EUROPEAN UNION AGENCY FOR RAILWAYS

Moving Europe towards a sustainable and safe railway system without frontiers.

Full Impact Assessment[1]

JNS Normal Procedure

"Accident Gotthard base tunnel – broken wheels" – Follow-up from 2024 reporting

[1]A **full impact assessment** (FIA) provides a qualitative and quantitative analysis of the impacts of a change; other IAS outputs are: an **impact note** is a concise analysis that is added to a Recommendation or Opinion in case the expected impacts are negligible or previously adequately assessed, and a **light impact assessment** (LIA) provides a mostly qualitative analysis of the main impacts of a change. For details on the Agency IA procedure and template see: DECISION n°290 of the Management Board of the European Union Agency for Railways amending annex 1 of MB Decision n° 195 adopting the amended Agency's Impact Assessment Methodology | European Union Agency for Railways (europa.eu); DECISION n° 257 of the Management Board of the European Union Agency for Railways adopting the annex 2 template for the impact assessment methodology | European Union Agency for Railways (europa.eu).

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1. Context and problem definition

1.1. Problem and problem drivers

On 10 August 2023, a freight train derailed in the Gotthard base tunnel, caused by a broken wheel of type BA 390. The accident led to a damage of infrastructure and rolling stock amounting to around 150 Mio. CHF (ca. 160 Mio. €). For the repair works, one tube of the Gotthard base tunnel had to be closed for more than one year and subsequently the cross alpine traffic was tremendously disturbed. Additional details about this accident are available in accident investigation report prepared by the NIB CH and published in June 2025[2].

In December 2023, the JNS launched a Normal Procedure (NP) following this accident with the objective to restore/increase the safety level, ensure interoperability, and return to the previous cost base or lower. Within this context, a JNS Task Force (JNS TF) was set up chaired by ERA and composed of European experts in the sector coming from other National Safety Authorities (NSAs) and of the Group of European Representative Bodies (GRB), the associations made up of companies responsible for the design, construction, operation and maintenance of the railway system. This JNS NP was completed in July 2024 putting forward a range of risk control measures (RCMs) and available from Agency's website[3]. Early 2025, the JNS Task Force re-worked the July 2024 Final report. The Task Force did not change the content of the final report, but increased the user-friendliness of Part II, Chapter 1 "Risk control measures" through integration of a flowchart and clarifications and further precisions.

Regarding broken wheels, three JNS procedures had already been completed in the past:

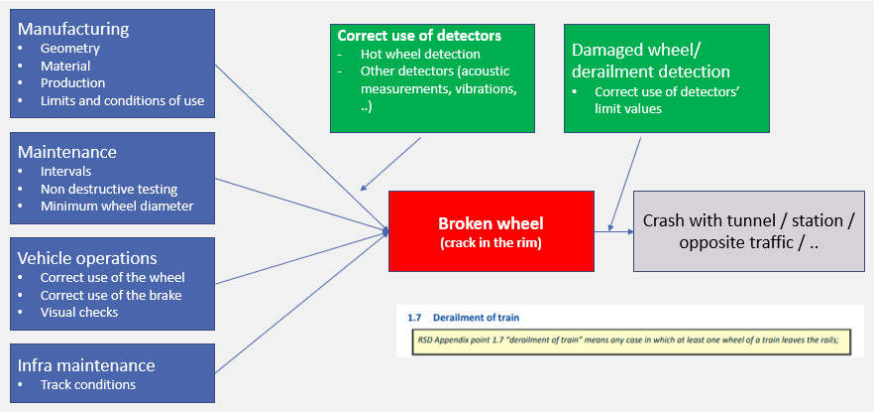
- *JNS Urgent Procedure "Broken Wheels" (May-July 2017),*
- *JNS Normal Procedure: "Broken Wheels" (2017-2019)*[4]
- *JNS Normal Procedure accident in the Gotthard base tunnel with focus on broken wheels (2023-24).*

RCMs from those earlier JNS procedure were replaced by the ones put forward in the most recent JNS procedure as published in April 2025. All actors are obliged to implement either these recommended risk control measures or alternative measures stemming from a risk assessment that guarantee at least the same level of safety.

Considering the complex context, the JNS TF elaborated a definition of the risk to be treated at the level of the entire European railway network and proposed proper RCMs (Figure 1). Risk analysis is based on the Fault Tree Analysis produced within the 2019 JNS NP that was verified in 2024 and confirmed by TF members to be still valid nowadays.

[2] NIB CH Gotthard Accident Investigation Report, June 2025
[3] jns np gothard_final report_v3.0.pdf
[4] Short Term measures agreed und proposed by UIC, ERFA, UIP dated 13/07/2017 (europa.eu).

Figure 1 – Risk structure (source: JNS TF Dec. 2023- Jun. 2024)



Within the most recent JNS procedure, the following tasks were defined and elaborated by the TF members:

1. *Analysis of the accident in the St. Gotthard tunnel,*
2. *Further elaboration of the risk to be tackled,*
3. *Identification of wheel types comparable to BA 004,*
4. *Application of RCMs for BA 004 to all identified comparable wheel types,*
5. *Check of the effectiveness of the RCMs for the wheel type BA 004 and identified comparable wheel types and possible further developments, if any.*

The identification of wheel types comparable to BA 004 included among others the description of wheel type BA 004, main features and the definition of criteria (linked to 5 relevant parameters[5]) / procedures for the identification of comparable wheels to BA 004. Using the overview of wheel types in the European freight sector provided by the VPI European Maintenance Guide (EMG)[6], complemented with information from the original designer and the JNS TF members, a reduced list of wheel types with a low residual rim thickness has been selected and further analysed in addition to the BA 004 (used also in some versions of Wheelset VRY):

- *Db-004sa;*
- *BA 390;*
- *RI 025;*
- *R 32,*
- *BA 304[7].*

Within task 5, the JNS TF collected accident cases started in the previous JNS procedures on Broken Wheels and analysed only the cases gathered after the implementation of the JNS measures focused identifying

[5] The 5 parameters are: position of the web in the middle of rim; radii in the transition between rim and web, nominal thickness of the web near the rim = 20 mm; design of the contour of the wheel web in the transition rim – web; relevant in combination with geometry comparable to BA 004 (wheels with geometry of the rim with residual rim thickness in worn conditions acc. prEN13979-1 - Criteria: 0,23 dm^2).

[6] The VPI-EMG (vpihamburg.de) - VPI EMG 04 – 04.02 has been used for the analysis.

[7] Additional wheel types were considered but not included in the JNS 2024 report (e.g. BA 005, BA 303, RI101).

similarities concerning for instance the rim as the crack initiation location, wheel material type, mileage since last reprofiling etc.

The JNS procedure carried out an in-depth analysis of the recalled 2019 JNS UP measures envisaging adjustments were needed and added additional RCMs structured as reported below:

- *Operation and wagon maintenance*[8];
- *Off vehicle maintenance*[9];
- *General requirements in operation, wagon and wheelset maintenance*[10].

In addition, improvements in standards, regulation and company rules were also proposed by the JNS TF members (e.g. GCU amendments)[11]. Concerning other JNS activities, the JNS NP "Consequences of unintended brake applications with LL blocks" (2024) and the Sector Project "Brake Blocks/Wheel Interaction" were identified as relevant.

As part of the latest reporting of the JNS TF (2024-25) the following follow-up activities were identified also considering the recently published accident investigation report from the Swiss National Accident Investigation Body and the subsequent measures put forward by the Swiss National Safety Authority:

- *Update of GCU (JSG);*
- *Follow UIC Sector project on composite brake block - wheel interaction (JSG);*
- *Collection and analysis of new cases.*

So far (since July 2024) some 19 follow-up meetings have taken place. Following the publication of the revised JNS report in April 2025 (see above) the priorities of the TF concern:

- *Consideration of analysis of newly reported cases of cracked and broken wheels (ongoing);*
- *Consideration of the safety recommendations in SUST (NIB CH) report (of 30 May 2025);*
- *Consideration of the Swiss Federal Office Transport (NSA CH) 'measures relating to freight wagons safety' of 11.09.2025 (incl. 2 follow-up amendments).*

In particular, the NSA CH measures from September 2025 are the key focus of the JNS Task Force. These measures concern provisions requiring minimum wheel diameters, more frequent maintenance interventions and systematic inspections. Wheels must have a minimum diameter of 864 millimetres, compared to the 860 millimetres currently applied at European level. Moreover, depending on the type of brake block, it must now be carried out systematically after 50,000 or 200,000 kilometres, rather than at the longer intervals currently in place. Additional checks, such as percussion tests, must be performed regularly. In the future, every freight wagon must carry documentation of its most recent technical inspection so that railway undertakings can verify compliance before using it in a train transiting Switzerland. Wheels must also feature a coloured stripe indicating any overheating.

As such, the JNS TF have been examining alternative measures to replace the Swiss national rules with commonly agreed European wide harmonised risk control measures to ensure railway safety while supporting the competitiveness of the freight railway sector in Europe. The result of this examination is documented in the updated JNS final report 2024 available by end of 2025 where the existing RCMs have been amended considering the Swiss measures. In this context, it should be mentioned that all stakeholders agreed to work together to design harmonised measures. For this part of the work of the JNS a substantial number of additional stakeholders from NSAs, NRBs (also NIBs) were invited and accepted to work in the JNS TF.

[8] For the full list of related RCMs see from slide 38 of the Final Report of the JNS 2024 procedure.
[9] For the full list of related RCMs see from slide 40 of the Final Report of the JNS 2024 procedure.
[10] For the full list of related RCMs see from slide 41 of the Final Report of the JNS 2024 procedure.
[11] For the full list of related RCMs see from slide 52 of the Final Report of the JNS 2024 procedure.

1.2. Evidence of the problem

The subject of broken wheels has been the subject of several JNS procedures since 2017. A graphical overview of the JNS procedures so far (up to the JNS TF report of 2024) with additional details is provided in Figure 2.

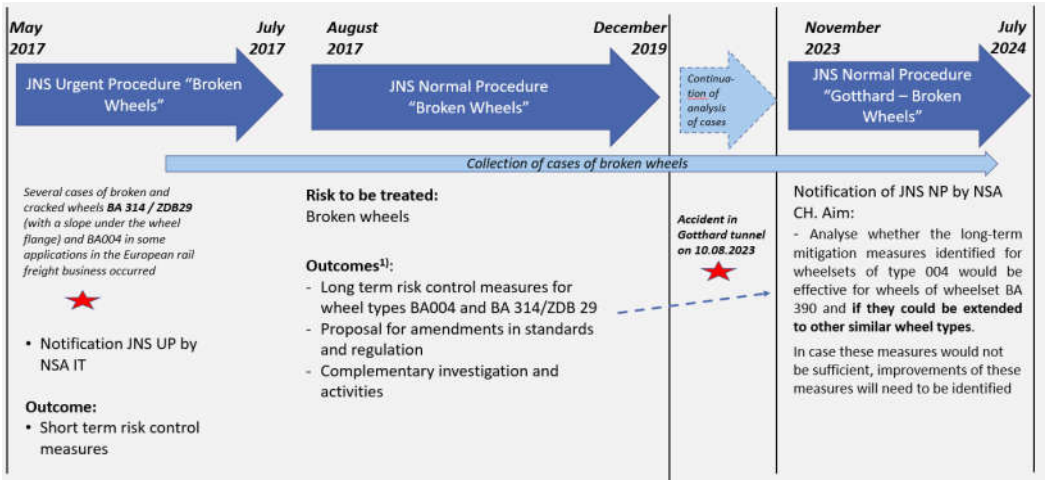
For the JNS 2024 report a total of 23 cases were identified by the JNS TF members with wheel type BA 004 and comparable ones as defined within the JNS procedure. On this regard, within these 23 cases:

- *there are 15 cases before the implementation of the JNS measures (2019), and*
- *8 cases after the implementation of the JNS measures (2019).*

Concerning the cases collected after the implementation of the mentioned JNS measures, the analysis on the implementation status of the 2024 JNS measures in the event of a rail accident showed some cases where information was not available or measures seemed not implemented.

