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William J. Hughes Technical Center
Aviation Research Division
Atlantic City International Airport
New Jersey 08405

Flammability Standardization Task Group—Final Reports: Federal Aviation Administration Draft Policy Memo, AMN-115-09-XXX, August 20, 2009

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16. Abstract

The Federal Aviation Administration (FAA) issued a proposed policy statement, AMN-115-09-XXX, August 20, 2009, for the purpose of providing guidance on acceptable methods of compliance (MOC) for the flammability requirements of Title 14 Code of Federal Regulations Part 25 for commonly constructed parts, construction details, and materials. The proposed policy statement divides materials and design features into two categories.

- Methods that are acceptable and can be used are as shown in Part 1 of the policy statement.
- Methods that are expected to be acceptable but require test data to support them are as shown in Part 2 of the policy statement.

Industry created the Flammability Standardization Task Group (FSTG) as an ad hoc action under the International Aircraft Materials Fire Test Working Group (IAMFTWG). The FSTG then initiated a 2-year substantiation activity to validate the contents of the draft policy in support of the FAA issuing a final policy in 2012. In September 2009, the FSTG organized a subteam to investigate the parts of the draft policy. Approximately 200 people were involved with this effort to standardize and simplify flammability compliance across industry. Many companies supplied data, materials, and testing.

The FSTG developed a process for substantiating each item in the draft policy memo. Test plans were developed and approved by industry and then made available to the FAA for concurrence. The test plan was then executed (occasionally with changes) and the data were gathered. The data were analyzed and a final report was posted for industry concurrence, followed by an FAA review. In the final report, the FSTG recommended using the MOC as written in the proposed policy; not using the proposed policy MOC; or, based on the data and analysis, using a modified approach to the MOC. The FSTG provided briefings of its activities to the IAMFTWG on a regular basis. The IAMFTWG participation is open to the public.

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The FSTG thanks the Federal Aviation Administration for the opportunity to generate flammability methods of compliance that significantly standardize, simplify, and reduce costs while maintaining safety.

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LIST OF ACRONYMS

FAA	Federal Aviation Administration
FSTG	Flammability Standardization Task Group
IAMFTWG	International Aircraft Materials Fire Test Working Group
MOC	Method of compliance
PWB	Printed wiring board
RTV	Room temperature vulcanizing

EXECUTIVE SUMMARY

The Federal Aviation Administration (FAA) issued a proposed policy statement, AMN-115-09-XXX, August 20, 2009, for the purpose of providing guidance on acceptable methods of compliance (MOC) for the flammability requirements of Title 14 Code of Federal Regulations Part 25 for commonly constructed parts, construction details, and materials.

The proposed policy statement divides materials and design features into two categories.

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Industry created the Flammability Standardization Task Group (FSTG) as an ad hoc action under the International Aircraft Materials Fire Test Working Group (IAMFTWG) in September 2009. The FSTG then initiated a 2-year substantiation activity to validate the contents of the draft policy in support of the FAA issuing a final policy in 2012. The FSTG organized subteams to investigate the parts of the draft policy. Approximately 200 people were involved with the effort, with the goal of using the policy to standardize and simplify flammability compliance across industry. Many companies supplied data, materials, and testing.

The FSTG developed a process for substantiating each item in the draft policy memo. Test plans were developed and approved by industry and then made available to the FAA for concurrence. The test plan was executed (occasionally with changes) and the data were gathered. The data were analyzed and a final report was posted for industry concurrence, followed by an FAA review. In the final report, the FSTG recommended using the method of compliance as written in the proposed policy; not using the MOC in the proposed policy; or, based on the data and analysis, using a modified approach to the MOC. The FSTG provided briefings of its activities to the IAMFTWG on a regular basis. The IAMFTWG participation is open to the public.

1. INTRODUCTION.

The Federal Aviation Administration (FAA) Transport Airplane Directorate issued a proposed policy statement, AMN-115-09-XXX, on August 20, 2009, with the purpose of providing guidance on acceptable methods of compliance (MOC) for the flammability requirements of Title 14 Code of Federal Regulations (CFR) Part 25 for commonly constructed parts, construction details, and materials.

The proposed policy statement divides materials and design features into two categories.

- Methods that are acceptable and can be used are as shown in Part 1 of the policy statement.

- Methods that are expected to be acceptable but require test data to support them are as shown in Part 2 of the policy statement.

In September 2009, the aviation industry created the Flammability Standardization Task Group (FSTG) as an ad hoc action under the International Aircraft Materials Fire Test Working Group (IAMFTWG). The FSTG initiated a 2-year substantiation activity to validate the contents of the methods in attachment 2, Part 2, as well as review Part 1 MOCs, of the proposed policy in support of the FAA issuing a final policy in 2012. Over 200 people were involved with this effort. Scott Campbell of C&D Zodiac and Michael Jensen of The Boeing Company co-chaired the FSTG. Task leaders from industry volunteered to work each subgroup of tasks. Task leaders met monthly via teleconference to discuss the status and the issues. The project structure for the effort is shown in figure 1.

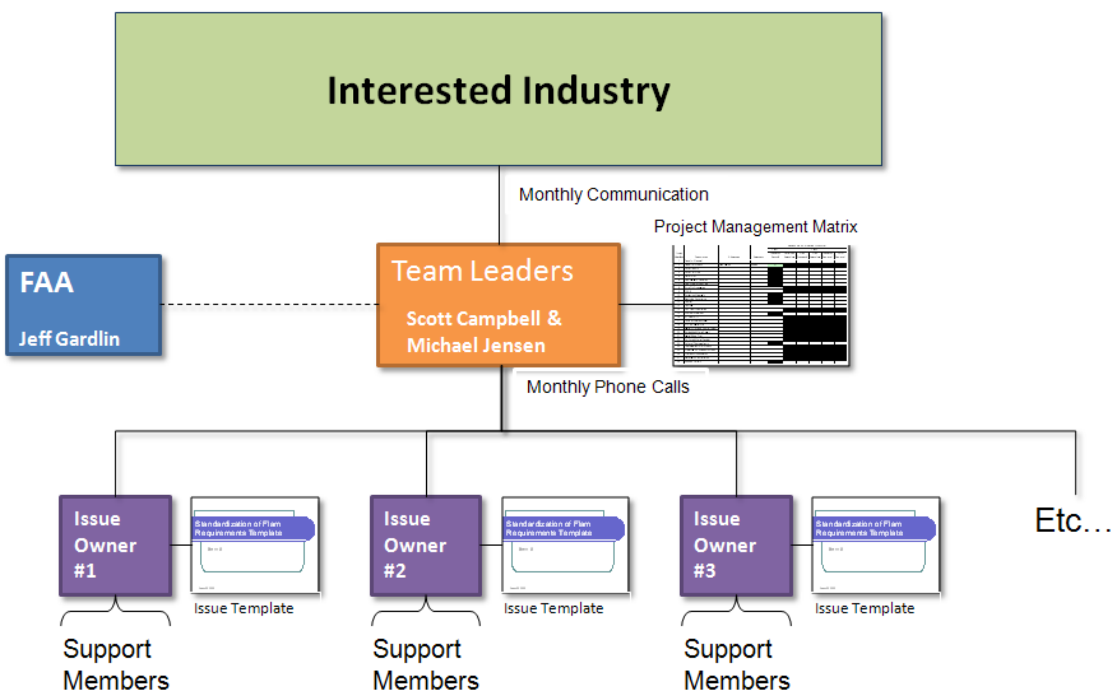


Figure 1. The FSTG Project Structure

The items in the FAA-proposed policy statement were grouped into common categories, such as panel features, and then subgrouped into projected similar data and analysis required for proving out the Part 2 MOC, as shown in figure 2. For example, items 20, 21, and 22 were grouped together because they all related to metal bonded to a panel in some way. This reduced the total number of tasks to manage from 49 to 22. It was also intended to provide a consistent approach to the MOCs for similar items. Item 5 was later split into two separate items, 5a for paint and 5b for decorative laminates. The item was split because the supply base, use of inks, and methods of validation for the MOC were very different. Item 12 was combined with item 5b because they both dealt with color of decorative film laminates, and item 12 was essentially a subset of item 5b.

Panel Construction

2 & 24	Thickness
6, 7, 8, 9, 11	Skin Ply
3 & 4	Core Variables
18 & 19	Metal Skins

Attached Items (Bonded)

28-41	Attached Items

Decorative / Color

5	Paint / Ink
12, 13, 14	Tedlar, texture and pattern
15	Synthetic leather/Suede
17	Powder coated metal
23	Plastic color

Panel Features

20, 21, 22	Bonded Metal
33 & 43a-f	Edge Fill
42	Inserts
44	Fillet Seals

Other

1 & 27	General
10	Surfacing Materials
16	Metal Parts
25	Clear Signs and Windows
26	Printed Wiring Boards

Figure 2. Groupings for Proposed Policy Parts 1 and 2 Items

C&D Zodiac developed a Microsoft® SharePoint® (https://portal.cdzodiac.com/sites/FSTG/default.aspx) as a common repository for all information and discussion for this effort (see figure 3). Any interested person from industry could obtain access to SharePoint via a personal user ID and password provided by Panade Sattayatam, C&D Zodiac, who coordinated all SharePoint development and inputs. SharePoint allowed for online collaboration using file libraries and discussion forums, voting polls, and item status. SharePoint provided complete transparency to the process.

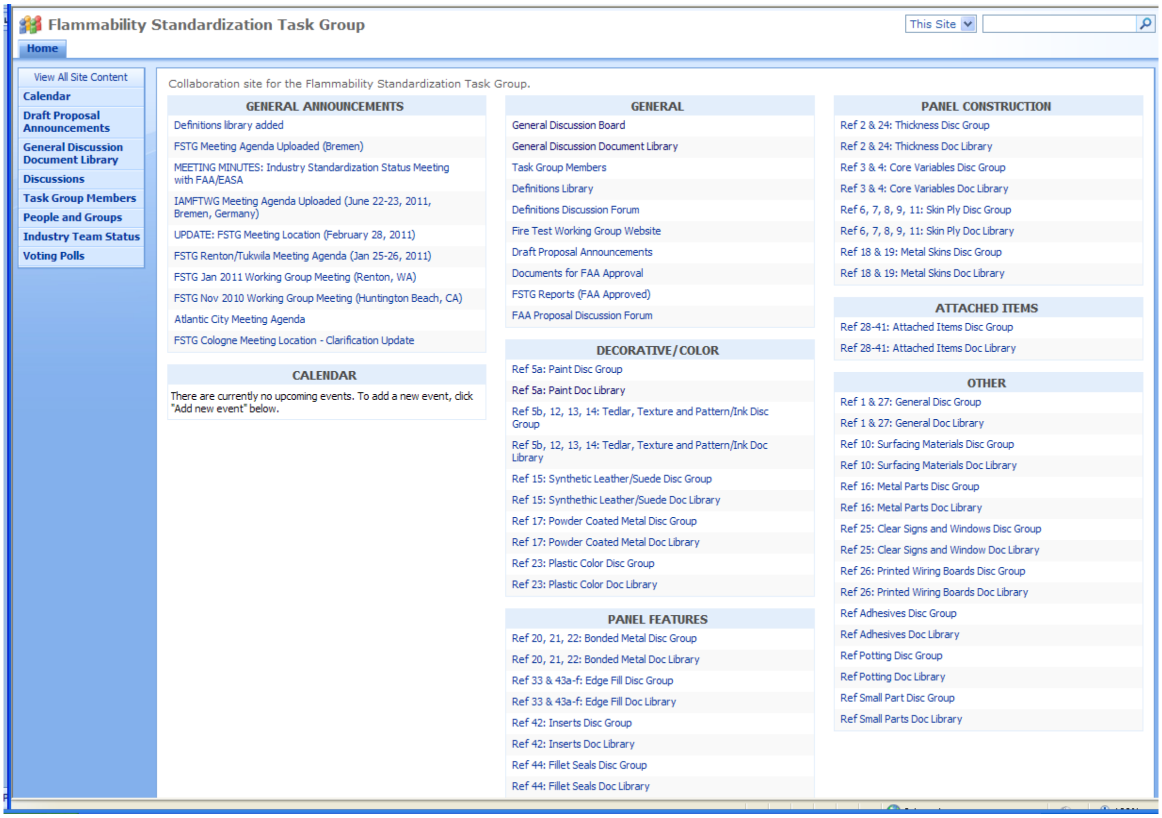


Figure 3. The FSTG SharePoint Home Page

The FSTG developed a process for substantiating each item in the proposed policy memo. Task leaders worked with industry members at meetings during 2010 and 2011 to develop test plans using a standard template. The meetings typically occurred in conjunction with IAMFTWG meetings. The test plans were discussed and, when finalized by the FSTG team, were voted on by industry. All voting was handled through SharePoint. Each company had a single vote to approve or disapprove the test plan. Industry-approved test plans were placed in the FAA folder on SharePoint for review and concurrence by the FAA. The test plan was then executed, occasionally with changes, and the data were gathered. Many companies and the FAA supported the fabrication of test coupons, gathering of existing data, and conducting of tests. The data were analyzed and final reports were written by the teams. The reports were posted for industry vote, again through SharePoint. Industry-approved reports were placed in the "Documents for FAA Approval" folder on SharePoint for FAA review. In the final report for each item, the FSTG recommended using the MOC as written in the proposed policy; not using the MOC in the proposed policy; or, based on the data and analysis, a modified approach to the MOC. The task leaders met monthly by teleconference to share status and issues. The FSTG provided briefings of its activities to the IAMFTWG on a regular basis. The IAMFTWG participation is open to the public.

Table 1 shows the items not pursued by the FSTG for inclusion in the final policy as they were not deemed useful, and the FSTG chose not to invest resources for the small benefit afforded.

Table 1. Proposed Policy Items not Pursued

Draft Policy Reference Number	Method of Compliance Description
18	Decorative laminate on metal skin of sandwich panel
19	Metal skinned foam/honeycomb panels

Item 7 could not be completed due to lack of data for comparable glass weave weight classes and partial loss of Bunsen burner data (burn length data). Due to time constraints, the tests could not be repeated, but industry was confident that inorganic glass weaves in the same weight class do not affect flammability characteristics and have not generated any data to the contrary. FSTG further recommends that this item be incorporated into final policy and, if necessary, is open to repeating the test program at a later date to support future AC development.

It is expected that many material cross sections will be substantiated by similarity, using multiple MoCs. None of the proposed policy MoCs were considered to exclude the use of additional MoCs, nor did industry evaluate a maximum number of MoCs allowed for any one compliance finding. None of the industry work identified any incompatible MoCs that, when used together, would produce unsafe or noncompliant parts.

Appendix A contains the definitions compiled from the individual reports. In cases in which there was more than one definition for the same or similar terms, a single version was developed. The chart in appendix B shows the comparison of the initial draft policy MOCs and the final industry recommendations. Appendices C through CC contain the FSTG final reports sent to the FAA with all definitions, data, analysis, and recommendations.

2. ANALYSIS.

Each report in appendices C through CC includes a technical analysis section for the relevant MOC.

Members of the FSTG estimate there will be a large cost savings (time and materials) over the next several years by implementing the final policy. Similarly, those companies who have implemented the draft policy memo have also experienced significant savings over the last 1 to 2 years.

3. RECOMMENDATIONS.

The FSTG recommends that the FAA accept the findings documented in the subtask reports in appendices C through AA. In addition, the FSTG recommends the following be added to the final policy:

3.1 GENERAL MOCS.

The FSTG recommends the following MoCs from the draft policy be cited in flammability test plans and reports in a general section and need not be cited individually for every applicable cross section of materials. Citing these MoCs in a general section will greatly reduce repetitive clutter in plans and reports.

Table 2. The MOCs for Citing in Compliance Showings in a General Section

Draft Policy Reference Number	MoC Description
10[1]	Surface Fillers
13	Decorative Mechanical Texture
21[2]	Metal Edge Trim
27	Material vs. Installation

[1] The test plan/report must cite data showing approval of the surface filler per the MoC.

[2] A statement must be made that all metal edge trims used are thicker than 0.020″ or a table must be inserted showing all the edge trim part numbers and thicknesses.

3.2 ITEMS THAT MEET EXISTING POLICY.

For decorative laminate orientation (14) and skin ply lay-up orientation (8), the data provided shows these materials behave isotropically, and therefore meet current FAA-written guidance as they do not need to be tested in more than one direction. Therefore, the FSTG recommends that no separate MOC be required to be cited in test plans and reports.

3.3 IMPLEMENTATION STRATEGY.

The conclusions and recommendations in this report represent, in some cases, significant changes to the MoCs for flammability certification defined in the draft policy. Additionally, although the material contained in this report represents an unprecedented collaborative effort among numerous contributors, representing a wide variety of organizations from across the aviation industry, the contributors do not represent all or even a majority of the companies that constitute the vast infrastructure of the commercial aviation industry. To ensure a smooth transition to the MOCs in the final FAA policy across the entire aviation industry, the FSTG recommends the FAA provide guidance on the time frame in which the transition to the final policy MOCs may be implemented. The FSTG proposes that a 6-month time period should be sufficient for organizations involved in flammability certification of aircraft interiors to assimilate the changes contained within the final policy. The activities to be completed within the 6-month period include thorough evaluation of the final policy with respect to differences from the draft policy, creation and review of training materials, implementation of training across the domestic and international supply base, and initiation of data collection efforts that facilitate implementation of the final policy. In addition to preparatory activities, a 6-month window for final policy implementation would help avoid concurrent usage of both the draft policy and the final policy for organizations having multiple certification projects at different points in the certification cycle occurring simultaneously.

The FSTG believes that, for those organizations transitioning from the draft policy to the final policy, a statement in the final policy, such as "Transition from the draft FAA Policy to this final Policy must be implemented for new certification programs no later than 6 months from the date of policy release," would be invaluable.

4. CONCLUSION.

The Flammability Standardization Task Group activity was unprecedented in size, scope, diversity, and especially in benefit. Communication with industry partners, task group participants, and regulators were seamless and constructive. The task group reports contained in this final report provide a wealth of data, context, recommendations, and guidance for use in the final policy and subsequent advisory material. None of the research data implicated any of the draft policy Methods of Compliance to negatively impact safety.

APPENDIX A—FLAMMABILITY STANDARDIZATION DEFINITIONS

The Flammability Standardization Task Group industry team recognized that definitions were important in the interpretation of methods of compliance (MOC). Each of the reports includes a section on definitions specific to the item being covered. These definitions have been compiled and are included in this appendix. Because a number of the items had similar terms defined, and the definitions were slightly different, the compiled definitions were standardized to easily apply to all items.

A number of the definitions contain references to specific materials or types of materials. This is because these MOCs are intended to cover current materials and processes and not significant inventions of future materials or processes. For instance, a newly invented thermoplastic core that looked like a Scotch-Brite® pad that is bonded to face sheets using a laser process would not be covered under these MOCs until it was shown (and Federal Aviation Administration (FAA)-accepted) that this material and process reacts to flammability tests in the same way as the current materials.

Adhesive or Bonding Material—The material used to bond two surfaces together or to fill between surfaces (such as filling honeycomb cells). Adhesives can be two-part materials made up of a base resin and accelerator (such as epoxies) or a single part (like some silicones and acrylic pressure-sensitive adhesives). Adhesives usually require a period of time (several minutes to several hours) to dry or cure to handling strength.

Approved Process Specification—An engineering specification or a set of process instructions on the design drawing that define and control the process, such as the application of a surface filler material. The approved process specification or drawing must be released using the approved company procedure for type design documents.

Backside—The side opposite of the test face in any flammability test. Note that in a vertical Bunsen burner test of panels 0.25″ or less, and the flame is placed at the specimen centerline rather than the centerline of the face, there is no backside, as both sides are tested simultaneously.

Bonded Insert—Bonded insert refers to the use of adhesives or potting compounds as part of the installation of a fastener insert into a panel. Adhesive or potting can be used to prepot the panel or can be wet-installed by injecting them around the insert in the panel. Some inserts have an external flange and the adhesive may only be applied to the faying surface to bond between the flange of the insert and the panel surface.

Bonded Detail (28)—A bonded detail is a metallic or nonmetallic element internal to the panel or attached to the panel surface or cutout areas and pockets of the panel using adhesive. Types of adhesives include, but are not limited to, epoxies, urethanes, silicones, and pressure-sensitive adhesives (inclusive of double-sided tapes with carriers such as foam and fabric). In some cases, bonded details may be cocured with a composite panel during cure. Bonding of hook tape or loop tape individually to a panel is covered under this proposal, but the attachment of the hook to the loop is not considered, as it is a mechanical attachment method. Typical bonded details include, but are not limited to, rub strips, edge trims, hook & loop fasteners, placards, brackets, clips, external wire raceways, kickstrips, felt, doublers, and mirrors.

Bondo®—A generic term for all putty-like materials typically used to fair mismatched surfaces; normally a two-part material.

Clear Plastic Windows—Clear plastic materials used functionally as windows; e.g., interior window pane and partition window.

Clear Plastic Signs—Clear plastic materials used functionally as signs, e.g.; safety information placards, exit signs, and light covers.

Component—A constituent part or element of an installation.

Conformal Coating (CC)—Conformal coatings are materials applied to electronic circuitry to act as protection against moisture, dust, chemicals, and temperature extremes that, if uncoated (unprotected), could result in a failure of the electronic system.

Copper Tracing—Printed wiring boards (PWB) are made by bonding a layer of copper over the entire bare substrate, sometimes on both sides (creating a blank PWB), then removing unwanted copper after applying a temporary mask (e.g., by etching), leaving only the desired copper traces. Some PWBs are made by adding traces to the bare substrate (or a substrate with a very thin layer of copper) usually by a complex process of multiple electroplating steps.

Core—A rigid foam, such as polyurethane, or a honeycomb structure made of aluminum or phenolic resin and Nomex®, Kevlar®, Ultem®, or fiberglass reinforcement.

Core Back—The process of removing core (e.g., honeycomb) from the edge of a panel without disturbing the panel skins. This process is typically used to prepare light-weight composite panels to be edge-filled with moisture-protective compounds.

Core Thickness—The nominal sheet thickness of honeycomb or foam core used in a sandwich panel. Note that panel core thickness applies to rigid panels with a separate material, such as honeycomb core, used for the inner layer. The thickness ranges for panel core thickness only apply to changes in core thickness, not to changes in face sheet thickness. At this time, the only core materials commonly used are foam core and honeycomb core. Because the Part 2 wording of item 2 excludes the use of thickness ranges for foam core panels, for Title 14 Code of Federal Regulations 25.853(d), the use of thickness ranges applies to honeycomb core panels only. Crushed-core panels normally specify the thickness of core to use, the number of plies to use in the face sheets, and a final part thickness. The final core thickness is not known; it can only be estimated. Therefore, for crushed-core panels, the applicable core thickness is the nominal core thickness before crushing. Determining the final core thickness in a crushed-core part is not required. Because it contains the same materials, but places the backside face closer to the heat source, data from a crushed-core panel can be used to substantiate a part that is made from the same materials, but is crushed less, that is, with a greater final thickness.

