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Information from Switzerland

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Detection of derailments

Up-to-date information on technical and operational aspects

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0 Introduction

As a basis for the further work of the RID Committee of Experts' working group on derailment detection, this document provides up-to-date information on the hitherto controversial technical and operational aspects of derailment detection.

At the 2nd session of the working group, the issues to be dealt with were defined as follows[1]:

> **B. Technical and railway operation aspects**
>
> \- to identify and analyse the progress made by DDD in terms of operation and safety since September 2009 (date of the previous agreement between EU RISC and TDG committees) including the impact on automatic brake of the train, the probability of false alarm, its use in winter conditions
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> I. Automatic breaking vs decision by locomotive driver
>
> II. Reaction to derailment in a tunnel *(information regarding derailments in tunnels by FR)*
>
> III. Use in winter conditions
>
> IV. False alarms: probability, consequences
>
> *(document on all four items will be provided by CH)*

In this document, each of the sections of ERA's final 2012 report[2] linked to these issues are quoted. Up-to-date information, new findings and additional expert opinions follow each of the citations. Substantial new scientific work has been carried out by examining the thesis by D. Bing[3]: at the Technical University of Berlin, Daniel Bing (Doctor of Engineering) examined in depth the question of introducing derailment detectors. In particular, he presented the **effects of braking by on-board detectors on the longitudinal dynamics of the whole train**.

This document was produced by the sections of the **Swiss Federal Office of Transport (BAV)** responsible for the various topics and takes into account contributions from the main actors in Switzer-

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[1] Extract from the report of the 2nd session held on 24 – 26 February 2015, Annex I

[2] http://www.era.europa.eu/Document-Register/Pages/Agency-Final-Report-on-FTD---v1.0---Public.aspx

[3] Wissenschaftliche Arbeit Nr. 5 des Institutes für Land- und Seeverkehr der Technischen Universität Berlin, Daniel Bing: „Entgleisungsdetektion im Schienengüterverkehr – Analyse der Einflüsse auf die Zuglängsdynamik“, Dissertation Zugl.: Berlin, Technische Universität, Diss., 2014 ISBN: 978-3-87154-520-7

land. **Swiss Railways SBB Cargo** and **Wascosa AG** (wagon keepers) were directly involved and fully support the content of this document.

1. Automatic braking vs. decision by the locomotive driver

1.1. Initial situation according to ERA's 2012 report

6.1.1 Consideration of comments received on the derailment detection (pp 41-42/84)

- (Knorr Bremse) considering that: “*The derailment detector acts in the very same way as if the loco driver does an emergency braking: the main pipe pressure is quickly reduced. This is normal train handling which happens frequently without causing derailments*.” *“What the DDD does is nothing else than what the loco driver does in an emergency situation!”.*

Agency position:

a) A derailment detector automatically acting on the train brakes is different from an ‘emergency braking’, at least for the following reasons:

- A locomotive driver knows the circumstances in which he/she applies a real ‘emergency braking’,
- The propagation of the brake effort (UIC pneumatic brake systems) goes from the locomotive towards the rear of the train,
- The traction cut-off occurs immediately, as the real ‘emergency braking’ is applied from the locomotive.

b) An ‘emergency braking’ complies with both technical specifications and operational specifications in relation with the previously listed points which are not complied with by the (‘DDD’) M1-a type derailment detectors.

c) In 2009, the amendments of the RID provisional text were devoted to solve these issues, and this is why the provisional text reported in annex 1 requires that a detection device:

- reports an alarm only: “*provides an immediate and clear signal to the locomotive driver that a derailment has occurred*”. “ ~~*Venting of the main brake pipe shall be considered as a clear signal*~~..”
- does not automatically vent the main brake pipe (text withdrawn from the initial version).

d) In this respect, the M1-a type derailment detectors do not comply with the provisional RID text reported in annex 1.