In addition, some 14 new cases have since the JNS 2024 report been identified. The analysis of these new cases has been carried out as part of the follow-up work as outlined in the December 2025 JNS report.

Figure 2 – Overview of JNS procedures on Broken Wheels (source: JNS TF Dec. 2023- Jun. 2024)



Within the 2024 JNS procedure work, a survey was designed aimed to collect data (via questionnaire) from TF members regarding the owned number of wheel sets and a cost estimation of the potential impact of the RCMs. With specific reference to the estimated economic impact of the RCMs from that JNS procedure, it is worth to mention the rough cost estimation provided within the 2019 JNS UP was considered as a starting point of the evaluation (Figure 3). Results of the ERA survey from 2024 and the comparison with the previous cost estimation are reported in section 4.2.

Further assessment of the economic implications of RCMs has been considered as part of this impact assessment with particular focus on the costs associated with the Swiss National rules and the alternative European harmonised measures.

Figure 3 – Aggregated financial impact of 2019 JNS measures (source: JNS TF 2019[12])

Responsible	Measures	Assumption for estimation (depends on ECM and application)	Cost estimation in the whole sector
RU	No additional measures	5.000 additional wagons (wheelsets) to sort out from service a 100€	500.000 €
For ECM/Keeper	Risk assessment	20.000 € per ECM Number of ECM: 50	1.000.000 €
For affected ECM/ Keeper	Additional measures	100 € per wheelset / year 200.000 affected wheelsets	20.000.000 €
For affected application	Diameter reduction in affected application	75 € per 1 mm => 20 mm reduction => 1.500 € per wheelset 50.000 affected wheelsets	75.000.000 €

1.3. Baseline scenario

If no actions are taken beyond the current JNS NP measures, the Swiss national rules would remain in place leading to the risk of fragmentation of the regulatory framework for rail freight and increased barriers to interoperability. As such the problems described in section 1.1 will persist and could potentially increase resulting in reduced competitiveness of rail freight in Europe and higher external costs of the transport systems (incl. higher levels of accidents due to potential traffic shift from rail to road).

1.4. Main assumptions

This IA is based on the information provided within the JNS TF exchanges on the problem statement as well as follow-up analyses and dedicated exchanges with TF members.

Within the JNS TF activities, a range of solutions have been discussed and assessed in-depth. Additional data were collected via a survey and bilateral interviews to contextualise the potential impact of the RCMs.

1.5. Stakeholders affected

The **stakeholders affected** by the issue are indicated in the table below.
The envisaged measures would affect a range of stakeholders. Moreover, there are significant differences within stakeholder groups. In particular, the complexity of the problem is likely to affect mainly (smaller) ECMs, RUs, keepers and manufacturers for which the tracking and compliance with new / additional requirements is relatively more burdensome or with limited availability of staff. In addition, the implications on society should also be considered notably in terms of any modal shift from rail to road that could result in changes in external costs (e.g. air pollution, climate change and accidents) from the transport system.

[12] Short Term measures agreed und proposed by UIC, ERFA, UIP dated 13/07/2017 (europa.eu) – slide 45.

Railway undertakings (RU)	☒	Member States (MS)	☒
Infrastructure managers (IM)	☒	Third Countries	☐
Manufacturers	☒	National safety authorities (NSA)	☒
Keepers	☒	European Commission (EC)	☒
Entity in Charge of Maintenance (ECM), including ECM Certification Bodies (CB)	☒	European Union Agency for Railways (ERA)	☒
Notified Bodies (NoBo)	☒	Citizens living nearby railway tracks	☐
Associations	☐	Persons with reduced mobility (PRM)	☐
Shippers	☐	Passengers	☐
Ticket vendors	☐	National Investigation Bodies (NIB)	☒

1.6. Subsidiarity and proportionality

The problem and proposed options fall into the scope of the Safety and Interoperability directives and the TSIs. As concluded within the JNS TF, European action is needed to ensure a coordinated and harmonised solution regarding broken wheel set events for freight wagons.

Proportionality is an integral part of both the JNS TF as well as the impact assessment to ensure that the proposed solutions are not excessive taking a holistic perspective on the railway system as part of the transport system within the overall socio-economic structures (in line with the EUs Better Regulation Guidelines).

2. Objectives

2.1. Specific objectives

The objectives concern the development and update of risk control measures, to sustainably:

- Restore/increase the safety level,
- Ensure interoperability, and
- Return to the previous cost base or lower.

These measures are put forward to replace the proposed measures by the Swiss authorities as a follow-up to the Gotthard tunnel accident in 2023. Moreover, it is foreseen that follow-up work to further optimise the in-service monitoring and maintenance arrangements in 2026 and beyond.

3. Options

3.1. List of options

The baseline scenario, **Option 0**, implies the status quo in which RCMs are in place as recommended by the 2024 JNS Normal Procedure (which included also proposals for amendments in legislation / standards and company rules (e.g. GCU)).

Besides the baseline scenario, two additional options have been considered. **Option 1** would be the situation with the Swiss National Rules[13]. **Option 2** would be the situation where the JNS 2024 measures are updated along with replacing the Swiss National rules (JNS 2026). As such the JNS 2026 replaces the RCMs from the JNS 2024. Full details of the new RCMs in JNS 2026 are available in the JNS Task Force report published on the Agency's website on the 19th of December 2025.

It should be noted that for both Options 1 and 2 there would be variation over time (e.g. for Option 1 in 2026, 3 out of 4 measures would be in place and from 2027 onwards all measures would in principle apply). A similar time-variant basis could be the case for the updated JNS 2026 measures put forward by December 2025). As such further adjustment of JNS measures could be foreseen beyond 2026-27, e.g. taking into progress with implementation and outcomes from research activities.

In 2027, it is likely that the JNS measures would further evolve (to be specified) with particular focus on M3 (Forced technical wagon inspection) considering that this measure will enter into force in Switzerland by 1.1.2027. During 2026 the JNS will aim to identify and agree on possible alternative / complementary measures to address the Swiss provisions re. forced technical wagon inspections in a more efficient and effective way considering that M1, M2 and M3 should be seen as a package.

Beyond 2027 further adjustments of the JNS 202X measures could be foreseen in terms of the introduction of smarter monitoring / maintenance concept considering research results in this domain with particular focus on the role of digitalisation and new innovations. The aim here would be to ensure a standardised / harmonised approach at European level. Over the medium term, it is then likely that the JNS 202X measures can gradually be lifted / eased thereby contributing to reduced maintenance costs, improved availability of rolling stock, while ensuring safe operations of rail freight in Europe.

[13] Details of these measures have been made available by the Swiss NSA and have been examined in-depth by the JNS experts. In particular, these measures concern provisions on four elements: M1 M1 – Thermal stability; M2 – Minimum wheel diameter; M3 – Forced technical wagon inspection; M4 – Hammer test

4. Impacts of the options

4.1. Qualitative analysis

Stakeholder assessment

A high-level overview on the expected impacts for clusters of stakeholders and aggregated results is provided in the following Tables. For Options 1 and 2 a distinction is made between the short-term horizon and longer-term perspectives. It should be noted that compared to the LIA in 2024 we have adjusted the chosen category for overall impact for national authorities for Option 0[14] to consider the perspectives from CH authorities.

Option 0 (Baseline) – JNS NP risk control measures (2024) [including proposals for amendments in standards / regulation and company rules]			
Category of stakeholder	*Impact type*	*Description*	*Overall Impact*
Sector (IM, RU, manufacturer, ECM etc.)	Positive	The JNS 2024 updated RCMs which ensure alignment across stakeholders, improving safety and interoperability, contributing also to the prevention of accidents due to the problem in question. No significant increase in the implementation / ongoing costs for the RCMs as defined within the JNS 2024 procedure[15].	Rather positive
	Negative	Fine tuning changes to the new requirements require a limited update of knowledge and procedures for the interested stakeholders. However, this baseline does not address the new situation represented by the measures put forward by the Swiss authorities and would represent a challenge for stakeholders operating / having activities in Switzerland without any harmonised action at European level. As such there is a possibility for reduced traffic / shifting to other modes.	
National Authorities and Assessment bodies (MS, NSA, NoBo etc.)	Positive	Further and updated harmonization of the legal framework (GCU) at European level for broken wheels.	Neutral
	Negative	Fine tuning changes to the new requirements require a limited update of knowledge and procedures for the interested. stakeholders. However, considering the introduction of the NSA CH measures by 1.1.26 and 1.1.27 no actions would not be feasible in practice. This implies the need to identify appropriate measures at European level to preserve interoperability. Moreover, to date there has been a slow implementation / monitoring of the JNS measures creating an important information gab from authority perspective.	
European Authorities (EC, ERA)	Positive	Implementation of updated RCMs and practices ensures improved alignment and harmonisation at European level across stakeholders, improving safety and interoperability levels.	Rather positive
	Negative	Fine tuning changes to the legislative framework requires a marginal update of knowledge and procedures. However, considering the introduction of the NSA CH measures by 1.1.26 and 1.1.27 no	

[14] It is noted that Option 0 here would be comparable to Option 1 from the LIA performed in relation to the JNS 2024 reporting.

[15] It is worth to mention that indications on the economic impact of the RCMs are aggregated estimates, and they might differ from the actual costs incurred by specific stakeholders.

		actions would not be feasible in practice. This implies the need to identify appropriate measures at European level to preserve interoperability while maintaining safety levels and when practicable, continuously improved.	

Option 1 – Option 0 + FOT (NSA CH) measures			
Category of stakeholder	*Impact type*	*Description*	*Overall Impact*
Sector (IM, RU, manufacturer etc.)	Positive	From a sector perspective, it is likely that there would only be rather limited positive impacts. In part, there could be some variation among stakeholders depending on the extent to which their arrangements are already largely aligned with the Swiss measures or not. It should be remarked that under this Option three out of four measures will apply in 2026 and only from 2027 will all four measures apply. This implies that impacts (positive or negative) will vary over time.	Very negative
	Negative	In comparison with Option 0 it is likely that there could be significant cost increases linked to wheelset in-service monitoring and maintenance. This would concern ECMs along with RUs (although it is noted that most of the proposed would be incurred by ECMs). It is likely that the negative impacts will increase from 2027 on, when all four measures will be applicable.	
National Authorities and Assessment bodies (MS, NSA, NoBo etc.)	Positive	Specific measures could lead to improved control of risks at national levels along with possible faster implementation (however, it is likely that the proposed measures are not cost-effective).	Rather negative
	Negative	Any positive impacts are likely to be outweighed by adverse implications on cross-border traffic especially for countries neighbouring Switzerland as well as loss of interoperability and railway competitiveness.	
European Authorities (EC, ERA)	Positive	No positive impacts are foreseen if this Option would be adopted on a European scale. However, addressing the challenges represented by this Option has been facilitated through a strong willingness for cooperation between authorities and sector to find common ground and compromises. It should be remarked that under this Option three out of four measures will apply in 2026 and only from 2027 will all four measures apply. This implies that impacts (positive or negative) will vary over time.	Very negative
	Negative	Overall, the main adverse impact associated with Option 0 concerns interoperability considering that the Swiss measures represent national rules that could hinder rail freight transport across Europe. Moreover, if these measures were to be expanded to the whole Union it is likely that there could be adverse impacts on railway competitiveness. It is likely that the negative impacts will increase from 2027 on, when all four measures will be applicable.	