Decorative Laminate—A polymer-based, nonfibrous, single- or multilayer, thin-gage, non-self-supporting decorative sheet that typically contains at least one layer of a fluoropolymer-based film material. (Decorative laminates are always applied to the surface of a part, and therefore never form self-supporting parts. Decorative laminates are typically used on surfaces of sidewalls, lavatories, galleys, closets, linings, partitions, bin doors, and ceilings. Other words used within the industry for the term decorative laminate are Tedlar®, Decorative Tedlar Laminate, Declam, Airdec, Panlam, AerFilm, Flexdec, Décor, and Decorative Film.)

Decorative Laminate Color—The complete visual appearance of a decorative laminate, including base color, prints, pearl effects, text, images, pattern, or design. Color is the result of combinations of pigments in the embossing resin, pigments in the plastic film layers, and printing inks on a surface layer. Inks used in decorative laminates are typically a liquid containing a mixture of various pigments and other ingredients (such as solvents, resins, or lubricants) used for printing on a thin surface layer to produce an image, text, or design.

Decorative Laminate Orientation—Machine and cross-machine direction (0º and 90º) of a decorative laminate.

Decorative Type—A decorative type is a product that is used as an aesthetic and/or functional surface for various components in the interior of airplanes, and includes the following:

- Decorative laminates
- Nontextile flooring
- Thermoplastic sheets

The following decorative types with natural grains and woven products are specifically excluded from texture and orientation similarity means of compliance in this document, as they are known to display anisotropic flammability properties:

- Wood (solid wood and wood veneers)
- Fabrics (seat covers, carpets, and curtains)

Doubler—A local reinforcement that is cocured, bonded, or mechanically fastened to a panel to add structural strength.

Doubler, Cocured—An additional ply (or plies) of material added as a local reinforcement on a panel for structural strength that is cured during the original panel cure and not as a secondary operation.

Doubler, Metal, Cocured—A metal sheet, block, or extrusion cocured with the composite skin materials. Additional adhesive (usually film adhesive) is typically added to the sandwich panel construction to adhere the doubler to honeycomb and prepreg. Refer to figure A-1 for a typical cross section of cocured sheet metal doubler. Refer to figure A-2 for a typical cross section of a cocured metal block or extrusion.

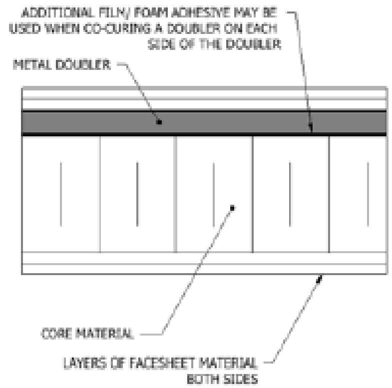


Figure A-1. Cocured Metal Double Cross Section

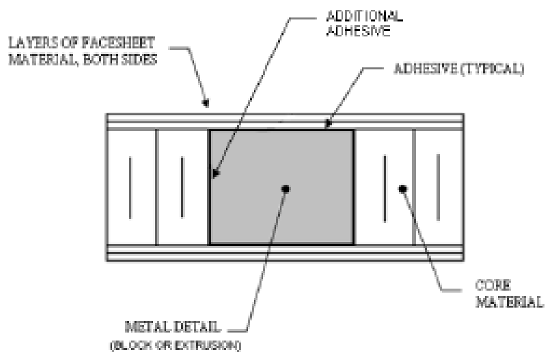


Figure A-2. Cocured Metal Double Extrusion Cross Section

Edge Fill Material (Edge Potting)—The material used to fill the core backer is incorporated into the panel edge prior to curing to improve the compression strength (in the z direction) of the panel edge, provide resistance to the ingress of water or other fluids, and to provide a flat and smooth surface for the attachment of other materials; e.g., paints, trim, or decorative laminates. Compositions vary by manufacturer, but are usually made of resin and fillers; resin, fillers, and blowing agents; or foams, which are incorporated into the panel manufacturing process. A panel edge is either at the periphery of the panel or the exposed edge created by a cutout.

Edge Trim—A molded, extruded, formed, or flat piece of material that is bonded or mechanically fastened to the edge of a panel or a panel joint. The trim may wrap around the edge of the panel(s) or be applied to the cut edge of the panel. Hardwood trim, commonly used as a bullnose, is included in this definition. Edge trim does not extend more than 2″ from the edge of the panel.

Embedded Metal Detail—A metal detail of any shape that is bonded to a sandwich panel, pre- or postcure of the sandwich panel. Usually, part of the base (stock) sandwich panel is modified by removing core or face sheets before bonding the embedded metal detail to the base panel.

Exposed—Large outer surface areas of interior materials that will be exposed to flames during a postcrash fuel fire scenario.

Face Sheet—The structural skins on either side of a core material that are made of either fiber-reinforced resins (such as phenolic or epoxy) or metal (typically aluminum). Fiber reinforcements are typically fiberglass, carbon, or Kevlar.

Felt—A nonwoven cloth that is produced by matting, condensing, and pressing nonmetallic fiber material used as a thermal insulation, sound damping, or moisture barrier.

Fiber Reinforcement—A woven or unidirectional fiber used to reinforce a thermosetting or thermoplastic resin. Fiber reinforcements are typically fiberglass, carbon, or Kevlar.

Fillet Seal—A seal applied after assembly at the juncture of two adjoining parts or surfaces, or along the edges of faying surfaces as a continuous bead of sealing material. It can be applied over, along the edges of, and between installed parts. A fillet seal can also be formed by fairing squeeze-out from a bonded joint.

Grommet—A grommet is a rigid or flexible edge trim that is applied around the inside edge of a hole through a panel. Grommets may be designed for a specific size hole or they may be a flexible trim piece that is cut to length and applied to various hole contours. Grommets are used to reinforce a hole, to shield something from the sharp edges of the hole, or both.

Honeycomb Panel—See sandwich panel.

Insert—Inserts are defined in the fastener category. Two main insert designs are used predominantly in interior panel fabrication. The first is a blind insert that contains an internal retaining nut. The second common insert is a flanged insert (either one- or two-piece), which creates a hole through the panel for a bolt or screw to be inserted. “Through” inserts can be plastic or metal. Fastener attachments bonded to the surface of panels (e.g., clickbonds) are not considered inserts and are covered under bonded details. See figures A-3 through A-9 that show the common insert types.

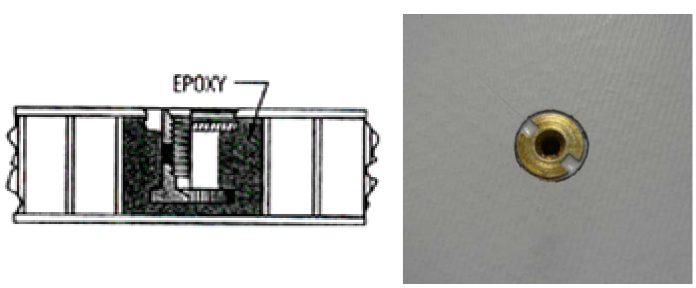
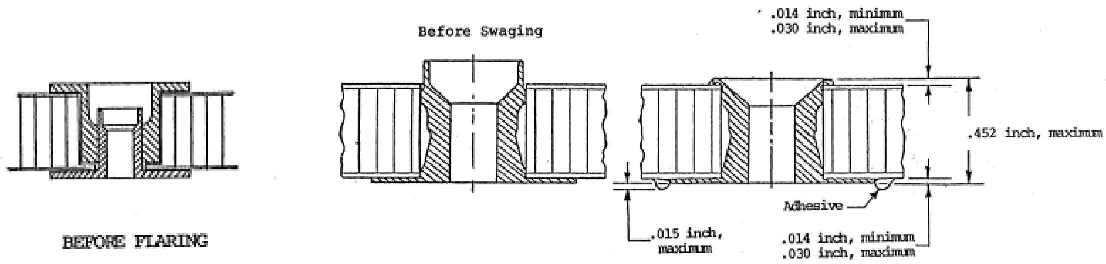


Figure A-3. Blind Insert



(a) (b)

Figure A-4. Flanged Insert (a) One-Piece and (b) Two-Piece

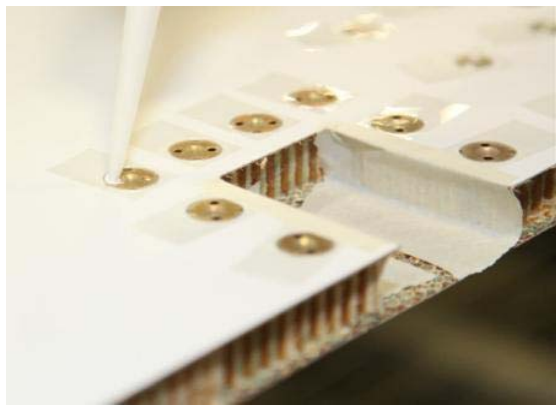


Figure A-5. Representative Assemblies Showing Localized and Lineally Applied Inserts

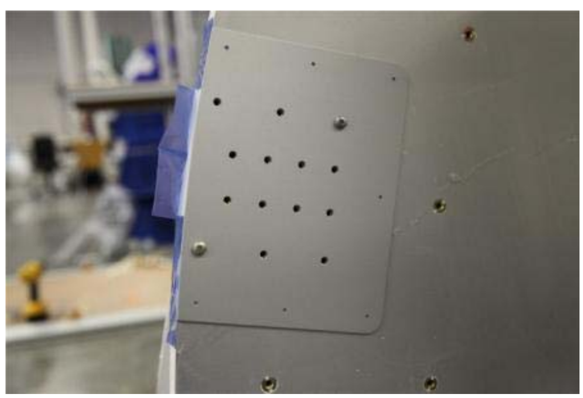


Figure A-6. Inserts Around a Cutout for a Fitting (Inserts in center of panel for attaching wire bundles)

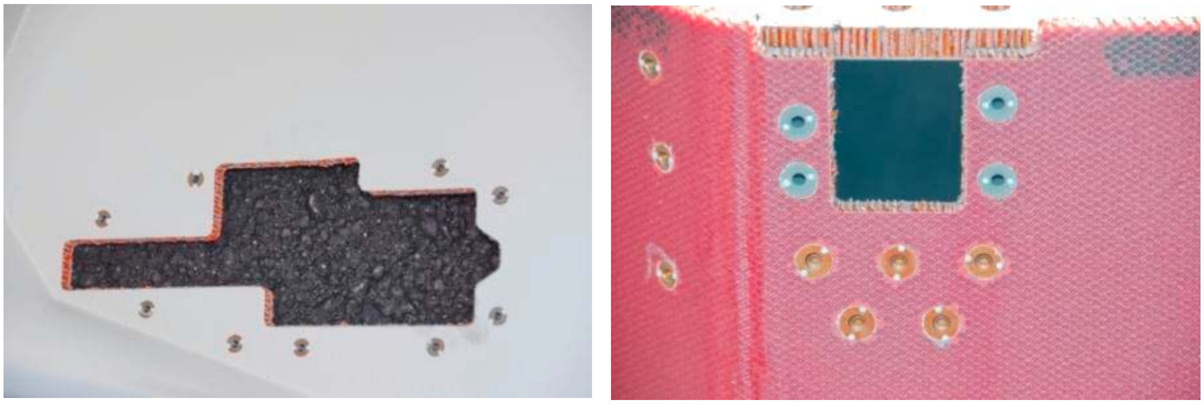


Figure A-7. Inserts Around a Cutoff for a Fitting

Figure A-8. Inserts Along a Panel Edge for Attaching Trim

Figure A-9. Inserts Inside a Stowbin for Attaching Trim

Joint Types—Figures A-10 through A-13 define ditch and pot, cut and fold, mortise and tenon, tab and slot, T-joints, and bonded pin joints.

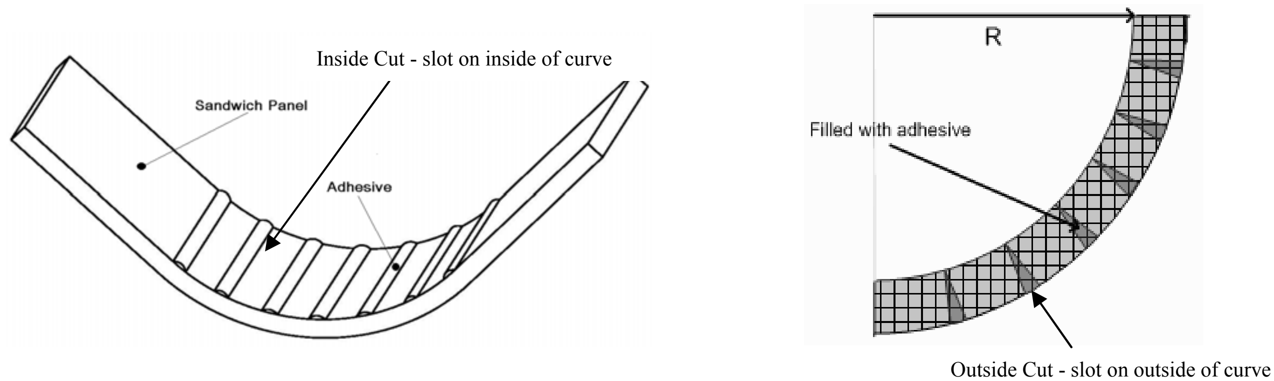
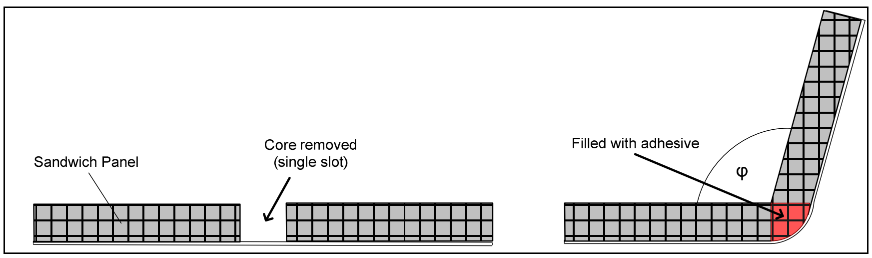
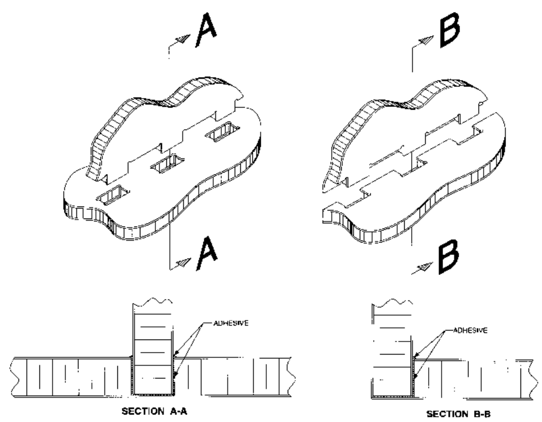


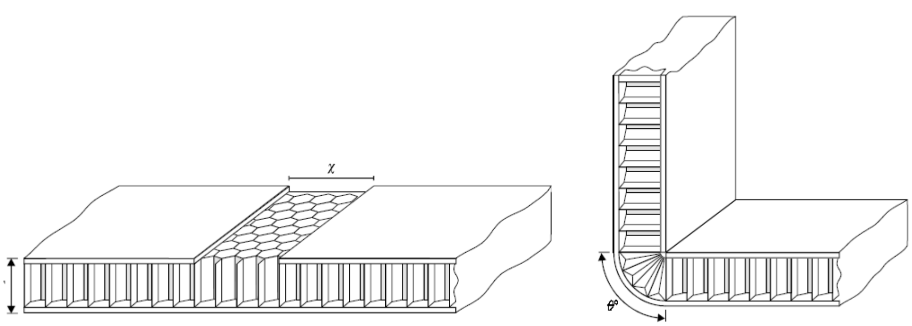
Figure A-10. Ditch and Pot (Multiple Slot)



(a) Tab and Slot



(b) Mortise and Tenon



(c) Cut and Fold

Figure A-11. Single Slot

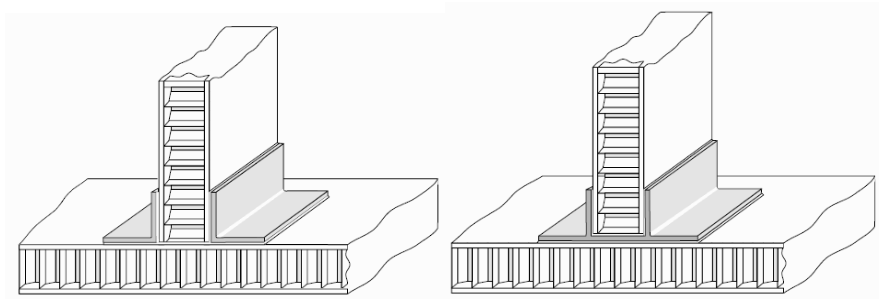


Figure A-12. T-Joints

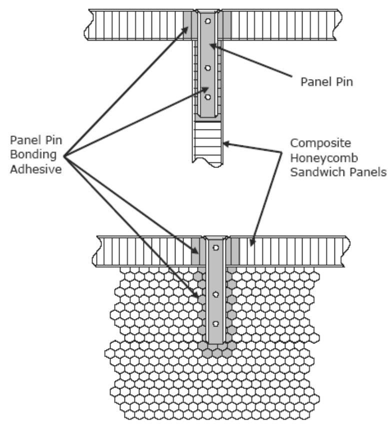


Figure A-13. Bonded Pins

Kickstrip—A material or combination of materials applied at floor level on a vertical or near-vertical surface (acting as a wall) as a means of protection of the base materials from damage and wear and not as the primary decorative covering of the panel.

Laminates—Thermosetting composites reinforced with continuous or discontinuous fiber but not incorporating core.

Method of compliance (MOC)—A way of showing a material or part meets a particular FAA regulation.

Monuments—A monument is a large interiors component, typically having to meet heat release requirements. Examples include lavatories, galleys, bulk heads, class dividers, and closets.

Nontextile Flooring (NTF)—A polymer-based, noncarpet floor covering, typically used in lavatories, galleys and entryways due to their resistance to liquids and durability.

Paint Chemistry—The mixed-resin system (all components combined) without the addition of pigments used for achieving a particular color.

Panel—A distinct portion, section, or division of a monument or other interior installation that comprises its structure or acts as an outer (cabin-facing) cover. Panels are typically made from sandwich panels, laminates, and thermoplastics.

Placard—A thin plaque printed with warnings or other information and attached to a surface.

Printed Wiring Boards—A printed wiring board, or PWB, is used to mechanically support and electrically connect components using conductive pathways, tracks, or traces etched from copper sheets laminated onto a nonconductive substrate. It is also referred to as a printed circuit board (PCB) or etched wiring board. A PWB populated with electronic components is a printed circuit assembly (PCA), also known as a printed wiring assembly (PWA) or printed circuit board assembly (PCBA).

Rub Strip—A molded, extruded, formed, or flat piece of nonmetallic material that is bonded or mechanically attached to the surface of a panel, typically in narrow strips, for the purpose of protecting the panel from damage.

Same (The Same)—The use of the term "the same" means that the only differences between compared materials and constructions are the properties defined by the one or more MOC that is being applied (e.g., decorative color or thickness of material). Materials that are qualified to the same type, class, grade, etc., of a specification that controls the physical, chemical, and flammability properties are considered the same for the purposes of the comparison. Decorative laminates and synthetic leather, because of their inherent, unique to the manufacturer, multimaterial constructions, cannot be considered the same based on their qualification to the same specification type, class, grade, etc. These materials must be from the same manufacturer and product line to be considered the same.

> Example 1: Phenolic prepregs from two different manufacturers qualified to the same type, class, grade, etc. of a material specification that controls the physical (e.g., tensile and compression strength), chemical (Phenolic resin system), and flammability (meets a specified level of vertical burn and or heat release and smoke) properties can be considered the same when comparing two sandwich panel constructions to show compliance for a change in decorative color and texture as shown below:
>
> Compliant Panel
> ………………….. SkyFlite 140 series dec, Cream Color 1643, Mesa Texture, by SkyFilm LLC
> ---------------------- 1 Ply DMS 2296 Type 1, Class 1 prepreg
> XXXXXXXXXXXX 0.5" DMS 1974 Type 3, Class 2, Grade A core
> ----------------------- 1 Ply DMS 2296 Type 1, Class 1 prepreg
>
> Panel to be shown compliant by similarity
> ………………….. SkyFlite 140 series dec, Blue Color 2387, Canvas texture, by SkyFilm LLC
> ---------------------- 1 Ply DMS 2296 Type 1, Class 1 prepreg
> XXXXXXXXXXXX 0.5" DMS 1974 Type 3, Class 2, Grade A core
> ----------------------- 1 Ply DMS 2296 Type 1, Class 1 prepreg
>
> The only differences in the two items being compared are for the MOCs being applied, decorative color, and decorative texture. The base panels are considered the same,

regardless of which source of material was purchased to the prepreg and honeycomb specifications.

Example 2: When comparing two thermoplastic sheet materials, a vinyl-based material and a polycarbonate, they cannot be considered the same even if they meet the same type, class, and grade of a specification because they are not of the same chemical family, even if they have the same strength and flammability characteristics.

Sandwich Panel—A rigid panel fabricated using face sheets (either reinforced thermosetting resins or metal) on either side of a core material (a rigid foam or a honeycomb structure made of aluminum or phenolic resin and Nomex paper, Kevlar, Ultem, or fiberglass).

Sealant—A viscous, elastomeric material that, once applied, changes state to become a solid and is used to fill voids and gaps of various sizes to prevent the passage of liquids or gaseous media, as well as to help meet health, security, and aesthetics requirements. Aerospace sealants are generally identified based on the main resin family used to produce them. The resin family most commonly used for fillet sealing of aircraft interiors is silicone. Within the silicone family, most of the materials used for fillet sealing aircraft interiors are RTV (room temperature vulcanizing) silicones. Therefore, in the context of this item, silicone (the generic term) refers to RTV silicones. Other resin families used are polyurethanes and polysulfides.

