FIRE REGULATION IN AIRCRAFTS

WORLD OVERVIEW
Beside specifications agreed for operational reasons between manufacturers and purchasers of aircraft, aeroplanes and the materials used in their constructions must comply with national and international regulations.

2 international standards are used at this moment all around the world:

The Federal Airways Regulation part 25 [43](FAR part 25, especially the appendix F which describes all the test methods for materials and components of the pressurised section of fuselage). The European equivalent is the JAR part 25 paper [42].

The requirements of these two references are largely similar, and the plane makers has integrated these requirements in their internal standard which are:

- ABD 0031 describing AITM test methods for Airbus [44],
- Boeing Safety Standard (BSS) for Boeing.
<table>
<thead>
<tr>
<th>JAR/FAR</th>
<th>Description</th>
<th>Parts</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAR/FAR Part 25, Appendix F - Part I</td>
<td>Flammability, 60s vertical Bunsen burner</td>
<td>Interior ceiling panels - Interior wall panels</td>
<td>- After burn length (average) shall not exceed 152 mm</td>
</tr>
<tr>
<td></td>
<td>Figure 1</td>
<td>Partitions - Galley structures and panels</td>
<td>- After flame time (average) shall not exceed 15 s.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Large cabinet walls - Structural flooring</td>
<td>- After flame time of drips (average) shall not exceed 3 s.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dado panels - Passenger service units</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Door linings incl. slide container - Class dividers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Door frame linings - Light panels</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Linings for stowage compartments</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Floor beam struts - Floor structure</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pressure bulkheads - Fuselage skin - Fuselage frames - Door structure</td>
<td></td>
</tr>
<tr>
<td>JAR/FAR Part 25, Appendix F - Part I</td>
<td>Flammability, 12s vertical Bunsen burner</td>
<td>Floor Covering - Textiles (incl. draperies and upholstery)</td>
<td>- After burn length (average) shall not exceed 203 mm</td>
</tr>
<tr>
<td></td>
<td>Figure 1</td>
<td>Seat cushions - Decorative and non-decorative coated fabrics</td>
<td>- After flame time (average) shall not exceed 15 s.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Padding - Leather</td>
<td>- After flame time of drips (average) shall not exceed 5 s.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Furnishings of trays and galleys - Electrical conduit</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thermal and acoustical insulation - Insulation covering</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Air ducting - Joint and edge covering</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Insulation blankets - Cargo covers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transparencies - Moulded and thermoformed parts</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Air ducting joints</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Linings (incl. floor panels) of all cargo and baggage compartments</td>
<td></td>
</tr>
<tr>
<td>JAR/FAR Part 25, Appendix F - Part I</td>
<td>Flammability, horizontal Bunsen burner</td>
<td>- Acrylic windows and signs - Seat belts</td>
<td>- Burn rate (average) shall not exceed 64 mm/min.</td>
</tr>
<tr>
<td></td>
<td>Figure 2</td>
<td>- Structural window panes elastomeric materials</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Edge lighted instrument assemblies consisting of two or more instruments in a common housing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Cargo and baggage equipment, including containers, bins pallets, etc.</td>
<td></td>
</tr>
<tr>
<td>JAR/FAR Part 25, Appendix F - Part I</td>
<td>Flammability, horizontal Bunsen burner</td>
<td>All other material not included in the first items</td>
<td>- Burn rate (average) shall not exceed 102 mm/min.</td>
</tr>
<tr>
<td>JAR/FAR Part 25, Appendix F - Part I</td>
<td>Flammability, 45° Bunsen burner</td>
<td>Liners of class B or E cargo and baggage compartments</td>
<td>- The flame shall not penetrate (pass through) the material during application of the flame or subsequent to its removal.</td>
</tr>
<tr>
<td></td>
<td>Figure 3</td>
<td>- After flame time (average) shall not exceed 15 s.</td>
<td>- After glow time (average) shall not exceed 10 s.</td>
</tr>
<tr>
<td>JAR/FAR Part 25, Appendix F - Part I</td>
<td>Flammability, 60° Bunsen burner</td>
<td>Insulation on electrical wire and electrical cable installed in any area of the fuselage</td>
<td>- After burn length (average) shall not exceed 76 mm</td>
</tr>
<tr>
<td></td>
<td>Figure 3</td>
<td>- After flame time (average) shall not exceed 30 s.</td>
<td>- After flame time of drips (average) shall not exceed 3 s.</td>
</tr>
<tr>
<td>No requirement</td>
<td>Flammability of heat shrinkable tubings</td>
<td>Heat shrinkable tubings used in any area of the fuselage</td>
<td>- After burn length (average) shall not exceed 76 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- After flame time (average) shall not exceed 30 s.</td>
<td>- After flame time of drips (average) shall not exceed 3 s.</td>
</tr>
</tbody>
</table>
### JAR/FAR Part 25, Appendix F

