Implementation of EU Requirements in the Field of Fire Safety of Passenger Rolling Stock

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Abstract—The article discusses fire test results according to EN 45545-2 [1] requirements, for various material groups which were tested at Instytut Kolejnictwa (Railway Research Institute) for Polish producers. Approach to evaluation of CCS equipment and electrical equipment to meet the requirements of fire protection are characterized. Areas of requirements of the EN 45545-2 [1] standard are also presented, which are a challenge for the Polish railways, i.e. producers and research laboratories.

Index Terms—EN 45545-2, Nonmetallic Materials, TSI LOC&PAS, TSI CCS, TR FCCS.

I. INTRODUCTION

From 1 January 2018, after the end of the transitional period in the LOC & PAS TSI [10], the requirements of European Standard EN 45545-2 [6] shall apply to new rail vehicles. They apply to materials and equipment, including onboard control and signaling systems (in accordance with CCS TSI [9]).

The new requirements have become a great challenge for producers of materials and equipment, rolling stock manufacturers as well as for research laboratories in most EU countries, including Poland.

II. FIRE TESTS FOR VARIOUS MATERIAL GROUPS

The above changes required the implementation of completely new fire test methods according to EN 45545-2 [6], other than previously used according to Polish standards, and the manufacturers were obliged to test their products for compliance with new requirements.

![Fig. 1 Percentage share of tested products that meet the requirements for upholstery of passenger seats (R21) and passenger seats (R18)](image)

Table 1: Percentage share of tested products that meet the requirements for Hazard Level

| Item | Name of products | Percentage share (%) |
|------|------------------|----------------------|
| 1    | paint coatings   | HL3: 31, HL2: 38, HL1: 8, Dmax: 23 |
| 2    | silicone-rubber  | HL3: 45, HL2: 26, HL1: 17, Dmax: 12 |
| 3    | rubber products  | HL3: 0, HL2: 0, HL1: 100, Dmax: 100 |
| 4    | polyester-glass  | HL3: 33, HL2: 47, HL1: 17, Dmax: 3 |
| 5    | transparent polycarbonate | HL3: 11, HL2: 24, HL1: 36, MARHE, CFE |
| 6    | floor composites | HL3: 22, HL2: 39, HL1: 25, Dmax: 14 |
| 7    | passenger seats  | HL3: 62, HL2: 31, HL1: 4, MARHE |
| 8    | upholstery of passenger seats | HL3: 9, HL2: 44, HL1: 5, MARHE |

![Fig. 2 Percentage share of tested products that meet the requirements for floor composites (R10) and transparent polycarbonates (R4)](image)
The next diagrams present tests result of MARHE (Maximum Average Rate of Heat Emission) according to EN ISO 5660-1 [8], Fig. 5 and CFE (Critical heat Flux at Extinguishment) according to EN ISO 5658-2 [7]), Fig. 6 for paint systems. It shows that, coating with epoxy filler is characterized by much more favorable properties, in terms of fire safety, than coatings with polyester filler. Moreover, as the thickness of the coatings increases, its fire parameters deteriorate, therefore it is necessary to remove the old coatings when renovating vehicles.

However, research work of experimental team (Barwa Company in Kielce, Kielce University of Technology and Instytut Kolejnictwa) shown that a good solution is to use a swelling layer in the paint coat. Fig.7 presents positive results for a layer thickness of 600 microns. It was used as the third layer from above. The thickness of the polyester putty in this system was 2000 microns [1-3].

However, for some materials, solutions still have a long way to go. Therefore, the EN 45545-2 standard (in accordance with point 4.7) [6] allows in justified cases, based on functional necessity, the use of materials that do not meet the fire requirements. If it can be shown that any of the requirements specified above are not technically achievable with functionally suitable products, then existing commercially available products can be used until and unless a suitable product is developed. There shall be no requirement to consider products made available after the date of the contract.

The use of this paragraph has the following conditions: essential requirements in 4.1 shall not be compromised; this shall be verified by assessment; taking the proposed design into consideration; including the functional reason and limitation for using the material in question (e. g. climate and/or infrastructure). This applies to, e.g.:
- rubber products
- the anti-spall layer for the windscreen on the driver's cab, (which according to Polish Standards did not require testing).