Solder Mask—Solder mask or solder resist is a lacquer-like layer of polymer that provides a permanent protective coating for the copper traces of a printed circuit board and prevents solder from bridging between conductors, thereby preventing short circuits. The solder mask is most often applied with a green tint, but is available in a wide variety of colors and finishes. It also provides some protection from the environment.

Surfacer (Pin Hole Filler, Sweep and Sand, Bondo, etc.) Pin Hole Filler—A material that is used locally to fill small pin holes left during the manufacturing process.

Sweep and Sand—The action of applying a thin film of filler material with a wide blade and then sanding the material down to just leave filler material between fibers.

Texture—The physical surface structure of a decorative type that is created by a mechanical transfer tool. Texture is a physical characteristic of a surface. It describes the way a surface feels to touch. Texture influences the physical surface structure and appearance of a decorative type. It does not change the buildup or chemical composition of the finished product.

Thermoplastic Sheet—A reformable polymer-based, single- or multilayer heavy-gage, self-supporting decorative sheet. (In contrast to decorative laminates, thermoplastic sheets are used to form self-supporting parts and are therefore typically not applied on top of other substrates. Thermoplastic sheets are typically being used for food trays, arm caps, shrouds, literature pockets, and consoles. Examples of thermoplastic sheets include Kydex®, AerForm®, Ultem, Radel®, and poly(ether ether ketone).)

Thermoplastic—A polymer-resin, capable of being formed using heat multiple times that may or may not incorporate fiber reinforcement.

Thickness—The nominal thickness of sheet material or the nominal thickness of the part. Part thickness is used for instances in which the dimensions of the part are not approximated by the raw material dimensions, such as an injection-molded part in which the raw material consists of small pellets, or the design does not identify a sheet stock dimension, but only a final thickness. (See also Core Thickness.) The intent of this item is to cover difference in the designed thickness of parts, not the very small differences covered by tolerances.

Weight Class—A group of fabrics (such as fiberglass) that have the same approximate areal weight, but are of different weaves (e.g., plain versus crow foot).

Wire Raceway—A conduit for routing wires and cables that can be installed either internally or externally to a panel.

APPENDIX B—SUMMARY TABLE

<table>
<tr><th rowspan="2">Ref. #</th><th rowspan="2">Feature/ Construction</th><th colspan="2">Part 1: Acceptable methods w/o additional data</th><th colspan="2">Part 2: Methods of compliance that require supporting data</th><th colspan="2">Industry Proposals for Final Policy Acceptable Methods</th></tr>
<tr><th>25.853(a) Bunsen Burner Test Req. / Similarity</th><th>25.853(d) HR & SD Test Req. / Similarity</th><th>25.853(a) Bunsen Burner Test Req. / Similarity</th><th>25.853(d) HR & SD Test Req. / Similarity</th><th>25.853(a) Bunsen Burner Test Req. / Similarity</th><th>25.853(d) HR & SD Test Req. / Similarity</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Panels, general</td><td rowspan="2">60-second vertical test data will substantiate configurations that only require 12-second vertical data. Vertical Bunsen burner data will substantiate configurations that only require horizontal Bunsen burner testing</td><td rowspan="2">Test requirement is decided based on size criteria.
1) Test required if greater than 2 sq ft;
2) No test if less than 1 sq ft; and
3) Specific determination required between 1 and 2 sq ft.</td><td rowspan="2"></td><td rowspan="2"></td><td>60-second vertical test data will substantiate configurations that only require 12-second vertical data. Vertical Bunsen burner data will substantiate configurations that only require horizontal Bunsen burner testing</td><td>Test requirement is decided based on size criteria.
1) Test required if greater than 2 sq ft;
2) No test if less than 1 sq ft; and
3) Specific determination required between 1 and 2 sq ft. Aspects to consider with this determination are location, quantity, and function of the given components.</td></tr>
<tr><td colspan="2"><u>Added Definitions**</u>

Component: The industry team therefore recommends that the term 'component' in the context of this item be defined as constituent parts or elements that comprise an installation.

Exposed: The industry team therefore recommends that the term 'exposed' in the context of this item be defined as an unconcealed surface that faces the interior of airplane passenger compartments during an emergency landing condition.</td></tr>
<tr><td>2</td><td>Thickness ranges (panels, thermoplastics, foams)</td><td>Data from testing a thinner construction substantiates a thicker construction made o the same materials.</td><td>See part 2</td><td><u>See part 1</u></td><td>Except for foam core panels with prepreg skins where each thickness will be tested, use the following approach:
Sandwich panels, laminates, thermoplastic parts, and parts made from a single material are shown to be compliant with § 25.853(d) (appendix F, parts IV and V) by test, or by similarity to a part with similar thickness (in the same thickness range). For certification purposes, thickness ranges are defined to eliminate the need to test every possible thickness. It is an acceptable practice to test a given thickness within a tight range and use these data to substantiate all thicker items within that range. The following table details standard thickness ranges currently used.
<table>
<tr><th>Type Part</th><th>Thick. Range (inch)</th></tr>
<tr><td rowspan="6">Sandwich Panels - Core Thickness</td><td>0.125</td></tr>
<tr><td>0.188</td></tr>
<tr><td>0.250</td></tr>
<tr><td>0.500</td></tr>
<tr><td>0.750</td></tr>
<tr><td>1.750 and thicker</td></tr>
<tr><td rowspan="10">Laminates and Thermopla stics</td><td>0.020</td></tr>
<tr><td>0.040</td></tr>
<tr><td>0.060</td></tr>
<tr><td>0.080</td></tr>
<tr><td>0.100</td></tr>
<tr><td>0.200</td></tr>
<tr><td>0.300</td></tr>
<tr><td>0.500</td></tr>
<tr><td>0.750</td></tr>
<tr><td>1.750 and thicker</td></tr>
<tr><td rowspan="5">Single Unit Materials</td><td>0.080</td></tr>
<tr><td>0.120</td></tr>
<tr><td>0.250</td></tr>
<tr><td>0.50</td></tr>
<tr><td>1.75 and thicker</td></tr>
</table></td><td>Data from testing a thinner construction substantiates a thicker construction made of the same materials.</td><td>Except for foam core panels with prepreg skins where each thickness will be tested, use the following approach:

Sandwich panels, laminates, thermoplastic parts, and parts made from a single-unit material are shown to be compliant with § 25.853(d) (appendix F, parts IV and V [Heat Release & Smoke Density]) by test, or by similarity to a part with similar thickness (in the same thickness range). For certification purposes, thickness ranges are defined to eliminate the need to test every possible thickness. It is an acceptable practice to test two thicknesses within a range and use these data to substantiate all items with thickness between those two values. The following table details the standard thickness ranges:
<table>
<tr><th>Part or material thickness</th><th>Thicknesses tested to show compliance</th></tr>
<tr><td>0.02 - 0.06 inch
0.5 –1.5 mm</td><td>0.02 inch & 0.06 inch
or
0.5 mm & 1.5 mm</td></tr>
<tr><td>0.06 – 0.1 inch
1.5 – 2.5 mm</td><td>0.06 inch & 0.1 inch or
1.5 & 2.5 mm</td></tr>
<tr><td>0.1 - 0.25 inch
2.5 - 6 mm</td><td>0.1 inch & 0.25 inch or
2.5 mm & 6 mm</td></tr>
<tr><td>0.25 - 0.5 inch
6 - 12.5 mm</td><td>0.25 inch & 0.5 inch or
6 mm & 12.5 mm</td></tr>
<tr><td>0.5 – 1.0 inch
12.5 – 25.5 mm</td><td>0.5 inch & 1.0 inch or
12.5 mm & 25.5 mm</td></tr>
<tr><td>1.0 - 1.75 inch
25.5 – 44.5 mm</td><td>1.0 inch & 1.75* inch
or
25.5 mm & 44.5* mm</td></tr>
<tr><td>1.75 inch & thicker
44.5 mm & thicker</td><td>1.75* inch or
44.5* mm</td></tr>
<tr><td colspan="2">* 1.75 inch or 44.5 mm specimens are not tested for smoke.</td></tr>
</table>
The smallest thickness range shown is 0.040 inch (1 mm). It is also acceptable to use data from an 0.040 inch range with different endpoints. That is, if there is data for two configurations that are the same except for a thickness difference of approximately 0.040 inch (1 mm), that data can be used to show compliance for a configuration with thickness between the other two.

When testing the maximum thicknesses for heat release, 1.75 inch or 44.5 mm, the thickness to test may require adjustment, so that the total specimen thickness does not exceed the maximum thickness that can be tested. This is most likely when testing</td></tr>
</table>

Ref. #	Feature/ Construction	Part 1: Acceptable methods w/o additional data: 25.853(a) Bunsen Burner Test Req. / Similarity	Part 1: Acceptable methods w/o additional data: 25.853(d) HR & SD Test Req. / Similarity	Part 2: Methods of compliance that require supporting data: 25.853(a) Bunsen Burner Test Req. / Similarity	Part 2: Methods of compliance that require supporting data: 25.853(d) HR & SD Test Req. / Similarity	Industry Proposals for Final Policy Acceptable Methods: 25.853(a) Bunsen Burner Test Req. / Similarity	Industry Proposals for Final Policy Acceptable Methods: 25.853(d) HR & SD Test Req. / Similarity
							a thick sandwich panel, but could occur for other materials in a bonded configuration. This adjustment is necessary to run the test and therefore acceptable. Thickness ranges can be used for a portion of a configuration. For example, a composite sandwich panel with a laminate stiffener bonded to it might use the (sandwich panel – core) thickness range for the sandwich panel, the (laminates and thermoplastics) thickness range for the stiffener, or both. Another example is that a painted part could use the thickness ranges, by testing two specimens within the range applicable to the part, with the same finish applied to the specimens as to the part.
						Added Definitions** **Thickness**: The industry team recommends that 'thickness' in the context of this item be defined as "the nominal thickness of sheet material or the nominal thickness of the part. Part thickness is used for instances where the dimensions of the part are not approximated by the raw material dimensions, such as an injection molded part where the raw material consists of small pellets, or where the design does not identify a sheet stock dimension, but only a final thickness." For sandwich panels and multilayer bonded assemblies, the thickness of individual materials or layers is more meaningful than the assembly thickness. Thickness normally need not take into account the small additional thickness of paint or a decorative laminate that may be applied to the part. **Panels—Core Thickness**: The industry team recommends that the term 'core thickness' in the context of this item be defined as "the nominal sheet thickness of the honeycomb core material used for the part." **Laminates**: The industry team recommends that the term 'laminates' in the context of this item be defined as "thermosetting composites reinforced with continuous fiber or discontinuous fiber but not incorporating core." **Thermoplastics:** The industry team recommends that the term 'thermoplastic' in the context of this item be defined as "polymeric materials capable of being repeatedly softened by increase in temperature and hardened by a decrease in temperature and which may or may not incorporate fiber reinforcement." **Single unit materials:** The industry team recommends that the term 'single unit materials' in the context of this item be defined as "materials which, unlike composite materials, are uniform throughout." **Same:** The industry team recommends that the term 'same' in the context of this item be defined as "the same color from the same manufacturer, the same product family, and the same product buildup, or the same color and controlled to the same specification callout and the same product buildup."	
3	Core, density			Data from testing a lower density honeycomb core substantiates a higher density honeycomb core, provided the core is made from phenolic aramid (e.g., Nomex® and Kevlar®) paper, phenolic fiberglass, or aluminum).	Data from testing a core's lightest and heaviest densities substantiates all densities in between.	Data from testing a lower density honeycomb core substantiates a higher density honeycomb core, provided the core is made from phenolic aramid (e.g., Nomex® and Kevlar®) paper, phenolic fiberglass, or aluminum).	Data from testing a core's lightest and heaviest densities substantiates all densities in between.
						Added Definitions** **Honeycomb core**: Sheets of phenolic aramid papers (Nomex®, Kevlar®), phenolic fiberglass, or aluminum joined together to form a honeycomb pattern used as lightweight core in sandwiched panels. **Core cell size**: This is the distance between the parallel surfaces of a cell typically hexagonal in shape. For over expanded core, it is the widest distance between parallel faces of the cell. **Core density**: The mass per unit volume of core (e.g., lb/ft^3) **Same:** The term 'same' in the context of this item refers to a honeycomb core from the same manufacturer or specification. Also it should be clarified that the different core materials are unique and should be considered separately. For example, different densities of Aluminum core do not substantiate Nomex® core.	
4	Core, cell size			Data from testing ANY core cell size/shape substantiates other core sell sizes/shapes of the same material, provided the core is made from phenolic aramid (e.g., Nomex® and Kevlar®) paper, phenolic fiberglass, or aluminum).	Data from testing a core's smallest and largest cell sizes substantiates all cell sizes in between.	Data from testing ANY core cell size/shape in a given panel construction and within a specific thickness range substantiates other core sell sizes/shapes of the same material, provided the core material is made from phenolic aramid (e.g., Nomex® and Kevlar®) paper, phenolic fiberglass, or aluminum.	Data from the smallest and largest cell sizes from panels in a given panel construction and within a specific thickness range substantiates all cell sizes in between.

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						Added Definitions** **Honeycomb core**: Sheets of phenolic aramid papers (Nomex®, Kevlar®), phenolic fiberglass, or aluminum joined together to form a honeycomb pattern used as lightweight core in sandwiched panels. **Core cell size**: This is the distance between the parallel surfaces of a cell typically hexagonal in shape. For over expanded core, it is the widest distance between parallel faces of the cell. **Core density**: The mass per unit volume of core (e.g., lb/ft^3) **Same:** The term 'same' in the context of this item refers to a honeycomb core from the same manufacturer or specification. Also it should be clarified that the different core materials are unique and should be considered separately. For example, different densities of Aluminum core do not substantiate Nomex® core.	
5a	Paint color			Test the part with same chemistry paint/ink system. Test of one color substantiates other colors of the same paint/ink system. Substantiate unpainted with painted panel.	Test of a part with one color substantiates any other color with the same paint/ink chemistry. Additionally, testing of a painted part substantiates an unpainted part with the same construction.	Test of a part with one colour substantiates any other colour with the same paint chemistry.	The industry is proposing that a HRR/HR/SD margin of 55/55/180 be adopted for colour similarity for heat release and smoke density testing. The 55/55/180 margin will provide a MoC that provides a more conservative approach than has been used as industry practice for many years, and significantly simplifies and standardizes the compliance process. (3/29/2012)
	Backside paint					**Test,** **or use other applicable MoC** [e.g. FASE (part 1, ref. 9)]	An item tested with paint on the backside (non-test surface) substantiates the identical construction without paint on the backside surface.
						Added Definitions** **Top Coat**: The top coat is the visible coating of a component. It provides, among others, color and surface texture. **Base Coat**: The base coat (primer) is an intermediate layer. Typically, it is applied onto a technical surface prior to applying the top coat. A Primer may, or may not, be applied. **Paint System**: A paint system is an aligned and harmonized couple of top coat and base coat (primer). **Paint Chemistry**: The chemistry of a paint system is defined individually by every paint manufacturer. Reason is that, even under global headline category (e.g. polyurethane, epoxy, acrylic), no common formulation can be assumed. Generally, paint chemistry addresses a certain defined ratio of binder, filler, solvents, hardener, additives - plus an amount of colour pigments, which may vary depending on the colour. The full range of colours shall be provided "by same paint chemistry", except for the colour pigments. **Same:** when the FAA draft policy memo refers to "same paint system", the only change being allowed in the context of this item would be the exclusive change from one colour to another, with all other product parameter staying the same. The industry team therefore recommends that the term "same" in the context of this item be defined as "from the same manufacturer and same product family and same product built-up".	
5b	Decorative Laminate Color					Data from testing one color of a substantiates the same	decorative laminate decorative laminate in a different color.
						Added Definitions** **Color**: The complete visual appearance of a decorative laminate used in the interiors of transport category airplanes, including base color, print colors, pearl effects, text, images, patterns or designs. (Alternative definition from Ref #12 industry report: **Color**: The complete visual appearance of a Tedlar used in the interiors of transport category airplanes, limited to one integrally pigmented base color.) **Decorative Laminate**: Polymer-based, single or multilayer thin-gage, non self-supporting colored decorative sheet that may include additional non-polymer based reinforcing layers and contains at least one layer of a fluoropolymer-based film material. **(Most recent definition for "Decorative Laminate" which is found in 12 August 2011 Final "FAA-approved report" for Item 5b.)** **Tedlar:** Polymer-based, single layer, solid-color, thin-gage, non self-supporting film made out of polyvinyl fluoride (PVF). **Same**: From the same manufacturer & same product family & same product build-up. So when the FAA draft policy memo refers to the "same ink system," the only change being allowed in the context of this item would be the exclusive change from one color to another, with all other product parameters staying the same.	

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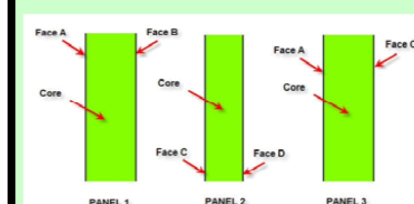
6	Multiple co-cured, non-metallic plies			No test required for same co-cured material as the skin.	Data from testing the thinnest and thickest doublers substantiates the thickness for all doublers in between.	Data from the minimum number of plies will substantiate all additional ply buildups of the same material with the same core	Data from the minimum number of plies and the maximum number of plies tested will substantiate for all plies in between for the same core
7	Fiber reinforcement cloth			Test of one fiber reinforcement cloth of a given weight class in a given resin type (e.g., phenolic, epoxy, etc.) substantiates other fiber reinforcement cloth of the same weight class and fiber type provided the weave is the only change. This applies to cloth made from fiberglass, aramid, or carbon. For example, fiberglass weaves 1581, 7781, and 181 are all equivalent within a given weight class.	Weaves within same weight class are equivalent.	Test of one fiber reinforcement cloth of a given weight class in a given resin type (e.g., phenolic, epoxy, etc.) substantiates other fiber reinforcement cloth of the same weight class and fiber type provided the weave is the only change. This applies to cloth made from fiberglass, aramid, or carbon. For example, fiberglass weaves a1581, 7781, and 181 are all equivalent within a given weight class.	Weaves within same weight class are equivalent.
8	Skin ply layup - orientation	Data from testing one panel construction plies for the same	substantiates any orientation of the skin panel construction.			Data from testing one panel construction plies for the same	substantiates any orientation of the skin panel construction.
9	Skin testing (FASE -Face As Separate Entity)	Data may be collected from each face of a sandwich panel independently. **Note:** The test coupon is a completed sandwich panel. The data from each face may be used to substantiate a panel construction when the panel thickness is greater than 0.25" and the thickness is the only difference between the core materials.	Not applicable.			Data collected from each face of a sandwich panel may be applied independently to other sandwich panels, provided the following conditions are true: • The core material for all panels is identical except for thickness • Each panel is 0.25 inches thick or greater. • Data from 0.25" thick panels may be used to qualify other 0.25" thick panels, or greater, only if the test data were obtained by placing the Bunsen burner such that the flame impinges on the applicable test face, and not the center, of the sample cross-section.  Certification data from Panel 1, Face A and Panel 2 Face C, can be used to substantiate panel 3 provided the core material for all three panels is identical except for thickness and each panel is 0.25 inches thick or greater. **Note:** The test coupon is a completed sandwich panel. The data from each face may be used to substantiate a panel construction when the panel thickness is greater than 0.25" and the thickness is the only difference between the core materials. **Added Definitions**** **Sandwich Panel**: A rigid panel fabricated using face sheets on either side or a core material. **Face Sheet**: Either reinforced thermoset resins or metal. **Core Material:** A rigid foam or a honeycomb structure made of aluminum, Ultem®, or phenolic resin reinforced with Nomex®, Kevlar®, or fiberglass.	Not applicable.
10	Surfacing materials (pin-hole filler, sweep and sand, Bondo)			No test requirement when surfacing process specification to assure that these materials do not contribute to	material is controlled within an approved conformance to flammability reqmts, or the propagation of a fire.	No test required when surfacing material is specification that has been validated using **Added Definitions**** **Pin Hole Filler**: A material that is used locally to fill small pin holes left during the manufacturing process. **Sweep and Sand**: The action of applying a thin film of filler material with a wide blade and then sanding the material down to just leave filler material between fibers. **Bondo**: A generic term for all putty like materials typically used to fair mismatched surfaces. Normally a 2-part material. **Approved Process Specification**: An engineering specification or a set of process instructions on the design drawing that define and control the application of the surface filler material. The document must specify the maximum limits of the application (weight per square area). The approved process specification or drawing shall be released using the approved company procedure for type design documents.	controlled within an approved process the method described within this MOC.