Option 2 – Option 0 + JNS / JSG amended measures			
Category of stakeholder	*Impact type*	*Description*	*Overall Impact*
Sector (IM, RU, manufacturer etc.)	Positive	Agreed on updated RCMs which ensure alignment across stakeholders, improving safety and interoperability, contributing	Very positive

		also to the prevention of accidents due to the problem in question. Although some increase in costs over the short term are expected this Option would avoid the potential for significant increases in costs associated with wheelset monitoring and maintenance with adverse consequences on railway performance in the market[16].	
	Negative	Some increase in costs over the short term compensated by the possibility to explore and develop an improved maintenance concept along with enhanced in-service monitoring over time.	
National Authorities and Assessment bodies (MS, NSA, NoBo etc.)	Positive	Further and updated harmonization of the RCMs considering the concerns raised following the accident in the Gotthard tunnel in 2023. In particular, the new provisions are likely to result in a faster implementation of the JNS 2026 measures along with improved visibility of the level of implementation by the stakeholders concerned.	Very positive
	Negative	Limited changes required on authority side to put place the JNS 2026 RCMs for which NSAs and / or ECM certification bodies are responsible along with update of knowledge and procedures for the concerned stakeholders.	
European Authorities (EC, ERA)	Positive	Implementation of the updated RCMs and practices (JNS 2026) ensures improved alignment and harmonisation across stakeholders, improving safety and interoperability levels. These measures ensures that potential adverse impacts on interoperability and rail freight competitiveness from Option 1 are prevented. Moreover, building on the JNS 2026 further work is foreseen during 2026 and beyond to optimise the JNS measures drawing on improved maintenance concept and in-service monitoring. Over a longer-term perspective this is likely to result in substantial improvements in cost-effectiveness.	Very positive
	Negative	Fine tuning changes to the legislative framework requires a marginal update of knowledge and procedures. However, some resources would over the short term be needed to capture the potential for significant cost savings concerning freight wagon maintenance while preserving safety levels.	

Railway system assessment

	Option 0 (baseline)	*Option 1*	*Option 2*
Safety	Harmonised implementation of safety actions regarding the identified problem. Two issues have though been seen as problematic: 1) slow implementation of JNS 2024 measures; 2) Communication between railway stakeholders linked to wagon maintenance	Based on the available information, it is likely that there could be an improvement in safety level. However, while the proposed measures may control the risks sufficiently it appears that these measures are not cost-effective. This implies that other complementary / alternative may exist for which the risk is still sufficiently controlled but with a lower cost impact	Amended JNS 2024 measures will ensure a harmonised approach for safety actions linked to in-service monitoring and maintenance for rail freight in Europe. This Option considers the concerns raised by stakeholders incl. authorities while also identifying follow-up actions that can further optimise the resources allocated in terms of efficiency and effectiveness

[16] It is worth to mention that indications on the economic impact of the RCMs are aggregated estimates, and they might differ from the actual costs incurred by specific stakeholders.

			promoting the safety of the transport system as a whole
Interoperability	The adopted JNS 2024 measures facilitate harmonisation of the EU railway sector and thus interoperability, including by further updating the legislative framework.	While the measures put forward under Option 1 is a reaction to safety issues perceived by the concerned authorities it is foreseen that national based approaches would result in reduced interoperability at European level incl. hindering cross-border freight transport.	The provisions put forward in the JNS 2025 TF report ensure that harmonised RCMs are in place across Europe, thereby facilitating interoperability in the Single European Railway Area
Competitiveness	No change in the competitive situation of railway.	Higher administrative burdens with changes that may in practice hinder rail freight due to reduced competitiveness.	Competitive situation of railway is returned to the level under Option 0. Moreover, with the anticipated follow-up work of JNS in the coming years it is possible that significant cost reductions could be achieved in terms of in-service monitoring and maintenance concepts
Effectiveness	Rather high	Neutral	Very high

Coherency assessment

	Option 0 (baseline)	*Option 1*	*Option 2*
Policy analysis	The 2024 updated the JNS 2019 RCMs along with putting forward changes of the legislative provisions in accordance with a harmonised framework.	The measures put forward within Option 1 builds on the JNS 2024 measures adding additional national requirements for stakeholders operating / maintaining (if scaled up to European level it could have significant adverse implications on EU policy objectives, e.g. green transition)	An amendment of the JNS 2024 measures is specified ensuring a harmonised European framework in line with the existing provisions of the Railway Acquis. These adjustments support the overall implementation of the measures
Coherence	Rather high	Very low	Very high

4.2. Quantitative analysis

A. Key quantitative information building on LIA 2024 (possible to put in Annex)

In Europe there are currently a total of more than 650,000 registered freight wagons (ERA EVR, 2023)[17].

Within the JNS 2024 procedure, a survey was designed and implemented to gather information from TF members concerning the:

- *Number of owned wheel sets, and*
- *Cost estimation of the potential impact of the RCMs.*

A total of 10 completed questionnaires was obtained. Although this figure does not have robust statistical significance or representativeness, some indicative evaluations follow.

Regarding the first point, it was asked to TF members to provide the number of wheel sets for specific types of wheels, including those selected as comparable ones to the BA004 (see * in Table 1); 3 additional wheel sets, discussed in the TF meetings, were also included (notably BA005, BA303 and RI101). An overview of the results is provided in Table 1, where the size and type of wheels vary across actors.

Table 1 – N. of wheel sets by stakeholders (source: selected JNS TF members, 2024)

JNS TF members	BA004*	Db-004sa*	BA 390*	RI 025*	BA304*	R32*	BA005	BA303	RI101
Actor 1	28,345	-	-	481	-	-	114	35,949	-
Actor 2	-	560	-	-	-	-	-	-	-
Actor 3	2,369	-	78	-	102	10	n.a.	n.a.	n.a.
Actor 4	412	-	-	-	-	-	-	-	-
Actor 5	31,027	431	-	9	5	-	80	12,516	-
Actor 6	70,000	-	-	-	8,500	-	23,500	12,600	-
Actor 7	100	-	-	-	-	-	2,300	2,500	-
Actor 8	1,434	-	-	-	-	-	-	239	559
Actor 9	53,500	41	-	11,351	272	594	1,675	14,331	4
Actor 10	800	-	-	-	-	-	-	-	-

Concerning the economic impact of the RCMs from JNS 2024, it is important to recall the analysis carried out within the 2019 JNS NP where a rough estimation was provided (Figure 3). Excluding a reply which did not provide the information related to this topic, around half of the sample confirmed that values included in Figure 3 are all still valid, while the other half is expecting an increase in costs (Table 2). Multiple actors indicate changes with regards to diameter reduction in affected application. Among the costs not covered by the mentioned table, wagon repair, wheel sets' transport and loss of wagon availability were mentioned by actors.

The cost related to the risk assessment of the measure for ECM or vehicle keeper (see item 2 of Table 2 below) are one-time type of costs, while the other cost items would be recurrent (per annum). In addition, item 4 is an estimate for a 10 year period, so the annual costs would be derived by dividing by 10.

With reference to the cost consequences of accidents/incidents for the Gotthard broken wheels' case SBB indicated that a property damage amount, including loss of income[18], of around 155 M€ (of which around 140 M€ are insured)[19] considering the time period in which the tunnel was closed for rail traffic.

[17] Data source: ERA Railway Factsheet - Europe.

[18] These consider 'losses' for SBB Cargo, SBB Infra, SBB Passenger Traffic and SBB International.

[19] The estimation accuracy for both figures is +/- 20%; Gotthard Base Tunnel in operation on 2 September | SBB News (27.06.2024).

Table 2 – Estimation of the aggregated economic impact of the 2024 JNS procedure (source: selected JNS TF members, 2024)

#	Responsible	Measures	Assumption for estimation (2024 calculation)	Cost estimation (Million euro) - 2019 JNS procedure	Cost estimation (Million euro) - 2024 JNS procedure
1 ●	RU	No additional measures	5.000 additional wagons (wheelsets) to sort out from service a 100 €	0,5 M€	-
1.1 ●	RU	No additional measures but additional number of wheelsets: Case " K + R1 (isolate brake)" (e.g.: paint burns of at connection rim\web - GCU 1.2.2)	10,000 additional wagons (wheelsets) to sort out from service a 60 €	-	0,6 M€
1.2 ●	RU	No additional measures but additional number of wheelsets: Case " Detach wagon " (e.g.: cracks on the rim surface - GCU 1.3.6)	5,000 † additional wagons (wheelsets) to sort out from service a 200€	-	1 M€
2	For ECM/Keeper	Risk assessment	From 10.000 to 20.000 € per ECM (only freight) Number of ECM (only freight): 500	1 M€	From 5 M€ To 10 M€ ∫
3	For affected ECM/ Keeper	Additional measures	From 110€ to 120€ per wheelset / year from 200.000 to 300.000 affected wheelsets	20 M€	From 22 M€ To 36 M€
4	For affected application	Diameter reduction in affected application	75€ per 1 mm => 24 mm reduction => 1.800€ per wheelset from 200.000 to 300.000 affected wheelsets	75 M€	From 360 M€ To 540 M€

Notes: Values = order of magnitude provided by around half of the sample. / ● - In the 2024 JNS Gotthard BW procedure, measures for RUs are disaggregated – see lines 1.1 & 1.2. / † - value underestimated. / ∫ - No AsBos' costs included.

Tunnel closure as a consequence of an accident is prejudicial not only to the regional economy but also to the national and in some cases even to the whole European economy, increasing transport costs, reducing competitiveness and safety of the affected areas[20]. Also, the literature has been demonstrated that accidents/incidents in tunnels might be very costly[21] as in some railway accidents (e.g. Rastatt tunnel [22]).

The impact evaluation of the RCMs should consider also the ability of the recalled measures to avoid these kinds of accidents with huge economic impacts that could more than offset the cost of the measures themselves.

B. Overall costs and benefits

Main components in the quantitative assessment include:

- *Cost of the RCM measures (under Options 0, 1 and 2)*
- *Safety gains of the RCM measures (under Options 0, 1 and 2)*
- *External costs (under Options 0, 1 and 2)*

Our focus in the analysis will be on Options 1 and 2, whereas the impacts associated with Option 0 was already assessed as part of the LIA from 2024 (see above).

In particular, the total costs associated with Options 1 and 2 will be compared covering both the costs of the measures along with foreseen external costs. It should be noted that the relative comparison between Options 1 and 2 is not influenced by the inclusion of external costs or not, considering that the external costs can be derived as a function of the costs of the measures.

The two options are compared using a cost-effectiveness criterion, total annual costs relative to a measure for effectiveness. In principle, expressed in this way the lower this ratio would be the higher level of cost-effectiveness, i.e. the preferred option would then be the option with the lowest costs per effectiveness score. The main challenge in using this approach is limited information on effectiveness. Two approaches could be utilised:

- *Assuming that both Options achieve the same level of effectiveness the comparison would only be in terms of costs where the preferred option would be the one with lowest costs*
- *An alternative approach could use as proxy for a quantitative effectiveness score the proportion of respondents to the survey (see Annex 2) distributed earlier to the JNS TF that consider that the NSA CH measures control the risks sufficiently. Moreover, it could plausibly be assumed that the agreed JNS measures would reach an equivalent score of 100%.*

Below, the estimates of cost of measures, external costs and overall cost-effectiveness are outlined for the two Options along with further explanations..

Cost estimates of RCM measures

Option 0:

See information above, Table 2. On an annual basis (where one-off costs are distributed over a 10-year period) an order of magnitude of the costs would be in the range around 60-90 mln EUR per annum.

