Safety Critical Components

Applying the definition of Safety Critical Components to the freight wagon business

Technical Guideline

1. Preamble

This document is a guide for evaluation of SCC. It shows how the procedure could work for freight wagons.
Due to reason of general approach and chosen methodology, the data and information of the following safety reports were reviewed checked:

- ERA report on safety and interoperability 2020 [1]
- EBA Sicherheitsbericht 2019 [2]
- BAV Sicherheitsbericht 2019 [3]
- SUB Sicherheitsbericht 2019 [4]

We would like to stress that every ECM must evaluate his own data for the purpose SCC and that there might be another result as in this document due to technical equipment and operational conditions.
As these reports mentioned above were not satisfying referring to data and information in matters of freight wagons, UIP/VPI acted according to the guideline of CEN/TC256 WG48.

2. Background

In connection with the release of the 4th Railway Package 2016 with the overarching goal to revitalize the rail sector and make it more competitive vis-à-vis other modes of transport – 6 legislative texts were designed to complete the single market for Rail services (Single European Railway Area). As part of its technical pillar, Directive (EU) 2016/798 (safety directive) defines common principles for the management, regulation, and supervision of railway safety. It also provides for a framework to be put in place to ensure equal conditions for all entities in charge of maintenance for vehicles.

According to Directive (EU) 2016/797 (interoperability directive), the manufacturer should determine the (safety-) criticality of the functions and components of their products by a risk-based analysis and record them in the technical file. The definition of 'safety-critical components' (SCCs) as "*components for which a single failure has a credible potential to lead directly to a serious accident*" is set out in section 4.2.12.1 of Annex to Commission Regulation (EU) No 1302/2014 (LOC&PAS TSI).

Finally, Article 4 of Commission Implementing Regulation (EU) 2019/779 of 16 May 2019 (ECM Regulation) entails the specific traceability and maintenance requirements concerning SCCs for entities in charge of maintenance (ECMs). However, since the criticality aspects of any component are related to the specific design of a vehicle and to the specific functions of the

components, the legislative texts mentioned above do not provide for a pre-defined exhaustive list of SCCs.

Consequently, based on the draft “Guide for identification and management of Safety Critical Component for railway vehicles” developed by CEN/TC256/WG48 [5], this document aims to create a shortlist and a recommendation on methodology to identify SCCs relevant for rail freight vehicles by considering its state-of-the-art applied components in the industry.

3. Scope of the document

To approach the task of identifying the SCCs, this document applies the risk management principles described in Figure 1. The principles cover three levels of risks handling, its analysis, assessment and management. The method shows that the steps are sequential, but that the overall management thereof is performed circular, ensuring an ongoing evaluation of the defined system. This document uses the risk management structure to scope, identify and assess the identified safety critical risks which are covered in the first risk handling level, the risk analysis (Figure 1). Additionally, this document differentiates between Safety Critical (SCC) and Safety Relevant (SRC) Components as follows:

Safety-critical components (SCC) are vehicle components which, if they fail, can lead to a direct, serious accident or serious event (e.g., in accordance with DIN EN ISO 50126, EU 2016/798). "Direct" means the imminent following effect, not any subsequent events or actions that lead to a serious event. The safety-critical components are subject to processes that clearly document maintenance and history tracking and must be identified as individual components.

Safety-relevant components (SRC) are important vehicle components that can trigger follow-up events and follow-up actions through a failure, which could turn into serious events, but which, as opposed to SCC do not lead directly to a serious event in the event of failure,. The Safety-Relevant Components are however subject to traceability obligations as to document maintenance works.

