International Aircraft Materials Fire Test Working Group Meeting

Development of New Flammability Tests for Magnesium-Alloy Cabin Components

Presented to: International Aircraft Materials Fire Test Working Group, Cologne, Germany

By: Tim Marker, FAA Technical Center

Date: June 7-8, 2017
Development of Flammability Test for Magnesium Components Located in Inaccessible Areas (Update)
Objective: force ignition of sample, and determine its ability to self extinguish.
Development of Flammability Test for Magnesium Components Located in Inaccessible Areas (Update)

- 161 tests completed using radiant panel apparatus (36 since last meeting)
- 3- by 6-inch sample size
- 2-minute piloted ignition, 4-minute total exposure
- 0.025-inch and 0.050-inch thickness samples tested
- Various shapes and sizes of sample holders tested
0.025-Inch Thickness Sample Weight Loss (%), 78 Tests (No Sample Holder)

- EL21
- EL43

Average: 11.99%
Standard Deviation: 5.82%
Percentage Standard Deviation: 48.5%

Average: 21.99%
Standard Deviation: 3.02%
Percentage Standard Deviation: 13.7%
Problem: Machined Samples Do Not Lay Flat
Machined Sample Manually Manipulated
Manipulated Machined Sample Still Not Flat
Raised Sample Using Shims

Perimeter-Style

Perimeter-Style

Non-Conductive Perimeter-Style
Low-Contact-Area Sample Holder, 4 Posts
Low-Contact-Area Sample Holder Test

Sample collapses
Low-Contact-Area Sample Holder, 6 Posts

*caused excessive failures on materials that typically passed
Truncated Perimeter Sample Holder
Truncated Perimeter Sample Holder
Truncated Perimeter Sample Holder
Truncated Perimeter Sample Holder
Truncated Perimeter Sample Holder
Truncated Perimeter Sample Holder
0.025-Inch Thickness Results Using Truncated Perimeter Holder

- Time of Ignition (Seconds)
- Self Extinguishment (Seconds)
- Weight Loss (%)

Development of a Flammability Tests for Magnesium
June 7, 2017
Weight Loss Comparison Using No Sample Holder vs Truncated Sample Holder

No Sample Holder

Truncated Sample Holder

- Average
- Standard Dev
- % Standard Dev
Wrapping Up…

Initial data does not indicate significant improvement in weight loss repeatability when using the sample holder versus not using sample holder:

<table>
<thead>
<tr>
<th>% Standard Dev</th>
<th>% Standard Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>First 78 Tests</td>
<td>Recent 40 Tests</td>
</tr>
<tr>
<td>No Sample Holder</td>
<td>Truncated Sample Holder</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>EL21</th>
<th>E43</th>
</tr>
</thead>
<tbody>
<tr>
<td>First 78 Tests</td>
<td>13.7</td>
<td>48.5</td>
</tr>
<tr>
<td>Recent 40 Tests</td>
<td>11.7</td>
<td>62.5</td>
</tr>
</tbody>
</table>

Thumb up for EL21: 13.7 to 11.7
Thumb down for E43: 48.5 to 62.5
Summary, Future Work

Finalize test parameters and pass/fail criteria for magnesium alloy components located in inaccessible areas:

- **Radiant Panel Apparatus**, 3- by 6-inch sample size, 0.025-inch thickness
- **No ignition before 60 30 seconds** (proposed)
- **Maximum weight loss of 30%** (proposed)
- **Continue experimentation with sample holder needed to prevent curling or lifting**
- **Experiment with duration of ignition** (increase from 120 sec to 180 sec)
Questions?
Chapter 25 Update

25.4.6 Sample Coatings

If a finish coating, anodizing, or other standard aerospace grade surface treatment is used on the magnesium alloy in service, it is sufficient to test the coated materials using the 12-second vertical Bunsen burner test method described in Chapter 1 of the Materials Fire Test Handbook (Vertical Bunsen Burner Test for Cabin and Cargo Compartment Materials). Vertical Bunsen burner test samples must be fabricated with the coating applied to the magnesium alloy substrate that it will be used on in service, using the production process. The test must be conducted using a substrate thickness representative of the thinnest cross section of the in-service component. If the coating/substrate passes in this thickness (critical test configuration), the coating can be applied to any thicker in-service components of the identical magnesium alloy material without additional testing. Any in-service components having thinner cross sections will require additional vertical Bunsen burner substantiation using that coating/substrate thickness.
Development of Advisory Circular
Potential Advisory Circular Topics

An AC on magnesium use may include some of the following:

- **Purpose**
- **Applicability**
- **Definitions**
- **Related documents**
- **Background**
- **Requirements of 25.853**
- **Compliance with 25.853**
- **Magnesium alloy flammability tests**
- **Measuring the weight of molten/re-solidified parts**
- **Determining self-extinguishment**
- **Test data collection**
- **Pass/fail criteria**
- **Engineering evaluation**
The Use of Magnesium Alloy in Cabin Areas

What is the appropriate method of test?

- Use in 5 primary seat components: Oil Burner
- Use in other non-primary seat components: Oil Burner, SAV ratio req
- Use in other cabin components: Ignition/Self Extinguishment

Accessible Below seat height:
- Oil Burner
- SAV ratio req

Accessible Above seat height:
- Oil Burner
- SAV ratio req

Inaccessible:
- Ignition/Self Extinguishment

Run full-scale test?
Magnesium Alloys Application in Aircraft Seat and Cabin Interiors – Installation Compliance & Approval Process

Legend/Acronyms Definitions:
- FAA: Federal Aviation Administration (USA)
- TSO: Technical Standard Order
- ETSO: Electronic Tech STD Order (EASA)
- TCDS: Type Certificate Data Sheet
- OEM: Original Equipment Manufacturer
- SC: Special Condition

Important Note: This is not Regulatory Guidance and should not be used in lieu of one. This is only for information sharing purposes and not intended for any regulatory approval aid/support. Image Courtesy: Multiple.
Discussion Items for Task Group

Discuss appropriate test method for magnesium alloy components located in inaccessible areas. Discuss recent testing conducted on thin samples in the radiant panel apparatus using updated sample holder. What is impact of increasing ignition duration? Should time of ignition be considered? Select test and begin to finalize pass/fail criteria.

Discuss the key elements that need to be included in an Advisory Circular. For example, the appropriate method of test for each application.

Discuss the draft flowchart detailing the processes required in the certification of aircraft containing magnesium components in the passenger cabin.