6.1.3 Agency conclusions on the derailment detection (pp 49-50/84)

The new findings concerning derailment detection of M-1a type (DDD) lead the Agency to the following conclusions: (…)

Most of the issues raised by the RISC and EU TDG Committees concerning the M1-a type derailment detectors, applying automatically full brake when a derailment is suspected, remain:

o This type of detector does not offer the functionalities corresponding to the new provisional text proposed for inclusion in RID 2013, because it does not report an alarm to the locomotive driver.

o The venting of the main brake pipe by this type of detector cannot be clearly interpreted by the driver as a derailment alarm.(…)

Concerning the M-1b type of derailment detection, reporting an alarm to the locomotive driver the Agency concludes: (…)

For the long term, the Agency considers that the detectors reporting an alarm have the following advantages:

o The issues identified for the M-1a type detectors -automatic-braking- could be mitigated or even avoided by using M-1b type detection –alarm reporting-, because:

- the automatic application of brakes by the M-1b type detection would be an exception, mitigating potential human errors by the locomotive drivers in case they would mishandled the pre-defined procedure for handling a reported alarm,

1.2. Up-to-date information

1.2.1 Bing thesis, TU Berlin 2014

In rail freight transport, the brakes are entirely pneumatically controlled. Reducing the pressure in the main brake pipe brakes the train. Owing to the length of freight trains, there is a clear delay in the braking signal (at least 250 m/s according to UIC requirements) reaching the rear wagons (up to around 4 seconds). Depending on the length of the train, it can take up to around 30 seconds until the full braking force has an effect on the last vehicle.

Strong braking causes strong longitudinal forces in the train. If braking is triggered by the locomotive, the braking forces are first built up in the front part of the train, while the back part runs into the front unbraked.

The following terms are used for the various braking possibilities (see Chapter 3.2, p. 21):

- "Spontaneous brake application": This is initiated by the locomotive driver. Causes a pressure drop of 5.0 bar to a value of between 4.6 bar and minimum 3.5 bar in the main brake pipe and generates brake cylinder pressure of between zero and the maximum value.
- "Full brake application": This is initiated by the locomotive driver. Causes a pressure drop of 5.0 to 3.5 bar in the main brake pipe and generates the maximum value of the brake cylinder pressure.
- "Emergency braking": This is initiated by the locomotive driver. Causes a pressure drop of 5.0 to 0 bar in the main brake pipe and generates the maximum value of the brake cylinder pressure.
- "Automatic braking": This is initiated by the control and safety technology. Causes a pressure drop of 5.0 to 0 bar in the main brake pipe and generates the maximum value of the brake cylinder pressure.

Comment: In "full, emergency or automatic braking", the maximum brake cylinder pressure is generated and hence the same braking effect.

In contrast, in "emergency and automatic braking", the main brake pipe is completely vented. Consequently, more time is needed to build up the operating pressure to 5.0 bar than in "full braking", in which the pressure in the main brake pipe only decreases to 3.5 bar.

The initiation of braking by means of an on-board derailment detector can be considered as automatic braking. Unlike braking initiated by the locomotive driver, braking – i.e. reducing the pressure in the main brake pipe – is triggered from one of the wagons in the train. In the event of braking being initiated in the back part of the train, the build-up of braking force begins there, while the locomotive hauls the train further. In this case, tractive forces occur between the locomotive and the train. It takes the locomotive driver a few seconds to notice the decreasing pressure in the main brake pipe and deactivate traction.

Tolerable longitudinal forces

UIC leaflet 530-2 and DIN EN 15839:2013 define the testing conditions and threshold values for determining the theoretically tolerable longitudinal compressive force of rail freight wagons. The test is carried out on an S curve with short radii and an intermediate straight. On open track, track geometry such as this only occurs with a reduction in speed, so higher tolerable longitudinal compressive forces can be assumed. The maximum tolerable longitudinal compressive force of two-axle freight wagons on S curve radii where R = 300 m is around 300 kN. A bogie wagon can tolerate higher compressive forces.

The potential consequences of automatic braking depend on various factors, especially:

- Brake position: The brake position set on individual vehicles plays an important role in the formation of longitudinal compressive forces. Chapters 3.2 and 3.3 provide precise information on brake positions "G" and "P", and on using them according to the total gross load of a wagon. In brake position "P", the brake demand from the main brake pipe leads to a quicker build-up of brake cylinder pressure than in the "G" position. The latter therefore presents smaller longitudinal compressive forces in the train than the "P" position. Whether to select "G" or "P" depends on the total weight of the train and the weight of the individual wagons. In Germany, for example, in most cases the first five wagons are set at position "G".
- Influence of initial braking speeds: Irrespective of the initial braking speed, the build-up of braking force begins directly on the first wagon, whereas the last wagon continues to move unbraked. The friction coefficient of the brake block sole materials increases at decreasing speeds; this means that the maximum occurring longitudinal compressive force decreases with increasing initial braking speed.
- Effect of the position of the vehicle that initiates braking: It has been shown that the maximum longitudinal compressive force occurs when, in brake position G, braking is triggered by the first vehicle in the train. Irrespective of the initial braking speed, the build-up of braking force begins directly on the first wagon, whereas the last wagon continues to move unbraked. In contrast, in brake position P, this force is at its highest when braking is triggered by the 7th wagon.
- Running on curves: When running on curves, the longitudinal forces are not distributed evenly between the left and right pair of buffers. Running on curves is therefore the critical situation. The tolerable longitudinal compressive force of a freight wagon is defined for travelling through S curves. When braking on a straight, much higher longitudinal compressive forces are non-critical. In the case of braking at 40 km/h, it has been shown that the distribution of forces between the coupling springs and buffer springs is virtually the same on the straight and on S curves. The distribution of the longitudinal force depends largely on the layout of the line.

Among the numerous simulations of train movements calculated, nowhere does a critical situation occur that is caused by the on-board triggering of automatic braking. In addition, the longitudinal forces in the train in brake position G, which is prescribed for long, heavy trains, are considerably less than in the P position.

Chap. 9.5, p. 184-185
It was shown that **the locomotive driver only notices the derailment of an individual wagon if the wagon concerned is as close as possible to the locomotive**. The longitudinal oscillations are softened by the coupling elements, so that as the distance from the head of the train increases, they are considerably reduced. In addition, the case of a derailment detector's being triggered was considered. It appears that the longitudinal forces resulting from the braking process are mostly much greater than the peak longitudinal forces resulting from a derailment, so from the point of view of the longitudinal dynamics of the train, braking processes are still the critical factor. **No increased risk of derailment was found on the basis of overlapping longitudinal forces from braking processes and longitudinal forces resulting from derailments.** The longitudinal forces that occur from braking depend on many factors, as shown in Chapter 8. In the event of the derailment of a single wagon, critical running conditions, in which high longitudinal compressive forces have an effect during the braking process, only worsen slightly, so that overall, **the likelihood of an accident occurring as a result of high longitudinal compressive forces during a derailment does not increase with simultaneous automatic braking**. In this scenario, it must also be borne in mind that a critical longitudinal compressive force must take effect over at

least a 10 m stretch for it to lead to a critical situation on the vehicle concerned. In the case of longitudinal oscillations, this is only possible to a small extent. **It even appears that a derailed wagon ultimately produces a tractive force owing to its increased traction resistance. This acts against the intrinsic critical longitudinal compressive forces.**

1.2.2 Swiss Train Operating Regulations (FDV)[4]

The Swiss Train Operating Regulations (FDV) contain the following provisions for events that can have effects similar to the activation of a mechanical detector:

R300.14, No. 3.6.2:

Decreasing pressure in the main brake pipe
If, without a leakage test, the locomotive driver notices that the pressure in the main brake pipe has decreased to below the set value, the driver's brake valve must immediately be put into the emergency braking position.

R300.14, No. 3.6.3:

Suspected coupling break (train separation)
If, with decreasing pressure in the main brake pipe, the locomotive driver suspects that the train has separated, the driver's brake valve must be left in the drive position. Shortly before coming to a stop, the driver's brake valve must be put into the spontaneous braking position.

1.2.3 Expert assessment:

The locomotive driver can only recognise automatic braking by the pressure reduction in the main brake pipe. In the event of suspected separation of the train, the purpose of leaving the driver's brake valve in the drive position is to try to ensure that the front part of the train that is still being driven is braked less quickly. This can prevent the part of the train running behind from colliding with the front part.

Something on a suspected derailment could be added to No. 3.6.3 FDV (including activation of an automatic derailment detector). **This would prevent the derailed vehicle from running on too much.**

A derailed vehicle axle leads directly to track damage. This increases the risk of derailment of the axles (vehicles) behind. The danger of a chain reaction (vehicles breaking loose/overturning, risk of fire from formation of sparks, damage to catenary, etc.) is very high.

Owing to the complexity of such subsequent damage and its effects, it is not realistic to make the driver responsible for the decision. He can hardly survey the train and analyse it within seconds, nor can he do this for the load and the hazards it might present. Assuming that in principle, a derailment is a "cold" event, which might however lead to a fire or environmental damage as a result of subsequent damage, immediate stopping is expedient.