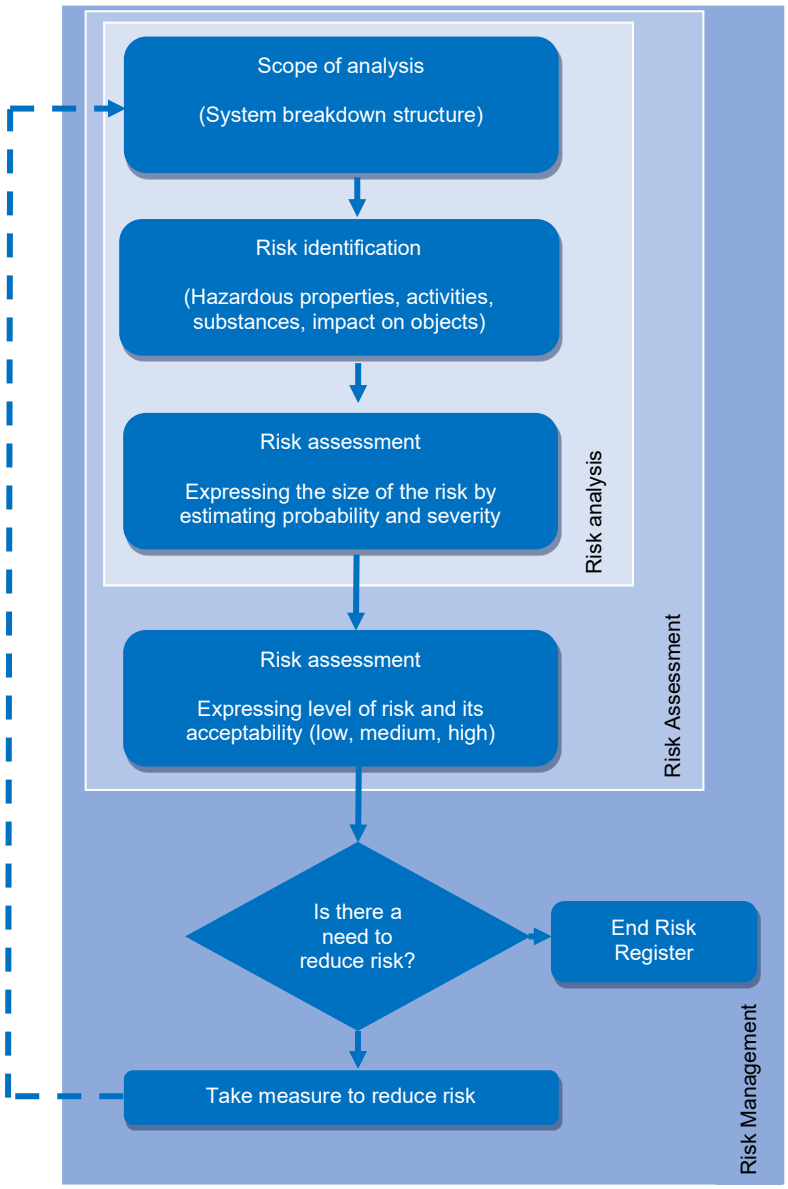

Figure 1: Risk management structure [6]

Utilizing the risk management structure in this document the system boundaries for the freight vehicle is scoped to the VPI European Maintenance Guideline recognized structure, listing its main components in Table 1 below.

Table 1: Freight vehicle components list

Underframe
Bogies
Superstructure
Wheelsets
Springs
Draw & Buffing gear
Brakes

Tanks and other components used for the transportation of dangerous goods have been excluded from this evaluation as their construction, their use and their maintenance are highly regulated under the UN 'Recommendations on the Transport of Dangerous Goods', known as the 'Model Regulations'. It provides the necessary framework of rules for the safe transport of dangerous goods by all modes – air, road, and rail as well as sea. For rail transport, RID regulations apply (Regulations concerning the International Carriage of Dangerous Goods by Rail).

Based on the Table 1's content, the Technical Committee of the VPI, with its board of industry experts has concluded on a short list of safety critical components seen in Table 2, including the safety critical sub-component in Table 3. Details on the technical evaluation are found in Table 4 below. The categorization of the component bases on the frequency and severity matrix disclosed in Appendix A.
If the component's risk evaluation is defined as "tolerable" it is categorized to being a "Safety Relevant Component".
If the component's risk evaluation is defined as "undesirable" it is categorized to being a "Safety Critical Component".

