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

Jolanta M. Radziszewska-Wolińska, and Adrian Kaźmierczak

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.

The results for all material groups tested at our Materials & Structure Laboratory of IK are presented in Table 1 and subsequent diagrams (Fig. 1 - 4). As it can be seen, tests carried out at the IK Laboratory shows that not all materials meeting the PN requirements meet the requirements of EN. It turned out to be very difficult for example for:

- paint coatings with a putty (according to the final application) intended for body of railway vehicles,
- rubber products (e.g. for old-style gangways),
- some painted polyester-glass laminates,
- transparent polycarbonates,
- paint coatings with a filler.

The most difficult parameter to meet

<table>
<thead>
<tr>
<th>Item</th>
<th>Name of products</th>
<th>Percentage share of products that meet the requirements for Hazard Level do not meet the requirements</th>
<th>The most difficult parameter to meet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>paint coatings with a filler</td>
<td>31  38  8  23</td>
<td>MARHE, CFE</td>
</tr>
<tr>
<td>2</td>
<td>silicone - rubber products</td>
<td>45  26  17  12</td>
<td>Dₘₚₓ</td>
</tr>
<tr>
<td>3</td>
<td>rubber products</td>
<td>0  0  0  100</td>
<td>Dₘₚₓ</td>
</tr>
<tr>
<td>4</td>
<td>polyester-glass laminates</td>
<td>33  47  17  3</td>
<td>MARHE</td>
</tr>
<tr>
<td>5</td>
<td>transparent polycarbonate</td>
<td>11  24  36  29</td>
<td>CFE</td>
</tr>
<tr>
<td>6</td>
<td>floor composites passenger seats</td>
<td>22  39  25  14</td>
<td>Dₘₚₓ</td>
</tr>
<tr>
<td>7</td>
<td>passenger seats</td>
<td>62  31  4  3</td>
<td>MARHE</td>
</tr>
<tr>
<td>8</td>
<td>upholstery of passenger seats</td>
<td>9  44  5  12</td>
<td>MARHE</td>
</tr>
</tbody>
</table>

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Fig. 3. Percentage share of tested products that meet the requirements for rubber products (silicone mixture) and rubber products

Fig. 4. Percentage share of tested products that meet the requirements for polyester-glass laminates (R1) and paint coatings with filler (R1, R7)

Fig. 5 Test results of MARHE for paints

Fig. 6. Test results of CFE for paints

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].

Fig. 7. Test results for paints with the intumescent layer

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...
standards. So, 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;
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The second phase will be implementation of the changes resulting from the verification of all parts of the EN 45545 standard [6]. The verification of Part 2 of the standard is to take into account the other comments submitted by the National Standardization Committees as part of voting in 2013, positions which could not be agreed during the 1st verification phase. The aim of the work is to achieve full consistency of all parts of the standard. The verification will also use the current experience and conclusions resulting from the use of existing versions. The end of this 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].

REFERENCES


Jolanta Maria Radziszewska – Wolińska was born in Poznań, Poland. She was graduated at Civil Engineering Faculty of Technical University of Poznań. And she completed Post-Graduate Study on Combustion and the next conferred the doctor’s degree at Mechanical Faculty of Power and Aviation of Warsaw University of Technology. Firstly, she worked at Institute of Natural Fibers in Poznań. She carried out works concerning fire and explosion hazard in industry. From '88 she is working at the Instytut Kolejnictwa (former name: Railway Scientific and Technical Centre) in Warsaw. She is Assistant Professor and head of Materials & Structure Laboratory. Dr Radziszewska-Wolińska is involved in subjects concerning fire protection in the passenger rolling stock. She was/is a member of:

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- Polish Institute of Combustion (from 1995),
- CEN/CENELEC TC 356 WG1 AND T9s WG3 Fire Protection on Railway Vehicles (from 2003)
- Advisory Group AEIF - CEN/CENELEC (2006),
- Technical Committee 138 Rolling Stock of PKN (Polish Committee of Standardization) (from 2003),
- Section of Experimental Mechanic of Polish Academy of Science (2008-2011),
- Polish Scientific Recycling Association (from 2009).

She is the author about 100 papers and presentations at national and international conferences.

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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.

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