Automatic braking by a vehicle's derailment detector vents the main brake pipe within the train composition. This results in the part of the train preceding this vehicle being elongated and the following part being compressed. Unlike emergency braking initiated by the locomotive driver from the front of the train, the risk of longitudinal forces that are too great is reduced. From the point of view of vehicle

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[4] See http://www.bav.admin.ch/grundlagen/03514/03533/03649/index.html?lang=de

movement dynamics, any venting of the main brake pipe from a point within the train is better than venting from the front of the train.

1.3. Conclusion

- **If a freight wagon derails, automatic braking should, from the point of view of railway operations and for technical reasons, take place before the warning signal to the driver.**
- **Mechanical derailment detectors enable the speed of the train to be reduced quickly; in so doing, the forces within the train composition remain within a tolerable range.**

2. Derailment in a tunnel

2.1 Initial situation according to ERA's 2012 report

6.1.1 Consideration of comments received on the derailment detection (pp 42-43/84)

(Knorr Bremse) commenting: "To my knowledge the attached version of the TSI SRT is the latest one. Here on page 28 it is clearly written: [4.4.2. Emergency rule The IM's operation rules shall adopt and develop in more detail, if necessary, the principle that in case of an incident (except a derailment, that requires an immediate stop)] So the DDD is fully in line with the TSI!"

Agency remark:

a) The current SRT TSI section 4.4.2 establishes the following general principles:

[The IM's operation rules shall adopt and develop in more detail, if necessary, the principle that in case of an incident (except a derailment, that requires an immediate stop)

— The train shall be brought to a halt before entering a tunnel, or driven out of a tunnel.

— In tunnels with underground stations, the train may be evacuated at an underground platform.

The procedures for this situation shall be developed by the IM and the RU and be detailed in the emergency plan.

In all cases, the IM shall be informed immediately by the train crew and no additional scheduled train shall be permitted to enter the tunnel.]

b) The SRT TSI is currently under revision process. The section 4.4.2 mentioned above is currently re-discussed by the Working Party on SRT TSI which proposed to align the requirement with the general requirement of the OPE TSI on managing emergency situations, which requires:

[4.2.3.7 Managing an emergency situation

The infrastructure manager must, in consultation with:

– all railway undertakings operating over his infrastructure, or, where appropriate, representative bodies of railway undertakings operating over his infrastructure,

– neighbouring infrastructure managers, as appropriate,

– local authorities, representative bodies of the emergency services (including fire fighting and rescue) at either local or national level, as appropriate.

define, publish and make available appropriate measures to manage emergency situations and restore the line to normal operation.]

c) The way the M1-a type detector ('DDD') acts does not allow the Infrastructure Manager to apply the general safety principle of section 4.4.2. of SRT TSI while other more efficient measures detecting degraded conditions of a train before entering a tunnel (e.g. hot axle box detectors) allow the Infrastructure Manager to comply with it.

d) Therefore the Agency considers that the 'DDD' is not fully in line with the SRT TSI safety principle and is not in line with the requirements of some other TSIs, as explained in the answer to the previous comments.

6.1.2 Findings concerning the issues identified by the EU Committees in 2009

4. "Study on the impact of automatic braking in tunnels/bridges".

For the electronic detection (M-1b type), and similarly to the functionalities adopted for handling an alarm in passengers' trains, the Agency would suggest handling the alarms reported by an electronic detection with the following process:

a. the derailment alarm is reported to the locomotive driver in the cabin without applying brakes,

b. the driver must acknowledge the alarm,

c. after acknowledgement of the alarm, the driver must bring the train to a safe stop in accordance with the applicable operational rules relating to the management of emergency situations,

d. in case the alarm is not acknowledged by the driver, the train is automatically brought to a stop,

e. the alarm handling system should offer the possibility to deactivate, where required, the automatic braking trigger on specific sections (e.g. tunnel/bridges).

Under this topic, the Agency received the following comments:

(Danish NSA) – considering that the study is of high quality, reminding that the issue of tunnels must be carefully examined in case derailment detection would be made mandatory and considering that the way an alarm reported by a detection should be handled (possibilities – limitations) should be clearly defined.