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11	Backside decorative			Test of a panel with a backside decorative that has	substantiates a panel with a backside no decorative.	Test of a panel with a backside decorative that has	substantiates a panel with a backside no decorative.
						Added Definitions** **Decorative**: For the purpose of this MOC the term "decorative" implies any finish applied to the back of a panel e.g. paint, Decorative Tedlar Laminates (DTL), co-cured bondable Tedlar.	
12	Tedlar			Testing of Tedlar® material on a panel construction with the same type and	decorative panel substantiates the same thickness of Tedlar® with a diff. color.	Item #12 to be completely removed and merged with item #5b.	Item #12 to be completely removed and merged with item #5b.
13	Texture	Data from testing one texture of a the same decorative type	decorative type substantiates a panel with a different texture.			**Proposed:** Accept as-is with further "Data from testing one texture of a a panel with the same decorative	clarification of key terms, i.e. decorative type substantiates type with a different texture."
						Added Definitions** **Texture**: The physical surface structure or a decorative type that is created by a mechanically structured transfer tool used in the interiors of transport category airplanes. **Decorative Type**: Decorative Laminate, Non-Textile Flooring (NTF), and Thermoplastic Sheet. **Decorative Laminate**: Polymer-based, non-fibrous, multilayer thin-gage, non self-supporting decorative sheet that typically contains at least one layer of a fluoropolymer-based film material. **(Definition from 03 May 2010 Final "FAA-approved report"—pre-dates definition in Item 5b.)** **Non-Textile Flooring (NTF):** Polymer-based, non-fibrous, non-carpet floor covering. **Thermoplastic Sheet:** Polymer-based, single or multilayer heavy-gage, self-supporting decorative sheet. **Same:** From the same manufacturer and same product family and same product build-up.	
14	Decorative laminate orientation	Data from testing one decorative laminate orientation substantiates a panel with the same decorative laminate that has a different orientation.	See part 2	See part 1	Data from testing one decorative laminate orientation substantiates a panel with the same decorative laminate with a different orientation.	Data from testing one decorative the same decorative laminate	laminate orientation **s**ubstantiates with a different orientation.
						Added Definitions** **Orientation**: Machine and cross-machine direction (0-deg and 90-deg) of a decorative laminate used in the interiors of transport category airplanes. **Decorative Laminate**: Polymer-based, multilayer thin-gage, non self-supporting decorative sheet that typically contains at least one layer of a fluoropolymer-based film material. **(Definition from 13 April 2011 Final "FAA-approved report"—pre-dates definition in Item 5b.)** **Same:** From the same manufacturer and same product family and same product build-up.	
15	Synthetic leather/suede	See part 2	Testing of each color synthetic leather/suede material is required.	Data from testing one synthetic leather/suede material sample will substantiate other colors of the same material.	See part 1	Data from testing one synthetic leather/suede material sample will substantiate other colors of the same material.	Testing of each color synthetic leather/suede material is required. (No attempt was made to address this by the industry team.)
						Added Definitions** **Same material**: Same manufacturer, same material composition (except for the color composition) and same test specimen build-up.	
16	Aluminum/steel/ titanium parts (excluding powder coating)	Unless they contain magnesium or magnesium alloys, unfinished metal parts do not require testing. Finished metal parts do not require testing provided: 1) standard paint/finishes are used and 2) the parts do not contain magnesium or magnesium alloys. Standard paint/finishes are defined as inorganic finishes (e.g., anodize, alodine), epoxy primers and topcoats, urethane topcoats, and corrosion inhibiting dry films. See item 17, below, for powder coatings.	The test requirement is decided based on size criteria. 1) Test required if greater than 2 sq ft; 2) No test if less than 1 sq ft; and 3) Specific determination required between 1 and 2 sq ft.			• Unfinished metal parts do not require testing provided they are not produced from magnesium-containing alloys. • Finished metal parts do not require testing provided: 1) standard paint/finishes are used, and 2) the parts do not contain magnesium-containing alloys. Standard paint/finishes are defined as inorganic finishes (e.g., anodize, alodine), epoxy primers and topcoats, urethane topcoats, and corrosion inhibiting dry films. See item 17, below, for powder coatings.	The test requirement is decided based on size criteria. 1) Test required if greater than 2 sq ft; 2) No test if less than 1 sq ft; and 3) Specific determination required between 1 and 2 sq ft.
						Added Definitions** **Standard paints/finishes**: aircraft OEM qualified inorganic finishes (e.g., anodize, alodine), epoxy primers and topcoats, urethane topcoats, and corrosion inhibiting dry films. **Aircraft (Original Equipment Manufacturer) OEM qualified**: defined as finishes and coatings that have been approved by the manufacturer (internally or through their supplier system) for use on that specific model aircraft for the specific application being certified.	

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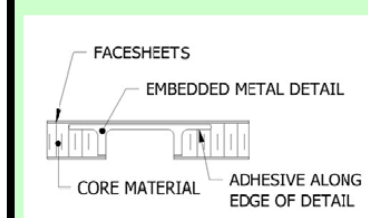
						Magnesium-containing alloys: Any metal alloy system comprised of greater than 20% magnesium metal. This definition includes Magnesium based alloys typically used in aircraft structure and are defined as magnesium alloys containing greater than 80% magnesium. (Aluminum alloys containing less than 20% magnesium are not included in the definition of a magnesium containing alloy.)Other methods of testing are required for certification of magnesium containing alloys parts.	
17	Powder coated metal	Unless they contain magnesium or magnesium alloys, powder coated metal parts do not require testing.	Testing each color of powder coating material is required.			WAS: Unless they **contain over 20%** magnesium, powder coated metal parts do not require testing. —————————————————— No report found, but, based on modifications to Item 16 above, guessing new wording would look like: **Powder-coated metal parts do not require testing unless the metals are magnesium-containing alloys.** (TWL, 3/14/2012) [See Item 16 for definition of magnesium-containing alloys.]	Testing each color of powder coating material is required.
18	Decorative laminate on metal skin of sandwich panel	Test the panel with decorative laminate using the appropriate requirement in appendix F, part I.	See part 2	See part 1	Data from testing a decorative laminate and an adhesive on a nonmetallic panel substantiates a metal skinned panel with the same decorative laminate and adhes	**No report found.** Intentionally left blank	**No report found.** Intentionally left blank
19	Metal skinned foam/honeycomb panels	Test the metal skinned foam/honeycomb panel to the appropriate requirement in appendix F, part I.	See part 2	See part 1	Data from testing the thinnest and thickest metal skinned panels substantiates the thickness for all panels in between.	**No report found.** Test the metal skinned foam/honeycomb panel to the appropriate requirement in appendix F, part I.	**No report found.** Data from testing the thinnest and thickest metal skinned panels substantiates the thickness for all panels in between.
20, 22, 40	Metal Detail, Bonded	Test the adhesive by itself or the detail and adhesive together per 12-second vertical. Limitation - detail may not be constructed of magnesium or magnesium alloys.	No test requirement.			No Test Requirement. Data from base panel substantiates (Provided that the detail is at least 0.01" thick). Limitation – Detail may not be constructed by magnesium or magnesium alloys. (i.e. "magnesium-containing alloys", TWL 3/14/2012)	No test requirement. Data from base panel substantiates.
						<u>**Added Definitions**</u>** **Embedded metal detail**: An embedded metal detail is defined as a metal detail of various shapes that is bonded to a sandwich panel, post cure of the sandwich panel. Usually, part of the base (stock) sandwich panel is modified by removing core or face sheets before bonding the embedded metal detail to the base panel. Examples of embedded metal details are conduits, fittings, edge supports, attachment fittings, hinges, latches, etc. General cases of bonded metal details are shown in the second figure below.  **Figure: Typical Cross-Section of Embedded Metal Detail**	

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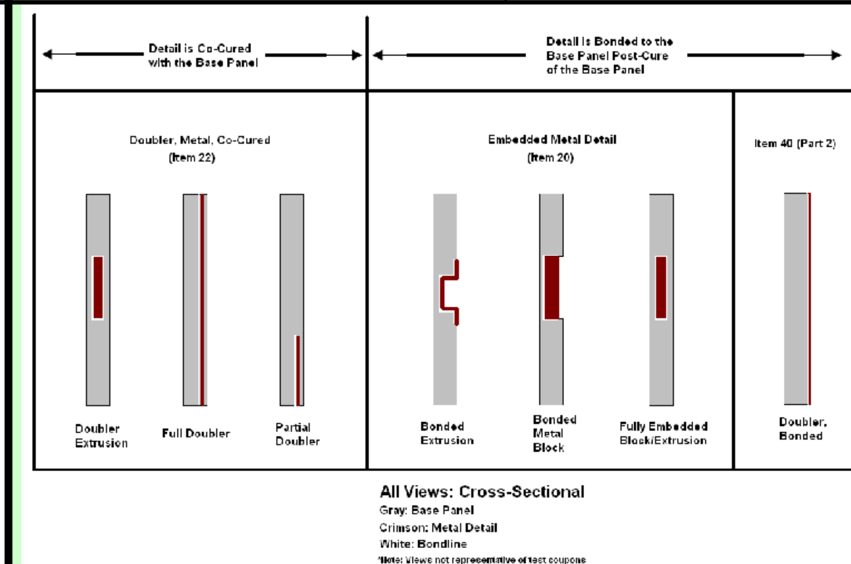
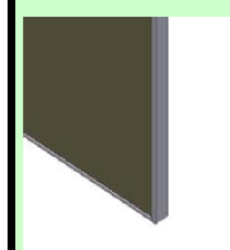
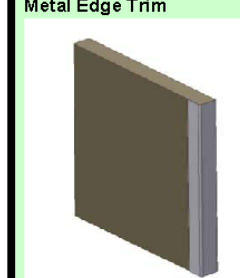
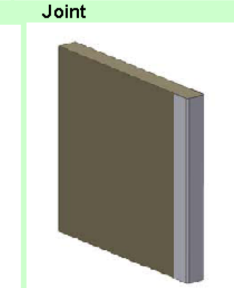
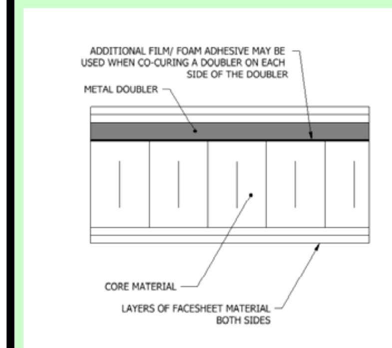
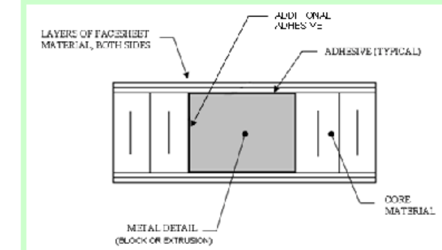
						 **Figure: General cases of bonded metal details.**	
21	Edge trim, metal	No test required provided edge trim is at least 0.02" thick.	No test requirement.			No test required provided edge trim is at least 0.02" thick. __Added Definitions**__ **Edge trims, Metal:** Metal trim attached mechanically, by hook-and-loop fasteners, by double-back tape or by adhesive to the edge of a sandwich panel. The metal edge trims can be formed metal, metal extrusions, machined or cast metal. Trim used as joints shall also be considered edge trim, metal.  **Metal Edge Trim**  **Joint**  **L-Shaped Metal Edge Trim**  **U-Shaped Metal Edge Trim**	No test requirement.
20, 22, 40	Metal Detail, Bonded	No test requirement. Data from base panel substantiates.	No test requirement. Data from base panel substantiates.			No Test Requirement. Data from base panel substantiates (Provided that the detail is at least 0.01" thick). Limitation – Detail may not be constructed by magnesium or magnesium alloys. (i.e. "magnesium-containing alloys", TWL 3/14/2012)	No test requirement. Data from base panel substantiates.

<table>
<tr><th rowspan="2">Ref. #</th><th rowspan="2">Feature/ Construction</th><th colspan="2">Part 1: Acceptable methods w/o additional data</th><th colspan="2">Part 2: Methods of compliance that require supporting data</th><th colspan="2">Industry Proposals for Final Policy Acceptable Methods</th></tr>
<tr><th>25.853(a) Bunsen Burner Test Req. / Similarity</th><th>25.853(d) HR & SD Test Req. / Similarity</th><th>25.853(a) Bunsen Burner Test Req. / Similarity</th><th>25.853(d) HR & SD Test Req. / Similarity</th><th>25.853(a) Bunsen Burner Test Req. / Similarity</th><th>25.853(d) HR & SD Test Req. / Similarity</th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2"><u>Added Definitions**</u>

Co-cured metal doubler (sheet, block or extrusion): a detail, co-cured with the composite skin materials. Additional adhesive (usually film adhesive) is typically added to the sandwich panel construction to adhere the doubler to honeycomb and prepreg. Refer to the figures below for a typical cross-section of co-cured sheet metal doubler and a typical cross-section of a co-cured metal block or extrusion. See also general cases of bonded metal details in Item #20.


Co-Cured Metal Doubler Cross-Section Co-Cured Metal Doubler Extrusion Cross-Section</td></tr>
<tr><td rowspan="2">23a</td><td rowspan="2">Color of thermoplastics, decorative non-textile floor covering and elastomers</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">Data from testing an integrally colored substantiates the same thickness for a different color.</td><td rowspan="2">For integrally colored thermoplastics, conduct engineering tests on a variety of colors to determine the most critical color. Conduct a certification test on the color that produces the most critical values. The resulting data can be used to substantiate other colors of the same materials by similarity / critical case analysis.</td><td>WAS: Data from testing an integrally colored material substantiates the same material type and thickness for a different color.

IS: Data from testing an integrally colored thermoplastic, decorative non-textile floor covering or elastomer substantiates the same thickness thermoplastic, decorative non-textile floor covering or elastomer of a different color.</td><td>WAS: For integrally colored thermoplastics, conduct engineering tests on a variety of colors to determine the most critical color. Conduct a certification test on the color that produces the most critical values. The resulting data can be used to substantiate other colors of the same materials by similarity / critical case analysis.

IS:
Option 1: Data from testing an integrally colored thermoplastic substantiates the same thickness thermoplastic of a different color.

Option 2 (if Option 1 is not accepted by the FAA): Data from testing an integrally colored thermoplastic substantiates the same thickness thermoplastic of a different color given the data used is less than or equal to:
• 55 kW-min/m2 for 2-min Total,
• 55 kW/m2 for Peak, and
• 180 Ds.</td></tr>
<tr><td colspan="2"><u>Added Definitions**</u>

Color: The complete visual appearance of a decorative sheet used in the interiors of transport category airplanes, including base color, prints, images, text or design.

Decorative Non-Textile Floor Covering: A decorative polymer based (typically an elastomer such as vinyl) mat used on aircraft floors that does not incorporate fibers on the exposed surface. These mats are typically used in entry ways, galleys and lavatories where fluid resistance and ease of cleaning are a concern.

Thermoplastic: A polymer-based, homogenous heavy-gage, self-supporting sheet capable of being formed using heat multiple times.

Same: A thermoplastic from:
• The same manufacturer or specification*,
• The same product family (same chemistry other than color pigmentation), and
• The same nominal thickness (within industry standard tolerances).

* The specification must control the flammability properties and general chemistry (i.e., polycarbonate or Nylon) for materials to be the same from different manufacturers but qualified to the same specification, including types, classes, etc. that control chemical properties.</td></tr>
<tr><td>24</td><td>Thermoplastic, thickness ranges</td><td>Data from testing a thinner construction substantiates a thicker construction made from the same materials.</td><td>It is an acceptable practice to test a given thickness within a tight range and use these data to substantiate all thicker items within that range. See item 2 in this attachment for acceptable thickness ranges.</td><td></td><td></td><td>See Item #2 above.</td><td>See Item #2 above.</td></tr>
<tr><td>25</td><td>Clear plastic windows and signs</td><td>Test per appendix F, part I, (a)(1)(iv).</td><td>No test requirement.</td><td></td><td></td><td>Test per appendix F, part I, (a)(1)(iv).
[15-second horizontal test]

Exceptions: Any application of clear plastic materials, other than windows and signs, will require different</td><td>No test requirement.</td></tr>
</table>

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						means of compliance, depending on material usage, for example: 1. Large, decorative coverings of sidewall panels with clear plastic material –These would need to fulfill 60 second vertical, smoke density and heat release requirements. 2. Clear front panels of stowages, or bar units – These belong to the category of cabin furnishing items requiring a 12-econd vertical test per Appendix F, part I, (a)(1)(ii). **Exemption to Exceptions**: Windows and transparent panels inserted in cabin partitions that are necessary to provide flight attendants with an unobstructed view of the passenger cabin.	
						Added Definitions** **Clear plastic windows:** Clear plastic materials used functionally as windows, e.g. interior window pane, partition window, etc. **Clear plastic signs:** Clear plastic materials used functionally as signs e.g. safety information placards, exit signs, light covers etc. Examples of clear materials include PMMA (Plexiglas), polycarbonates, PEI (polyetherimide), acrylic, etc. Note that mineral glass is not considered as it is not a plastic material, even though it can be clear.	
26	Printed wiring boards (PWB)	The test coupons must replicate the PWB laminate; however, the copper tracing may be excluded from the coupon configuration. The test must include the PWB material with solder mask and conformal coating, if a conformal coating is used. Testing of the laminate in the thinnest cross section will substantiate other PWBs made of the same laminate with thicker constructions.	No test requirement			The test coupons must replicate the PWB laminate; however, the copper tracing may be excluded from the coupon configuration. The test must include the PWB material with solder mask and conformal coating, if a conformal coating is used. Testing of the laminate in the thinnest cross section will substantiate other PWBs made of the same laminate with thicker constructions. PWBs produced under UL surveillance to an IPC-4101 Specification that requires a minimum requirement of UL 94 V-0 rating are accepted without further flammability testing. (Proposal only. Final report with data appears to not have been submitted yet.– 3/15/2012, TWL)	No test requirement
						Added Definitions** **Printed wiring boards (PWBs):** Used to mechanically support and electrically connect electronic components using conductive pathways, tracks or traces etched from copper sheets laminated onto a non-conductive substrate. Also referred to as a printed circuit board (PCB) or an etched wiring board. A PCB populated with electronic components is a printed circuit assembly (PCA), also known as a printed circuit board assembly (PCBA). **Copper Tracing:** The vast majority of printed wiring boards are made by bonding a layer of copper over the entire bare substrate, sometimes on both sides, (creating a "blank PWB") then removing unwanted copper after applying a temporary mask (e.g. by etching), leaving only the desired copper traces. A few PWBs are made by adding traces to the bare substrate (or a substrate with a very thin layer of copper) usually by a complex process of multiple electroplating steps. **Conformal Coating (CC):** Materials applied to electronic circuitry to act as protection against moisture, dust, chemicals, and temperature extremes that if uncoated (non-protected) could result in a complete failure of the electronic system. **Solder mask (aka solder resist)**: Lacquer-like layer of polymer that provides a permanent protective coating for the copper traces of a printed circuit board (PCB) and prevents solder from bridging between conductors, thereby preventing short circuits. The solder mask is most often applied with a green tint but is available in a wide variety of colors and finishes. It also provides some protection from the environment. **Same:** Means from the same manufacturer and same product family (same material / chemical composition) and same product build-up. So when the FAA draft policy memo refers to the "same type", the only change being allowed in the context of PWBs similarity would be the exclusive change from one thickness to another, provided it falls within the thickness range qualified and all other product parameters as listed above staying the same. Additionally different copper traces and bare substrate textures are allowed for similarity purposes.	
27	Material versus installation	The part installation overrides the test method applicable to the material. For instance, carpet is substantiated using the 12-second Bunsen burner test unless the carpet is installed on the sidewall. Then it is tested as part of the sidewall using the 60-second Bunsen burner test.	Not applicable.			WAS: The part installation overrides the test method applicable to the material. For instance, carpet is substantiated using the 12-second Bunsen burner test unless the carpet is installed on the sidewall. Then it is tested as part of the sidewall using the 60-second Bunsen burner test. See clarification per item #27, paragraph 6.1 (Revised Proposal), Rev. NC	Not applicable.

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						IS: With the clarifications listed below, the part installation overrides the test method applicable to the material. For example, formed thermoplastic parts would typically be substantiated by testing per the 12-second vertical test of (a)(1)(ii). But if a sidewall panel is made from a thermoplastic material, it would have to be tested to the 60-second vertical flammability test of (a)(1)(i). Another example would be carpet, which is substantiated by testing per the 12-second vertical test of (a)(1)(ii) unless it is installed on the sidewall. Then it is tested as part of the sidewall using the 60-second vertical test of (a)(1)(i). Lastly, a relatively small cover or door consisting of materials defined in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(ii), attached mechanically to a component identified in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(i) would be substantiated by testing per the 12-second vertical test of (a)(1)(ii). Materials and/or parts called out in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(ii), installed on parts called out in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(i), shall be tested to the requirements of 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(i) [60-sec VBB]. Materials and/or parts called out in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(ii), not installed on parts called out in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(i), shall be tested to the requirements of 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(ii) [12-sec VBB]. Clarifications 1. The general panel construction (including decorative finishes) for parts defined by CFR Part 25 Appendix F Part 1 sub part (a)(1)(i) must be constructed of materials that meet the test requirements of (a)(1)(i) [60-sec VBB]. See additional clarification below.[1] 2. Parts defined by 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(ii) made of materials specified in sub part (a)(1)(iv) may be tested per the requirements of (a)(1)(iv) [15-sec HBB]. 3. Installed panel details or materials defined as separate items per FAA Policy Memo ANM-115-09-XXX shall be substantiated per those applicable MOCs (e.g. Part 2, Item 28). 4. Carpet and Floor Coverings installed on structural flooring shall be tested per the requirements of 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(ii) [12-sec VBB]. [1]Due to different interpretations of the current terms in Appendix F Part 1 sub part (a)(1)(i), refer to 14 CFR Part 25.853(d) definitions and descriptions when additional clarification is needed: (1) Interior ceiling and wall panels, other than lighting lenses and windows; (2) Partitions, other than transparent panels needed to enhance cabin safety; (3) Galley structure, including exposed surfaces of stowed carts and standard containers and the cavity walls that are exposed when a full complement of such carts or containers is not carried; and (4) Large cabinets and cabin stowage compartments, other than under seat stowage compartments for stowing small items such as magazines and maps. The preceding items shall be tested to the requirements of 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(i). [60-sec VBB]	