Option 1:

Cost estimates here would be on top of the costs under Option 0. The Joint Sector Group (JSG) has provided detailed cost figures on both the Swiss measures (Option 1) and the alternative / complementary measures (which provides indications for the possible cost impacts associated with the Option 2 JNS measures). These estimates have been shared with the JNS TF and are available on the Agency's JNS Extranet. The Agency has undertaken a detailed analysis of the provided cost estimates incl. validation of the underpinning assumptions, e.g. in terms of unit costs for the different activities involved for these measures. Based on the available information about the cost impacts a plausible range could be from 150 mln EUR to 1000 mln EUR per annum. On balance an order of magnitude figure could then be around 500 mln EUR considering variation between stakeholders. This cost estimate would be at European level in the situation, where the NSA CH measures are introduced across Europe. Obviously, the cost estimate would be substantially lower if Option 1 measures would be limited to stakeholders based in or operating in Switzerland. Further validation of the cost figures is foreseen, incl. costs for each of the individual measures. In particular, in 2026 further updates of the impact assessment are foreseen. It is noted that the cost estimates would refer to all 4 measures put forward by NSA CH, incl. M3 (Forced technical wagon inspection) that has been postponed until 1.1.27

Option 2

Cost estimates here would be on top of the costs under Option 0. The Joint Sector Group (JSG) has provided detailed cost figures on both the Swiss measures (Option 1) and the alternative / complementary measures (which provides indications for the possible cost impacts associated with the **Option 2 JNS measures**). These estimates have been shared with the JNS TF and are available on the Agency's JNS Extranet. The Agency has undertaken a detailed analysis of the provided cost estimates incl. validation of the underpinning assumptions, e.g. in terms of unit costs for the different activities involved for these measures. Based on the available information about the cost impacts a plausible range could be from 40

[20] Haukur Ingason, 2023, Proceedings of the International Symposium on Catastrophic Tunnel Fire, 20-21 November 2003.
[21] OECD (2006), OECD Studies in Risk Management – tunnel safety, Paris.
[22] Rastatt Tunnel - Wikipedia, the free encyclopedia.

mln EUR to 100 mln EUR per annum. On balance an order of magnitude figure could then be around 80 mln EUR considering variation between stakeholders. This cost estimate would be at European level where the JNS measures are introduced across Europe. The 80 mln EUR annual estimate takes into account the latest discussion in the JNS TF on the 18th of December 2025. Further validation of the cost figures is foreseen as part of the follow-up work in 2026, incl. detailed costings for each of the individual measures. The identified cost range has been derived based on changing assumptions on parameters for additional resources required from the additional requirements included in the JNS 2026 measures. As such it should also be noted that a couple of cost elements have not been included in the cost range given above (see above), e.g. transport to workshops and loss of wagon availability as well costs associated with tasks undertaken by ECM certification bodies (surveillance) and National Safety Authorities (supervision). These elements could be considered as part of the planned update in 2026. It should be noted that the conclusions of the impact assessment will not be affected by these elements.

Further sensitivity testing will be carried out in 2026 regarding any follow-up on the JNS 2026 measures. The findings from this analysis will be included as part of the planned 2026 update of impact assessment report.

External costs estimates

Apart from the costs of the RCMs the impact assessment is also considering the external costs in accordance with the EC's Better Regulation Guidelines as well as substantial academic literature on the implications of shifting transport from rail to road. As noted above, the inclusion of external costs will not change the ranking of the two do-something options. The changes in external costs from transport would arise provided that: 1) There are cost impacts of the RCMs that are passed through to the customers in terms of prices; 2) Freight customers would respond to freight rate increases by partially moving to other modes (notably road); 3) unitary external costs per tonne kilometre vary between modes. For each of these elements in the chain to reach external cost changes details are provided in Annex 0. It should be noted that the estimated external costs figures consider a European level of implementation of the measures within the different Options. The external cost estimates for three Options are based on:

- *Cost of measures (see values / range given above) relative to the total operating costs for rail freight in Europe to determine the percentage change in costs*
- *Data on rail freight volume (measured in tonne kilometres) available from the EC Transport Statistical Pocket book[23]*
- *Marginal external costs (eur-cents / tonne-klm) for road and rail covering the following external cost categories (Accidents, Air pollution, Climate change, Noise, Congestion, Well To Wheel (WTT), Habitat available from CE-Delft Handbook on external costs (2019)). Link to the Handbook available in Annex 0. For this analysis we use the following values for marginal external costs for road and rail respectively: 0.272 eur-cents / tonne-klm for rail and 4.865 for road eur-cents / tonne-klm*
- *Therefore, the additional external costs of modal shift from rail to road per tonne-klm would be 4.593 eur-cents / tonne-klm*
- *Cross-price elasticity value (relative shift of volume from rail to road due to price increase in rail): 0.3 (OECD report from 2022[24])*

Based on these elements additional external costs per Option would be (preliminary values to be confirmed):

[23] EU transport in figures: Statistical Pocketbook - Mobility and Transport

[24] OECD (2022) Mode choice in freight transport

- *Option 0: (not considered at this stage)*
- *Option 1: 85-95 mln EUR per annum*
- *Option 2: 10-20 mln EUR per annum*

Safety gains

Limited quantitative information is available about the possible safety gains associated with the measures from NSA CH (in addition, limited qualitative considerations were provided in the questionnaire distributed to the JNS TF members). Some semi-quantitative evidence is emerging form the survey undertaken as part of the follow-up for the JNS on unintended brake applications of LL BB. Considering the link between unintended brake applications and cracks / broken wheels this is highly relevant. Further information about this survey and the preliminary findings is available in Annex 4. More comprehensive details of the results will be provided over the coming period (expected in Q1 2026). As such with improved awareness, adoption and indications of effectiveness of these RCMs it is likely that the risk associated with broken wheels may already be reduced significantly. An early indication about the importance of these RCMs is provided by one respondent that stated that the company '*…modified its brake tests by eliminating the assimilation function before performing the train's brake application/release test. During an on-track driver changeover, the new driver also applies the assimilation function before starting. This company reduced incidents related to these involuntary brake applications by* ***23% between 2023 and 2024****. A monthly review is carried out to analyse incidents and identify areas for improvement from a regulatory or operational perspective. And in 2025, during periods of high temperatures (late March to late August), there was also a decrease of around* ***20% in brake applications compared to 2024****.* It is strongly recommended to launch a similar survey for the JNS 2024 RCM measures to track among the concerned stakeholders the level of awareness, adoption and effectiveness to increase the knowledge about how the measures are working and any areas for further fine-tuning and improved. Survey findings could well complement the evidence available from the reported cases of broken wheels or cracks through the whole rim or web thickness (see Section 1).

Summary of results

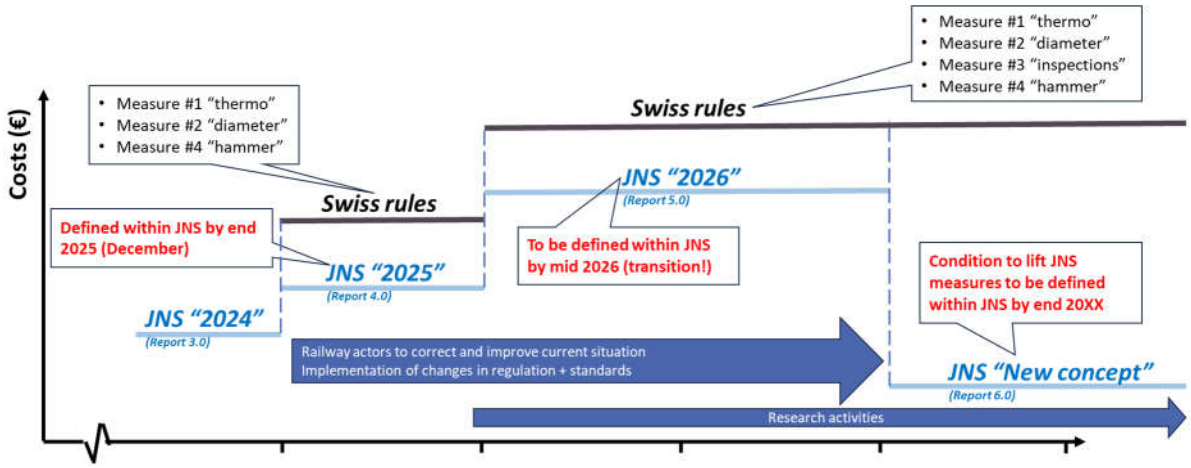
Table 3. Overview of quantitative results

	Option 1	Option 2
Cost of RCM measures (mln EUR per annum)	500	80
External costs (EUR per mln annum)	90	15
Total costs (EUR per mln annum)	590	95
Effectiveness score	0.62	1.00
Cost-effectiveness score	959	95

Overall, Table 3 indicates that Option 2 perform substantially better on a cost-effectiveness score basis compared to Option 1, where the value of the score is comparatively lower for Option 2 than Option 1 (a factor 10 difference).

C. Future perspectives building on smart solutions using digital / AI tools

The overall framework concerning the impacts with the risk control measures for Broken Wheels is well outlined in the chart below focussing on the changes in costs over time reflecting both the JNS and the Swiss measures. As such, it is likely that over time substantial reduction in costs of wheelset maintenance and in-service monitoring could be facilitated building on ongoing research and innovation activities. It is foreseen that in the future the JNS Broken Wheels workstream will be geared towards capturing this efficiency and effectiveness potential ensuring a harmonised European framework. While it has not been possible to incorporate these gains directly in the impact assessment it is worth noting that the possible cost savings using smart / digital solutions supporting condition-based maintenance among others could be rather high. For example, through AI-based monitoring of wheelsets it is possible that the number of wagons that would need to be withdrawn from service for maintenance can be reduced (see RSSB, 2024)[25].



[25] RSSB introduces AI-Powered tool to optimise wheelset maintenance | Rail Industry Connect | Connecting you with rail industry insight and best practice

5. Comparison of options and preferred option

5.1. Comparison of options

	Option 0 (baseline)			*Option 1*			*Option 2*		
Stakeholder impact	Sector org	Nat. Auth & AsBo	EU Auth.	Sector org	Nat.Auth & AsBo	EU Auth.	Sector org	Nat.Auth & AsBo	EU Auth.
Effectiveness	Rather high/pos.			Neutral			Very high/pos.		
Coherence (optional)	Rather high/pos.			Very low/neg.			Very high/pos.		

Colour legend	Very low/neg.	Rather low/neg.	Neutral	Rather high/pos.	Very high/pos.

5.2. Preferred option(s)

Based on the assessment of the measures from the JNS TF, Option 2 avoids the substantial negative cost consequences associated with Option 1 while at the same time controlling the risks sufficiently. Therefore, Option 2 would be the preferred choice considering the different quantitative and qualitative elements available.

5.3. Risk assessment

The measures embedded in Options 2 have been drafted in close cooperation with industry experts, representative bodies and national authorities over the course of the JNS NP duration which also benefits from previous JNS procedures as described in section 1. Considering the elaborated and iterative discussions of the JNS TF, as well as the detailed analyses underlying each change, there are only limited risks associated with the implementation of the related measures of the JNS. However, it would be important to ensure that the measures put forward are timely implemented to ensure that the risks are sufficiently controlled. Comprehensive follow-up monitoring on this aspect should be put in place (as mentioned in Section 6).

The conclusion of the risk assessment is also put forward on the basis that further work is foreseen in 2026 and beyond to further refine the risk control measures to optimise resources involved and the effectiveness of the measures.

Risk level assessment			
Risk variables	**Option 0**	**Option 1**	**Option 2**
Data: Baseline	Low risk	Low risk	Low risk
Method: Forecast 2026	Low risk	Medium risk	Low risk
Method: Forecast 2030	Medium risk	Medium risk	Low risk
Implementation (stakeholder support)	Medium risk	High risk	Low risk

5.4. Further considerations

In the short-term it is already foreseen that the present impact assessment report will be amended during the first half of 2026 in order to consider the agreed follow-up JNS work for which updates of one or several RCMs are foreseen. The timeline for this update would be July 2026.