Agency position:

a) The Agency agrees the view of the Danish NSA and analysed carefully the question of tunnels and bridges. As a result the Agency proposed, as reported above, the way an alarm should be handled in case of use of M-1b type derailment detection in the EU.

b) The Agency also supports the Danish NSA view that the M-1a type derailment detection should not be mandatory, as explained in section 6.1.3 below.

6.1.3 Agency conclusions on the derailment detection (pp 49-50/84)

Concerning the M-1b type of derailment detection, reporting an alarm to the locomotive driver the Agency concludes: (…)

For the long term, the Agency considers that the detectors reporting an alarm have the following advantages:

o *The issues identified for the M-1a type detectors -automatic-braking- could be mitigated or even avoided by using M-1b type detection –alarm reporting-, because: (…)*

- concerning the specific case of tunnels and bridges it would be easier to comply with specific operating rules (e.g. overriding automatic braking from the locomotive in specific locations).

2.2 Up-to-date information

2.2.1 Provisions

The new version of the TSI SRT was published on 12.12.2014[5]. According to the TSI SRT 2014, Chapter 4.4.1 (Emergency rule), in the case of an incident inside the tunnel the train must be driven out of the tunnel, or to the next fire fighting point. The same procedure is laid down in TSI SRT 2014, Chapter 2.2.1 (Fire starts on a train). However, the specific case of derailment of a freight train in a tunnel is not dealt with in more detail.

2.2.2 Bing thesis, TU Berlin 2014

Taking into consideration the applicable rules, D. Bing comes to the conclusion in Chapter 2.5 that in the event of imminent danger in a tunnel, the train should be brought to a halt immediately. Rejecting the introduction of derailment detection on the basis that the locomotive driver cannot deactivate braking in the tunnel is questionable. In the event of a derailment, the train should be stopped immediately.

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[5] http://www.era.europa.eu/Document-Register/Pages/SRT-TSI.aspx

2.2.3 Expert assessment (section "Grundlagen" – Tunnel safety experts BAV):

As it has many tunnels, some of which are very long, Switzerland has a great deal of experience and consequently, numerous experts in tunnel safety who are recognised worldwide. The experts consulted at the competent Federal Office and the largest railway undertaking (SBB) agree: from the point of view of tunnel safety, automatic emergency braking in cold events is considered to be the correct procedure.

The focus is on limiting damage to infrastructure and reducing the hazard potential of further derailments and damage. Nevertheless, there are possible scenarios in which driving out of the tunnel would seem to be advisable. If a cold incident (e.g. derailment) becomes a hot incident (e.g. fire) and if the train is near the end of the tunnel, it may be that driving out of the tunnel would cause less damage than if the train were stopped in the tunnel. However, it is very unlikely that such an incident (derailment with fire and specific place in the tunnel) would occur. It must be assumed that derailment occurs much more frequently as a cold incident. In addition, the locomotive driver would have to be in a position to recognise the fire as well as the detected derailment.

Automatic braking in a tunnel, starting with the detection of a derailment, should be the aim. Depending on how the incident develops and the local circumstances, it is also possible for the locomotive driver to escape to a safe area, even following a stop in a tunnel. If need be, after a stop brought about by a mechanical derailment detector, it is still possible to drive the locomotive or part of the train composition out of the tunnel.

2.3 Conclusion

- **Automatic braking in a tunnel, starting with the detection of a derailment, should be the aim.**

3. False alarms

3.1 Initial situation according to ERA's 2012 report

4.3.1 Conclusions of DNV's study (p24/84)

0.4.3 Technical Mitigation Measures

We consider the following mitigation measure as potentially efficient if the significant identified drawbacks could be solved:

M1a-Derailment Detection (with automatic brake application) applied to All Freight Trains

This present assessment is fully in line with the previous assessment made by the Agency [4]. The significant drawback previously identified is confirmed by the present study and the related accident analysis. A false alarm of such a device may lead to train compression which is a contributory cause of freight train derailments (and also a significant operational disruption). In this respect we note that CSM Regulation, Annex I, point 2.5.4 states:

For technical systems where a functional failure has credible direct potential for a catastrophic consequence, the associated risk does not have to be reduced further if the rate of that failure is less than or equal to 10-9 per operating hour.