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						Added Definitions** **Material:** Substances or raw matter with certain physical properties that are used as inputs to production, manufacturing or finishing processes. **Installation:** Finished materials or finished products installed in position or connected for use on parts through a process of bonding, or co-curing (not mechanically fastened or taped).	
28	Bonded details (Now also includes Items #29 through 32, Items #34 through 39, & Item #41)	See part 2	The test requirement is decided based on size criteria. 1) Test required if greater than 2 sq ft; 2) No test if less than 1 sq ft; and 3) Further considerations required between 1 and 2 sq ft.	Unless it can be concluded that the part is small and does not contribute to the propagation of a fire in accordance with Appendix F, Part I (a)(1)(v), testing of the detail, without adhesive, to the appropriate requirement in Appendix F, Part I (a)(1)(ii) or (a)(1)(iv) substantiates the bonded configuration.	See part 1, item 28	WAS: Unless it can be concluded that the part is small and does not contribute to the propagation of a fire in accordance with Appendix F, Part I (a)(1)(v), testing of the detail, without adhesive, to the appropriate requirement in Appendix F, Part I (a)(1)(ii) or (a)(1)(iv) substantiates the bonded configuration. IS: Unless it can be concluded that the part is small and does not contribute to the propagation of a fire in accordance with Appendix F, Part I (a)(1)(v), the following methods of compliance are available to substantiate the bonded construction. **OPTION #1:** Adhesive, Detail, and Substrate tested separately: Test the adhesive by itself to 12-sec VBB and separately test the detail and substrate, without adhesive, to the applicable requirements in Appendix F, Part I (a)(1)(i) [60-sec VBB], (a)(1)(ii) [12-sec VBB] or (a)(1)(iv) [15-sec HBB]. NOTE: This MoC is not applicable to hook/loop, placards, or other thin polymer films; use other MoCs options for compliance of these bonded features. NOTE: This MoC is also valid when adhesive is not used and the bonded construction is created from cocuring with a composite panel (e.g. no adhesive). **OPTION #2:** Non-metallic Bonded Construction of specific adhesive: Separately test the detail and substrate, without adhesive, to the applicable requirements in Appendix F, Part I (a)(1)(i) [60-sec VBB], (a)(1)(ii) [12-sec VBB] or (a)(1)(iv) [15-sec HBB], and show compliance of the specific adhesive using data bonding two non-metallic materials together. Note: This option is not applicable to hook and loop, placards or thin films, and these bonded details will need to be substantiated using option 3 or 4. **OPTION #3:** Specific Detail Bonded to a Worst Case Substrate: Test the specific detail bonded to a thin laminate at a thickness of 0.02" or less (considered worst case) in accordance with Appendix F, Part I (a)(1)(ii) [12-sec VBB]. Once qualified in this manner, the detail/adhesive combination may be bonded to other substrates without further test. Data substantiates the bonded detail/adhesive combination on any substrate. Test data on the minimum thickness of the detail substantiates any thicker detail of the same material. **OPTION #4:** As Installed Configuration Test the "as installed" configuration to the applicable requirements in Appendix F, Part I (a)(1)(i) [60-sec VBB], (a)(1)(ii) [12-sec VBB] or (a)(1)(iv) [15-sec HBB] based on the detail being bonded. If the bonded area of the detail is greater than 2 square feet, test the bonded construction to 60sec VBB. Note: If the base panel is over 0.25 inches, the back side would be either tested to the same test requirement, or by using item # 9 (FASE) to the base panel testing.	WAS: Unless it can be concluded that the part is small and does not contribute to the propagation of a fire in accordance with Appendix F, Part I (a)(1)(v), testing of the detail, without adhesive, to the appropriate requirement in Appendix F, Part I (a)(1)(ii) or (a)(1)(iv) substantiates the bonded configuration. IS: The test requirement for bonded details is decided based on size and installation/proximity criteria defined below. 1) Test required if cumulative total greater than 2 sq ft; 2) No test if cumulative total less than 1 sq ft; and 3) Further considerations required between 1 and 2 sq ft 4) A Bonded Detail can be excluded from testing if a) It is a bond line less than 1.0" wide on an individual item b) It is located fully within 2.0" of panel edge c) It is located fully within 4.0" of cabin floor d) Lineally applied and less than 2 sq ft in total surface area on a panel surface **Additional discussion for 25.853(d):** While the proposed size criteria are generally accepted & used by the industry for determination of when a panel surface area reaches a size where it can be considered a "large panel surface area," use of these generic panel criteria requires further clarification to define instances where Bonded Details do not need to be considered as part of the bonded construction for compliance to 25.853(d). Refer to the figure below (at the end of the Added Definitions) for an example of each of the following scenarios. a. Bonded Details with bond lines less than 1" wide should be excluded from consideration due to their lineally applied nature and small area contribution. b. Bonded Details located fully within 2" of panel edge should be excluded from consideration due to their lineally applied nature and will not constitute a large surface area. c. Bonded Details located fully within 4" of floor should be excluded from consideration given their close proximity to the cabin floor which was found during full scale testing to have very little involvement until after flashover had occurred. d. Rubstrips, raceways, and other bonded details that are lineally applied and less than 2sq ft on a single panel surface should be excluded from consideration. These types of Bonded Details are applied on discrete monuments and by their nature will not constitute a large surface in a concentrated area. In all of the above mentioned considerations, the requirements of 14 CFR 25.853(d) must still be met for the panel surface onto which the Bonded Detail is adhered and the detail itself must meet the applicable requirements of 25.853(a). In addition, for bonded details of the same material construction on the same panel surface area, the determination of size is based on the cumulative

Ref. #	Feature/ Construction	Part 1: Acceptable methods w/o additional data — 25.853(a) Bunsen Burner Test Req. / Similarity	Part 1: 25.853(d) HR & SD Test Req. / Similarity	Part 2: Methods of compliance that require supporting data — 25.853(a) Bunsen Burner Test Req. / Similarity	Part 2: 25.853(d) HR & SD Test Req. / Similarity	Industry Proposals for Final Policy Acceptable Methods — 25.853(a) Bunsen Burner Test Req. / Similarity	Industry Proposals: 25.853(d) HR & SD Test Req. / Similarity
							total of those details.

Added Definitions**

Bonded detail: an additive element that is secured by non-mechanical means to a panel surface. The bonding materials include adhesives such as epoxy, urethane, etc. The application methods are usually applied manually or sprayed onto one or both surfaces. In some cases, bonded details may be co-cured with the composite panel during the cure cycle. Pressure sensitive adhesive (PSA), inclusive of double sided tapes, is another common type of non-mechanical means that is covered under this proposal. Bonding of the hook side or loop side individually to a panel is covered under this proposal, but the attachment of the hook to the loop is not considered as it is a mechanical attachment method. Typical bonded details include, but are not limited to, rub strips, edge trims, hook & loop fasteners, placards, brackets & clips, external wire raceways, kick strips, felt, pre-cured doublers, and plastic mirrors.

The term 'bonded detail' in the context of this item is defined as inclusive of all items described in attachment 2, Part 2 items 29-32 & 34-41.

Edge trim, non-metallic: A molded, extruded, formed, or flat piece of non-metallic material that is bonded to the edge of a panel or a panel joint. The trim may wrap around the edge of the panel(s) or be applied to the cut edge of the panel. Hardwood trim, commonly used as a bullnose, should be included in the definition of non-metallic materials in the context of this item. Edge trim does not exceed more than 2" from the edge of the panel.

Kickstrip: A material or combination of materials applied at floor level of a vertical surface as a means of protection of the base materials from damage & wear and not as the primary decorative covering of the panel.

Felt: In the context of this item, refers to a non-woven cloth that is produced by matting, condensing and pressing non-metallic fiber material used as a thermal insulation, sound dampening, or moisture barrier and not used as the primary decorative covering of the panel.

Grommet: A rigid or flexible type of edge trim that is applied around the inside edge of a hole through a panel. Grommets may be designed for a specific size hole or they may be an flexible trim piece that is cut to length and applied to unique hole contours. Grommets are used to reinforce a hole, to shield something from the sharp edges of the hole, or both.

Wire raceways: A type of conduit to provide for placement of wires and cables. It can be installed internal to a panel or externally applied with various adhesives.

Rub strip: A molded, extruded, formed, or flat piece of non-metallic material that is bonded to the surface of a panel for the purpose of protecting the panel from damage.

Panel surface area: A surface is a single panel or multiple individual panels that butt together with minimal or no gap to provide a continuous surface. Panels in different geometrical planes that join together and are not contiguous are considered to be separate surfaces.

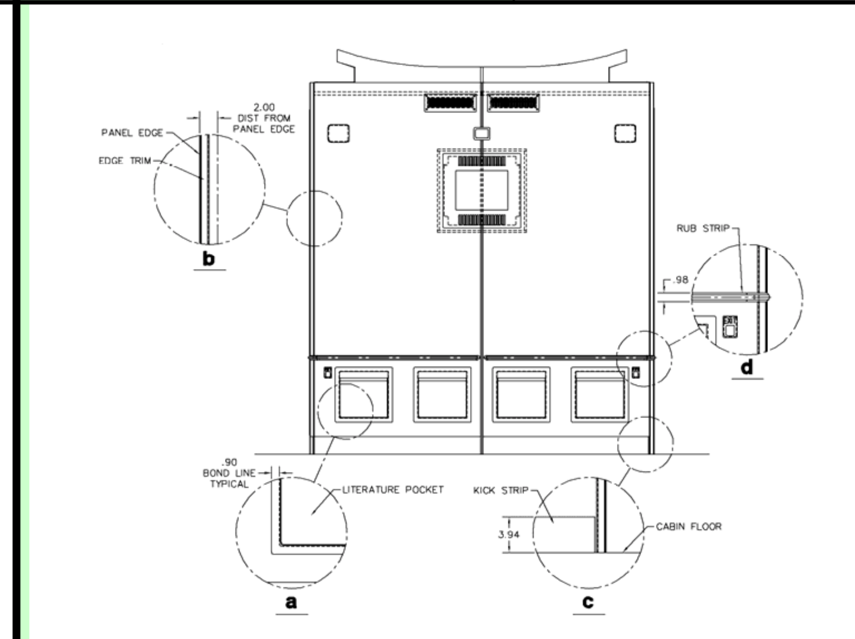
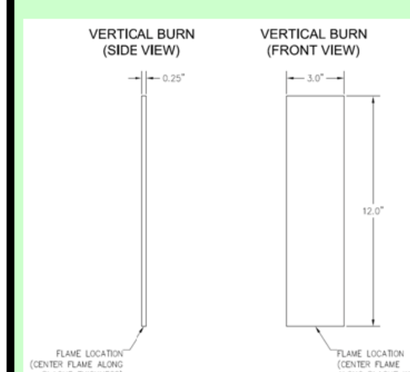
Examples
- 2 panels meeting at a 90-degree joint are not considered to be contiguous so are separate surfaces.
- A curved bag bin door is a contiguous panel surface.
- The work face of a galley with multiple individual panels/doors all in the same plane is considered to be a contiguous surface.

Bonded construction: The build-up of a panel inclusive of all materials and details at a specific cross section that are attached by means of adhesive bond.

Bond area: The effective surface area where adhesive is applied between the panel surface area and the attached adherent.

Lineally applied: A bonded detail is considered to be lineally applied when it is a long thin part typically with a width of 2.0" or less and the surface area is spread out in a long, narrow band. Examples of Bonded Details that commonly meet this definition include, but are not limited to, Rub Strips/Trims (#29), Edge Trim/non-metallic (#30), Exterior Wire Raceways (#35), Felt (#37), Kickstrips (#36), Metal & Plastic Bracket (#34), Hook & Loop Fastener (#31), and Grommets (#38).

Cumulative detail: Groupings of small items of same construction, each of which individually falls below the 1 to 2 sq ft rule but as a collective group on a single **Panel Surface Area** may exceed that criterion. Examples of Bonded Details that commonly meet this definition include, but are not limited to, Placards (#32), Metal & Plastic Bracket (#34), Hook & Loop Fastener (#31), Felt (#37), and Grommets (#38).

Ref. #	Feature/ Construction	Part 1: Acceptable methods w/o additional data		Part 2: Methods of compliance that require supporting data		Industry Proposals for Final Policy Acceptable Methods	
		25.853(a) Bunsen Burner Test Req. / Similarity	25.853(d) HR & SD Test Req. / Similarity	25.853(a) Bunsen Burner Test Req. / Similarity	25.853(d) HR & SD Test Req. / Similarity	25.853(a) Bunsen Burner Test Req. / Similarity	25.853(d) HR & SD Test Req. / Similarity
							
29	Rub strips/trim (chafing and decorative, includes bullnose trim)			See part 2, item 28	See part 1, item 28	See item 28	See item 28
30	Edge trim, nonmetallic (includes bullnose edge trim)			See part 2, item 28	See part 1, item 28	See item 28	See item 28
31	Hook and Loop			See part 2, item 28	See part 1, item 28	See item 28	See item 28
32	Placards			See part 2, item 28	See part 1, item 28	See item 28	See item 28
33	Edge potting and/or edge foam	Test a fabricated section of the panel containing the edge potting compound or foam to 60-second vertical.	See item 28	Test a block of foam or potting compound by itself per appendix F - part I, (a)(1)(ii).	See part 1, item 28	The edge fill in a panel may be shown compliant using one of the following options: Option 1: Test a plaque of edge fill material by itself per Appendix F - Part I, (a)(1)(ii). (12-second vertical Bunsen burner test) Plaque of nominal size 0.25" x 3" x 12" configured per figure below.  Option 2: Test a standard panel containing the edge fill material per Appendix F - Part I, (a)(1)(i) (60-second vertical Bunsen burner test). Standard panel 3" x 12" with 0.125" to 1" of the edge fill material configured per figure below.	No Test Required when less than 1" wide of edge fill material is used. (looking at face of panel). Could also state, less than 1" deep into the panel measured from the edge. (Cannot find the wording in red in any of the Item 33 team reports. Where did it come from? 3/16/2012, TWL) If greater than 1" based on the size criteria 1. Test required if greater than 2 sq ft. 2. No test if less than 1 sq ft and 3. Further considerations required between 1 & 2 sq ft. (Size criteria above come from latest Item 33 report, Rev. D dated 8/18/2011. Accessed 3/16/2012, TWL.)

Ref. #	Feature/ Construction	Part 1: Acceptable methods w/o additional data		Part 2: Methods of compliance that require supporting data		Industry Proposals for Final Policy Acceptable Methods	
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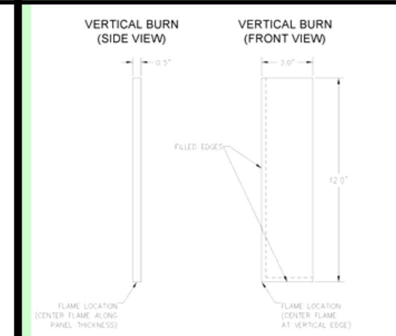
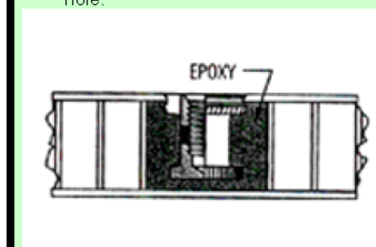
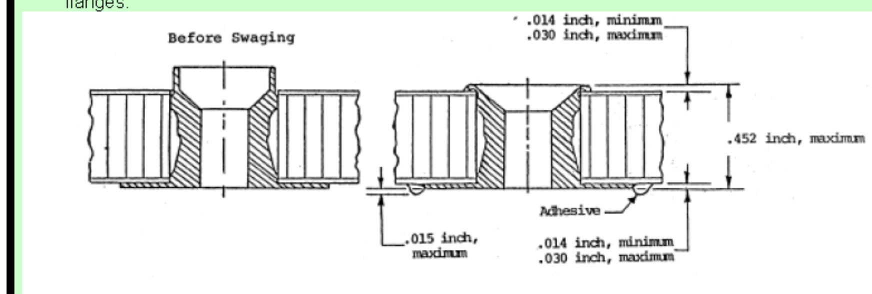
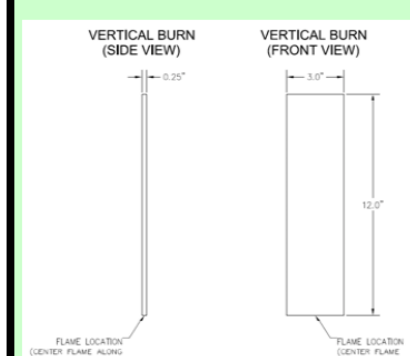
						 **Added Definitions**** **Sandwich panel:** A rigid panel fabricated using face sheets (either fiber reinforced resins or metal) on either side of a core material (a rigid foam or a honeycomb structure made of aluminum or phenolic resin and aramid paper or fiberglass). **Standard panel:** A panel with 1- or 2-ply non-metallic skins, nominally 6.35 to 13 mm (0.25" - 0.51") thick, non-metallic honeycomb core, which meets 14 CFR 25.853(a), Appendix F, Part 1(a)(1)(i) [60-sec VBB]. **Core back:** The process of removing the core (e.g. honeycomb), from the edge of a panel back a determined dimension, while maintaining the upper and lower skins. **Edge fill material:** The material used to fill the edge of a panel, usually to improve the compression strength (in the z direction) of the panel edge, provide moisture resistance to avoid ingress of water or other fluids, and to provide a flat and/or smooth surface for the attachment of other materials, e.g. paints, trim, decorative laminates. Compositions vary by manufacturer but are usually made of either resin/fillers, resin/fillers/blowing agents, or foams incorporated into the panel manufacturing process. **Monuments:** A monument is a functional interiors component within the passenger cabin of the airplane. Examples are, but are not limited to, Lavatories, Galleys, Class dividers and Closets. **Plaques or bricks:** A solid construct made up exclusively of Edge Fill Material which is of ¼" x 3" x 12" nominal size.	
34	Brackets and Clips, metallic or non-metallic			See part 2, item 28	See part 1, item 28	See item 28	See item 28
35	Wire raceways (bonded to panel vs. conduit bonded within panel)			See part 2, item 28	See part 1, item 28,	See item 28	See item 28,
36	Kickstrips			See part 2, item 28,	See part 1, item 28	See item 28	See item 28
37	Felt			See part 2, item 28,	See part 1, item 28	See item 28	See item 28
38	Grommets			No test requirement per appendix F, part I, (a)(1)(v) (Small Part).	See part 1, item 28	WAS: No test requirement per appendix F, part I, (a)(1)(v) (Small Part). IS: See item 28	See item 28
39	Doublers, pre-cured			See part 2, item 28	See part 1, item 28	See item 28	See item 28
40	Doublers, metal (bonded)			See items 20 & 22. (Originally, "See part 2, item 28." -TWL, 3/16/2012)	See part 1, item 28	WAS: See item 28 IS: See item 20 (consolidation of 20, 22, 40).	WAS: See item 28 IS: See item 20 (consolidation of 20, 22, 40).
41	Mirrors, plastic			See part 2, item 28 **Note:** If the mirror is large enough to be considered part of the wall construction, then the mirror should be tested to appendix F, part I, (a)(1)(i).	See part 1, item 28	See item 28	See item 28
42	Bonded Inserts	Test adhesive to 12-second vertical.	See part 2	No test required	No test required	No test requirement for bonded inserts that are potted individually with adhesive localized to each insert. The bonded inserts shall not make up a majority of the panel area. **Added Definitions**** **Bonded:** Bonded refers to the use of adhesives, glue, or potting compounds as part of the installation of a fastener insert into a panel. From here forward, the bonding material will be described as an adhesive. Adhesive materials can be used to pre-pot the panel or may be "wet" installed by injecting the adhesive around the insert in the panel. Some inserts have an external flange and the adhesive may only be applied to the faying surface bond between the flange of the insert and the panel surface.	No test requirement for bonded inserts that are potted individually with adhesive localized to each insert. The bonded inserts shall not make up a majority of the panel area.

Ref. #	Feature/ Construction	Part 1: Acceptable methods w/o additional data		Part 2: Methods of compliance that require supporting data		Industry Proposals for Final Policy Acceptable Methods	
		25.853(a) Bunsen Burner Test Req. / Similarity	25.853(d) HR & SD Test Req. / Similarity	25.853(a) Bunsen Burner Test Req. / Similarity	25.853(d) HR & SD Test Req. / Similarity	25.853(a) Bunsen Burner Test Req. / Similarity	25.853(d) HR & SD Test Req. / Similarity
						Insert: Inserts are defined in the "fastener" category. Two main insert designs are used predominantly in interior panel fabrication. The first is a blind insert that contains an internal retaining nut. Blind inserts are commonly metal construction. The second common insert is a flanged insert, either one piece or two, and creates a hole "through" the panel for a bolt/screw to be inserted through the panel. "Through" inserts can be plastic or metal. Fastener attachments bonded to the surface of panels (e.g. "Clickbonds") are not considered inserts and are covered under bonded details. See attached figures to illustrate the common insert types: • Blind Insert: Hole drilled in panel and adhesive injected around the insert through holes in the insert flange. Some installation processes remove additional core up to 3X the diameter of the insert after drilling the hole.  • Flanged Insert: Hole drilled through the panel and a two piece or one piece is installed with adhesive under flanges.  **Figure 19 INSERT PROTRUSION REQUIREMENTS**	
43	**Bonded Joint Constructions**	**(tab & slot, mortise & tenon, ditch & pot, cut and fold, T-joints, pins, etc.)**		See below	See below	See below	See below
43a	Ditch and pot	Test panel and adhesive together (60-second vertical).	See item	See part 1	No test requirement	Compliance of a bonded joint construction can be shown by: <u>Option 1:</u> similarity to the base panel when the following are met: 1) The Adhesive is an epoxy based material 2) Panel is a honeycomb core panel with composite skins and meets 14CFR 25.853(a), Appendix F, Part 1 (a)(1)(i), 60-sec VBB, which is the compliance data used for similarity analysis. 3) Joint construction other than an outside bend Ditch & Pot joint (e.g. inside cut). <u>Option 2:</u> Test a plaque of adhesive by itself per appendix F - part I,(a)(1)(ii) (12-sec VBB). (Plaque of nominal size: 0.25" x 3" x 12" configured as shown in the figure below.  	<u>For ditch and pot and cut and fold joints:</u> No test requirement, if the exposed adhesive is 1" wide or less and a single cut. (Use of the word "wide" does not appear in industry report.—TWL, 3/19/2012). If ~~outside this scope~~ beyond this criteria, then test criteria is decided based on the size criteria 1. Test required if greater than 2 sq ft. 2. No test if less than 1 sq ft and 3. Further considerations required between 1 & 2 sq ft. <u>For Tab & Slot, Mortise & Tenon, T-joints, Bonded Pins:</u> No test requirement.
43d	Cut and fold	Test panel and adhesive together (60-second vertical).	See item 28	See part 1	No test requirement		
43b	Tab and slot	See part 2	No test requirement.	No test requirement. Traditionally industry has not tested these features.	See part 1		

Ref. #	Feature/ Construction	Part 1: Acceptable methods w/o additional data		Part 2: Methods of compliance that require supporting data		Industry Proposals for Final Policy Acceptable Methods	
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						Option 3: Test the Adhesive in a standard honeycomb panel in accordance with Appendix F Part I (a)(1)(i) [60-sec VBB]~~Per Figure IV in 4.1 above.~~ as shown in the figure below. The appropriate DAP joint configuration shall be used (inside or outside DAP joint. NOTE: The inside DAP joint will validate the other joint types of tab and slot, mortise and tenon, T-joints, and pin joints). Once qualified in this manner, the adhesive may be used in any other honeycomb panel configuration and shown to be compliant by similarity.  A generic corner joint indicating the location of the flame centered just below the honeycomb skin. The flame would be placed on the inside or outside joint with the greatest adhesive exposed in the corner of the test panel not the center of the 3" horizontal edge. Coupon sets would be cored back 1/8" – 1/4" depending on the joint type. If the adhesive is not exposed on the bottom edge of the test panel, the panel will be cut to expose adhesive to the flame. Option 4: Test the adhesive in a standard honeycomb panel in accordance with the Foam Block Test Method defined in Appendix A and in accordance with Appendix F Part I (a)(1)(i) [60-sec VBB] using test specimens per figure above. The test results shall meet burn length and drip extinguishing time only. The appropriate DAP joint configuration shall be used (inside or outside DAP joint. NOTE: The inside DAP joint will validate the other joint types of tab and slot, mortise and tenon, T-joints, and pin joints). Once qualified in this manner the adhesive may be used in another honeycomb panel configuration and shown compliant by similarity. Option 5: Test the "as installed" configuration to the applicable requirements in Appendix F, Part 1(a)(1)(i) [60-sec VBB].	
43c	Mortise and tenon					**Added Definitions**** **Standard panel:** A panel with 1- or 2-ply non-metallic skins, nominally 6.35 to 13 mm (0.25" - 0.51") thick, non-metallic honeycomb core, which meets 14 CFR 25.853(a), Appendix F, Part 1(a)(1)(i) [60-sec VBB]. **Core back:** The process of removing the core (e.g. honeycomb), from the edge of a panel back a determined dimension, while maintaining the upper and lower skins. **Adhesive or Bonding Material:** The material used to bond a cut edge of a panel. Often two part materials made up of a base resin and accelerator. Usually requires a period of time (several minutes to several hours) depending on temperature to dry or cure to handling strength. **Joint Types** (see descriptions & figures in report, "Items 43a-f Bonded Joints (Rev. C).pdf")	
43e	T-joints						
43f	Bonded pins			No test requirement			

Ref. #	Feature/ Construction	Part 1: Acceptable methods w/o additional data		Part 2: Methods of compliance that require supporting data		Industry Proposals for Final Policy Acceptable Methods	
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						1. Ditch & Pot a. Single slot b. Multiple slots 2. Tab & Slot 3. Mortise & Tenon 4. Cut and Fold 5. T Joints 6. Bonded Pins **Adhesive Plaque:** A specimen of the material to be tested that is made from 100% of the adhesive or bonding material. Plaques are sometimes referred to as a "brick." **Monuments:** A monument is a functional interiors component which makes up the passenger cabin of the airplane. Examples are, but are not limited to, Lavatories, Galleys, Bulk Heads, Class dividers, Closets, etc.	
44	WAS: Sealant, fillet seals IS: Sealant used for fillet sealing of aircraft interiors	See part 2	No test requirement. Industry has not traditionally tested fillet seals.	No test requirement	See part 1	No test requirement NOTE: Testing of the elastomeric material by itself to 14 CFR 25.853(a), Appendix F, Part I, (a)(1)(iv) will provide the substantiation data needed to show compliance for the use of elastomeric materials in sealing/bonding applications. (This paragraph added **04/23/2012**. Not yet officially approved by IP-44 Industry Team.)	WAS: No test requirement. Industry has not traditionally tested fillet seals. IS: No test requirement.
						Added Definitions**: **Fillet Seal**: The industry team agrees that the term 'fillet seal' in the context of this item refers to a seal applied after assembly at the juncture of two adjoining parts or surfaces, or along the edges of faying surfaces as a continuous bead of sealing material. It can be applied over, along the edges of, and between installed parts. Cleaning up of adhesive squeeze-out around bonded details is not considered a fillet seal and is covered as part of the bonded details items. **Sealant**: The industry team agrees that the term 'sealant' in the context of this item refers to a viscous, elastomeric material which, once applied, changes state to become solid, and is used to fill voids and gaps of various sizes to prevent the passage of liquids or gaseous media, as well as to help meet health and safety requirements, and meeting aesthetics requirements. Aerospace sealants are generally identified based on the main resin family used to produce them. The resin family most commonly used for fillet sealing of aircraft interiors is silicone. Within the silicone family, most of the materials used for fillet sealing aircraft interiors are RTV (room temperature vulcanizing) silicones. Therefore, in the context of this item, the generic term 'silicone' refers to RTV silicones. Other resin families used are polyurethanes and polysulfides.	

