Organisation intergouvernementale pour les transports internationaux ferroviaires
Zwischenstaatliche Organisation für den internationalen Eisenbahnverkehr
Intergovernmental Organisation for International Carriage by Rail

Groupe de travail TECH
Arbeitsgruppe TECH
Working Group TECH

TECH-25034

21.05.2025

Original: EN

55TH SESSION

Covering additional technical systems in UTPs

Multi-system wagons

Feasibility and possible approaches to facilitate freight traffic by rail between the GCC area and Europe

Introduction and background

1. Working document TECH-25014-CTE17-6.5 of 22 April 2025, prepared for the 17th session of the Committee of Technical Experts (CTE), considered the role of the CTE in implementing OTIF's long-term strategy. It made specific comments on the possibilities and benefits of covering additional wagons built to 1520 mm standards and US/AAR standards in UTPs:

   "[…] *Technical interoperability under COTIF is designed to accommodate different technical systems (e.g. 1435 mm and 1668 mm gauges). Based on the EU's TSIs, OTIF's UTPs follow a clear hierarchy, starting from essential requirements, moving on to basic parameters, then to specific requirements, and finally to harmonised standards. UTPs/TSIs primarily align with CEN/CENELEC standards; either the standards are harmonised with UTPs/TSIs, or these standards are referenced within the UTPs/TSIs. Specific technical solutions are not generally mandated unless necessary for network compatibility. The concepts of area of use and route compatibility allow for the development of different types of vehicles for various networks, all under a unified set of procedures and responsibilities. The result is that the rules are suitable for adaptation to and the inclusion of technically different networks.*

   To the east of the EU, there is a 1520 mm network based on GOST standards. In the GCC area, a new network is emerging, with freight traffic based on US/AAR standards. OTIF and the EU could jointly explore the possibilities of incorporating different systems with their specific standards into the TSIs/UTPs. *Vehicles, in particular freight wagons, could then be designed and certified for use in one or more regions, complying with the relevant rules for each area of use. For example, CEN/CENELEC standards would apply to an area or use including the EU, while AAR standards would apply to an area of use including the GCC. When vehicles need to comply with different sets of standards, all applicable standards should be considered to derive the dominant parameters. If standards are found to have conflicting requirements, the legal provisions in TSIs/UTPs could be adapted to resolve the conflict. This approach would enable the rail industry to develop freight wagons that meet multiple sets of standards, allowing them to operate across different regions. Developing such wagons would require significant efforts and resources, but the economic potential may outweigh that. Despite these technical variations between regions, the essential requirements, basic parameters, responsibilities, and procedures for the design, production, conformity assessment, and authorisation would remain the same for any area of use. Therefore, no fundamental changes with respect to the general legal framework should be required. The provisions could leave vehicles and traffic optimised for a particular region (e.g. EU or GCC) unaffected, so that the provisions would be no obstacle to further regional rail developments and optimisation*."

2. Working document TECH-25017-CTE17-6.5 of 22 April 2025, that was also prepared for the 17th session of the CTE, set out a proposal for the CTE's work programme, including the following: "*The Committee of Technical Experts requests WG Tech to consider how the integration of GCC specifications into the UTPs could be mutually beneficial to current and possible future OTIF members. As a first step, the focus should be on freight wagons only*."

Objective and scope of this paper

3. With references to points 1 and 2, this paper explores the technical and legal feasibility of developing freight wagons that can connect the Gulf Cooperation Council (GCC) rail network with the European rail network, and potentially other rail networks. Both networks are 1435 mm track gauge, basically making it possible to build compatible wagons. This paper addresses several challenges and suggests initial ideas for overcoming them.

4. The paper examines whether the technical and operational GCC and OTIF/European approaches can be reconciled to permit the construction and use of dedicated freight wagons for transporting goods between the GCC area and Europe. Such wagons are referred to in this paper as multi-system wagons. This paper serves as a discussion paper for experts in this field.

