instructions.

The detailed technical conditions for the construction of CPK railway infrastructure, as presented in the sectoral volumes, are structured by subject matter without division based on the levels of requirement sources. This ensures clarity of requirements. Nevertheless, mandatory requirements under TSI specifications are framed, indicating their source documents. Additionally, in a tabular format, specific detailed technical conditions have been linked to the essential, basic, and general requirements for CPK railway infrastructure.

Conclusion

At the HSR conference in Łódź, out of fifty presentations, seven addressed selected areas of requirements from the CPK railway standards—requirements for tunnels, railway track, traction power supply, control systems, communication, rolling stock requirements resulting from infrastructure characteristics, as well as railway interoperability and intraoperability. However, the standards encompass a much broader scope of requirements.

This article illustrates how to perceive the role of technical standards. It deliberately omits both the key requirements presented in the aforementioned areas and several volumes that were not discussed at the conference. This is intentional, as the standards are publicly available and can be accessed without restrictions. However, obtaining a broader perspective on standards in the context of legal regulations and standardisation is considerably more challenging.