Beyond this short term two aspects would need to be explored in future analyses re. their likely impacts on controlling / managing risks as well as changes in costs for the concerned stakeholders:

- *Updated maintenance concept(s)[26]: In particular,*
  - *Manufacturers, ECMs and RUs to update the EN 15313 regarding maintenance rules considering the most recent freight train operational rules: 1) definition of maintenance intervals for EN13979-1compliant and non-compliant wheels; 2) definition of matching in-service wheel checks against irregularities (e.g. overheating, tread damages, cracks), in collaboration with the IM if needed*
- *Research on solutions for in-service monitoring with particular emphasis on digital / smart measures:*
  - *ECMs, RUs and IMs to initiate research into automatized and highly reliable systems to entirely monitor wheels in-service (e.g. EMAT, video gates, etc...)*

In addition, regarding the use of detection devises, it is important to highlight for future activities to explore the comparison in terms of costs and risks between rolling stock (on-board) and trackside systems not included in this LIA. In particular, the topic of trackside systems (availability and location) has already been considered in the impact assessment carried out for the JNS Procedure "Consequences of unintended brake applications with LL blocks", closed on March 5th 2024 (especially, sections 1.2, 4.2 and 6.1)[27].

With specific reference to the costs for the risk assessment for ECMs, the IA analyses revealed the need to be further explored to have more evidence not only for risk assessment but other activities within the railway system with the aim to better determine a) what are the typical costs, and b) possible variations between entities.

6. Monitoring and evaluation

6.1. Monitoring indicators

Overall, the adopted JNS NP 2024 measures along with the ones put forward in the JNS follow-up report from December 2025 are directly linked to the monitoring activity undertaken by the different railway stakeholders. These measures imply a particular cooperation between actors (IMs, RUs, ECMs etc.) in the frame of operations to facilitate the monitoring of the risk control measures.

The **monitoring scope** should cover the following aspects:

- the continued collection and analysis of cases similar to the cases already under analysis,
- the monitoring of the implementation status of the RCMs produced by this JNS procedure,
- the HABD/HWD trackside installation availability all over Europe (including in case of incidents), number of detections per year per MS (and related deployment costs),
- the collection of the incurred implementation / ongoing costs of measures by stakeholder type.

Moreover, considering the significant value of the survey undertaken concerning the awareness, adoption and effectiveness of the RCMs from the JNS LL BB / unintended brake applications, it would be highly beneficial to prepare and launch a similar survey(s) for the RCMs put forward in the JNS Broken Wheels / Gotthard. Such surveys could take place in two stages: 1) An initial survey stage would focus on the awareness, adoption and effectiveness of the already established RCMs from JNS 2024 (considering that these were put forward in July 2024 this could be launched already in Q1 2026); 2) A follow-up survey

[26] Some elements regarding the maintenance are also identified in the: First Ex-post Evaluation Report on ECM Regulation (Commission Implementing Regulation 2019/779) | European Union Agency for Railways, carried out in 2024 by the Agency.

[27] It did not include the quantification in monetary terms of these devices; it is indeed an issue that emerged within the JNS NP 2024 procedure.

covering the RCMs as amended with the JNS 2026 report end of December 2025 (this survey could be launched in Q1 2027).

6.2. Future evaluations

According to the Agency regulation, ERA can undertake ex-post evaluation (Article 8.3). In the future, it could be highly relevant to undertake an ex-post evaluation linked to broken wheels to assess the efficiency and effectiveness of the risk control measures put forward to identify the actual impact, lessons learnt and scope for future improvements / fine-tuning. This would also involve the launch of effectiveness survey similar to the one carried out for follow-up of the JNS NP on unintended brake applications (as mentioned above, Section 6.1).

7. Sources and methodology

7.1. Sources

Drafting this impact assessment benefited from inputs received in various meetings with both ERA colleagues directly involved in the JNS procedure and other JNS TF experts. The desk research was aimed to collect relevant documentation produced by participants in the JNS TF along with other information sources (e.g. industry and academic reports). The ERA database used refer to the JNS investigations as well as other information sources, notably the Agency's Railway Factsheets.

Within the context of the JNS TF Broken Wheels follow-up, section 4.2 benefitted from data gathered via a dedicated questionnaire from JNS TF members regarding both the cost estimation of measures and the number of wheel sets disaggregated by selected type of wheels (questionnaire distributed to JNS members in 2024 and included in the LIA from July 2024).

Moreover, a dedicated questionnaire distributed in November 2025 provided complementary information on the perceptions regarding the proposed Swiss measures along with the JNS measures put forward in Sep / Oct. 2025. Moreover, data from the Joint Sector Group on the costs of the Swiss measures and the JNS measures supported the Agency's FIA. Finally, a survey among keepers provided knowledge about the frequency with which wagons experience a maintenance event was also considered as part of the impact assessment work.

Desk research	☒	Interviews	☒
ERA database	☒	Meetings	☒
External database	☒	Survey	☒

Annexes

Annex 0. Background information

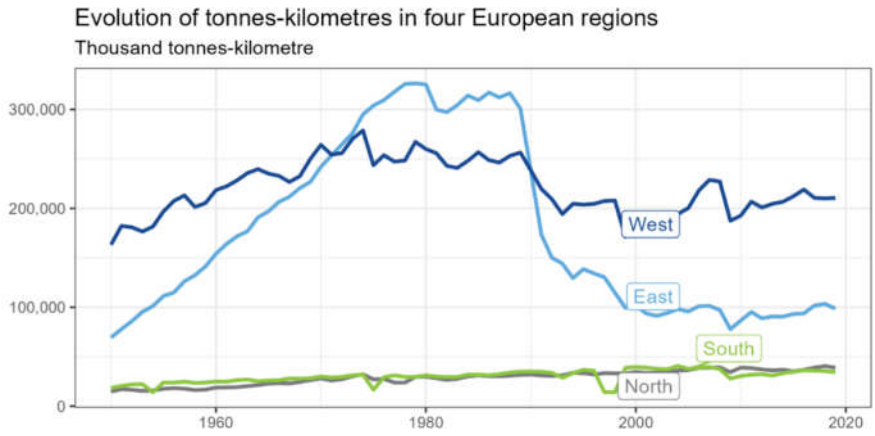
This annex covers the following elements all of relevance for this impact assessment:

- *Rail freight performance*
- *Rail freight assets and maintenance costs*
- *Incidents involving wheels / wheelsets and consequences*
- *Multimodal perspectives*

A. Rail freight performance

Insights re. trends for rail freight performance are offered by Figure 2 where rail freight volumes (measured in tonne-kilometres) are grouped into larger European geographical regions (North, South, East and West).

Figure A1. Rail tonne-kilometres in four European regions



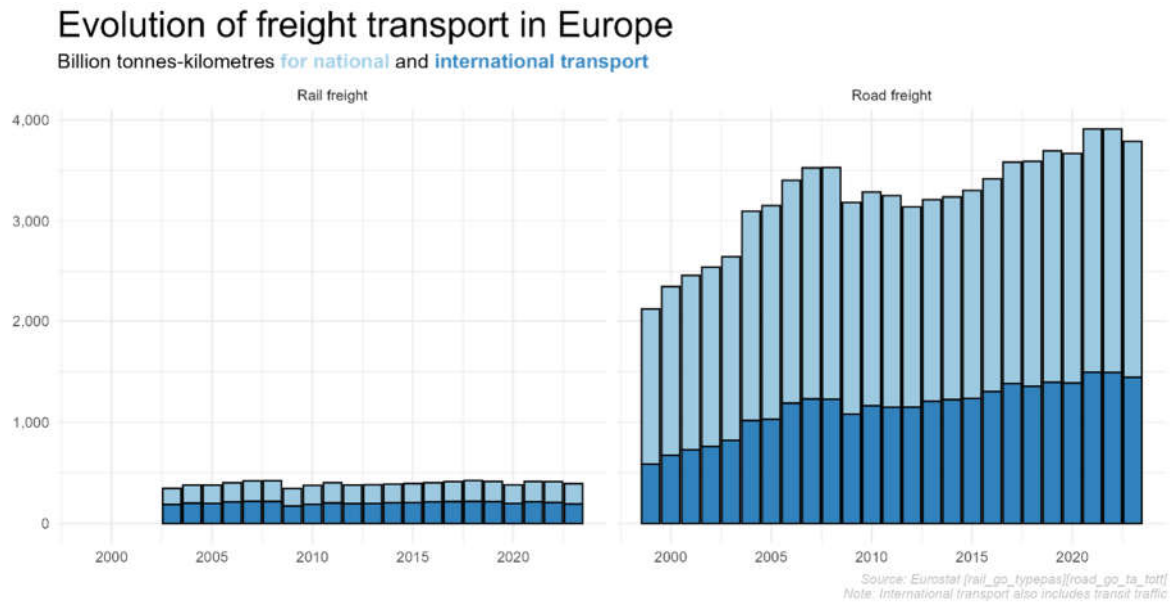
Source: International Historical Statistics, Eurostat

Note: North – DK, FI, NO, SE; East – BG, CZ, HU, PL, RO; South – EL, IT, PT, ES; West – AT, BE, FR, DE, IE, NL, CH, UK

Moreover, road and rail freight transport volume figures for the Alpine region (with focus on Switzerland) have also been examined during this impact assessment showing the importance of rail freight. Further information on this aspect will be incorporated in the planned update of the impact assessment report in 2026.

The modal share for rail in Europe has stagnated at quite low levels (around 12% for freight as shown in Figure A2. Hence, transport demand has increased but rail has not been able to take a greater share of it. This despite that long-distance transport, a segment in which rail is commonly believed to have a competitive advantage, grew particularly strong.

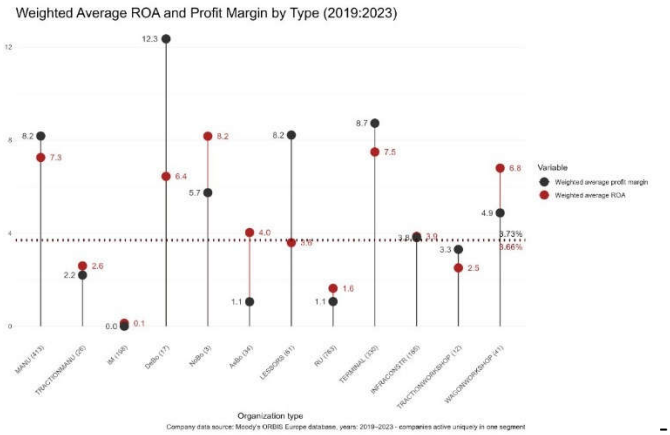
Figure A2. Freight transport trends in the EU



Source: Eurostat

Available information (Orbis data[28]) on financial performance of the railway stakeholders provides at European level (and country level) indications on return of assets and profit margin. The figure below (Figure A3a) shows the results for about 1500 companies across the main stakeholder groups. Two main findings should be highlighted: 1) overall margins are relatively small, e.g. about 3% profit margin; 2) there is significant variation in financial performance within and between stakeholder groups. Figure A3b provides indications for freight only RUs on a country basis. As such this context is of relevance whenever consideration is given to new or updated regulatory provisions.

