Fire resistance testing of railway rolling stock - initial findings from the implementation of a new testing standard, EN 45545-3:2013, in the Ship Design and Research Centre S.A.

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Outline

• Introduction – Fire resistance testing in the past and the current approach
• Objectives of EN 45545-3:2013
• Definitions – Description of the requirements and rules of classification
• Classification of fire barriers – e.g. E 30, I 15
• Performance requirements – for different locations/trains
• Selected results – Real data from a fire test of railway fire barrier
• Conclusions
Introduction

• Before 2013, fire resistance tests of railway rolling stock have been performed according to UIC card no. 564-2 (regulations of International Union of Railways) which referred to the ISO Standard 834-1 “Fire-resistance tests - Elements of building construction- Part 1: General requirements” containing description of testing procedures used in the building industry.
Introduction (cont.)

• In July 2013, a new standard was published, EN 45545-3:2013, “Railway applications — Fire protection on railway vehicles. Part 3: Fire resistance requirements for fire barriers” which describes testing methods and classification rules for different railway vehicles according to the intended use and location.
OBJECTIVES OF EN 45545-3:2013
Objectives

• EN 45545-3 objective it to protect passengers and staff in railway vehicles in the event of a developing fire on board.

• The ultimate objective in the event of a fire on board is to allow passengers and staff to evacuate the railway vehicle and reach a place of safety.

• It is not within the scope of this part of EN 45545 to describe measures that ensure the preservation of the railway vehicles in the event of a fire.
DEFINITIONS
Definitions

• **Fire barrier** - element that is intended for use in maintaining separation between two adjacent areas of a railway vehicle in the event of a fire which resists the passage of flame and/or heat and/or effluents for a period of time under specified conditions.

• The requirements for fire barriers depend upon the operation and design categories and their location in the railway vehicle.
Definitions (cont.)

• **Operation Category of a railway vehicle** - relationship between service, infrastructure and evacuation conditions for passengers and staff. There are four OC categories, these will be explained on slides to follow.
Testing procedure

Furnace construction and testing requirements are based on EN 1363-1, which is technically related to ISO 834-1.
Steel sheet, 2 mm thick, with 50 mm thick mineral fibre insulation will last **60 minutes** for integrity and **only 15 minutes** for insulation.

(E60 I15, based on EN 45545-3, page 15)
CLASSIFICATION OF FIRE BARRIERS
Explaination of fire resistance classification

• Integrity criterion E
• Insulation criterion I
• Radiation criterion W

Barrier performance shall be designated for example as E 30, I 15, which means: integrity is maintained for 30 min and insulation is maintained for 15 min.
Integrity criterion - E

Time for which test specimen continues to maintain its separating function during the fire test:

a) No gaps larger than 6mm (25mm) wide
b) No sustained flaming in excess of 10 s duration.
Insulation criterion - I

- Time for which the test specimen continues to maintain its separating function without developing temperatures on the unexposed side, which are:
  - $\Delta T$ average $> 140^\circ C$ above ambient
  - $\Delta T$ max $> 180^\circ C$ above ambient (at any single point)
Radiation criterion - W

- A product/element that satisfies the insulation criterion I is also deemed to satisfy the W requirement for the same period.

Radiation – function of surface temperature (to the fourth power)
Classification requirements for fire barriers

The expected fire barrier performance falls within the following requirements:

**Minimum:** No requirement;

**Maximum E30/ E15 I15;**

**Most common E15 or E10**

The requirements for fire barriers depend upon the operation and design categories and their location in the railway vehicle.