5. The GCC countries have opted for North American-style wagons for their freight transport. This paper therefore refers to the Association of American Railroads (AAR) standards and compares them to OTIF law, including UTPs.

6. To avoid excessive complexity, the focus of this paper does not extend to 1520 mm wagons.

7. Broadening the scope of the UTPs by adding GCC requirements would be an opportunity to expand the systemic and procedural concepts of COTIF to a wider geographical area, if GCC countries were to become OTIF members.

UTP requirements for freight wagons

8. The application of COTIF and its provisions is not principally limited to particular gauges or technical network characteristics. Not all ATMF Contracting States have technically similar networks. Most Contracting States have a 1435 mm (standard) track gauge network, but Spain and Portugal have a 1688 mm track gauge, Ireland and the Northern Irish network of the UK have a 1600 mm track gauge, the Baltic states have a 1520 mm track gauge and Finland has a 1524 mm track gauge network. Most of these different track gauge networks and the rolling stock suitable for use on them are covered, partially[1] or fully, by UTPs.

9. The interoperability Directive (for EU) and UTP GEN-A (for OTIF) lay down high level essential requirements. All subsystems, such as rolling stock, must fulfil these essential requirements. The essential requirements are grouped into: safety, reliability and availability, health, environmental protection, and technical compatibility. Essential requirements are not system and gauge dependent.

10. To cover the essential requirements, each UTP/TSI contains basic parameters (i.e. “subjects”) and subsequent requirements to be complied with for each basic parameter. The basic parameters for freight wagons in the UTP WAG are grouped into: structures and mechanical parts, gauging and vehicle track interaction, brake, environmental conditions, system protection.

11. The UTP WAG covers the following basic parameters for freight wagons:

    - **Structures and mechanical parts**: End coupling, Inner coupling, Strength of unit, Integrity of the unit.

    - **Gauging and vehicle-track interaction**: Gauging, Compatibility with load carrying capacity of lines, Compatibility with train detection systems, Axle bearing condition monitoring, Safety against derailment running on twisted track, Running dynamic behaviour, Derailment detection and prevention function, Structural design of bogie frame, Characteristics of wheelsets, Characteristics of wheels, Characteristics of axles, Axle box/bearings, Automatic variable gauge systems, Running gear for manual change of wheelsets.

    - **Brake**: Safety requirements, General functional requirements, Brake performance (In service brake, Parking brake), Thermal capacity, Wheel slide protection (WSP), Friction elements for wheel tread brakes.

    - **Environmental conditions**: (conditions of heat, cold, snow, etc., in which a wagon must continue to function safely).

    - **System protection**: Fire safety (Barriers, Materials, Cables, Flammable liquids), Protection against electric hazard, Attachment device for rear-end signal.

12. Point 4.2.1 of the UTP WAG states: *Except where this is strictly necessary for the interoperability of the rail system and to meet the relevant essential requirements, the functional and technical*

[1] Vehicles intended for use on 1520 mm networks, in particular freight wagons, are not fully covered by UTPs as these vehicles are usually covered by other rules issued by OSJD.

specifications of the freight wagon and its interfaces do not impose the use of any particular technical solutions. For example, UTPs do not require all vehicles to be built to a certain gauge. The UTPs do however require that the loading gauge of each vehicle and the structure gauge of the infrastructure are calculated and classified according to the same standard, so that it is possible to ascertain whether a particular vehicle fits on a particular line. The same principle applies to other compatibility parameters, such as axle loads, train weight, train detection method, etc. The procedure for checking all compatibility parameters is referred to as "route compatibility checks".

13. For many requirements, applying a harmonised standard (often EN standards) allows presumption of conformity. It is generally permitted not to apply the standard and use alternative solutions to achieve a similar performance. However, if necessary for interoperability, UTPs refer to specific points in standards or other normative documents directly. These points then become part of the legal requirements and thus mandatory.