#### Heat Release and Heat Release Rate
- Ceiling panels, Wall panels, Partitions, Galley, outer surfaces of, Large cabinet walls, Dado panels, Door linings incl. slide container, Passenger service units, Class dividers, Door frame linings, Storage compartments
- The (average) total positive heat release (HR) over the first two minutes shall not exceed 65 kW min/m².
- The (average) maximum heat release rate (HRR) during the five minutes test shall not exceed 65 kW/m².

#### Smoke Density / Interior and Equipment parts
- Ceiling panels, Wall panels, Partitions, Galley, Large cabinet walls, Dado panels, Door linings incl. slide container, Passenger service units, Class dividers, Door frame linings, Storage compartments
- The maximum specific optical smoke density (average) shall not exceed. $D_m = 150$ within 4 minutes test duration under flaming conditions.

#### Smoke Density / Interior and Equipment parts
- Floor beam struts, Floor structure, Pressure bulkheads
- See Table 2

#### Flammability of Seat Cushions
- Seat cushions, except those on flight crew member seats
- For at least two-thirds of the total number of the specimens sets tested, the burn length shall not reach the side of the cushion opposite the burner.
- The burn length shall not exceed 432 mm (17 inches).
- The average percentage weight loss shall not exceed 10%.
- For at least two-thirds of the total number of the specimens sets tested the weight loss shall not exceed 10%.

#### Flame Penetration of Cargo Liners
- Ceiling and sidewall liner panels of Class C and Class D cargo or baggage compartment
- No flame penetration of any specimens within 5 minutes after application of the flame source.
- Maximum (peak) temperature measured 102 mm (4 inches) above the upper surface of the horizontal test sample shall not exceed 204°C.

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The JAR/FAR part 25 regulation does not mention the smoke toxicity assessment. The plane makers has developed internal standards to assess the smoke toxicity. The test method is based on the smoke chamber analysis and analyse during the same round the opacity and the toxicity of smokes.

**Figure 7**

<table>
<thead>
<tr>
<th>For AIRBUS: AITM 3.0005 test method</th>
<th>For BOEING BSS 7239 test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toxicity / Interior and Equipment parts</td>
<td></td>
</tr>
<tr>
<td>Insulation on. Wire/Cable</td>
<td></td>
</tr>
<tr>
<td>Component parts or sub-assemblies, electrical cable/wire insulation materials, and non metallic Structural parts, that are intended for use inside the pressurized section of the fuselage</td>
<td></td>
</tr>
<tr>
<td>The average concentration (in parts per million, ppm) of following gas components of smoke shall not exceed the limits, listed table below, within the relevant test duration under the required test conditions.</td>
<td></td>
</tr>
</tbody>
</table>

Limiting values as specified in the ABD 00031 Airbus Industrie material test specification:
- Hydrogen Fluoride HF $\leq 100$ ppm vol
- Hydrogen Chloride HCl $\leq 150$ ppm vol
- Hydrogen Cyanide HCN $\leq 150$ ppm vol
- Sulfur Dioxide SO$_2$ / H$_2$S $\leq 100$ ppm vol
- Nitrous Gases NO / NO$_2$ $\leq 100$ ppm vol
- Carbon Monoxide CO $\leq 1000$ ppm vol
Table 2: JAR/FAR part 25 Smoke requirements