**Industry Flammability Standardization Task Group boilerplate on "Definition of Terms" (Section 3.2 in Industry Team reports): "In the interest of the overall stated goal of standardization of industry flammability practices, clear definitions of the terms _____, ____, and _____ shall be provided so that the confusion between different parties over their meaning (i.e. the meaning of the terms) shall be avoided. The industry group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document."

APPENDIX C—ITEM 1: PANELS, GENERAL

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM PROPOSAL

Part 1, Reference Item #01, “General”

Revision – A, dated 2010-Jul-12

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REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
NC	Official Release	2010-Apr-21	Keith Couilliard
A	Incorporated Jeff Gardlin comments dated 5/19/2010	2010-Jul-12	Keith Couilliard

1 INTRODUCTION

As part of the industry activities to provide validation of the Part 1 items from the referenced FAA draft policy, the industry teams are reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Item 1 has been reviewed by the industry team and is submitted the following proposals and justification.

The hierarchy of Bunsen burner testing (e.g. the substantiation of what requires horizontal Bunsen burner testing with vertical Bunsen burner data, and substantiation of what requires 12-second vertical Bunsen burner testing with 60-second vertical Bunsen burner data) and size criteria for what requires Heat Release and Smoke Density testing (e.g. testing components greater than 2 square feet in area, not testing components less than 1 square foot in area, and making a specific determination for components between 1 and 2 square feet) for general surfaces in aircraft interiors flammability testing according to 14 CFR 25.853 (a) and (d) is currently well established industry practice.

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials” [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA’s technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Item 01 has been reviewed by the industry team and is submitting the following concurrence, justification and proposal.

2 INDUSTRY TEAM LEADER AND SUPPORT TEAM

During an industry meeting on 24 September 2009 in Huntington Beach, CA, and the FAA Materials Fire Test Working Group meeting on 21 October 2009 in Atlantic City, NJ, the following individuals have volunteered to form the industry team for this reference item:

2.1 TEAM LEADER

- Keith Couilliard (Boeing)

2.2 SUPPORT TEAM

- Weichert, Ingo (Airbus)
- Landroni, Francisco (Embraer)
- Alcorta, Hector (Bombardier)
- Slaton, Dan (Boeing)
- Lulham, Ian (Bombardier)
- Smith, Jeff (Gulfstream)
- Le Neve, Serge (CEAT)

This list is by no means final, but represents a snapshot of the currently active industry participants. Additional remarks, suggestions, corrections and contributions from other individuals are very much encouraged.

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on 20 August, 2009. Attachment 2, Part 1, reference item #01 reads (see

Part 1, acceptable methods without additional data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
1	Panels, general	60-second vertical test data will substantiate configurations that only require 12-second vertical data. Vertical Bunsen burner data will substantiate configurations that only require horizontal Bunsen burner testing.	Test requirement is decided based on size criteria. 1) Test required if greater than 2 sq ft; 2) No test if less than 1 sq ft; and 3) Specific determination required between 1 and 2 sq ft.

Figure 1):

- 14 CFR 25.853 (a): *"60-second vertical test data will substantiate configurations that only require 12-second vertical data. Vertical Bunsen burner data will substantiate configurations that only require horizontal Bunsen burner testing."*
- 14 CFR 25.853 (d): *"Test requirement is decided based on size criteria.*
  1) Test required if greater than 2 sq ft;
  2) No test if less than 1 sq ft; and
  3) Specific determination required between 1 and 2 sq ft."

Part 1, acceptable methods without additional data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
1	Panels, general	60-second vertical test data will substantiate configurations that only require 12-second vertical data. Vertical Bunsen burner data will substantiate configurations that only require horizontal Bunsen burner testing.	Test requirement is decided based on size criteria. 1) Test required if greater than 2 sq ft; 2) No test if less than 1 sq ft; and 3) Specific determination required between 1 and 2 sq ft.

Figure 1: Attachment 2, Part 1, Reference Item #1

No equivalent entry exists for reference item #01 in attachment 2, Part 2.

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of the terms 'component', and 'exposed' should be provided so that confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

3.2.1 COMPONENT

The industry team agrees that a definition of the term 'component' is necessary as it is used in the supporting regulatory documentation validating the size criteria applicable to 25.853(d).

The industry team therefore recommends that the term 'component' in the context of this item be defined as constituent parts or elements that comprise an installation.

3.2.2 EXPOSED

The industry team agrees that a definition of the term 'exposed' is necessary as it is used in the supporting regulatory documentation validating the size criteria applicable to 25.853(d).

The industry team therefore recommends that the term 'exposed' in the context of this item be defined as an unconcealed surface that faces the interior of airplane passenger compartments during an emergency landing condition.

4 VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

25.853(a):

The usage of 60-second vertical test data to substantiate configurations that only require 12-second vertical data is supported technically by the petition for rule making filed by the AIA and addressed by the 1969 CFR NPRM 69-33 that led to Amendment No. 25-32 to 14 CFR Part 25. A modified more stringent test procedure (60-second vertical Bunsen burner) was required and implemented as improved state-of-the-art materials were available. The key aspect was to delineate between the improved state-of-the-art materials and the previous materials used by virtue of a test procedure that could characterize this difference in performance relative to a pass/fail criteria. The 60-second vertical test procedure was the newly implemented procedure to provide this capability in conjunction with revised pass/fail criteria compared to the previous standard defined by the 12-second vertical test procedure. The AIA report demonstrated that materials that met the 60-second vertical Bunsen burner test were shown to provide improved levels of cabin fire safety.

Per Advisory Circular 25-17A, guidance issued against Amendment 25-32 of 14 CFR 25.853 indicates that:

"(14) Paragraphs (b), (b-2), and (b-3). If material is demonstrated to comply with

paragraph (b) [12 second vertical], it is also considered to comply with paragraphs (b-2)[horizontal 2.5in/min] and (b-3)[horizontal 4in/min]. The reverse is not true. (Amendment 25-32)”

Based on this FAA guidance, there is technical justification in using data generated from either 60-second, or 12-second testing, to substantiate a requirement for horizontal data.

25.853(d):

Per the preamble discussions of Amendment 25-83 to 14 CFR 25.853, the size criterion is summarized as:

“*It is not possible to cite a specific size that will apply in all installations; however, as a general rule, components with exposed-surface areas of one square foot or less may be considered small enough that they do not have to meet the new standards. Components with exposed-surface areas greater than two square feet may be considered large enough that they do have to meet the new standards. Those with exposed-surface areas greater than one square foot, but less than two square feet, must be considered in conjunction with the areas of the cabin in which they are installed before a determination could be made.*”

4.2 PROPOSED STANDARD TO MEET

25.853(d):

The information above forms the basis for the size criteria on surfaces requiring compliance with 25.853(d). However, to add more clarification to the MOC wording, it is recommended by industry to describe the situations when a specific feature has criteria that overrides the criteria proposed in Part 1, Item 1 for general surfaces. Lastly, the clarification from the Amendment 25-83 preamble regarding exposed vs. non-exposed components is an important distinction that should also be mentioned in the proposed MOC wording.

5 DATA / ANALYSIS

N/A

6 CONCLUSION

The Part 1, Item 1 team believes that the current proposed MOC applicable to 25.853(a) is justified and acceptable as written.

The Part 1, Item 1 team believes that the current proposed MOC applicable to 25.853(d) is justified, but could benefit from the addition of more clarification wording as follows.

6.1 REVISED PROPOSAL

Test requirement is decided based on size criteria. This applies to component installations with large surfaces. Note: specific feature criteria defined in the new policy takes precedent over the general size criteria defined below. This MOC applies to component installations with exposed-surface areas.

1) Test required if greater than 2 sq ft;
2) No test if less than 1 sq ft; and
3) Specific determination required between 1 and 2 sq ft. Aspects to consider with this determination are location, quantity, and function of the given components.

7 ABBREVIATIONS

FAA	=	Federal Aviation Administration
MOC	=	Methods of Compliance
CFR	=	Code of Federal Regulations

8 REFERENCES

[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

[2] n.n., *14 CFR Part 25, [Docket No. 26192; Amendment No. 25-83], Improved Flammability Standards for Materials Used in the Interiors of Transport Category Airplane Cabins,* Department of Transportation, Federal Aviation Administration, February 1995.

[3] n.n., *14 CFR Part 25, [Docket No. 9605; Amendment No. 25-32], Crashworthiness and Passenger Evacuation Standards; Transport Category Airplanes*, Department of Transportation, Federal Aviation Administration, February 1972.

APPENDIX D—ITEMS 2 AND 24: THICKNESS RANGES

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM PROPOSAL

Part 1, Reference Items #2 and 24, “Thickness Ranges”

Revision – B, dated 2011-November 29

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REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
Draft	Draft Issue	2010-Mar-03	Mary Pacher
FINAL DRAFT	Incorporated changes from peer review	2010-Apr-08	Mary Pacher
NC	Added a team member and removed 2 hyperlinks.	2010-May-05	Mary Pacher
A	Updated to address FAA comments	2010-Aug-03	Mary Pacher
B	Removed editing marks in section 4.2. Updated Sections 4, 5 and 6 and added data in new appendices	2011-Aug-18	Mary Pacher

1 INTRODUCTION

For many years, industry practice has been to use “thin for thick” criteria for Bunsen burner testing. In 1990 when the FAA published Report # DOT/FAA/CT-99/15, the Aircraft Materials Fire Test Handbook included testing the thinnest material and using that data for thicker parts. The chapter on horizontal burn testing also notes a maximum specimen thickness 1/8 inch or 3mm. For heat release and smoke, industry practice is less uniform.

Industry practice has used various thickness range thickness criteria for showing compliance to 25.853(d). It is not uncommon to have a single thickness range bounded by the thinnest and thickest constructions used in production and both the thinnest and thickest constructions are tested. Elsewhere multiple thickness ranges are used, and the thinnest construction in each range is tested. Where multiple ranges are used, there is the possibility but not a requirement that the top of the range is tested by testing the bottom of a higher range.

The maximum specimen thickness that can be tested for heat release is 1.75 inch. Therefore, specimens with 1.75-inch core can be too thick to test. The maximum thickness tested for smoke is 1 inch.

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials” [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA’s technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Items 2 and 24 have been reviewed by the industry team and are submitting the following concurrence, justification and proposal.

2 INDUSTRY TEAM LEADER AND SUPPORT TEAM

During an industry meeting on 24 September 2009 in Huntington Beach, CA, and the FAA Materials Fire Test Working Group meeting on 21 October 2009 in Atlantic City, NJ, the following individuals have volunteered to form the industry team for this reference item:

2.1 TEAM LEADER

- Pacher, Mary O. (The Boeing Company)

2.2 SUPPORT TEAM

- Cheryl Hurst (American Airlines)
- David Julin (BE Aerospace)
- Michael Jensen (The Boeing Company)
- Hector Alcorta (Bombardier)
- Brad Shelton (Dassault Falcon)
- Eddie Cortes (Driessen)
- Gilberto Niitsu (Embraer)
- Jym Kauffman (Kydex LLC)
- Martin Spencer (Marlin Engineering)
- Shawn Clark (Recaro Inc.)
- Dirk Langer (Sell GmbH)
- Don Wang (Boltaron Performance Products)

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on 20 August, 2009.

3.1.1 REFERENCE ITEM #2

Attachment 2, Part 1, reference item #2, Thickness ranges, reads as follows (see Figure 1):

Part 1, acceptable methods without additional data			
Reference Number	**Feature / Construction**	**25.853(a) Bunsen Burner Test Requirement/Similarity**	**25.853(d) Heat Release and Smoke Test Requirement/Similarity**
2	Thickness ranges (panels, thermoplastics, foams)	Data from testing a thinner construction substantiates a thicker construction made of the same materials.	See part 2 of this attachment.

Figure 1: Attachment 2, Part 1, Reference Item #2

Attachment 2, Part 2, reference item #2 reads as follows (see Figure 2):

<table>
<tr><th colspan="4">Part 2, methods of compliance that require supporting data</th></tr>
<tr><th>Reference Number</th><th>Feature / Construction</th><th>25.853(a) Bunsen Burner Test Requirement/Similarity</th><th>25.853(d) Heat Release and Smoke Test Requirement/Similarity</th></tr>
<tr><td>2</td><td>Thickness ranges (panels, thermoplastics, foams)</td><td>See part 1 of this attachment.</td><td>

Except for foam core panels with prepreg skins where each thickness will be tested, use the following approach:

Sandwich panels, laminates, thermoplastic parts, and parts made from a single material are shown to be compliant with § 25.853(d) (appendix F, parts IV and V) by test, or by similarity to a part with similar thickness (in the same thickness range). For certification purposes, thickness ranges are defined to eliminate the need to test every possible thickness. It is an acceptable practice to test a given thickness within a tight range and use these data to substantiate all thicker items within that range. The following table details standard thickness ranges currently used.

<table>
<tr><th>Type Part</th><th>Thickness Range (inch)</th></tr>
<tr><td rowspan="6">Sandwich Panels - Core Thickness</td><td>0.125 - 0.187</td></tr>
<tr><td>0.188 - 0.249</td></tr>
<tr><td>0.250 - 0.499</td></tr>
<tr><td>0.500 - 0.749</td></tr>
<tr><td>0.750 - 1.749</td></tr>
<tr><td>1.750 and thicker</td></tr>
<tr><td rowspan="10">Laminates and Thermoplastics</td><td>0.020 - 0.039</td></tr>
<tr><td>0.040 - 0.059</td></tr>
<tr><td>0.060 - 0.079</td></tr>
<tr><td>0.080 - 0.099</td></tr>
<tr><td>0.100 - 0.199</td></tr>
<tr><td>0.200 - 0.299</td></tr>
<tr><td>0.300 - 0.499</td></tr>
<tr><td>0.500 - 0.749</td></tr>
<tr><td>0.750 - 1.749</td></tr>
<tr><td>1.750 and thicker</td></tr>
<tr><td rowspan="5">Single Unit Materials</td><td>0.080 - 0.119</td></tr>
<tr><td>0.120 - 0.249</td></tr>
<tr><td>0.250 - 0.499</td></tr>
<tr><td>0.50 - 1.749</td></tr>
<tr><td>1.75 and thicker</td></tr>
</table>
</td></tr>
</table>

Figure 2: Attachment 2, Part 2, Reference Item #2

3.1.2 REFERENCE ITEM #24

Attachment 2, Part 1, reference item #24, Thermoplastic thickness ranges, reads as follows (see Figure 3):

Part 1, acceptable methods without additional data			
Reference Number	**Feature / Construction**	**25.853(a) Bunsen Burner Test Requirement/Similarity**	**25.853(d) Heat Release and Smoke Test Requirement/Similarity**
24	Thermoplastic, thickness ranges	Data from testing a thinner construction substantiates a thicker construction made from the same materials.	It is an acceptable practice to test a given thickness within a tight range and use these data to substantiate all thicker items within that range. See item 2 in this attachment for acceptable thickness ranges.

Figure 3: Attachment 2, Part 1, Reference Item #24

No entry exists for reference item #24 in attachment 2, Part 2.

3.1.3 INTERPRETATION OF 25.853(d) ENTRY FOR REFERENCE NUMBER 24

As stated in attachment 2, Part 1, it is an acceptable practice to use thickness ranges. "See item 2… for acceptable thickness ranges" is a convenience, to avoid multiple listings of the same information. It does not mean (by referring to ranges listed in Part 2) that the ranges for thermoplastic parts require data. No further validation of the thickness ranges shown in Section 3.1.1 for heat release and smoke testing of thermoplastics is required.

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of terms 'should be provided so that confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

3.2.1 THICKNESS

The industry team agrees that the intent of this item is to cover difference in the designed thickness of parts, not the very small differences covered by tolerances.

Except for machined parts and molded parts, the thickness variable that can be directly controlled is the thickness of the material used to make the part. For machined or molded parts, the final thickness is the controlled variable. In the case of thermoformed sheet parts, the predominant thickness (in flat areas of the part) is typically very close to the nominal sheet thickness with thinner areas in the areas where there is significant stretching of the sheet. In some cases, the type design does not control the part thickness beyond specifying the sheet thickness to use in forming the part. In laminate parts, the thickness of the part is controlled by the number of plies used. There is some variation in the resulting thickness, but it is difficult to fine-tune the thickness of parts or specimens.

FAA Memorandum
ANM-115-09-XXX, "Policy Statement on Flammability Testing of Interior Materials"
Parts 1 and 2, Reference Items #2 and 24, "**Thickness Ranges**"

The industry team recommends that 'thickness' in the context of this item be defined as "the nominal thickness of sheet material or the nominal thickness of the part. Part thickness is used for instances where the dimensions of the part are not approximated by the raw material dimensions, such as an injection molded part where the raw material consists of small pellets, or where the design does not identify a sheet stock dimension, but only a final thickness." For sandwich panels and multilayer bonded assemblies, the thickness of individual materials or layers is more meaningful than the assembly thickness.

Thickness normally need not take into account the small additional thickness of paint or a decorative laminate that may be applied to the part.

3.2.2 PANELS - CORE THICKNESS

The industry team agrees that "Panels – core thickness" applies to rigid panels with a separate material such as honeycomb core used for the inner layer. The thickness ranges for "panels – core thickness" apply only to changes in core thickness, not to changes in facesheet thickness. At this time, the only core materials commonly used are foam core and honeycomb core. Because the Part 2 wording excludes the use of thickness ranges for foam core panels, for 25.853(d) the use of thickness ranges applies to honeycomb core panels only.

Crushed core panels normally specify the thickness of core to use, the number of plies to use in the facesheets, and a final part thickness. The final core thickness is not known; it can only be estimated. Therefore, for crushed-core panels, the applicable core thickness is the nominal core thickness before crushing. Determining the final core thickness in a crushed-core part is not required. Because it contains the same materials, but places the backside face closer to the heat source, data from a crushed-core panel can be used to substantiate a part made from the same materials, but crushed less, that is, with a greater final thickness.

The industry team recommends that the term 'core thickness' in the context of this item be defined as "the nominal sheet thickness of the honeycomb core material used for the part."

3.2.3 LAMINATES

The industry team agrees that the category of 'Laminates and Thermoplastics' was intended to cover reinforced or unreinforced thermoplastic materials plus thermosetting composite materials not incorporating honeycomb core or foam core. These materials include composites reinforced with short fibers as well as continuous fiber reinforced composites made from preimpregnated sheets of material reinforced with woven fabric or unidirectional tape.

The industry team recommends that the term 'laminates' in the context of this item be defined as "thermosetting composites reinforced with continuous fiber or discontinuous fiber but not incorporating core."

3.2.4 THERMOPLASTICS

The industry team agrees that the category of 'Laminates and Thermoplastics' was intended to cover reinforced or unreinforced thermoplastic materials plus thermosetting composite materials not incorporating honeycomb core or foam core. These materials include composites reinforced with short fibers as well as continuous fiber reinforced composites made from preimpregnated sheets of material reinforced with woven fabric or unidirectional tape.

The industry team recommends that the term 'thermoplastic' in the context of this item be defined as "polymeric materials capable of being repeatedly softened by increase in temperature and hardened by a decrease in temperature and which may or may not incorporate fiber reinforcement.”

3.2.5 SINGLE UNIT MATERIALS

The industry team agrees that this category of materials was intended to cover materials which, unlike composite materials, are uniform throughout. Examples identified as single unit materials included metals, unreinforced elastomers, and foam. While the team could identify single unit materials with Bunsen burner requirements, single unit materials subject to 25.853(d) were difficult to find.