14. The UTP WAG requires that all wagons comply with selected points of certain standards. These standards are listed below, including a short summarising description of the purpose of the mandatory points and whether alternative solutions are also permitted:

    - EN 12663 for strength of the wagon
    - EN 15877 for marking lifting and jacking points
    - EN 15273-2 for calculating the gauge
    - EN 15528 for calculating the payload in relation to the maximum axle load
    - EN 15437-1 for the position of axle bearings to ensure they can be monitored by track-side equipment
    - EN 14363 for testing and simulating running behaviour (including EN 16235 for dispensation, e.g. when particular types of bogies are used)
    - EN 13749 structural design of bogie frames and assessment of their strength
    - EN 13260 testing wheelsets – it is permitted to use alternative standards that form part of a technically consistent set of standards
    - EN 13979-1 testing wheels – it is permitted to use alternative standards that form part of a technically consistent set of standards
    - EN 13103-1 testing axles – it is permitted to use alternative standards that form part of a technically consistent set of standards
    - EN 12082 testing mechanical resistance and fatigue characteristics of the rolling bearing
    - EN 14531-1, EN 16834, or UIC 544-1 calculating brake performance
    - EN 50125-1 environmental conditions in which the wagon must function
    - EN 1363-1, ISO 5658-1, ISO 5660-1, EN 13501-1, EN 45545-2 and -7, EN 50355, EN 50343 fire safety of materials
    - EN 50153 protection against electrical hazards
    - EN 16116-2 attachment devices for rear-end signals
    - EN 15153-1 or EN 12899-1 rear end signals or reflective plates to mark the end of the train

15. The full list of applicable standards is provided in Appendix D1 to the UTP WAG. Certain standards listed in Appendix D1 to the UTP WAG apply exclusively to highly standardised wagons (as defined in Appendix C to the UTP WAG). Compliance with Appendix C is optional, so these standards are therefore excluded from the list of mandatory standards above. Also, standards specific to some networks only (e.g. for 1668 mm or 1524 mm gauge) are excluded from the above list, as they apply only to designated national infrastructure.

16. As illustrated by the list above, UTPs refer mainly to European (CEN/CENELEC) standards. This can be explained by the fact that most OTIF members are in Europe and the UTPs are based on the EU's TSIs.

17. The requirements in the UTP do not refer to standards directly but refer to a specific 'index' in Appendix D1. For example, point 4.2.3.1 of the UTP WAG requires that "…*the reference profile for the lower part shall be established by one of the methods set out in the specification referenced in Appendix D Index [4]*". Each index number in Appendix D.1 refers to a specific (part of) a standard or other normative document. In this example, index [4] refers to EN 15273-2:2013+A1 :2016. The concept of this approach makes it possible to mention not only one specific standard, but also alternative standards related to each index number in Appendix D.1. Thus, to comply with a UTP requirement, specific sets of standards could be assigned to specific areas of use for a wagon.

18. Freight wagons must also comply with pass-by noise requirements defined in the UTP Noise. Despite being an important aspect, noise emissions are not further addressed in this paper.

AAR requirements for freight wagons

19. In order to understand the requirements for North American wagons (or "freight cars", as they are referred to in North America), it is important to have a basic understanding of how rail freight transport is organised in North America. The system is largely vertically integrated, with major Class I railroads (such as Union Pacific, BNSF, and CSX) owning and operating the infrastructure, providing traction (locomotives), and managing train operations. These railroads are organised under the umbrella of the Association of American Railroads (AAR). The AAR plays a central role in standardisation, setting detailed technical and performance requirements for wagons to ensure interoperability between different railroads. It also defines many of its own operational and safety rules, whilst having to comply with Federal Railroad Administration (FRA) regulations. The FRA is the government agency responsible for safety regulation, focusing on overarching legal requirements such as crashworthiness, braking systems, and maintenance rules. The compliance process in North America is industry-driven through AAR. Wagons are often owned by leasing companies or private industries rather than the railroads themselves. Maintenance of freight wagons is typically the responsibility of the owner, who must ensure compliance with both AAR and FRA regulations.