6.1.1 Consideration of comments received on the derailment detection (pp 40-44/84)

c) The Agency concludes that both measures P1 and M1-a have the potential to directly provoke a derailment under unfavourable circumstances. Concerning the M1-a measure the identified unfavourable circumstances are, for example if a false-alarm occurs where tracks are under performing, or/and if it occurs at a curve, or/and if it is combined with an unsuitable composition/loading of the train. (…)

- (Knorr Bremse) informing:

> -*"Some words on the false alarms themselves: - The data base is very small, so real statistics are not possible*
> *- Since the installation of the derailment detectors with higher trigger level (EDT101) in 2004 we had had no false alarms anymore.*
> *- There had been 56 cases of false alarms reported with the old type EDT100. By the way: none of them caused a derailment."*

Agency position:

a) In principle the fact that no false alarm have been reported since 2004 with the new version of detectors does not mean that false alarms cannot occur with this new version.

b) The Agency notes that Knorr-Bremse agrees that "The data base is very small, so real statistics are not possible"

c) Therefore the Agency believes that only a detailed assessment concerning the reliability of the new version could provide an estimate of the false-alarm rate. The Agency did not receive such detailed information since the 'false-alarm' issue has been raised in 2009.

- (Knorr Bremse) mentioning that "*We do therefore not understand why "emergency braking" should be evaluated according CSM Regulation, Annex I, point 2.5.4 as it is normal operation rather than it "has credible direct potential for a catastrophic consequence"!"*

Agency position:

a) As it is explained previously the automatic application of brake by a derailment detector is something different than an 'emergency braking' invoked by a locomotive driver.

b) In this respect, the automatic brake application triggered by a derailment detector must be considered as a change (new technical system) in the railway system.

c) In EU Member States the SMS requires every change to be risk assessed and that a procedure is in place to apply the CSM on Risk Evaluation and Assessment (Regulation 2009/352/EC) when the change is deemed to be significant under the terms of this CSM.

d) This CSM states: *"Where hazards arise from failures of technical systems not covered by codes of practice or the use of a reference system, the following risk acceptance criterion shall apply for the design of the technical system: For technical systems where a functional failure has a credible direct potential for a catastrophic consequence, the associated risk does not have to be reduced further if the rate of that failure is less than or equal to 10-9 per operating hour. Nevertheless, if the applicant can demonstrate that the national safety level can be maintained with a less demanding criterion than the 10-9, this criterion can be used by the applicant after agreement with the assessment body "If a technical system is developed by applying the 10-9 criterion defined in paragraph 4, mutual recognition shall be applied according to section 5.3*"

e) The Agency, supported with the assessment performed by DNV, concluded that a false-alarm (functional failure) of the M1-a type detector has a credible direct potential for a catastrophic consequence.

f) "Credible": The analysis of past derailment performed by DNV tells us that over 238 analysed derailments there were 6 derailments where strong braking (applied to the whole train) has led to the derailments or has been a contributory cause. Therefore it is credible that a full application of the brake invoked by a M1-a type detector under false-alarm conditions could lead to a derailment.

g) "Direct": The direct nature of this potential effect is explained by the fact that there is no possibility to override the automatic full brake application invoked by an M1-a type detector when the detector has wrongly (false-alarm) suspected a derailment. Therefore a false-alarm is a functional failure which can directly lead to a derailment.

h) "Potential for a catastrophic consequence": a derailment can potentially lead to catastrophic consequences, depending on the circumstances.

i) In conclusion, because the derailment detectors of M1-a type represents a change in the current railway system, and because a functional failure of the derailment detector has a credible direct potential for a catastrophic consequence, the Agency considers that the above mentioned CSM is applicable to the M1-a type derailment detectors.

6.1.2 Findings concerning the issues identified by the EU Committees in 2009

2. "Study on the impact of false alarms and the level of reliability that should be imposed for the derailment detection device (DDD)".

DNV's study confirmed that the question of false-alarm remains an issue for the derailment detection because the false activation of an alarm (i.e. without actual derailment occurred) has the potential to provoke a derailment. Effectively the DNV's analysis of past derailments shows that a small proportion of these derailments (around 5%) has been caused by inappropriate application of brakes in combination with unfavourable train composition, track condition or wagon loading.

The M-1a type of detector applying automatically full brake by venting the main brake pipe there is a (small) probability that such an action on brake, in case of false-alarm, would provoke a derailment.