Table 2: Safety criticality of freight vehicle component list

Component	Criticality
Underframe	Not Safety Critical
Bogies	Not Safety Critical
Tanks/Superstructure	Not Safety Critical
Wheelsets	Safety Critical
Springs	Not Safety Critical
Draw & Buffing gear	Not Safety Critical
Brakes	Not Safety Critical

Table 3: Safety criticality of wheelset sub-components

Component	Criticality
Axle	Safety Critical
Wheel	Safety Critical
Axle box	Not Safety Critical
Bearings	Not Safety Critical

Table 4: Risk evaluation, Safety Critical and Safety Relevant Components

		Frequency	Severity	Risk Evaluation	SRC	SCC
Underframe		**4**	**6**	**tolerable**	**x**	
Bogies		**2**	**9**	**tolerable**	**x**	
Superstructure		**4**	**6**	**tolerable**	**x**	
Wheelsets		**4**	**10**	**undesirable**		**x**
	Axle	3	10	**undesirable**		**x**
	Wheel	4	9	**undesirable**		**x**
	Bearing	4	6	**tolerable**	**x**	
	Axle box	3	7	**tolerable**	**x**	
Springs		**5**	**4**	**tolerable**	**x**	
Draw- & Buffing Gear		**5**	**4**	**tolerable**	**x**	
Brakes		**3**	**8**	**tolerable**	**x**	

The Technical Committee is recommending that the specific ECM provisions for the management of Safety Critical Components apply for the wheels and the axle of a wheelset. This serves as a recommendation to the ECMs, which can be either fully or partially acknowledged, or rejected.

Regardless of the ECMs level of acknowledgement of the recommendation, it is the responsibility of each ECM to evaluate and assess its corresponding freight wagon fleet to confirm or adjust the scope of safety relevant components and the categorization thereof.

Chapter 4 presents a recommended evaluation method for the ECM developed by the CEN/TC256/WG48 [5] to perform the risk identification step stipulating how to classify safety critical components. The identified and listed safety relevant components are evaluated according to one of the two risk assessment methods FMECA & FTA, contained in the DIN EN 50126-2 “Railway Applications – Systems Approach to Safety”.

4. Evaluation methodology

For the identification of the Safety Critical Components (SCC) in the freight wagon business, the decision tree developed under the CEN/TC256/WG48 [5] works, see Figure 2, has been applied to the components list mentioned above.

Each component of the safety relevant components is evaluated based on a risk analysis which considered the following points:

- Intended use and environment
- Normal or degraded mode of operation
- Return on experience (REX) from operation and maintenance