20. The main construction requirements for freight wagons are set out in the AAR Manual of Standards and Recommended Practices, Section C Part II - Design, Fabrication and Construction of Freight Cars. While a more detailed assessment of these requirements may be necessary at a later stage, it is worth providing a summary:

    - **Design requirements**: specific design criteria for components of wagons, ensuring they meet performance and safety standards. This includes strength requirements for the wagon body and underframe, requirements for bogies and wheelsets and axles, requirements for couplers such as strength and energy absorption, brake system and its components including air reservoirs, valves and piping, and specifications for handholds, ladders, platforms, and other safety-related features.

    - **Manufacturing:** the manufacturing processes and quality control measures necessary during the construction of wagons including welding, casting and forging, machining and assembly of subcomponents. These focus on quality control, accuracy and tolerances.

- **Construction:** guidelines on how the subassemblies must be integrated in the freight wagon, including protocols for inspections and documentation of the construction process.

- **Testing and inspection:** the procedures to verify compliance with the manufacturing and construction standards, including ultrasonic, radiographic, and magnetic particle inspections to detect internal and surface defects, load testing, measuring tolerances and functional testing.

- **Materials and components:** specifications for materials to be used in the construction of wagons. This includes the types of metals, composites, fasteners, sealants and adhesives to be used.

- **Safety and performance standards:** the safety requirements and performance benchmarks that wagons must meet to ensure safe operation within the rail network

21. The design, production and maintenance approaches for freight wagons differ significantly between North America's AAR rules and OTIF law. AAR wagons are highly standardised and are rules-based to ensure interchangeability. AAR maintenance approaches are based on fixed intervals and the prescriptive exchange of components.

Different approaches to design, production and maintenance

22. The table below provides an overview of the different philosophies and approaches of OTIF (and EU) law and the AAR/FRA of North America.

Aspect	*AAR (North America)*	*OTIF/Europe*
Design	Standardised by AAR to ensure interchangeability	Performance-based TSI/UTP compliance, approved by third party assessing entity (NoBo in EU)
Production quality	AAR component approval	Manufacturer/applicant must certify compliance, assisted by assessing entity
Maintenance	Rules-based fixed intervals, mandated by AAR and executed by railroads and leasing companies	ECM (Entity in Charge of Maintenance) is responsible, risk-based: wagon must be safe to run at all times
Responsible for Safety	Railroad responsible for safe operation	ECM responsible for maintenance, railway responsible for operations

23. The design philosophy in AAR (North America) is highly standardised and prescriptive. Production of AAR wagons is based on fixed, proven designs using pre-approved components. This ensures uniformity and compatibility across the networks, but limits design freedom. Interchangeability is a key principle, meaning components such as bogies, couplers, and braking systems are of fixed design. In contrast, OTIF (and EU) rules are more functional and performance-based.

24. AAR quality control is enforced through mandatory component testing and supplier approval rather than regulatory certification of each wagon type. In OTIF, new wagon designs must be approved through a formal certification process by an assessing entity (NoBo in the EU), ensuring compliance with UTPs or TSIs.

25. The maintenance approach in AAR is based on fixed intervals for inspections, component replacement and periodic overhauls. Railroads control these requirements, enforcing compliance through inspections and penalties. In contrast, OTIF requires that wagons must be kept in a safe operational state, without imposing intervals. Maintenance is often risk-based, with checks and overhauls scheduled according to operational conditions, wear, and failure probabilities.

26. Responsibilities are assigned differently in the AAR and OTIF frameworks. In AAR, railroads bear primary responsibility for ensuring safe operation. Compliance with maintenance and operational standards is enforced through strict rules. Wagon owners, often private leasing companies, are responsible for maintenance but must follow the prescribed standards. In the OTIF framework, responsibilities are more explicitly distributed. Manufacturers/applicants, assisted by third party assessing entities, must certify compliance of the wagon with UTPs/TSIs before requesting admission to traffic from competent authorities. The ECM has legal responsibility for maintenance. Railway undertakings are responsible for ensuring wagons are fit for operation on their networks, but they rely on the ECM's maintenance records rather than conducting routine in-house inspections. This separation of responsibilities in the OTIF framework contrasts with the centralised approach in AAR, where railroads play a dominant role in both operation and maintenance supervision.