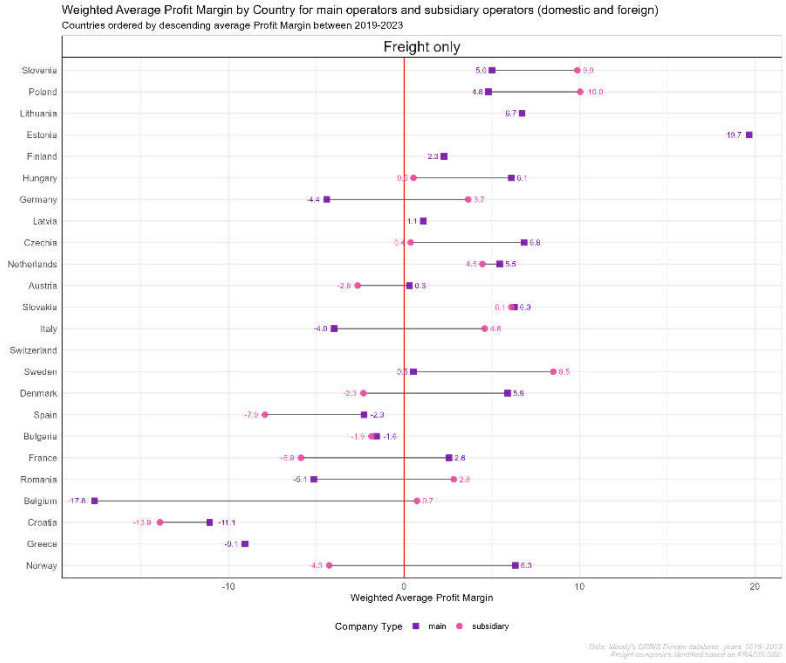
Figure A3a. Weighted average ROA and profit margin by stakeholder type



Source: Orbis and Agency analyses

[28] Orbis - BvD is now Moody's

Figure A3b. Weighted average ROA and profit margin for freight only RUs by country



Source: Orbis and Agency analyses

B. Rail freight assets and maintenance costs

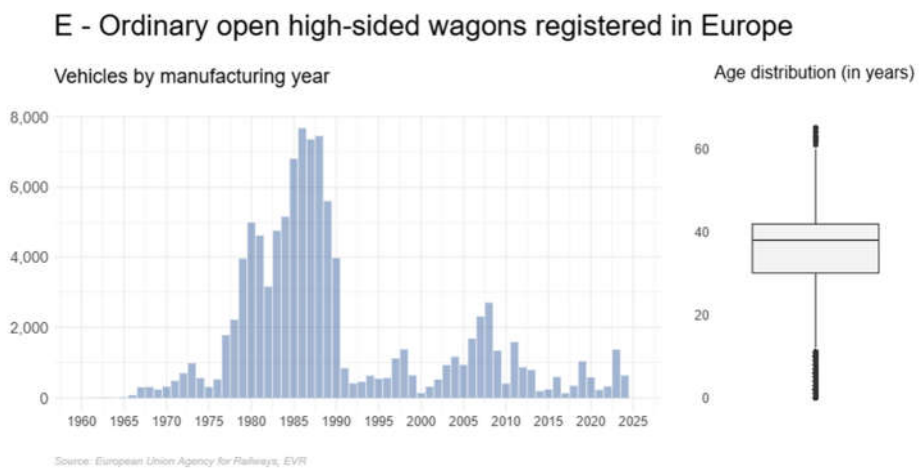
According to the Agency's Railway Factsheets a total of 658000 wagons were registered in Europe for the year 2025. The distribution per type is shown in Table A1

Table A1. Freight wagons by type 2025)

Number of freight wagons by type 2025	
O - Open multi-purpose wagons	322
K - Ordinary flat wagons	5010
I - Temperature controlled wagons	5362
G - Ordinary covered wagons	7924
L - Special flat wagons	29885
T - Wagons with opening roof	32535
U - Special wagons	50809
R - Ordinary flat wagons with bogies	51510
H - Special covered wagons	53048
F - Special open high-sided wagons	59440
E - Ordinary open high-sided wagons	102631
Z - Tank wagons	117293
S - Special flat wagons with bogies	141605
Total	**657374**

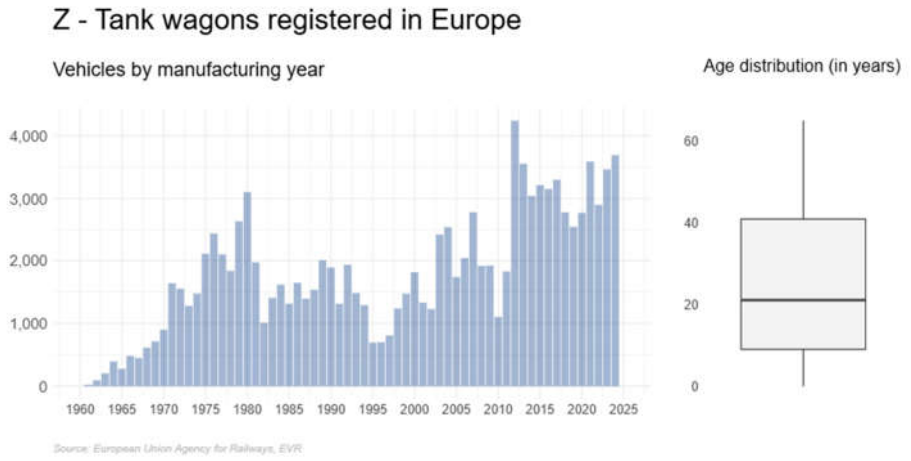
Additional information for the 3 most registered wagon types is provided below (notably type E, Z and S). In particular, the 3 charts provide information about wagons by manufacturing year along with data on the age distribution of the different wagon types.

Figure A4a. E - Ordinary open high-sided wagons registered in Europe



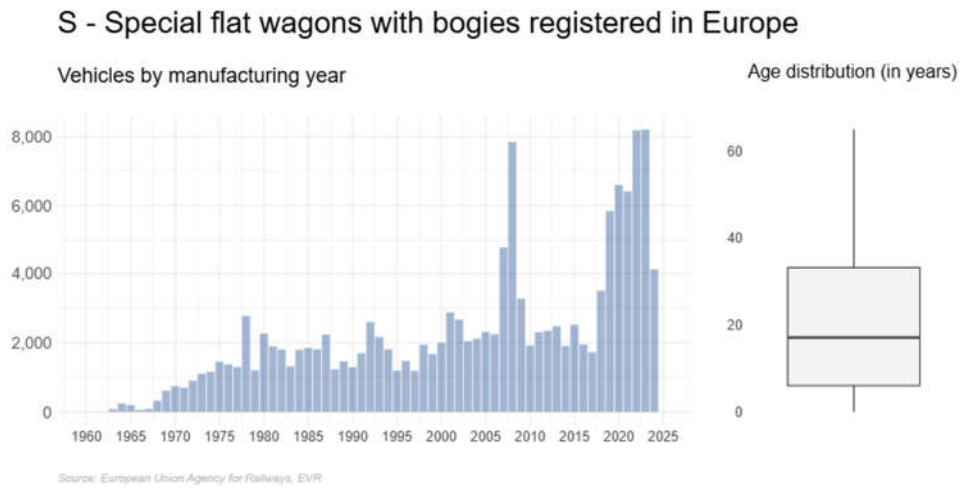
Source: EVR

Figure A4b. Z- Ordinary open high-sided wagons registered in Europe



Source: EVR

Figure A4c. S – Special flat wagons with bogies registered in Europe



Source: EVR

Available information suggests that the technical service life of freight wagons in Europe would be in a range from 35 to 50 years, although the useful (economic) life would typically be lower, e.g. 35 years (DG COMP, 2023 and TÜV Rheinland InterTraffic GmbH (2019)[29][30]. In DG COMP (2023) it was mentioned that approximately 10% of the freight wagon fleet was older than 50 years at the time of the study and had in theory already reached the end of its technical useful life. The figures given are in line with the information provided in the Agency Railway Factsheets mentioned above.

Although there is no European database on number of wheelsets in use, it can be estimated that there would be minimum about 2+ million considering that there are around 650.000 freight wagons (see source above) and that most and each wagon typically runs on 4 wheelsets (8 wheels).

The typical lifetime of wheels / wheelsets is influenced by several factors such as residual stress state from manufacturing, material properties, wheel and rail profiles, wheel-rail contact forces, operating environment including speed and braking all subject to variation. As such this makes it difficult to determine a universal definition of wheel life[31]. Available information suggests the economic lifetime would be around 15+ years, while the technical (design) lifetime would be higher. While maximum mileage would be around 1,200,000 klm (UIP, 2011)[32].

According to the Agency's Railway System Data Inventory (RSDI)[33] the **costs of wagons** in Europe (purchase costs) would typically fall in the ranges given below depending on the wagon type involved (values are expressed in mEUR):

- *Freight 4-axle E wagon cost: 90 to 120*
- *Freight 6-axle E wagon cost: 105 to 140*

[29] DG COMP (2023) Impact assessment support study for the review of the Community guidelines on State aid for railway undertakings

[30] TÜV Rheinland InterTraffic GmbH (2019) Quantification of the need to retrofit freight wagon fleets in Germany and member states of the European Union in light of the differing legal frameworks

[31] US Federail Railroad Administration (2022) Framework for Wheel Life Model – Phase

[32] Microsoft Word - UIP WG EI - Final report - V 6.0 2011_11_21

[33] Standard Inputs for Economic Analysis in Rail | European Union Agency for Railways

- *Freight 4-axle non-articulated S wagon cost: 80 to 150*
- *Freight 6-axle non-articulated S wagon cost: 110 to 170*
- *Freight >6-axle non-articulated S wagon cost: 120 to 180*
- *Freight 4-axle Z wagon (not for transport of dangerous goods) cost: 100 to 110*
- *Freight 4-axle Z wagon (for transport of dangerous goods) cost: 100 to 200*

As for the cost per wheelset (new) a plausible range would be from around 6000 EUR to 10000 EUR considering the heavy duty use for rail freight along with compliance with industry standards and requirements. The exact costs would be dependent on the specific wheel type and other factors. This range is confirmed by a recent tender (2025)[34] in Ireland for Irish Rail concerning 400 axles and 1600 wheels that amounted to a total budget of approx. 4.2 mln EUR. Using assumptions about number of wheels and axles per wheelset this would imply a cost per wheelset of around 7000 EUR. It should be noted that a refurbished wheelset would normally be cheaper and hence in the lower end of the cost range given for a new wheelset.

For freight wagons there are several types of maintenance events, that varies in terms of effort and complexity:

- *Routine safety checks (brakes, couplers, wheels).*
- *Periodic maintenance covering wheelset turning, brake system servicing, and minor component replacements.*
- *Heavy overhaul including bogie overhaul, repainting, and structural checks.*

More specifically of relevance for this impact assessment wheelset maintenance activities, include:

- *Routine visual inspection (EVIC standard), checking axles, wheels, and bearings.*
- *Re-profiling (turning wheels on a lathe):*
- *Bearing replacement or axle work:*
- *Full overhaul (part of bogie maintenance):*

Quantitative indications about the current volume of maintenance events[35] in Europe linked to wagons have been provided by the Joint Sector Group (JSG) based on a survey among wagon keepers covering 57.2% of the entire European freight wagon fleet[36]. Key survey results show that approximately 91% of all freight wagons undergo a maintenance event within a maximum of 24 months, enabling essential components such as wheelsets and brakes to be inspected. Moreover, maintenance events for a time horizon of 12 months involve on average 70% of the wagons covered with a range from 34% to 100%.

Below, plausible costs ranges for the different wheelset maintenance activities are provided based on available information:

- *Light maintenance (IS1): Around 400 EUR per wheelset (excl. special delivery to location and unavailability of wagon); visual inspection alone would be about 10 – 30 EUR per wheelset*
- *Medium maintenance (IS2): Around 1500 EUR per wheelset (incl. also re-profiling / turning of wheel)*
- *Heavy overhaul / renewal (IS3): Between 4000 and 6000 EUR*

[34] 534363-2025 - Result - TED

[35] Maintenance events in the JSG survey include stationary and mobile interventions commissioned by the wagon keeper / ECM, and maintenance performed under the GCU

[36] JSG made the survey results available on the 5th of December 2025.

C. Incidents involving wheels / wheelsets and consequences

As part of the Common Safety Indicators information is gathered on several precursors that are reported annually by the National Safety Authorities to the Agency. Of relevance for this JNS are the following two types of precursors:

- *Broken wheel on rolling stock in service*
- *Broken axle on rolling stock in service*

In the case of broken wheel on rolling stock the following should be included in the annual CSI statistics from the NSAs:

- *Defects - Fractures (complete separation of the material) having caused an accident;*
- *Defects - Fractures or cracks identified during pre-departure checks of a severity to exclude the rolling stock from running;*
- *Defects - Fractures or cracks detected on the wheel of train-sets in operation of a severity to exclude the rolling stock from running*

However, Defects - Fractures or cracks detected in workshops during planned maintenance operations should be excluded.