The industry team recommends that the term ‘single unit materials’ in the context of this item be defined as “materials which, unlike composite materials, are uniform throughout.”

3.2.6 SAME

The industry team agrees that when comparing the properties of different thicknesses of material, other aspects of the construction must be the same, that is, the material must be either the same color and the same product from the same supplier, or the same color and controlled to the same specification callout (specification number, type, class, grade, form, etc.) with the same decorative elements applied (if any). Since core thickness is evaluated by testing panels, the data for a honeycomb core material must be generated from panels with the same material used for the facesheets, the same number of plies, and the same decorative elements applied (if any). The decorative elements might be paint, Tedlar, or a decorative laminate, but the same decorative element, of the same color, would be used for all the test data for a material.

The industry team recommends that the term ‘same’ in the context of this item be defined as “the same color from the same manufacturer, the same product family, and the same product buildup, or the same color and controlled to the same specification callout and the same product buildup.”

4 VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

The use of the Item #2 MOC has been grouped by the FAA into Part 1 for 14 CFR 25.853(a) and into Part 2 for 14 CFR 25.853(d). The use of the Item #24 MOC has been grouped by the FAA into Part 1 for both 14 CFR 25.853(a) and (d). As such, only Item #2 for 14 CFR 25.853(d) requires supporting data. Item #2 for 14 CFR 25.853(a) and Item #24 for 14 CFR 25.853(a) and (d) could be accepted as written without further supporting data.

Based on review by the industry, Part 1, Item #2 and #24 guidance is acceptable as written. However, based on differences in industry practices, the following modifications are proposed for Items #2 and #24 guidance for 14 CFR 25.853(d):

- Use the same thickness ranges for the different types of materials and parts,
- Adjust the thickness ranges to use fewer significant figures,
- Add metric ranges as well as English-unit ranges, and
- Use a smaller number of thickness ranges, and test both the bottom and top of the range.

4.2 PROPOSED STANDARD TO MEET

Modify attachment 2, Part 2, reference item #2 to read as follows:

- 14 CFR 25.853 (a): “See part 1 of this attachment”

- 14 CFR 25.853 (d): “Except for foam core panels with prepreg skins where each thickness will be tested, use the following approach:
  Sandwich panels, laminates, thermoplastic parts, and parts made from a single-unit material are shown to be compliant with § 25.853(d) (appendix F, parts IV and V) by test, or by similarity to a part with similar thickness (in the same thickness range). For certification purposes, thickness ranges are defined to eliminate the need to test every possible thickness. It is an acceptable practice to test two thicknesses within a range and use these data to substantiate all items with thickness between those two values. The following table details the standard thickness ranges:

Part or material thickness	Thicknesses tested to show compliance
0.02 - 0.06 inch 0.5 –1.5 mm	0.02 inch & 0.06 inch or 0.5 mm & 1.5 mm
0.06 – 0.1 inch 1.5 – 2.5 mm	0.06 inch & 0.1 inch or 1.5 & 2.5 mm
0.1 - 0.25 inch 2.5 - 6 mm	0.1 inch & 0.25 inch or 2.5 mm & 6 mm
0.25 - 0.5 inch 6 - 12.5 mm	0.25 inch & 0.5 inch or 6 mm & 12.5 mm
0.5 – 1.0 inch 12.5 – 25.5 mm	0.5 inch & 1.0 inch or 12.5 mm & 25.5 mm
1.0 - 1.75 inch 25.5 – 44.5 mm	1.0 inch & 1.75* inch or 25.5 mm & 44.5* mm
1.75 inch & thicker 44.5 mm & thicker	1.75* inch or 44.5* mm

* 1.75 inch or 44.5 mm specimens are not tested for smoke. “

The smallest thickness range shown is 0.040 inch (1 mm). It is also acceptable to use data from an 0.040 inch range with different endpoints. That is, if there is data for two configurations that are the same except for a thickness difference of approximately 0.040 inch (1 mm), that data can be used to show compliance for a configuration with thickness between the other two.

When testing the maximum thicknesses for heat release, 1.75 inch or 44.5 mm, the thickness to test may require adjustment, so that the total specimen thickness does not exceed the maximum thickness that can be tested. This is most likely when testing a thick sandwich panel, but could occur for other materials in a bonded configuration. This adjustment is necessary to run the test and therefore acceptable.

Thickness ranges can be used for a portion of a configuration. For example, a composite sandwich panel with a laminate stiffener bonded to it might use the (sandwich panel – core) thickness range for the sandwich panel, the (laminates and thermoplastics) thickness range for the stiffener, or both. Another example is that a painted part could use the thickness ranges, by testing two specimens within the range applicable to the part, with the same finish applied to the specimens as to the part.

5 DATA / ANALYSIS

5.1 TEST DATA

The industry has called upon its members to submit existing flammability test data to support these thickness ranges for 14 CFR 25.853(d). Several data packages are expected to be submitted by the industry to support these ranges. Data from a variety of materials including honeycomb core (in a panel configuration), laminate materials, and thermoplastic materials will be collected. Many materials are not used over the entire range of thicknesses shown in the table, but for a material used over this broad range of thicknesses, the following data would be preferred.

Heat release and smoke data will be presented for thermoplastic materials, thermoset materials, and honeycomb core materials. The honeycomb core materials will be tested in a panel configuration. The data for a material will all use the same configuration except for thickness. Color, decoratives that may be applied to the parts, number of plies, etc. will be held constant for each material, but may be different for different materials.

Part or material thickness	Thicknesses tested to show compliance	Data wanted to show this testing is sufficient
0.02 - 0.06 inch or 0.5 – 1.5 mm	0.02 inch & 0.06 inch or 0.5 mm & 1.5 mm	0.02 inch or 0.5 mm
		0.04 inch or 1 mm
		0.06 inch or 1.5 mm
0.06 - 0.1 inch or 1.5 – 2.5 mm	0.06 inch & 0.1 inch or 1.5 mm & 2.5 mm	0.06 inch or 1.5 mm
		0.08 inch or 2 mm
		0.1 inch or 2.5 mm
0.1 - 0.25 inch or 2.5 - 6 mm	0.1 inch & 0.25 inch or 2.5 mm & 6 mm	0.1 inch or 2.5 mm
		one test between 0.1 inch & 0.25 inch or between 2.5 mm and 6 mm
		0.25 inch or 6 mm
0.25 - 0.5 inch or 6 - 12.5 mm	0.25 inch & 0.5 inch or 6 mm & 12.5 mm	0.25 inch or 6 mm
		one test between 0.25 inch & 0.5 inch or between 6 mm and 12.5 mm
		0.5 inch or 12.5 mm
0.5 - 1.0 inch or 12.5 - 25.5 mm	0.5 inch & 1.0 inch or 12.5 mm & 25.5 mm	0.5 inch or 12.5 mm
		one test between 0.5 inch & 1.0 inch or between 12.5 mm and 25.5 mm
		1.0 inch or 25.5 mm
1.0 - 1.75 inch or 25.5 - 44.5 mm	1.0 inch & 1.75 inch or 25.5 mm & 44.5 mm	1.0 inch or 25.5 mm
		one test between 1.0 inch & 1.75 inch or between 25.5 mm and 44.5 mm (Heat release only) Smoke compliance is shown using data from test of 1.0 inch or 25.5 mm thickness only
		1.75 inch or 44.5 mm (Heat release only) Smoke compliance is shown using data from test of 1.0 inch or 25.5 mm thickness only
1.75 inch & thicker or 44.5 mm & thicker	1.75 inch or 44.5 mm	1.75 inch or 44.5 mm (Heat release only) Smoke compliance is shown using data from test of 1.0 inch or 25.5 mm thickness

5.2 ANALYSIS OF TEST DATA

Analysis of laminate data from different materials 0.019 to 0.200 inches thick is shown in Appendix A.

Analysis of thermoplastic data from different materials 0.028 to 0.125 inches thick is shown in Appendix B.

Analysis of sandwich panels with core thickness from 0.125 inch to 1 inch is shown in Appendix C.

Analysis of sandwich panels with the same core thickness and different thicknesses of facesheet (0.01 to 0.03 inch nominal) is shown in Appendix D.

6 CONCLUSION

As shown in Appendix A, laminate data from different materials supports the use of the thickness ranges shown.

As shown in Appendix B, thermoplastic data from different materials supports the use of the thickness ranges shown.

As shown in Appendix C, data from sandwich panels supports the use of core thickness ranges shown.

As shown in Appendix D, data from sandwich panels with different facesheet thickness supports the use of thickness ranges for honeycomb facesheets as well as for stand-alone laminates.

7 ABBREVIATIONS

FAA	=	Federal Aviation Administration
MOC	=	Methods of Compliance
CFR	=	Code of Federal Regulations

8 REFERENCES

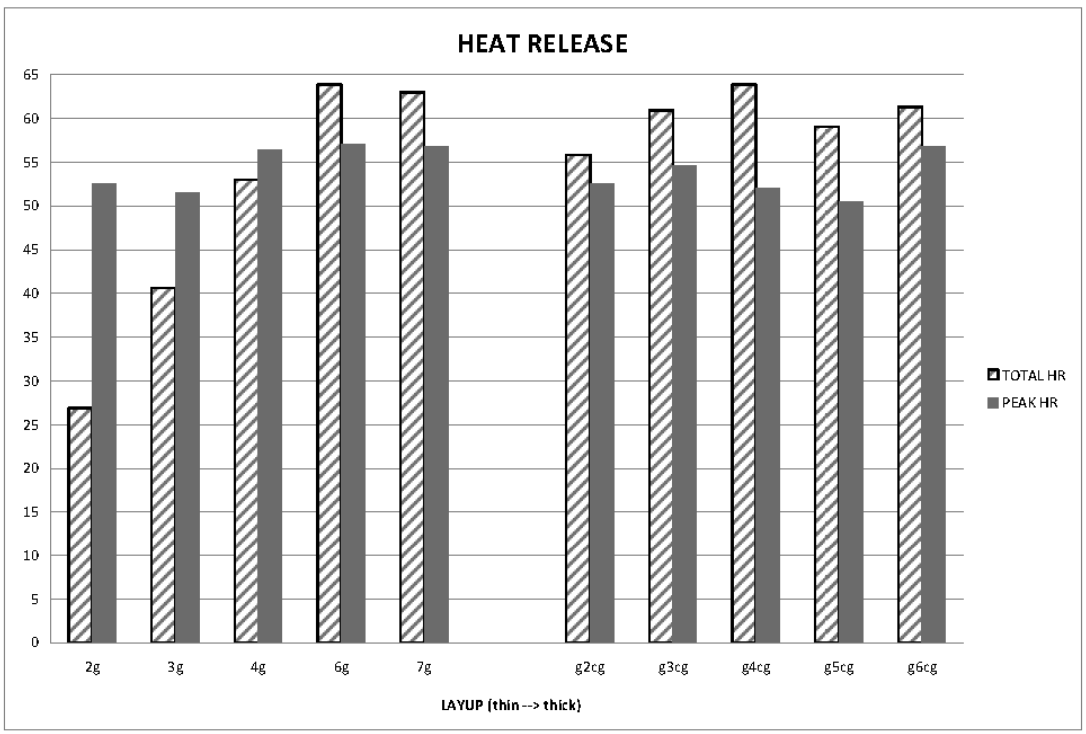
[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

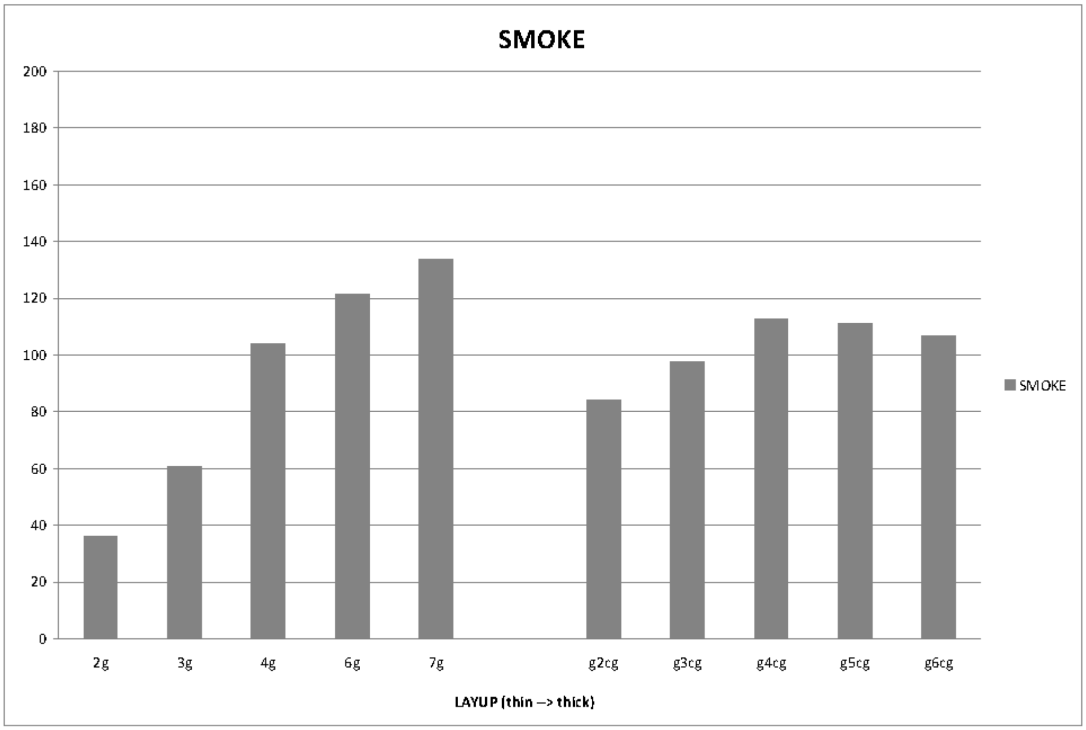
APPENDIX A LAMINATE DATA

Seat Laminate Data from Test Report 4FR4157-43

The following charts show data from fiberglass laminates with two (2g) to seven (7g) plies and fiberglass/carbon hybrid laminates with two (g2cg) to six (g6cg) plies of carbon between outer plies of fiberglass. Each data point is the average of three test specimens of that configuration. The nominal thickness of each fiberglass ply is 0.240 inch and the nominal thickness of each carbon ply is 0.310 inch.

Thickness had little effect on the peak heat release rate. Initially, as thickness increases total heat release also increases. As specimens get to be thick, the total heat release and smoke release level off or drop slightly. This is consistent with slower ignition for thick specimens.





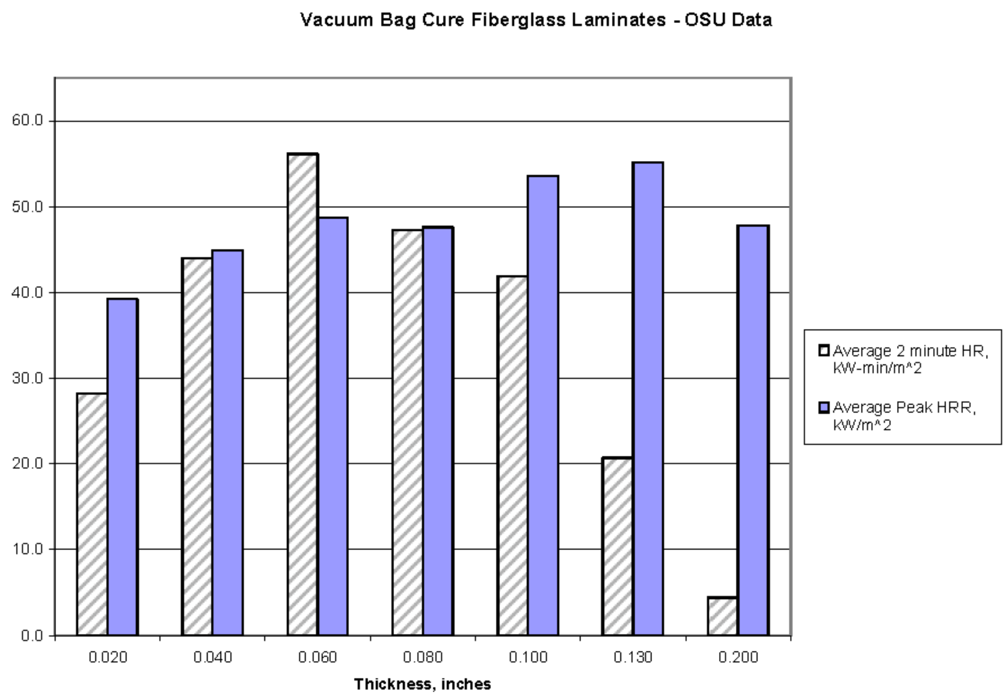
SPECIMEN THICKNESS

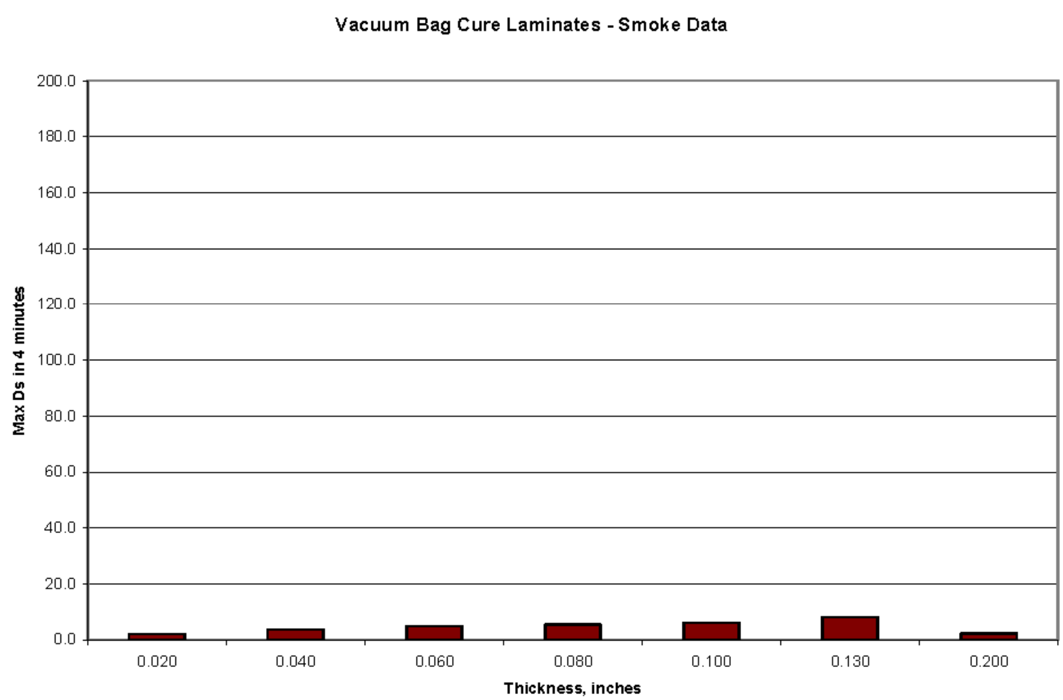
Fiberglass Layup	2g	3g	4g	6g	7g
Nominal Thickness (inches)	0.019	0.028	0.038	0.057	0.066
Hybrid Layup	g2cg	g3cg	g4cg	g5cg	g6cg
Nominal Thickness (inches)	0.043	0.056	0.068	0.080	0.092

<u>Laminate Data from Engineering Test Report MFR-20101201 Rev B.</u>

The following charts show data from laminates fabricated by Magee Plastics Company and tested at the FAA Technical Center. Specimens were fabricated from a Cytec fiberglass phenolic prepreg using a Magee vacuum bag process specification. Three specimens of each thickness were tested for heat release and smoke generation.

These specimens generated an insignificant amount of smoke, regardless of thickness. Peak heat release rate generally increased as specimen thickness increased, although the thickest configuration did not have the highest values. Thickness did not have a strong effect on Peak HRR, as the difference between the thinnest specimens (0.020 thick) and the specimens with the highest values (0. 130 thick) was only 15.9 points. The time to peak consistently increased with increasing thickness. As a result, the thicker specimens had lower two-minute total heat release than the thinner specimens. Two-minute Total HR increased as specimen thickness increased between 0.020 inch thick and 0.060 inch thick, and then decreased.

