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RID: **13th Session of the RID Committee of Experts' standing working group** (Geneva, 15 – 19 November 2021)

Subject: **Comments from the German Centre for Rail Traffic Research at the Federal Office for Railways (DZSF) on informal documents INF.10 (CEFIC) and INF.12 (CEFIC)**

Information from DZSF on behalf of Germany

Introduction

The German Centre for Rail Traffic Research at the Federal Office for Railways (DZSF) comments on informal documents INF.10 (CEFIC) and INF.12 (CEFIC) as follows:

Remarks on BASF's comments on the DZSF position on the risk assessment of extra-large tank-containers

WP 1

BASF: "The risk assessment is based on an evaluation of significance carried out by BASF. Based on this, TU Berlin provides technical support for identifying and assessing risks. The use of a risk management process or the review of a safety management system (SMS) is not necessary due to the availability of the significance analysis. As such, they do not form part of TU Berlin's work packages."

(1) **DZSF:** The significant change assessment is part of the CSM RA and must be applied to each change. The decision regarding significance or non-significance does not imply that no risk assessment needs to be carried out. If significant, an independent assessment body (Asbo) must be involved. Since this is a safety-relevant change anyway, a risk assessment must also be carried out according to its own principles. As part of the risk assessment, the hazard identification and e.g. the choice of the principle of risk acceptance "similar reference systems" should be considered.

BASF: "The general risk assessment is based on a system comparison in terms of technical failure probabilities. The principle selected for risk acceptance was "the analysis of similarities to reference systems," with reference systems being tank cars and standard tank containers. The B-TCs do not carry any additional hazards with regard to driving through tunnels, accident scenarios or environmental impact (see comment below). For this reason, the interfaces listed were not explicitly investigated further."

(2) **DZSF:** The interface consideration generally refers to operations, maintenance and processes within BASF's safety management system. It is also unclear what the specific division of tasks between BASF and the TU Berlin is within the risk assessment. The completeness of the assessment cannot therefore be assessed.

BASF: "This remark refers to the effect of a failure (environmental impact, driving through tunnels) that is comparable to a large tank car (identical tank size). The probability of occurrence is investigated and found to not be higher (WP 1, Section 4.4). This means that the risk for these scenarios was assessed.
Accident scenarios were analyzed in WP 4 and WP 5."

(3) **DZSF:** Conventional tank-containers and tank-wagons were used as a reference system. This approach is basically appropriate, but a well-founded analysis of the similarity of the reference system with the new system should be carried out. In our view, a justification that is largely based on tank size is not sufficient for this purpose. A more detailed investigation of the similarity of the two systems would be helpful in determining the suitability of the choice of reference system.

WP 2

BASF: "WP 2 merely serves to estimate the stability values and to compare configurations. It is not intended to produce a complete assessment. The simplified method was selected for this reason, due to the fact that it produces good comparative values. Given that the main focus was on empty rail cars (which is critical for driving safety) and partially loaded cars (sloshing movement, influence of sloshing), the rail-wheel contact force was not considered as an exclusion criterion for fully loaded railway cars."

(4) **DZSF:** We refer to our comment (7) with regard to this statement. This makes clear the relevance of a fully loaded condition, which is excluded from consideration here.

BASF: "The tests were additionally carried out, as they are important for gathering data for the model validation in WP 3."

BASF: "The elastomer components were introduced to stiffen the transverse bearing, in order to enable a better inference between displacement (small amplitude) and force. The stated factor was given by the manufacturer.
All in all, the individual measurements only have low significance with regard to the limit value, given that only a small number of measurements were conducted at low velocities. In addition, there may be large fluctuations in terms of component sizes. However, the measurement confirmed that the magnitude of the parameters measured for the new system is comparable to that of the conventional system and partially loaded railway cars. As such, the measurement forms the basis of the simulations.
Measurement uncertainties can be found for all types of railway cars and are reflected in all measurements. In the course of the investigation, it was found that the simulation made it possible to make more comprehensive and more reliable statements. For this reason, the less efficient investigation based on conducting S-curve tests had lost its relevance."

(5) **DZSF:** The statements concerning the low significance of individual measurements, the fluctuations in component sizes and the relevance of measurement inaccuracies confirm the comments made by DZSF in its original position. The reference made here to the resulting less efficient investigation and the resulting uncertainties in the results would be helpful in terms of the classification of relevance in the original report.

WP 3

BASF: "In this case, the sloshing movement of water (measured) is compared to the movement of water bodies (simulated in the model). Since the models merely represent a behavioral model of force build-up and given that they can only be compared to the sloshing movement measured within the tank (it was not possible to measure the force of the water against the tank), a mere comparison of force amplitudes or movement amplitudes is neither possible nor sensible.
The models were taken from various sources, in which their plausibility was also checked.
From an empirical perspective, the phase position for the simulations was selected such that the least favorable sloshing movements would occur at the most critical track sections."

BASF: "An advanced investigation on this aspect was subsequently carried out in November 2020. Simulations were performed with a higher-density liquid (1.8 kg/l) and a load of 50%, as well as with a load of 75% of water. The following results were obtained:
"In the S-curve, it was found that a load of 50% is the most critical case of partial loading at regular speeds, regardless of the configuration. At excessive velocities, rail cars with conventional Y25 bogies showed slightly increased values for a B-TC with 75% load, albeit without reaching more critical values."