In the case of broken axle on rolling stock in service the following should be included in the CSI statistics from the NSAs:

- *Defects - Fractures (complete separation of the material) having caused an accident;*
- *Defects - Fractures or cracks identified during pre-departure checks of a severity to exclude the rolling stock from running;*
- *Defects - Fractures or cracks detected on the essential parts of the axle of train-sets in operation of a severity to exclude the rolling stock from running;*

However, Defects - Fractures or cracks detected in workshops during planned maintenance operations should be excluded.

The latest data on these precursors from 2023 and 2024 for the EU Member States + Norway, Switzerland and Channel Tunnel show the following:

- *Total number of broken wheels in 2023: 17*
- *Total number of broken wheels in 2024: 12*
- *Total number of broken axles in 2023: 7*
- *Total number of broken axles in 2024: 8*

For broken wheels it should be noted that the latest numbers are substantially reduced compared to the period from 2006-10. On average some 140 broken wheels were reported during that period.

Evidence on the number of unintended brake applications in European rail freight was gathered in the context of the JNS NP on Consequences of unintended brake applications with LL block[37]. In 2021 there was a cluster of fixed brakes incidents for freight wagons in Italy. Many of the wagons were equipped with LL brake blocks made of organic composite material. In some events, LL brake blocks did not dissipate sufficiently to avoid secondary damages (e.g. fires along the track and wheel damages). Moreover, additional incidents were reported to ERA totalling 19 cases, of which 15 defined as 'relevant': 6 cases with extraordinary wheel tread deformation and fire, 5 cases with fire only, and 4 cases with extraordinary wheel tread deformation only. Regarding these cases, the JNS TF pointed out the main observations from the analysis of the 19 cases: all kind of different wagons involved (cases all over Europe); no relation to the

[37] JNS NP LL brake blocks_Final report_v2.0.pdf

season; all incidents occurred with 100 km/h trains; no relation to the geography (gradient, slope, etc.) of the track (braking occurred on level tracks or on slopes and gradients). The issue of unintended brake applications with LL blocks is linked to the risk of broken wheels and therefore, the RCMs defined by the JNS report is of relevance to the current JNS on Broken Wheels. These RCMs (if properly implemented) could reduce the risk of broken wheels.

Moreover, the JNS is also receiving information from stakeholders about cases with broken wheels or cracks through the whole rim or web thickness, incl. for BA004 and comparable wheel types. An important consideration is the extent to which reported cases are comprehensive. Further information is available in Section 1.2.

As such the impact assessment should also consider the costs associated with railway accidents / incidents and hence the benefits resulting from avoiding accidents, e.g. linked to new / updated risk control measures. The economic Common Safety Indicators provide annual data about the costs of accidents across the EU Member States + Norway, Switzerland and Channel Tunnel. These data are available on the Agency's website and included in the Agency's statutory reporting concerning safety and interoperability. The latest Biennial report on Safety and Interoperability form 2024 shows that the total costs of accidents amounted to about 4 bln EUR per annum (based on 2022 data). Considering that there were some 1569 significant accidents in 2022 an average cost per accident would be 2.6 mln EUR. Accordingly, every significant accident prevented would represent a benefit of 2.6 mln EUR. Obviously, the Gotthard tunnel accident in 2023 was substantially more costly (see Section 1.2), due to damage costs on (tunnel) infrastructure, rolling stock and lost traffic during the period when the tunnel was closed.

Complementary insights into the benefits linked to preventing railway accidents are provided by the estimated statistical value of preventable fatalities / casualties (VPF and VPC). The VPF measures the aggregate willingness to pay for typically very small reductions in individual risk of death (which, realistically, is what most safety improvements offer at the individual level). This reflects people's normal approach to risks which they face in everyday life, where they trade off cost or convenience against real, but very small, risks. A similar definition for VPC is available in the Agency's implementation guidelines for the CSI[38]. In particular, in that guide the following values are provided for the VPC for fatalities, serious injuries and minor injuries:

- *VPC for fatality: 3,273,910 (€ 2016)*
- *VPC for serious injury: 498,591 (€ 2016)*
- *VPC for minor injury: 38,514 (€ 2016)*

D. Multimodal perspectives

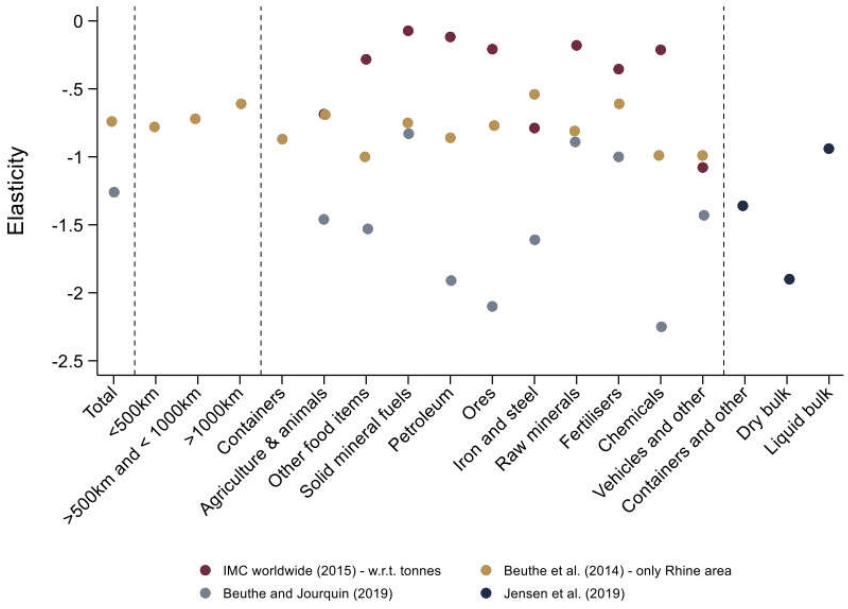
Multimodal perspectives are of importance for the assessment of the implications of the measures re. broken wheels as there could be a risk of increased external costs of transport due to higher costs of rail freight and a consequent shift of traffic from rail to road. Several elements will determine the extent to which such a modal shift would happen and what the consequences on external costs would be. Firstly, the extent to which cost increases are passed on to the customers in terms of higher rail freight rates would be a key factor. Secondly, how responsive customers are in terms of shifting from rail to road (i.e. how many tonne kilometres would change mode from rail to road) would be of relevance. Thirdly, given the amount of transport volume shifted from rail to road the impact on external costs would be determined by the difference in costs per tonne kilometre for road and rail respectively.

The extent to which railway undertakings can pass cost increases to customers can be explored using price elasticities. Typical ranges for price elasticities will depend on the market segment / goods transported. As

[38] European Union Agency for Railways (2023) Implementation guidance for CSIs.pdf

such, the higher the elasticity (price-sensitive) the more limited would be the extent of pass-through rate. In general bulk transport are expected to be less price-sensitive than intermodal transport (considering the extent to which alternatives exist). For example, if the elasticity would be around 1.5 the resulting pass-through rate of cost increases would be about 65%, while an elasticity of 2 would imply a pass-through rate of 50%. Figure A5 provides an overview of price-elasticity estimates of rail (freight) demand in Europe. The values recorded in the Figure would suggest a typical range for elasticities of about 0.8 and 1.3, implying a pass-through rate of close to 100% depending on the market segment concerned.

Figure A5. Price-elasticity estimates of rail demand in Europe



Source: DG COMP (2023)[39]

A recent overview of the responsiveness of different freight transport modes in terms of shifting to another mode due to a change in cost (price in another mode) is available in an OECD report from 2022[40]. Table A2 provides the main information of relevance for the impact assessment showing the so-called cross-price elasticities. According to the table an increase in rail freight rates of 10% would typically result in an increase in road freight transport in the interval between 1% and 5% (considering that the range for the cross-price elasticity for road in response to a change in rail freight rates would be from 0.1 to 0.5).

[39] DG COMP (2023) Impact assessment support study for the review of the Community guidelines on State aid for railway undertakings

[40] OECD (2022) Mode choice in freight transport

Table A2. Overview of price-demand cross-elasticities for freight transport modes

Cost	Demand			
	Road	Rail	Inland waterways	Short sea shipping
Road	0 to -1.2	0.4 to 1.7	0.3 to 0.9	0.2 to 1.1
Rail	0.1 to 0.5	0 to -1.6	0.2 to 0.8	0 to 0.3
Inland waterways	0.1	0.2 to 0.9	-0.4 to -1.3	
Short sea shipping	0.1 to 0.3			0 to -1.8

Source: OECD (2022)

It should be noted that these elasticity values also implies that 10% increase in rail costs does not translate into a 10% shift to road considering that road and rail are not perfect substitutes. Some of the rail traffic will continue albeit with smaller margins while other rail traffic would be cancelled either temporarily or permanently.

As for information about external costs per tonne kilometres for different modes of freight transport the most recent European wide is the study undertaken by CE-Delft for the European Commission (CE-Delft, 2019)[41]. The following external costs are considered in the CE-Delft study: accidents; air pollution; climate change; noise; congestion; well-to-tank emissions; habitat damage; other external cost categories (e.g. soil and water pollution). Table A3 provides an overview of external costs for different modes of freight transport.

Table A3. Average external costs 2016 for EU28 freight transport by cost category and transport mode

	Freight Transport					
	Road			Rail		IWT
	LCV-petrol	LCV-diesel	HGV - total	Electric freight	Diesel freight	Inland vessel
Cost category	**€-cent/vkm**	**€-cent/vkm**	**€-cent/tkm**	**€-cent/tkm**	**€-cent/tkm**	**€-cent/tkm**
Accidents	4.1	4.1	1.3	0.1	0.1	0.1
Air Pollution	1.2	3.4	0.8	0.0	0.7	1.3
Climate	2.6	2.8	0.5	0.0	0.2	0.3
Noise	1.1	1.1	0.5	0.6	0.4	n/a
Congestion**	11.6	11.6	0.8			
Well-to-Tank	0.8	0.8	0.2	0.2	0.1	0.1
Habitat damage	0.9	0.9	0.2	0.2	0.2	0.2
Total	**22.3**	**24.7**	**4.2**	**1.1**	**1.8**	**1.9**

Source: CE-Delft (2019), Table 71

Overall, these values demonstrate the significant difference between external costs for road and rail. Looking at HGV total average external costs per tonne kilometres is about 2 twice as high compared diesel rail freight and 4 times higher than electric rail freight.

[41] CE-Delft (2019) Handbook on the external costs of transport

Annex 1. Summary of questionnaires and bilateral meetings

As part of the impact assessment a questionnaire was distributed to the JNS TF members along with follow-up bilateral exchanges. A total of 15 completed questionnaires were provided by TF members from RUs, ECMs, Keepers and NSAs. Some 10+ bilateral exchanges were also organised that allowed the respondents to provide more insight into their answers and complementary information. Overall, the combination of questionnaire and bilateral exchanges worked well in terms of improved understanding of the issues involved in connection with the Swiss measures along with possible alternative / complementary measures with particular focus on the extent to which risks are sufficiently controlled, lowest cost impact, consideration to safety gains and the possible adverse impacts associated with higher costs of rail freight operation in competition with other modes.

Surveys with a more quantitative angle could explore the extent of efficiency and effectiveness associated with the JNS Broken Wheels (similar to what was undertaken for the JNS on unattended brake applications, see the main text of the report for further information and Annex 4 for an overview of the scope of the survey). This could complement well the qualitative survey considered here.