6.1.3 Agency conclusions on the derailment detection (pp 49-50/84)

The new findings concerning derailment detection of M-1a type (DDD) lead the Agency to the following conclusions: (…)

> Most of the issues raised by the RISC and EU TDG Committees concerning the M1-a type derailment detectors, applying automatically full brake when a derailment is suspected, remain:
>
> o The new study findings confirms that this type of detector has the potential to provoke a derailment in case of false alarm, (…)
>
> Concerning the M-1b type of derailment detection, reporting an alarm to the locomotive driver the Agency concludes: (…)
>
> For the long term, the Agency considers that the detectors reporting an alarm have the following advantages:
>
> o The issues identified for the M-1a type detectors -automatic-braking- could be mitigated or even avoided by using M-1b type detection –alarm reporting-, because: (…)
>
> - the M-1b type detectors, probably based on electronic systems, would offer more possibilities for limiting the number of false alarms (multiple checks of actual derailment occurrence would be feasible with this type of detection) or for identifying a false alarm (driver check),

3.2 Up-to-date information

3.2.1 Provisions

On 19.03.2015, ERA published the recommendation entitled "*Recommendation of the European Railway Agency on the amendment of the Commission implementing Regulation (EU) No 402/2013 on the common safety method for risk evaluation and assessment*"[6], which contains the following explanations, among others

Regulation (EU) No 402/2013 is hereby amended as follows:

(36) 'highly improbable' means a failure occurring at a frequency less than or equal to ***10^{-9}*** *per operating hour;*
(37) 'improbable' means a failure occurring at a frequency less than or equal to ***10^{-7}*** *per operating hour;*
(…)
2.5.1. If the hazards are not covered by one of the two risk acceptance principles laid down in points 2.3 and 2.4, the demonstration of risk acceptability shall be performed by explicit risk estimation and evaluation. Risks resulting from these hazards shall be estimated either quantitatively or qualitatively, or when necessary both quantitatively and qualitatively, taking existing safety measures into account.

2.5.4. The proposer shall not be obliged to perform additional explicit risk estimation for risks which are already considered acceptable by the use of codes of practice or reference systems.

2.5.5. If hazards arise from failures of functions of a technical system, without prejudice to points 2.5.1 and 2.5.4 above, the following requirements shall apply to those failures:
(a) where a failure has a credible potential to lead directly to a catastrophic accident, the associated risk does not have to be reduced further if the frequency of the failures of the associated function is demonstrated to be ***highly improbable****.*

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[6] http://www.era.europa.eu/Document-Register/Pages/Recommendation-of-the-European-Railway-Agency-on-the-amendment-of-the-Commission-implementing-Regulation-(EU)-No-4022013-on.aspx

(b) where a failure has a credible potential to lead directly to a critical accident, the associated risk does not have to be reduced further if the frequency of the failures of the associated function is demonstrated to be ***improbable****.*

2.5.6. Without prejudice to points 2.5.1 and 2.5.4 above, the requirements in point 2.5.5. shall be referred to as the harmonised design targets. They shall be used for the design of electrical, electronic and programmable electronic technical systems. They shall be the most demanding design targets that can be required for mutual recognition.

The design targets in point 2.5.5. shall neither be used *as overall quantitative targets for the whole railway system of a Member State* ***nor for the design of purely mechanical technical systems****.*

3.2.2 Expert assessment (BAV section safety risk management incl. exchange with EBA[7] and BMVIT[8]):

For initial approval, derailment detection with automatic braking constitutes a technical modification. A modification is made to an existing system (freight wagon with conventional braking system) by adding a function. Thus in each case, it must be checked whether the modification is significant. The results of the check must be documented. In any case, once this step has been taken, the CSM-RA process is concluded.

The above-mentioned clarification of the CSM-RA means that 10^{-9} or the explicit risk analysis should not be used for purely pneumatic mechanical systems, but only regulations or reference systems.

The obvious one is the **use of a reference system in accordance with IMPLEMENTING REGULATION (EU) No. 402/2013**[9]

2.4.1. The proposer, with the support of other involved actors, shall analyse whether one, several or all hazards are appropriately covered by a similar system that could be taken as a reference system.