27. It is not clear whether the GCC has taken over all the North American approaches summarised above. However, this is of secondary relevance to the technical analysis in this paper.

Conceptual possibilities for multi-system wagons

28. The following points explore how the existing OTIF legal framework might accommodate the development and integration of wagons capable of operating between the GCC region and Europe. Such wagons will be referred to as "multi-system wagons".

29. As a general principle, the design flexibility permitted by the UTPs, combined with the limited number of mandatory standards and the risk-based approach to operations and maintenance, should facilitate the development and approval of multi-system wagons for traffic between the GCC region and Europe. Although the GCC railway system is influenced by North American freight standards, it also uses European technology for passenger operations. This hybrid character may simplify the adaptation of wagons to meet OTIF requirements. Nevertheless, it is expected that dedicated multi-system wagons will need to be developed specifically for this corridor, with design, operational responsibilities, and maintenance aligned with OTIF law.

30. Although the standards applied to GCC wagons and European wagons differ in their approaches to design, production, testing, and maintenance, they are intended to achieve comparable levels of safety and performance. As a general principle, each basic parameter of a wagon (such as structural strength, gauging, or braking performance) should be designed, built, and tested according to a single, coherent family of standards. Mixing elements from different standards within the same basic parameter should be avoided, as it could create inconsistencies and undermine the ability to demonstrate compliance in a structured and verifiable way.

31. It may, however, be feasible to apply different families of standards to different, functionally distinct basic parameters of a vehicle. For instance, the strength and integrity of the vehicle body could be designed according to one standard family (such as AAR rules), while the braking system could be designed according to another (such as EN standards), provided that any possible interfaces are managed. Where different standards are applied to different basic parameters, appropriate risk management must be conducted to ensure that the overall system remains safe and interoperable.

32. In certain cases, compliance with multiple families of standards for the same basic parameter may be necessary, particularly if cross-acceptance of the standards is not possible. In such situations, the design must independently meet the full set of requirements prescribed by each applicable standard. This differs from mixing elements from different standards within the same basic parameter, as it ensures full and verifiable compliance with each standard separately, thereby preserving legal clarity and technical robustness.

33. Resulting from the points above, there are two fundamental approaches to accepting freight wagons (or parts of freight wagons) across multiple regions, such as between OTIF and GCC networks.

- The **cross-acceptance** approach allows compliance with either of the relevant standards to be considered sufficient for operation in both regions.

- The **multiple compliance** approach requires wagons to meet all applicable standards for their entire area of use.

For example, if a wagon built to AAR standards is used in Europe under a cross-acceptance regime, it would be necessary to demonstrate that the AAR requirements for structural integrity are equivalent to those of EN 12663 for the intended type of use. Under multiple compliance, the wagon would be required to meet both AAR and EN 12663 standards, even if this leads to some redundancy.

34. From a legal perspective, the multiple compliance approach appears easier to implement because it avoids the need for OTIF members to conduct a detailed comparison between different sets of standards to establish whether standards are mutually acceptable. Instead, it provides a clear regulatory framework within which the rail industry, where most technical expertise is found, can develop dual-use wagons that meet all necessary requirements. While this approach may lead to higher development costs and less optimised designs compared to wagons built strictly to one family of standards, it can still be economically viable if it enables seamless freight transport without the need for transshipment.

35. However, it is unlikely that an entire wagon can be designed to comply with both families of standards, as standards for some basic parameters (e.g. braking) seem inherently incompatible. Where different standards impose conflicting requirements for certain basic parameters, the mutual acceptance of standards may still be necessary. In such cases, specific provisions may need to be incorporated into the UTPs to define explicitly how compliance should be demonstrated while ensuring safety and interoperability. The next section of this document explores this in more detail.