Questionnaires

- *A total of six questions were included in the questionnaire. Details of these questions are provided in Annex 2.*
- *The questionnaire was distributed to the all the JNS Task Force members by email covering a range of stakeholders from sector and authority side*
- *Overall, the responses received reflected similar positions albeit with certain variations between organisations.*
- *In particular, concerning the first question about whether the Swiss measures controlled the risk sufficiently and at the lowest cost impact none of the respondents chose answer A (risks are controlled sufficiently and costs are at their lowest).*
- *On the other hand, 8 respondents chose answer B, while 5 respondents chose answer C and 1 respondents did not select any of the available options.*
- *Respondents also provided specific indications on their view on the importance of each of the different measures put forward by NSA CH along with suggestions for alternative / complementary measures*
- *As for the impact of the expected cost increase on rail freight volume a majority of respondents indicated that it would result in a shift from rail to road (10 respondents out of 14); while 7 respondents considered that volume would be permanently cancelled; 6 respondents selected temporarily or partly cancelled. Only 1 respondent expected that the rail transport volume would not be affected.*
- *It should be noted that a number of respondents selected more than one option*

Bilateral meetings

- *The bilateral meetings were structured around the topics covered in the questionnaire allowing respondents to elaborate on their answers as well covering additional information (e.g. on the perceived costs associated with the measures put forward by NSA CH and alternative / complementary measures)*
- *The time allocated to these meetings were in general about 30 minutes to capture the key points of the respondents without taking up too much time*
- *These bilateral meetings allowed an improved understanding of the answers provided in the questionnaire*

Annex 2. Questionnaire

Questions for Members of the JNS TF on Broken Wheels and Gotthard Tunnel

Please indicate here your name:

Please indicate here your organisation:

Please indicate here your email-address for any follow-up exchanges:

The survey is completely **anonymous**, but feel free to indicate the name of your company if you are interested in follow-up activities. Your personal data is processed in accordance with Regulation (EU) 2018/1725 of the European Parliament and of the Council of 23 October 2018 on the protection of individuals with regard to the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data, and repealing Regulation (EC) No 45/2001 and Decision No 1247/2002/EC

Q1. Could you indicate your expectations concerning the extent to which the NSA CH measures are controlling the risk sufficiently and if they have the lowest negative cost impact?

- *a.* ☐ *Measures control the risk sufficiently and have the lowest cost impact*
- *b.* ☐ *Measures control the risk sufficiently, but alternative measures also control* the risk sufficiently and have a lower cost impact
- *c.* ☐ *Measures do not control the risk sufficiently*

Any additional details about the reasoning behind your answer to this question can be provided in the text box below. **In particular, in case you have selected as answer either b. or c.** above we would appreciate any information about what the alternative / complementary measures would be and to which of the 4 measures from NSA CH these concern.

Measure 1: Thermal stability

Measure 2: Minimum wheelset diameter

Measure 3: Forced technical wagon inspection

Measure 4: Sound test / Hammer test

Complimentary measures

Q2. Would you have any information (quantitative or qualitative) about the order of magnitude of expected safety gains associated with each of the four measures from NSA CH? (please use the text below for your answer)

Measure 1: Thermal stability

Measure 2: Minimum wheelset diameter

Measure 3: Forced technical wagon inspection

Measure 4: Sound test / Hammer test

Complimentary measures

Q3. Could you share any other observations about the measures proposed by NSA Switzerland or alternative/complimentary measures? (please use the text box below for your answer)

Measure 1: Thermal stability

Measure 2: Minimum wheelset diameter

Measure 3: Forced technical wagon inspection

Measure 4: Sound test / Hammer test

Complimentary measures

Q4. From your experience if the proposed measures would result in an increase in costs of rail freight operations to what extent will transport volume be retained, cancelled or shifted to another mode?

- *a. ☐ Transport volume on rail will not be impacted*
- *b. ☐ Transport volume on rail will be permanently cancelled*
- *c. ☐ Transport volume on rail will be temporarily or partly cancelled*
- *d. ☐ Transport volume will be shifted to another mode*

Please use this text box to elaborate on your answers (e.g. proportion of traffic that will be retained, cancelled, shifted). In the text box you could also detail out any reflections on the geographical dimensions of the changes in traffic volume.

Q5. Would you have any other comments to put forward on these topics. Please use this text box to elaborate on your answers.

Q6. Would your organisation be interested in having a bilateral meeting to discuss the issues about the impacts of the proposed measures and any alternative measures

☐ Yes
☐ No

Annex 3. Key recommendations from ECM ex-post evaluation in relation to the JNS BW

In 2024 the Agency addressed for the first time a report[42] to the European Commission (EC) on the implementation of Commission Implementing Regulation (EU) 2019/779 laying down detailed provisions on a system of certification of entities in charge of maintenance of vehicles pursuant to Directive (EU) 2016/798 as amended by Commission Implementing Regulation (EU) 2020/780 (hereinafter, the 'ECM Regulation'), which established a system of mandatory certification of entities in charge of maintenance (ECM) for all rail vehicles as well as set out the requirements to be met concerning the maintenance functions. Next edition of this report is due in 2027. Several recommendations were put forward in the report:

- *encouraging an amendment of the ECM Regulation,*
- *suggesting new RfUs to be adopted by the cooperation of ECM Certification bodies,*
- *proposing amendments to the Agency's ECM guide,*
- *proposing a more balanced application of the ECM Regulation across MSs,*
- *promoting the organisation of professional training by the Agency for all stakeholders,*
- *promote the consolidation of existing data collection and analysis and the design and implementation of additional ones for monitoring and supervision purposes of the ECM Regulation implementation by the Agency,*
- *proposing a new TSI Maintenance to address the main needs of actors in a systemic way.*

Of particular relevance to the JNS Broken Wheels work it is important to recall in detail the following recommendation:

Gathering information from stakeholders to design dedicated indicators for monitoring and supervising purposes (List of the main headline indicators):

- *Overall level of correct implementation of the Regulation including the possible national peculiarities and the unbalanced application of the ECM Regulation across MSs stated by some railway stakeholders.*
- *Number of identified major non-compliances with the certification requirements per country and per application,*
- *Overall level of correct exchange of data between the main actors,*
- *Overall level of harmonisation of the requirements for ECMs concerning the SCCs,*
- *Overall level integration of the safety management system and the maintenance management system.*

[42] First ex-post evaluation report on ECM Regulation.pdf

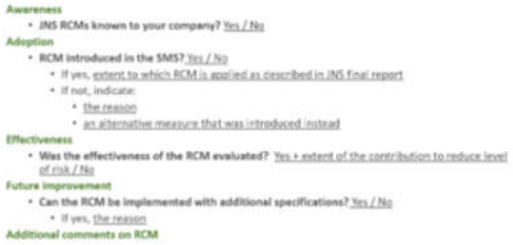
Annex 4. Survey on RCM effectiveness from JNS NP Unintended Brake Applications

EUROPEAN UNION AGENCY FOR RAILWAYS

Method, stakeholders and timeline

Methodology:

- Semi-quantitative survey aimed at stakeholders mainly impacted by the RCMs
- Final questionnaire validated by JNS LL BB members
- Questionnaire designed using the EUSurvey platform
- Distributed to JNS, NSA, NRB and ESG networks. Special effort in dissemination by the NSA IT.
- Individual contributions (1 reply = 1 company) by each rail operator
- Key elements of the RCM assessment



Involved selected stakeholders:

- IMs, RUs, ECMs (wagons and locomotives)

Timeline:

- Launched 08 August 2025 & Closed 24 October 2025
- Fine tuning of the data processing and analysis of the replies ongoing
- Final presentation of results planned during the first follow-up meeting of the JNS LL BB procedure foreseen in Feb 2026

Overview respondents

Type of operator	N. of respondents	% of total respondents
IMs:	20	11%
ECM Wags:	41	23%
ECM Locs:	27	15%
RUs:	Unique: 87 (G1: 86 & G2: 67) *	50%
Total:	**175**	100%

*
66 have replied to both G1 and G2 RCMs (= complete / all JNS RCMs)
20 replies of G1 replied only to those JNS RCMs
1 reply of G2 replied only to those JNS RCMs

Country	IM	ECM Wag	ECM Loc	RU	TOT	TOT %
Austria	2	1		7	10	6%
Belgium	1	2	1	3	7	4%
Croatia		2		3	5	3%
Czechia	1	1			2	1%
Denmark	1	2	1	1	5	3%
France	2		1	2	5	3%
Germany	2	10	7	19	38	22%
Hungary	1			7	8	5%
Italy	3	6	6	26	41	23%
Lithuania	1	1	1	1	4	2%
Luxembourg	1	1		1	3	2%
Netherlands	1			3	4	2%
Poland		1			1	1%
Romania		3			3	2%
Slovak Republic		1	1	4	6	3%
Slovenia		1		2	3	2%
Spain	1	4	3	2	10	6%
Sweden	3	2	1	3	9	5%
Switzerland		3	5	3	11	6%

Preliminary findings: general awareness of JNS LL BB RCMs

Are the results of JNS Urgent and Normal Procedures on "*Consequences of unintended brake applications with LL blocks*" known to your company?

Type of actor	JNS UP and NP known	JNS UP and NP unknown
IMs:	55%	**45%**
ECM wagons:	88%	12%
ECM locomotives:	89%	11%
RUs:	87%	13%

- There is the possibility to do follow-up with respondents that indicated availability.

Preliminary findings: disaggregated analysis on **awareness** of JNS LL BB RCMs by operator size

Operator type	**Network length (in km)**	**N. of replies**	**JNS UP and NP known**	**JNS UP and NP unknown**
IMs	<1.000 km	10	50%	50%
	1.000-9.999 km	7	71%	29%
	>10.000 km	3	33%	67%
Operator type	**Maintenance Staff**	**N. of replies**	**JNS UP and NP known**	**JNS UP and NP unknown**
ECM WAGs	Less than 30 employees	22	95%	5%
	Between 31 and 100 employees	9	89%	11%
	More than 100 employees	10	70%	30%
ECM LOCs	Less than 30 employees	11	91%	9%
	Between 31 and 100 employees	7	100%	0%
	More than 100 employees	9	78%	22%
Operator type	**Operations volume (tr km/year)**	**N. of replies**	**JNS UP and NP known**	**JNS UP and NP unknown**
RUs	<1 M tr km/year	37	86%	14%
	1-10 M tr km/year	39	90%	10%
	>10 M tr km/year	11	82%	18%

- There is the possibility to do follow-up with respondents that indicated availability.

Preliminary findings: EXAMPLE on JNS RCM n. 14 for Railway Undertakings (RUs)

Start-up test (instructions for procedure and detection of irregularities)

Q1 Did you introduce the above measure in your safety management system (SMS)?

N. of respondents	Introduced in SMS	Not introduced in SMS
67	82%	18%

Q2 If introduced in SMS, is this measure applied as it is described in the JNS final report?

Introduced in SMS	Fully	Mostly	Partially	Rarely	No
82%	76%	18%	4%	-	2%

Q1.1 If not introduced in SMS, please select the reason fits better to you (single answer, optional):

Not introduced in SMS	RCM does not apply to the context of the organization	RCM is difficult to be implemented in the specific context of the organization	The operator is working to implement the RCM in the management system	RCM is considered to determine an insignificant reduction of the level of risk	Other reason(s)	No answer
18%	25%	-	25%	8%	34%	8%

Q1.2 If not introduced in SMS, did you implement an alternative measure?

Not introduced in SMS	Yes	No	No answer	Description alternative measure
18%	-	100%	-	*more details available, if provided*

Q3 Did you evaluate the effectiveness of the measure on the unintended brake block application? NB: only respondents who introduced the RCM in their SMS considered

N. of respondents	Contribution to risk reduction evaluated	Significantly contributed to risk reduction	Partially contributed to risk reduction	Not contributed to risk reduction	Contribution to risk reduction not evaluated
55	64%	31%	31%	2%	36%

Q4 Do you consider that the measure can be further implemented with additional specifications?

Yes	No	Reason for additional specifications
9%	91%	*more details available, if provided*

Additional qualitative details available, when provided

Conclusions

- **Ex-post evaluation** of introduced RCMs is part of **good policy practice inspired on Better Regulation (EC) principles**
- Results could be used as an input for the follow-up on the **JNS Normal Procedure 'Accident in the Gotthard base tunnel with focus on broken wheels'**
- Joint efforts for the analysis of RCMs' adoption and effectiveness: **NSAs, sector and ERA**