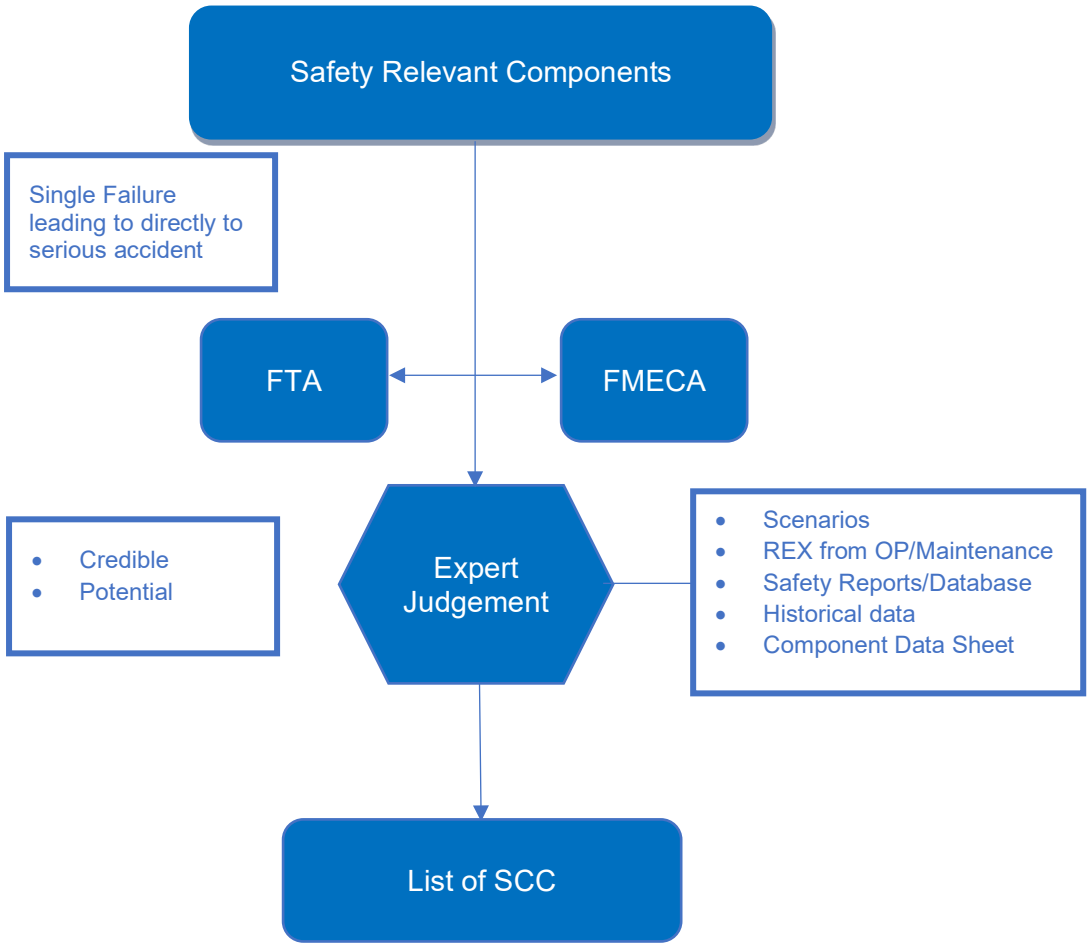

Figure 2: Evaluation method for safety critical components (SCCs)

Failure modes of the components shall be considered together with its detectability. The method FMECA (Failure Mode Effect and Criticality Analysis) or FTA (Fault Tree Analysis) is to be applied to identify the components failure modes.

The list of Safety Relevant Components with their failure modes need to be further analyzed through an “expert judgement”. The common rules for applying the “expert judgement” concept

are defined in EN 50126-2 “Railway Applications – Systems Approach to Safety” and It consists of the following elements:

- Check/Estimation should not be the opinion of a single person. Agreement among several (independent) experts and approved knowledge enhances the confidence in an assessment.
- Experts have adequate knowledge of the area in question.
- All necessary areas of expertise (which could arrive at differing classifications) should be included in the judgement.
- If the “expert judgement” is applied to estimate the frequency and consequences of hazards (or of accidents), a clear understanding of the categories promotes a common interpretation.
- The results of “expert judgement” are documented. This ensures the transparency and plausibility of the conclusions. It demonstrates the integrity and enables third parties to trace the conclusion.
- The documentation is refined if new information become available.

Documentation of “expert judgement” should include:

- Participants and respective areas of expertise
- Information like references to publications, sources, assumptions, deliberately excluded aspects with justification and rationale of conclusion.

The “expert judgement” is based on documentation and findings from the individual maintenance systems of certified ECMs and freight wagon keepers as well as on the return of experience gained from procedures launched at European level under the Joint Network Secretariat (JNS) or information available in the European Union Agency’s Safety Alert IT tool (SAIT). The documentation should provide information which covers at least partially:

- failure rate of the failure mode of the component
- historical statistics of serious accident linked to the component
- return on experience (REX) from operation and maintenance for the component
- scenarios of the operation
- component datasheet
- available safety recommendations/reports

After creating a repository of failure modes and their effects on the freight vehicle components, the definition of a Safety Critical Component has to be applied to each of the effects to either neglect or approve the classification of a component as SCC. The decision tree used to this end is shown in the Figure 3 hereunder.