<table>
<thead>
<tr>
<th>Component parts to be tested</th>
<th>Dm (flaming)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major Interior Panels</strong></td>
<td></td>
</tr>
<tr>
<td>- Ceiling and side wall panels</td>
<td></td>
</tr>
<tr>
<td>- Dado panels (without textile covering)</td>
<td></td>
</tr>
<tr>
<td>- Door and door frame linings</td>
<td></td>
</tr>
<tr>
<td>- Partitions</td>
<td></td>
</tr>
<tr>
<td>- Cabin walls, eg: lavatories</td>
<td>150</td>
</tr>
<tr>
<td>- Overhead passenger service units</td>
<td></td>
</tr>
<tr>
<td>- Stowage compartments (other than under seat)</td>
<td></td>
</tr>
<tr>
<td>Cargo liners</td>
<td>100</td>
</tr>
<tr>
<td><strong>Textile components</strong></td>
<td></td>
</tr>
<tr>
<td>- Textile covered panels</td>
<td>200</td>
</tr>
<tr>
<td>- Cabin floor panel</td>
<td></td>
</tr>
<tr>
<td>Upholstery</td>
<td>200</td>
</tr>
<tr>
<td>Drapery</td>
<td></td>
</tr>
<tr>
<td>Carpets</td>
<td>250</td>
</tr>
<tr>
<td><strong>Other components</strong></td>
<td></td>
</tr>
<tr>
<td>- Air ducting</td>
<td>100</td>
</tr>
<tr>
<td>- Thermal and acoustic insulation</td>
<td></td>
</tr>
<tr>
<td>- Insulation Coverings</td>
<td></td>
</tr>
<tr>
<td><strong>Seat cushion</strong></td>
<td>200</td>
</tr>
<tr>
<td>- Components, eg: Transparencies, elastomeric (used within the passenger cabin and for air conducting) and thermoplastic parts, non-textile floor covering interior equipment parts</td>
<td></td>
</tr>
</tbody>
</table>

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**Figure 1: vertical Bunsen burner test set up [43]**

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Figure 4: Rate of Heat Release Apparatus [6]

Figure 5: test apparatus for horizontal and vertical mounting for Cargo Liner Oil Burner Testing [6]
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REFERENCES


[3] CREPIM, Parc de La Porte Nord, Rue Christophe Colomb, 62700, Bruay La Buissière, France, Tel : 00 33 3 21 61 64 00, Fax: 00 33 3 21 61 64 01, crepim@wanadoo.fr


[7] Fire Testing Technology, P.O. Box 116, Eadl Grinstead, West Sussex, RH19 4FP,UK


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[40] ISO 3795: road vehicles, and tractors and machinery for agriculture and forestry determination of the burning behaviour of material.


[42] JAR Part 25, Appendix F, Part I, para. (a) (1) (i), Change 14

[43] FAR Part 25, Appendix F, Part I, para. (a) (1) (i), Amdt. 25-83

[44] Airbus Directives (ABD) and Procedures, Fireworthiness Requirements, ABD 0031, Pressurized Section of Fuselage, Airbus Industrie 1997, Airbus Industrie, Programmes and Processes Directorate, 31707 Blagnac CEDEX, France

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pr EN 32952 Part 3 and 4 : Textiles Burning behaviour of bedding items. Parts 3 and 4 Ignitability by a small open flame.

UIC 564-2 Annex 5 : Regulations relating to fire protection and fire-fighting measures in passenger-carrying railway vehicles or assimilated vehicles used on international services. Appendix 5 : Test method to measure the reaction to fire of covered textiles.

UIC 564-2 Annex 13 : Regulations relating to fire protection and fire-fighting measures in passenger-carrying railway vehicles or assimilated vehicles used on international services. Appendix 13 : Test method to measure the ignitability of seats.

pr EN 1021 Part 3 : Furniture Assessment of the ignitability of upholstered furniture Ignition source : Flame equivalent to the flame from 20 g of newspaper.

pr EN 1021 Part 4 : Furniture Assessment of the ignitability of upholstered furniture Ignition source : Flame equivalent to the flame from 100 g of newspaper.

NT FIRE 032 Furniture calorimeter tests : Upholstered furniture : burning behaviour Full scale.


IEC 60695-2-4/2 : Fire hazard testing Part 2 Test Methods Section 4 sheet 2 : 500 W nominal pre-mixed test flame and guidance.

IEC 60695-2-4/1 : Fire hazard testing Part 2 Test Methods Section 4 sheet 1 : 1 kW nominal pre-mixed test flame and guidance.

pr EN 50264 : Railway applications Railway rolling stock cables having special fire performance Standard wall.

pr EN 50266-2-4 : Cable calorimeter tests.


NF F 16-102 : Rolling stock Fire behaviour Materials selection Application for electrical equipment.