*Type B arc barriers according to EN 45545-5 shall satisfy the requirements for an E60 fire barrier. Type B arc barrier is a device to contain an electrical arc, resulting from a failure of high power equipment, within a prescribed region.*

Type A arc barrier is a device to contain an electrical arc of short duration, resulting from the normal operation of high power equipment, within a prescribed region. The fire resistance is defined as E15 in 5.3 of EN 45545-3:2013.
EXAMPLES OF PERFORMANCE REQUIREMENTS FOR FIRE BARRIERS
Underfloor technical cabinet

<table>
<thead>
<tr>
<th>Operation category</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2 and 4</td>
<td>E15</td>
</tr>
<tr>
<td>3</td>
<td>E15; I15</td>
</tr>
</tbody>
</table>

**Operation category 1** - Vehicles for operation on infrastructure where railway vehicles may be stopped with minimum delay, and where a safe area can always be reached immediately. The running time for Operation Category 1 vehicles in the event of fire is not specified as these vehicles may be stopped with minimum delay and evacuation started.
Underfloor traction transformers or reactors filled with insulation fluid

<table>
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</tr>
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<td>3 and 4</td>
<td>E15; I15</td>
</tr>
</tbody>
</table>

**Operation category 2** - Vehicles for operation on underground sections, tunnels and/or elevated structures, with side evacuation available and where there are stations or rescue stations that offer a place of safety to passengers, reachable within a short running time. The running time for Operation Category 2 vehicles in the event of fire shall be 4 min.
Fire in passenger area, protection of adjacent passenger area

<table>
<thead>
<tr>
<th>Operation category</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2 and 4</td>
<td>No requirement</td>
</tr>
<tr>
<td>3</td>
<td>E15</td>
</tr>
</tbody>
</table>

**Operation category 3** - Vehicles for operation on underground sections, tunnels and/or elevated structures, with side evacuation available and where there are stations or rescue stations that offer a place of safety to passengers, reachable within a long running time. The running time for Operation Category 3 vehicles in the event of fire shall be 15 min.
Fire in passenger area, protection of driver’s cab

<table>
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</thead>
<tbody>
<tr>
<td>1, 2</td>
<td>No requirement</td>
</tr>
<tr>
<td>4</td>
<td>E10</td>
</tr>
<tr>
<td>3</td>
<td>E15; I15&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> I15 is required for vehicles subject to the Directive 2008/57/EC. For other railway vehicles W15 is required instead of I15.

**Operation category 4** - Vehicles for operation on underground sections, tunnels and/or elevated structures, without side evacuation available and where there are stations or rescue stations that offer a place of safety to passengers, reachable within a short running time. The running time for Operation Category 4 vehicles in the event of fire shall be 4 min.
## Luggage Compartments

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No requirement</td>
</tr>
<tr>
<td>2</td>
<td>E15</td>
</tr>
<tr>
<td>3</td>
<td>E30</td>
</tr>
<tr>
<td>4</td>
<td>E30</td>
</tr>
</tbody>
</table>
SELECTED RESULTS
Selected results – integrity failure

Unexposed side

Before the test

After the test
Selected results – integrity failure
Selected results – integrity failure

Exposed (fire) side

Before the test

After the test

II International Conference
MODERN TRENDS OF FIRE PROTECTION
IN ROLLING STOCK,
25th June 2014, Warsaw, Poland
Selected results – successful test

Unexposed side

Before the test  After the test
Selected results – successful test

Exposed (fire) side

![Before the test](image1)

![After the test](image2)
Another sample—Insulation criterion

Unexposed side

Before the test

After the test
Another sample—Insulation criterion

Exposed (fire) side

Before the test
After the test
Insulation criterion – temperature history

Temperature rise, °C

Time, min

- point 1
- point 5
- point 6
- average 1-5
- point 3
- point 7
- max 1-5
- point 4
- point 8
Selected results – another successful test

Unexposed side

Before the test

After the test
Selected results – successful test

Exposed (fire) side

Before the test  After the test
Conclusions

• It may appear that escaping from a train in case of a fire is a trivial problem, however railway vehicles very often travel with high speeds, or in locations such as tunnels and therefore cannot stop immediately.

• Consequently appropriate measures of fire contained to the place of its origin are of vital importance for passenger evacuation.

• Presented standard offers measures and requirements for better protection of passengers.
Conclusions (cont.)

EN 45545-3 vs. UIC card no. 564-2.

• It is more specific, horizontal barriers tested as ceilings, whereas vertical barriers as walls.
Conclusions (cont.)

- EN45545-3 introduces precise testing requirements and eliminates disambiguates known from UIC card.
- It is vital that such standard are published for railway applications as these initiatives increase the safety level of passengers.
Thank you for attention

Any questions?