36. Route compatibility checks remain essential to ensure that both the wagons and the fully loaded train are suitable for the specific infrastructure and operating conditions of each route.

37. Irrespective of the technical requirements, application of OTIF's certification and admission procedures is imperative for vehicles running on networks of OTIF Member States. This means third party conformity assessment and approval by competent authorities.

Technical comparison – an initial assessment

38. The basic parameters strength, axle load calculation and gauging of the UTP WAG seem compatible with the multiple compliance approach, i.e. it should be possible to comply with multiple standards. The initial design should follow the dominant standard with the most stringent requirements, while compliance with other standards can be demonstrated separately. This would probably mean that for strength, the AAR standard would be dominant, and for gauging the EN standards would be critical. With regard to axle loads, the lower permissible axle loads on European lines may require wagons to be loaded below their maximum design capacity.

39. Basic parameters related to interfaces between vehicles, particularly the coupling and brake system interfaces, can only be designed to a single standard (i.e. a coupler cannot be a GCC Janney type coupler and DAC at the same time). It is worth noting that UTPs do not currently mandate a specific technical solution for coupler or other vehicle interfaces, so legal challenges are likely to be limited. It is obvious that only vehicles built to the same standard can be coupled together in a (block) train. One solution should therefore be mandated for multi-system wagons. This is also important because dedicated interfaces with the locomotives (adapters) providing traction on the different networks would also be needed.

40. The basic parameter of train braking may be one of the more technically challenging subjects. European freight wagons use graduated-release brakes (UIC standard), while GCC rail networks use AAR direct-release brakes, which releases all brakes on the train fully and instantly after braking. The latter is useful on particularly long trains. Using direct release brakes in Europe could

lead to operational challenges, particularly on gradients. Considering the operation of passenger trains with European technology on GCC networks, UIC brakes could possibly be acceptable for the GCC for multi-system wagons. Alternatively, the feasibility of a (software-controlled) dual-mode braking system, adapted to both regions, could be explored by industry experts. Suitable interfaces on/with locomotives would be required as well. It is important to note that train brake calculations should be compatible with operational rules of all networks in the wagon's area of use, i.e. along the corridor.

41. Another challenge may be vehicle-track interaction. GCC freight wagons may have a different wheel/rail contact geometry than UTP compliant wagons, but the details still need to be analysed. UTP and AAR rules for wheel and rail profiles are different and in terms of equivalent conicity, AAR wagons are optimised for lower conicity than prescribed by the UTP. The bogie design and suspension are also different. These elements could lead to different running behaviour. Specific wheel profiles may be required to negotiate different networks and bogie suspension may require optimisation. Extensive running dynamics testing in the entire area of use will probably be necessary. These issues should be technically solvable by involving industry experts.

42. Lastly, the requirements for train detection for the different networks should be inventoried and analysed. The parameters relevant to train detection are dimensions, weight, electrical resistance, wheel diameter and metal mass. It is reasonable to assume that a wagon can comply with all train detection requirements. Related to train detection is electromagnetic compatibility (EMC). In particular, wagons must not emit levels of electromagnetic energy that could disrupt trackside equipment for train detection and signalling systems. Although EMC is safety critical, this would only be a concern if wagons were to be equipped with electrical equipment.

Basic steps towards multi-system wagons

43. Define exact routes and engage with the relevant authorities in all states along the corridor.

44. Ensure OTIF membership of states along the corridor, as a necessary common legal basis is necessary for vehicle approvals, operational responsibilities, transport documents and contractual relations.

45. Engage with GCC railway authorities to obtain and analyse their detailed applicable wagon requirements and how they could be reconciled with OTIF law.

46. Assess whether modifications to the UTPs are required. If specific standards or technical solutions are necessary that do not fully comply with existing UTP requirements, an amendment may be necessary. By analogy with Appendix C of the UTP WAG, a new appendix could be added to establish the specific requirements for interoperable multi-system wagons.