2.4.2. A reference system shall satisfy at least the following requirements:

- *(a) it has already been proven in-use to have an acceptable safety level and would therefore still qualify for approval in the Member State where the change is to be introduced;*
- *(b) it has similar functions and interfaces as the system under assessment;*
- *(c) it is used under similar operational conditions as the system under assessment;*
- *(d) it is used under similar environmental conditions as the system under assessment.*

2.4.3. If a reference system fulfils the requirements listed in point 2.4.2, then for the system under assessment:

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[7] German Federal Office for Railways

[8] Federal Ministry of Transport, Innovation and Technology, Austria

[9] COMMISSION IMPLEMENTING REGULATION (EU) No. 402/2013 of 30 April 2013 on the common safety method for risk evaluation and assessment and repealing Regulation (EC) No. 352/2009.

(a) <u>the risks associated with the hazards covered by the reference system shall be considered as acceptable</u>;

(b) the safety requirements for the hazards covered by the reference system may be derived from the safety analyses or from an evaluation of safety records of the reference system;

(c) these safety requirements shall be registered in the hazard record as safety requirements for the relevant hazards.

This principle can be applied in the case of the mechanical derailment detector: The current "model" has proved itself in practice and would already be approved by Switzerland now. A version of the current model, slightly adapted if necessary, could thus be approved by BAV on this basis in accordance with the CSM-RA process.

3.2.3 Bing thesis, TU Berlin 2014

<u>Chap. 3.5 (p. 31)</u>

<u>Frequency observation of automatic braking</u>

Taking into consideration the annual distance travelled by the freight trains of all rail transport undertakings in Germany in 2010 (250 million train kilometres) [92] and assuming the same frequency of emergency and automatic braking as in 1990, there are around 17,000 braking operations which, owing to the low initial braking speed, can lead to increased longitudinal compressive forces in the train.
In view of this relatively high number of braking operations, which can cause high longitudinal compressive forces as a result of a low initial braking speed, **additional automatic braking initiated by derailment detection is of course a further risk, but it is a minor one**.

What is said in the Bing thesis about the potential effects of automatic braking (see section 1.2.1 above) should also be taken into account here.

3.2.4 Experiences with mechanical derailment detection

In Switzerland, more than 1000 wagons with derailment detectors are in daily operation. They are kept mainly by Wascosa AG, but also directly by the railway undertakings BLS (car loading for the Lötschberg tunnel) and RhB (car loading for the Vereina tunnel).

In recent years, the trains operated by SBB Cargo have experienced 1 to 2 activations per year without actual derailment. However, these activations are not generally random, as they usually point to irregularities in the infrastructure which could perhaps lead to an actual derailment and have to be repaired.

The wagon keepers, rail transport undertakings and infrastructure managers in Switzerland that are concerned consider the use of wagons with mechanical derailment detectors as unproblematic and desirable.

In the words of WASCOSA: *WASCOSA now operates well over 700 tank-wagons with derailment detectors. We have detectors by two manufacturers (Knorr and Wabtec) in operation, both of the most up-to-date standard. Both systems function without any problems. False alarms such as those that occurred with the first generation of derailment detectors no longer occur. The proportion of false alarms is 0%.*

3.3 Conclusion

- **Mechanical derailment detectors have been in use for more than ten years. Today, more than 1000 wagons are fitted with them. In daily operations, false alarms are not a problem.**
- **The CSM-RA can be applied to the derailment detector with automatic braking. In contrast, the "availability criterion" of 10^{-9} is not applicable. Safety must be proved by comparison with a reference system.**

4. Winter conditions

4.1 Initial situation according to ERA's 2012 report

> **6.1.1 Consideration of comments received on the derailment detection** (p 41/84)
> (…)
> (Finnish NSA) – Questioning the comprehensiveness of the tests of the derailment detectors under severe winter conditions.
> And,
> - (Knorr Bremse) – Stating that “*The test conditions were approved by the Finnish and Swedish people, the tests were done and the result (no false alarms even under very low temperature conditions) was reported to RID.”.*
>
> Agency remark:
> a) Concerning winter tests the Agency did not receive detailed information and therefore could not assess the behaviour of the derailment detectors (M-1a type) under severe winter conditions; however the RID Committee of experts reported that such tests have been carried out.

4.2 Up-to-date information

With the first version, EDT 100, there were certainly problems when used in the winter. However, these problems have now been resolved. In the experience of SBB Cargo, there is now no noticeable difference between summer and winter using the EDT 101 version.

4.3 Conclusion

- **Today, the wintertime operation of wagons with mechanical detectors causes no problems in Switzerland.**