NF 16-201 : Railxay Rolling stock Fire resistance test for seats

NF P 92-501 : Safety against fire Building materials Reaction to fire tests Radiation test used for rigid materials, or for materials on rigid substrates (flooring and finishes) of all thicknesses, and for flexible materials thicker that 5 mm.

NF P 92-503 : Safety against fire Building materials Reaction to fire tests Electrical burner test used for flexible materials.

NF P 92-504 : Safety against fire Building materials Reaction to fire tests Flame persistence test and speed of flame spread.

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[93] NF P 92-505 : Safety against fire ñ Building materials ñ Reaction to fire tests ñ Test used for thermoplastic materials ñ Dripping test.

[94] NF P 92-506 : Safety against fire ñ Building materials ñ Reaction to fire tests ñ Radiant panel test for flooring.

[95] NF P 92-510 : Safety against fire ñ Building materials ñ Reaction to fire tests ñ Determination of upper calorific value.


[98] DIN 5510 : Preventive Fire Protection in railway vehicles. Part 1: Levels of protection, fire preventive measures and certification, Part 2: Fire behaviour and fire side effects of materials and parts; Classifications, Demands and test methods, Part 4: Vehicle design; Safety requirements, Part 5: Electrical equipment; Safety requirements, Part 6: Auxiliary measures, emergency brake operation function; Information systems, fire alarms, fire fighting equipment; Safety requirements


[100] DIN 54837 : Testing of materials, small components and component sections for rail vehicles; Determination of burning behaviour using a gas burner.


[102] DIN 54431 : Testing of seats in railways for public traffic; determination of burning behaviour with a paper pillow ignition source.

[103] TL 918433 : Technical specifications for delivery; material combinations, passenger seats; particular demands against burning behaviour.


[105] BS 476-7 : Fire tests on building materials and structures ñ Part 7 : Method of test to determine the classification of the surface spread of flame of products.

[106] pr EN 2825 : Aerospace series ñ Burning behaviour, determination of smoke density and gas components in the smoke of materials under the influence of radiating heat and flames ñ Determination of smoke density.

[107] pr EN 2826 : Aerospace series ñ Burning behaviour, determination of smoke density and gas components in the smoke of materials under the influence of radiating heat and flames ñ Determination of gas components in the smoke.
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[108] UNI 8456 : Combustible materials which can be hit by flame on both surfaces. Reaction to fire by applying a small flame.

[109] UNI 9174 : Reaction to fire of material which can be hit by flame with radiant heating.

[110] UNI 8457 : Combustible materials which can be hit by flame on one surface. Reaction to fire by applying a small flame.

[111] UNI 9175 : Reaction to fire of upholstered furnitures by applying a small flame.

[112] IEC EN 50267 : Common test methods for cables under fire conditions i Test on gases evolved during combustion of materials from cables

[113] IEC EN 50267 : Common test methods for cables under fire conditions ii Test on gases evolved during combustion of materials from cables


[119] NF C 32-070, Insulated cables and flexible cords for installations- Classification tests on cables and cords with respect to their behaviour to fire.

[120] Shinichi Sugahara, Department of Architecture, Graduate School of Engineering, University of Tokyo; Masashi Yoshida, Building Department, National Institute for Land and Infrastructure; Kazuo Ueda, Toyo Seiki Seisaku-Sho Ltd; A study on the structure of cone calorimeter as the authorized apparatus, Interflam®2001, Conference Proceedings Volume 1, pp 543-554

[121] Tuula Hakkarainen, VTT Buiding and Transport, Espoo, Finland, Correlation studies of SBI and cone calorimeter test results; Interflam®2001, Conference Proceedings Volume 1, pp 519-530
Peter Briggs, Warrington Fire Research Centre, UK; Yannick Le Tallec & Alain Sainrat, Laboratoire National d’Essais, France; Serge Metral, SNCF, France; Silvio Messa, LSF, Italy; Hervé Breulet, ISSEP, Belgium; The Firestarr Research project on the reaction-to-fire performance of products in European trains, Interflam2001, Conference Proceedings Volume 2, pp 519-530

British Standard 6807, Methods of test for Ignitability of mattresses with primary and secondary sources of ignition, British standard institution, Maylands Avenue, Hemel Hempstead, Herts HP24SQ, UK, 1982.

http://www.gtfi.org/
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