### III. EVALUATION OF CCS EQUIPMENT AND ELECTRICAL EQUIPMENT TO MEET THE REQUIREMENTS OF FIRE PROTECTION

Second challenge before the manufacturers of passenger rolling stock and its equipment elements was the necessity to meet fire safety requirements by electrotechnical equipment (including monitoring and information systems for passengers, on-board control and signaling systems and other devices, heating devices).

It was posed by EN 45545-2 standard [6], TSI LOC&PAS [2] and TSI CCS [3].

According to EN 45545-2 [6] electrotechnical products should be tested and/or evaluated in accordance with:
- requirements according to Table 5 [6] (listed products mentioned in Table 2 [6])
- Table 3 and grouping rules according to clause 4.3.

The evaluation of on-board control and signaling systems and other devices were not tested earlier according to Polish
The implementation of these requirements was a big challenge both for manufacturers and for Laboratory.

Manufacturers had to learn the need to assess the fire safety of their devices and to prepare for this purpose their documentation containing full information about the non-metallic materials used.

However, we had to master the rules of grouping. Next figures (Fig. 8 – 10) present examples of devices being evaluated in the range of fire safety using the grouping rules in accordance with EN 45545-2 [6].

The first phase applies:
- test procedure of complete seats according to EN 16989:2018 [4]. This standard is the development and refinement of Annexes A and B, removed from EN 45545-2 during phase 1 verification - IK Laboratory has implemented and accredited the method. However, Polish manufacturers of rolling stock seats are not yet interested in adapting their products to new requirements. They wait for the publication of the new edition of the standard and for the transitional period;
- test procedure of toxicity according to EN 17084: 2019 [5]. This standard is the development and refinement of Annex C removed from EN 45545-2 [6] during phase 1 verification - IK Laboratory is in the process of implementing the modified test methodology;
- EN 45545-2 (according to 1 phase of standard revision) - The standard introduces changes in the general rules of conduct and requirements for some products, as well as the requirement to use two above standards [9,10]. The publication of this version of the standard is scheduled for June 2020. At the same time, it is anticipated that prEN 45545-2:2020 will contain information on the adopted transition period;
- EN 45545-2 during phase 1 verification phase with the publication of new standards, according to the last WG01 position, is planned for the beginning of 2025.

Also assessment in the field of FCCS will be a separate challenge. The planned development of the draft standard on fire detection and containment was only completed with the development of the draft Technical Report prTR FCCS [11]. It was considered necessary to carry out additional tests to clarify unconfirmed issues before refining the standard. By the time the EN is established, the published TR FCCS will be introduced as an auxiliary document for voluntary use. Nevertheless, it should be emphasized that allowing FCCS solutions to be used in vehicles alternative to fire barriers will create additional opportunities for manufacturers in rolling stock design.

However, it will be a challenge for laboratories requiring the implementation of new methods into laboratory practice and obtaining their accreditation.

IV. AREAS OF EN 45545 REQUIREMENTS THAT ARE A CHALLENGE FOR THE RAILWAY INDUSTRY

The implementation of the results of ongoing verification of the EN 45545 series of standards will be the next challenge for Poland and other UE countries. It will be the challenge for research laboratories in the implementation of changes in test methodologies and the challenge for manufacturers on the railway market in meeting new requirements for materials and elements that will introduce. The above refers to two stages of verification work.

V. CONCLUSION

Areas of EN 45545 requirements that are a challenge for the Polish railway area result from the necessity of:
- the use of materials and components, including electronic equipment, meeting European requirements in the field of fire safety (EN 45545-2 [6], TSI LOC&PAS [10], TSI CCS [9]);
- implementation of modified toxicity testing methods in laboratory practice,
- meeting new requirements by tested materials and objects (according to: EN 16989 [9], EN 17084 [10], EN 45545-2-1 phase) - A method of adjusting paint coatings to the requirements has already been developed. However, it can be a big challenge to adapt passenger seats to new requirements;
- implementation the assessment by FCCS according to prTR FCCS [11].

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- testing the fire properties of non-metallic materials,
- assessment of the devices and equipment used in rolling stock in the field of fire safety,
- fire safety assessment of railway tunnels.