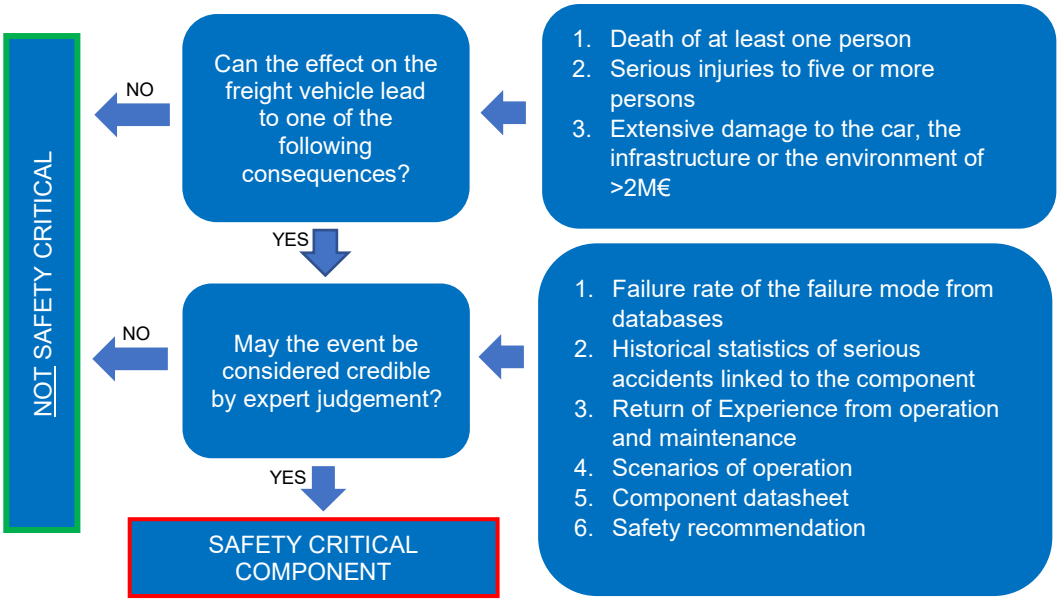

Figure 3: Identification of Safety Critical Components by serious accident and "expert judgement" definition.

5. Conclusion

Applying the described risk analysis and the "expert judgement" evaluation method on the safety relevant components, allows to put together a list of effects which can potentially affect the freight vehicle. By iteratively applying this process to every component in the safety relevant component list allows creating a repository of failure modes and their effects on the freight vehicle components. The ECM can use the Template provided in Appendix B if it concludes the same classification as the VPI Committee.

The result of the evaluation performed by the ECM on the safety relevant components should result in an ECM-specific conclusion to what its Safety Critical Component according to the requirements set in Directive (EU) 2016/797 are.

The traceability and maintenance requirements are then to be fulfilled according to the ECMs identified SCCs, in accordance with Article 4 of Commission Implementing Regulation (EU) 2019/779.

6. Remarks

To further strengthen the significance of the conclusions and confirm the compliance of the methodology with the provisions of the CSM on Risk Assessment (EU regulation 402/2013), an Assessment Body (AsBo) reviewed this technical guideline of SCC in the freight wagon business against the regulatory requirements.

The technical evaluation & risk assessment performed by the Technical Committee of VPI is based on the current accepted approach and applicable rules to the freight wagon business. They should be handled with due care as they only cover the current knowledge of modern

components but do not represent an exhaustive evaluation of all old vehicles or components which might still be in use.
New findings, return of experience or the introduction of new types of components and of new technologies might justify that the technical evaluations performed by the group of experts are reviewed and that a revision of the conclusions is performed following the principles described in the CEN/TC256/WG48 “Guide for identification and management of Safety Critical Component for railway vehicle” [5].