(6) **DZSF:** The additional investigations are to be welcomed, but due to a lack of insight, no full assessment of the content can be made. It therefore remains questionable whether the statements from the risk analysis are sufficient to substantiate changes to the regulations in the area of filling levels and surge movements with sufficient certainty.

BASF: " – The curve results show that no rail car with partial loading reaches a critical value.
– As a general rule, rail cars with empty or fully loaded containers require more scrutiny than cars with partial loading."

(7) **DZSF:** The statement that a vehicle with a full container is to be considered more critical partly contradicts the comments on WP 2 that the exclusion criterion *is not considered in a fully loaded state* (see also comment (4)).

BASF: "The viscosity was not considered here. The models only refer to the viscosity of water. In this case, the critical state would be: high density, low viscosity. The following table (provided by BASF) lists potential/probable goods to be transported. It shows that higher-density liquids tend to have a high viscosity, while those with low viscosity tend to have a low density. Based on this information, it was decided not to investigate this matter any further."

(8) **DZSF:** The statements on the critical combinations regarding density and viscosity are plausible. However, the extent to which these apply to certain possible extreme values and the extent to which possible routing plays a role here is an interesting question for further research.

BASF: "It was a sensible decision to set the limit at 10 cm. However, all simulations showed that there was NO lifting or tilting (i.e., lifting of individual corner castings) of the container in any direction. This means that it was not really necessary to define a limit value. The report states:

“The maximum vertical displacement between spigot and corner casting of any set is less then 0.3 , which is caused by the non-infinite stiffness of the container-fixing force element” (source: BASF RA, WP3, section 3.3)”.

(9) **DZSF:** If no plausible limit value is established, no reliable assessment of the criticality of absolute values can be made. Here we refer to our proposal in the original comments.

WP 4

BASF: “The results of the simulations refer to the comparison of the new vs. the conventional system. They do not reflect absolute certainties. For this reason, no minimum safety reserve was used here.”

(10) **DZSF:** The original comments regarding the underlying uncertainties still hold.

BASF: “All welds have been modeled as rigid joints that are stiffer than the base material. In the crash zone, the element size was defined at 2 mm, which is smaller than usual in crash simulation.

BASF: According to the FEM software support, welding seams can be simplified as face-to-face and rigid joints. This approach was used here.

BASF: A (area [mm²]) refers to the tank bottom on which the water column acts on impact. In a partial load case, this means the lower half of the tank bottom. This area is subject to greater pressure in the tank, which is was implemented using an additional surface pressure.
A preliminary analysis was conducted to assess the impact of sloshing movements on container structures. The impacting car was not investigated further during the crash simulation because no effects were found and given that the acting forces are small compared to the impact force during a crash. In the partial load case, the forces are distributed over a longer time scale and thus smaller than in the full load case.

BASF: Due to the unpredictability of occurrence, a probable scenario (switch with a 190 m radius) was selected. For the scenario definition, the impact scenario that produces the most damaging results (large impact area on the container, low energy absorption of the car body) was determined empirically using CAD. All systems were investigated under the same conditions.”

(11) **DZSF:** These comments clarify the original comment.

WP 5

BASF: “This velocity does not represent the initial velocity prior to impact, rather it is the velocity after impact of the buffers incl. overriding. The velocity corresponds to the vehicle velocity prior to impact of about 27 km/h according to the principle of conservation of energy. The energy absorbed by the deforming car body is not taken into account. For this reason, the impact velocity was specified as ~ 15 km/h.”

(12) **DZSF:** It is still questionable whether the quoted standard EN 15227 is applicable. In addition, the relevant speed is still well below 36 km/h.

BASF: “To ensure comparability, one set each was used for a B-TC on iCTW45 (sets 3 and 4):
– Filling level of 50% (set 5)
– Conventional containers (set 11)

Two sets were used here given that the fully filled (100%) B-TC on iCTW45 was tested as the main system. Simulations show that the measurement values remain around or below the reference values. About 200 measurements have been conducted for both filling levels to ensure comparability.

However, the amount of data available for set 11 is rather small. But since this is not the system to be evaluated, this is not considered crucial."

(13) **DZSF:** The extended description of the experimental set-up is comprehensible. However, the original comment regarding the conventional set remains. Even if set 11 is not the system to be assessed, more extensive data could provide an even better basis for comparison. This would also apply to the use of another conventional set with a filling level of 50%.

BASF: "Runs 3 and 4 were not representative due to a defective sensor (see "Data exclusion" in Section 2.3.2). For this reason, no excessive values were recorded on the mainline (0/11, 0%).

The reference to shunting was intended for differentiation purposes. The wording of the sentence "The only exceedances are recorded at the destinations during shunting." may have been ambiguous and should be deleted."

(14) **DZSF:** The statements about the defective sensors are comprehensible. However, the tests are contained in the assessments and are therefore presented in a misleading manner. In addition, if these tests were excluded, the sample size would no longer include 18, but 16 journeys.