References

1. European Railway Agency (ERA), *Report on safety and interoperability 2020,* June 2020

2. Eisenbahnbundesamt (EBA), *Bericht des Eisenbahn-Bundesamts gemäß Artikel 18 der Richtlinie über Eisenbahnsicherheit in der Gemeinschaft (Richtlinie 2004/49/EG, „Sicherheitsrichtlinie“) über die Tätigkeiten als Sicherheitsbehörde,* 15th November 2019

3. Bundesamt für Verkehr (BAV), *Bericht über die Sicherheit im öffentlichen Verkehr,* 2019

4. Sicherheitsuntersuchungsstelle des Bundes (SUB), *Sicherheitsbericht 2019 gemäß § 19 UUG 2005,* 2019

5. Giuseppe Ragusa *Guide for identification and management of Safety Critical Component for railway vehicle,* 2020

6. Juraj Grenčík1, Roman Poprocký, Jana Galliková, Peter Volna, *Use of risk assessment methods in maintenance for more reliable rolling stock operation* Department of Transport and Handling Machines, Faculty of Mechanical Engineering, University of Ţilina, Univerzitná 8215/1, 010 26 Ţilina, Slovak Republic (2018)

Appendix A – Hazard Frequency and Severity evaluation matrix according to DIN EN 50126.

Hazard Frequency			Hazard Severity: None	Very low	Low		Moderate		High		Extreme	
			1	2	3	4	5	6	7	8	9	10
Extreme	10^{0} hours^{-1}	10	undesirable	undesirable	inacceptable	inacceptable	inacceptable	inacceptable	inacceptable	inacceptable	inacceptable	inacceptable
	10^{-1} hours^{-1}	9	tolerable	tolerable	undesirable	undesirable	inacceptable	inacceptable	inacceptable	inacceptable	inacceptable	inacceptable
High	10^{-2} hours^{-1}	8	tolerable	tolerable	undesirable	undesirable	inacceptable	inacceptable	inacceptable	inacceptable	inacceptable	inacceptable
	10^{-3} hours^{-1}	7	tolerable	tolerable	undesirable	undesirable	undesirable	undesirable	inacceptable	inacceptable	inacceptable	inacceptable
Moderate	10^{-4} hours^{-1}	6	acceptable	acceptable	tolerable	tolerable	undesirable	undesirable	inacceptable	inacceptable	inacceptable	inacceptable
	10^{-5} hours^{-1}	5	acceptable	acceptable	tolerable	tolerable	undesirable	undesirable	undesirable	undesirable	inacceptable	inacceptable
	10^{-6} hours^{-1}	4	acceptable	acceptable	acceptable	acceptable	tolerable	tolerable	undesirable	undesirable	undesirable	undesirable
Low	10^{-7} hours^{-1}	3	acceptable	acceptable	acceptable	acceptable	acceptable	acceptable	tolerable	tolerable	undesirable	undesirable
	10^{-8} hours^{-1}	2	acceptable	acceptable	acceptable	acceptable	acceptable	acceptable	acceptable	acceptable	tolerable	tolerable
Very low	10^{-9} hours^{-1}	1	acceptable	acceptable	acceptable	acceptable	acceptable	acceptable	acceptable	acceptable	acceptable	acceptable

Appendix B – ECM Risk Assessment Template

	Frequency	Severity	Frequency (ECM)	Severity (ECM)	ECM Assessment	Risk Evaluation	SRC	SCC
Underframe	**4**	**6**				**tolerable**	**x**	
Bogies	**2**	**9**				**tolerable**	**x**	
Superstructure	**4**	**6**				**tolerable**	**x**	
Wheels	**4**	**10**				**undesirable**		x
Axle	3	10				**undesirable**		x
Wheel	4	9				**undesirable**		x
Bearing	4	6				**tolerable**	**x**	
Axle box	3	7				**tolerable**	**x**	
Springs	**5**	**4**				**tolerable**	**x**	
Draw & Buffing Gear	**5**	**4**				**tolerable**	**x**	
Brakes	**3**	**8**				**tolerable**	**x**	