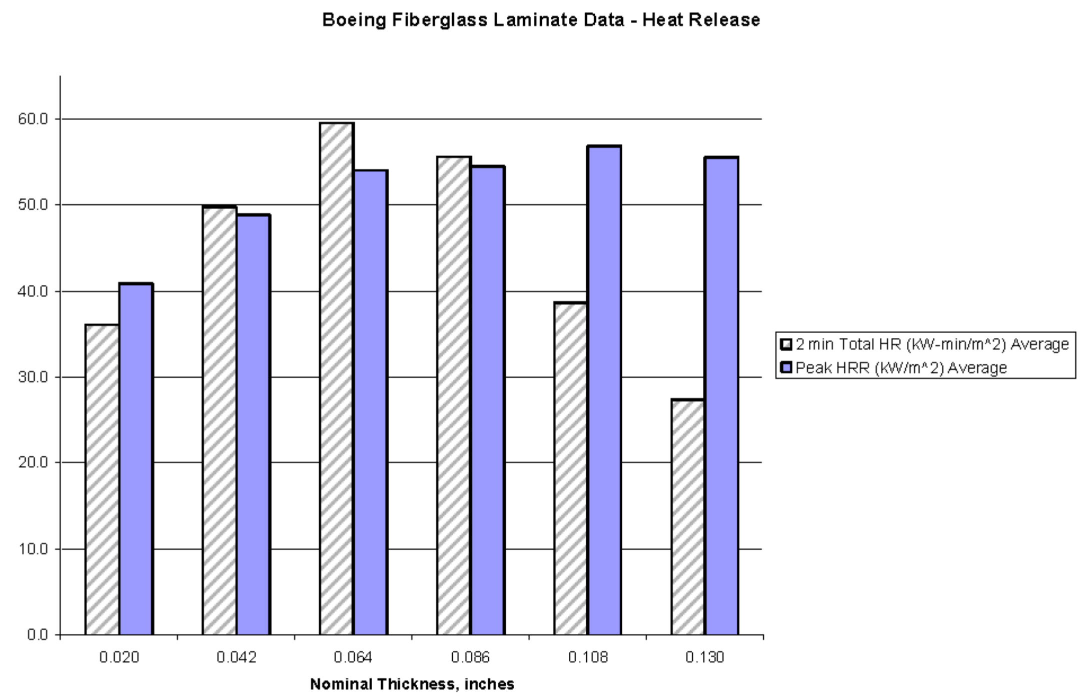

Vacuum Bag Cure Fiberglass Laminates - OSU Data
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.020
0.040
0.060
0.080
0.100
0.130
0.200
Thickness, inches
Average 2 minute HR, kW-min/m^2
Average Peak HRR, kW/m^2

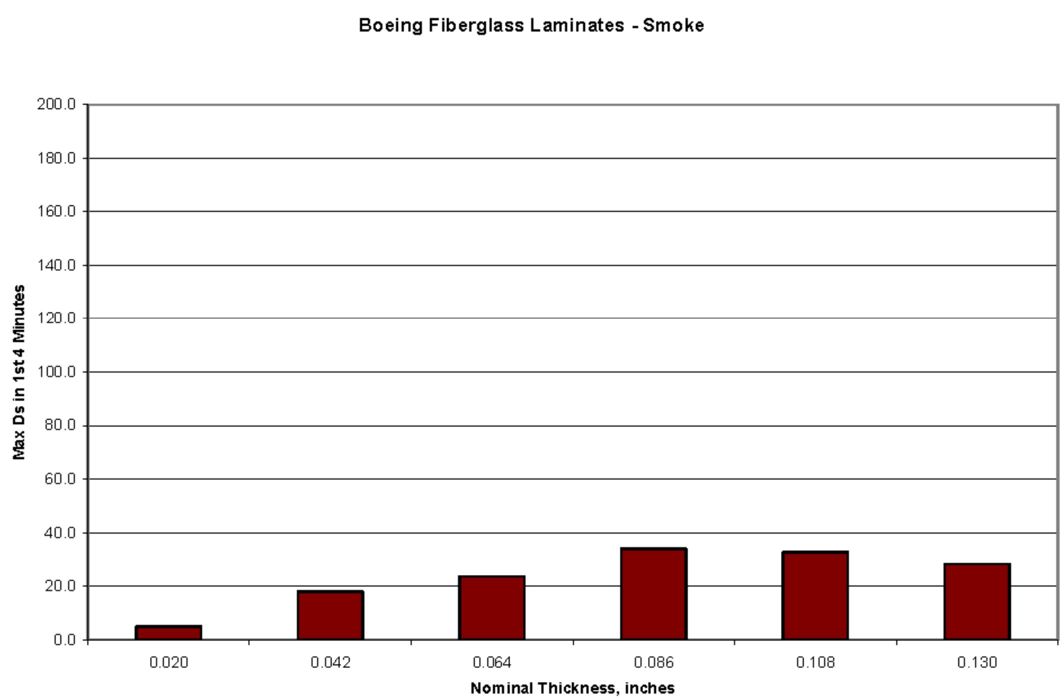

Vacuum Bag Cure Laminates - Smoke Data
Max Ds in 4 minutes
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
0.020
0.040
0.060
0.080
0.100
0.130
0.200
Thickness, inches

Boeing Laminate Data from Engineering testing per WR201100220

The following charts show fiberglass/phenolic laminates three to thirteen plies thick. In each case the outer ply on each side is a fine-weave fiberglass with nominal thickness of 0.045 inch and central plies of a coarser weave with nominal thickness 0.011 inch. Each heat release data point is the average of nine test specimens of that configuration. Each smoke data point is the average of three specimens of that configuration.

These specimens generated an insignificant amount of smoke, though the amount of smoke generated tended to increase as thickness increased. Peak heat release rate generally increased as specimen thickness increased, although the thickest configuration did not have the highest values. Thickness did not have a strong effect on Peak HRR, as the difference between the thinnest specimens (0.020 thick) and the specimens with the highest values (0. 108 thick) was only 16.0 points. The time to peak consistently increased with increasing thickness. As a result, the thicker specimens had lower two-minute total heat release than the thinner specimens. Two-minute Total HR increased as specimen thickness increased between 0.020 inch thick and 0.064 inch thick, and then decreased.


Boeing Fiberglass Laminate Data - Heat Release
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.020
0.042
0.064
0.086
0.108
0.130
Nominal Thickness, inches
2 min Total HR (kW-min/m^2) Average
Peak HRR (kW/m^2) Average

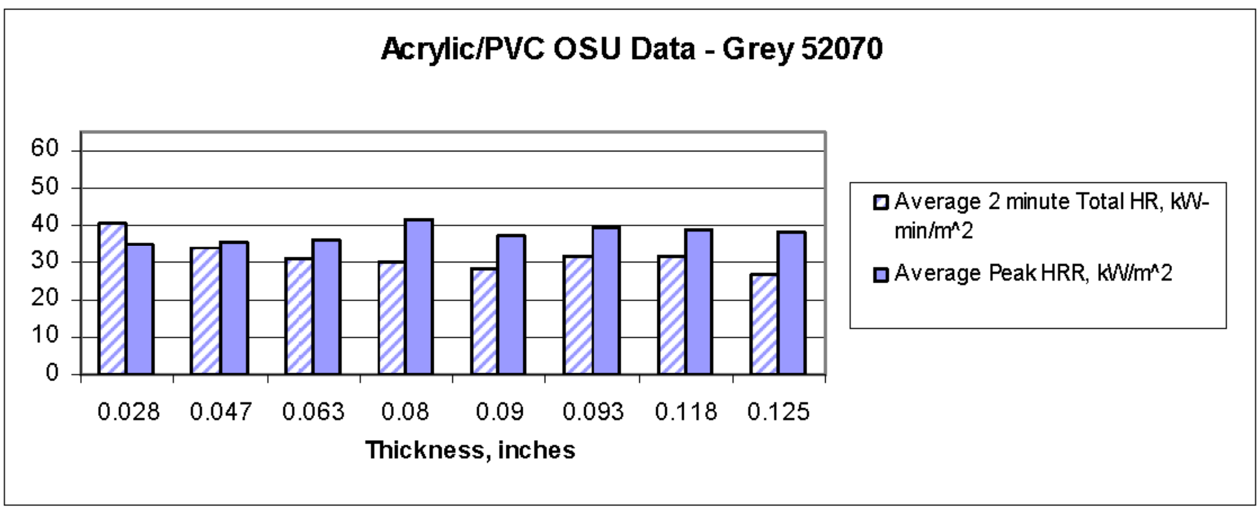

Boeing Fiberglass Laminates - Smoke
Max Ds in 1st 4 Minutes
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
0.020
0.042
0.064
0.086
0.108
0.130
Nominal Thickness, inches

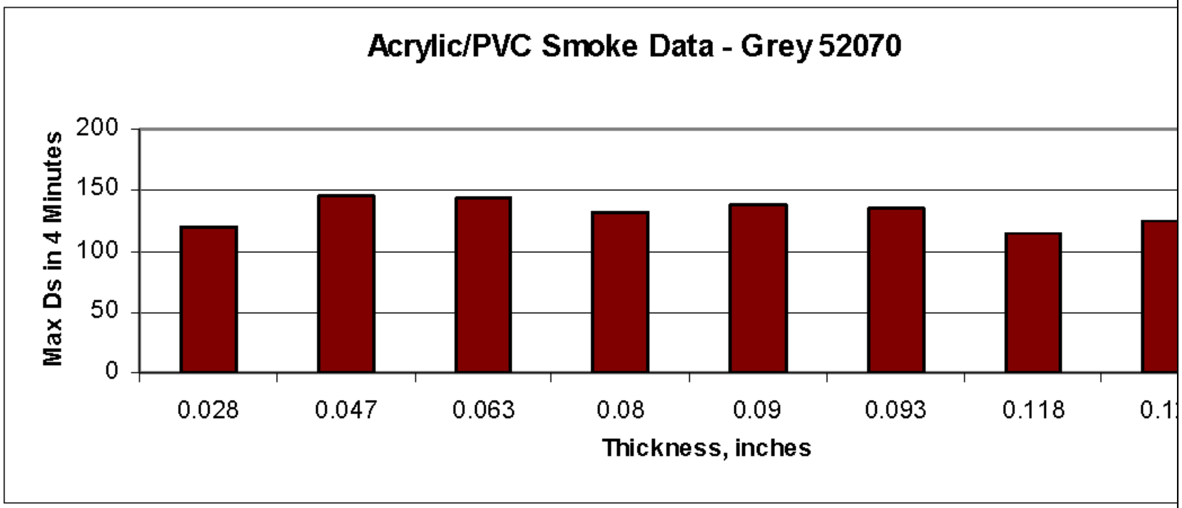
APPENDIX B – THERMOPLASTIC DATA

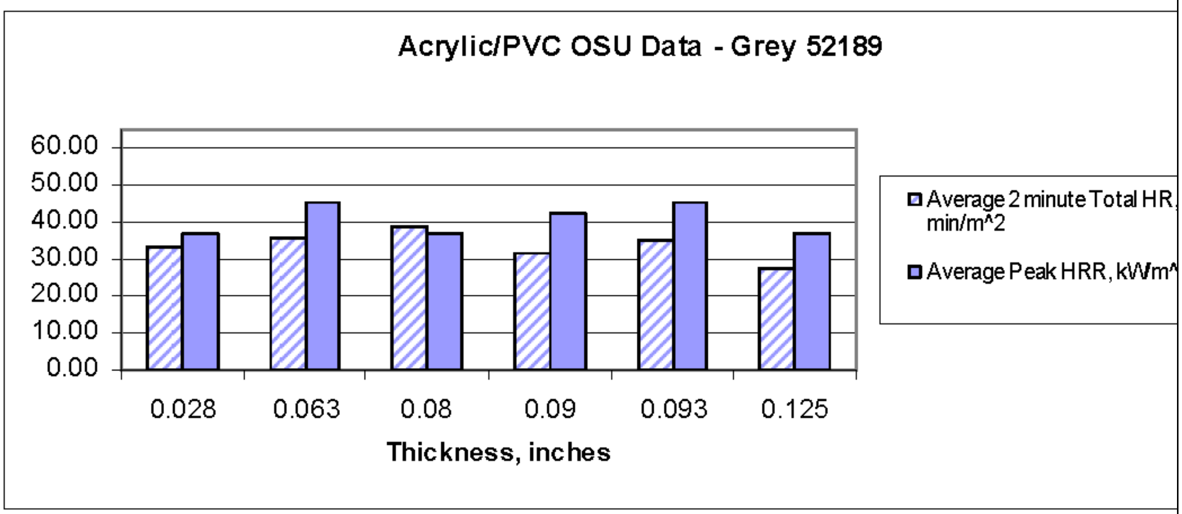
Acrylic-PVC Blend

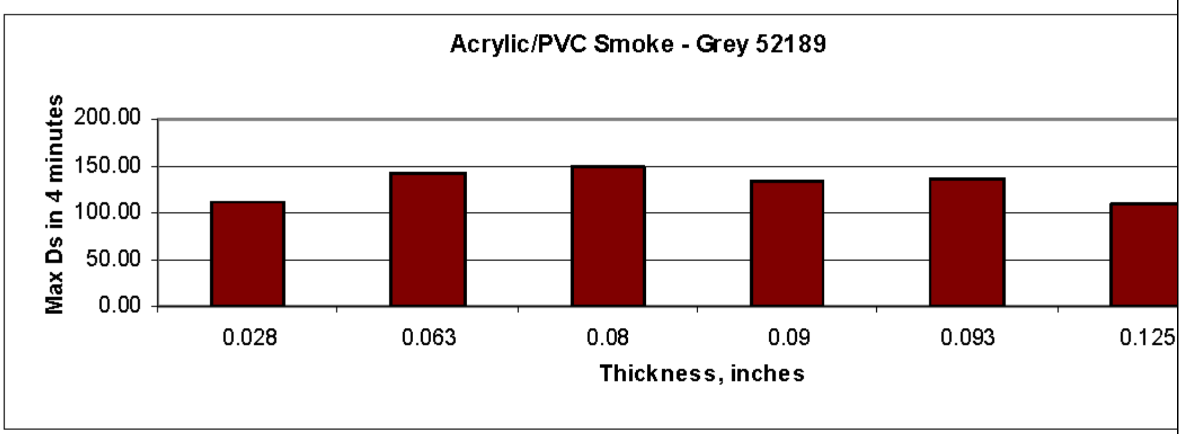
The following charts show data from various colors of thermoplastic coupons 0.028 to 0.125 inches thick. Not all colors have all thicknesses, but most data points show data from testing several sets of specimens, as shown below. There are significantly more sets of data for the grey colors than the white colors. The data show some variation, but does not show a significant effect of thickness on heat release, heat release rate, or smoke generated. Due to the smaller quantity of data, there appears to be more variation in the results from the white colors.

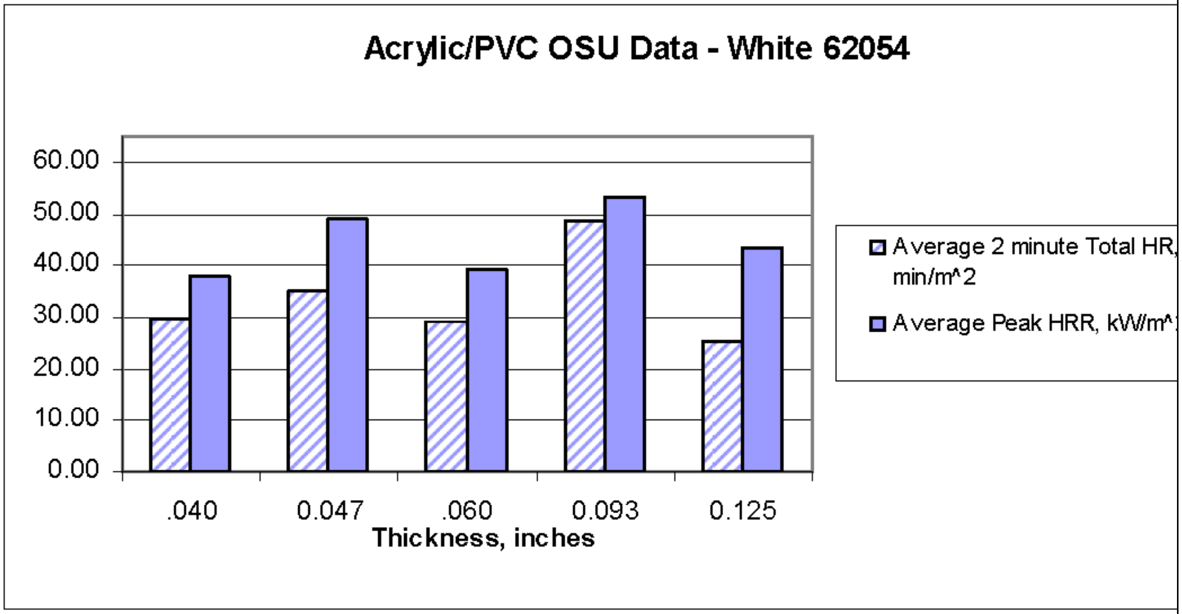
Thickness	Color	Grey 52070	Grey 52189	White 62054	White 62100
0.028		6	4	0	0
0.04		0	0	12	0
0.047		5	0	1	4
0.06		0	0	0	2
0.063		24	16	11	2
0.08		30	2	0	3
0.09		19	41	0	0
0.093		33	31	3	12
0.118		20	0	0	0
0.125		15	13	8	6

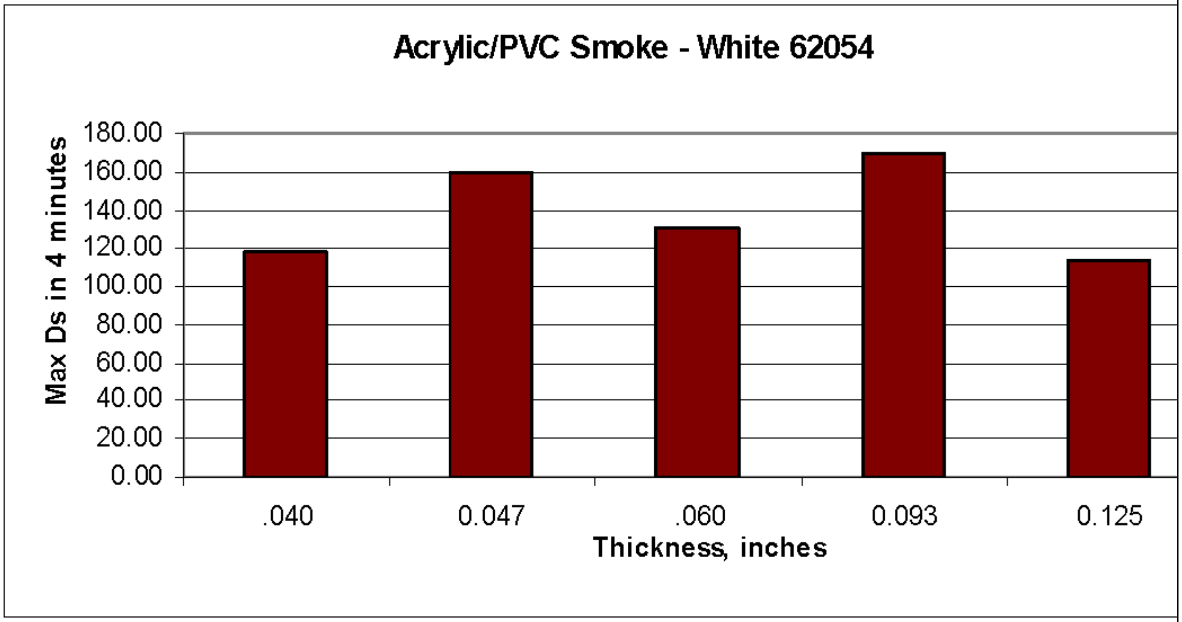


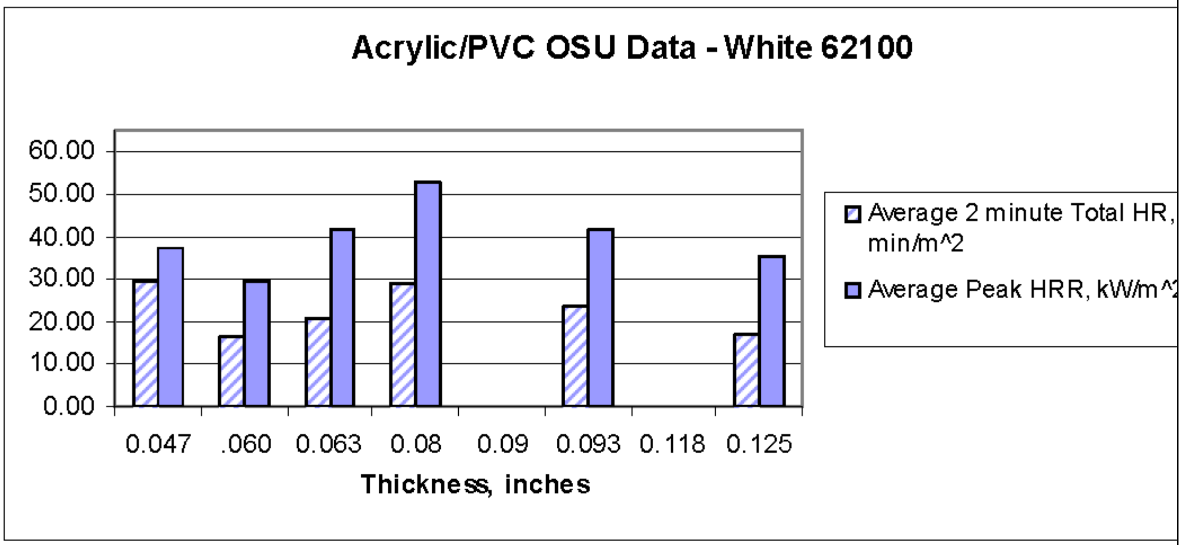

Acrylic/PVC Smoke Data - Grey 52070
Max Ds in 4 Minutes
200
150
100
50
0
0.028
0.047
0.063
0.08
0.09
0.093
0.118
Thickness, inches

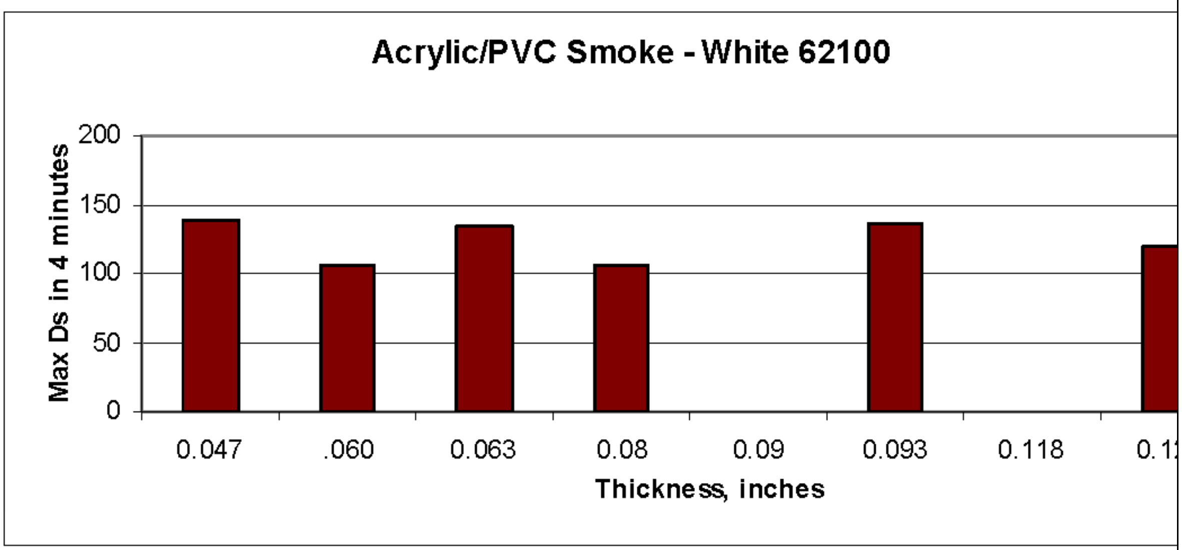

Acrylic/PVC OSU Data - Grey 52189
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.028
0.063
0.08
0.09
0.093
0.125
Thickness, inches


Acrylic/PVC Smoke - Grey 52189
Max Ds in 4 minutes
200.00
150.00
100.00
50.00
0.00
0.028
0.063
0.08
0.09
0.093
0.125
Thickness, inches


Acrylic/PVC OSU Data - White 62054
60.00
50.00
40.00
30.00
20.00
10.00
0.00
.040
0.047
.060
0.093
0.125
Thickness, inches
Average 2 minute Total HR, min/m^2
Average Peak HRR, kW/m^


Acrylic/PVC Smoke - White 62054
Max Ds in 4 minutes
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
.040
0.047
.060
0.093
0.125
Thickness, inches



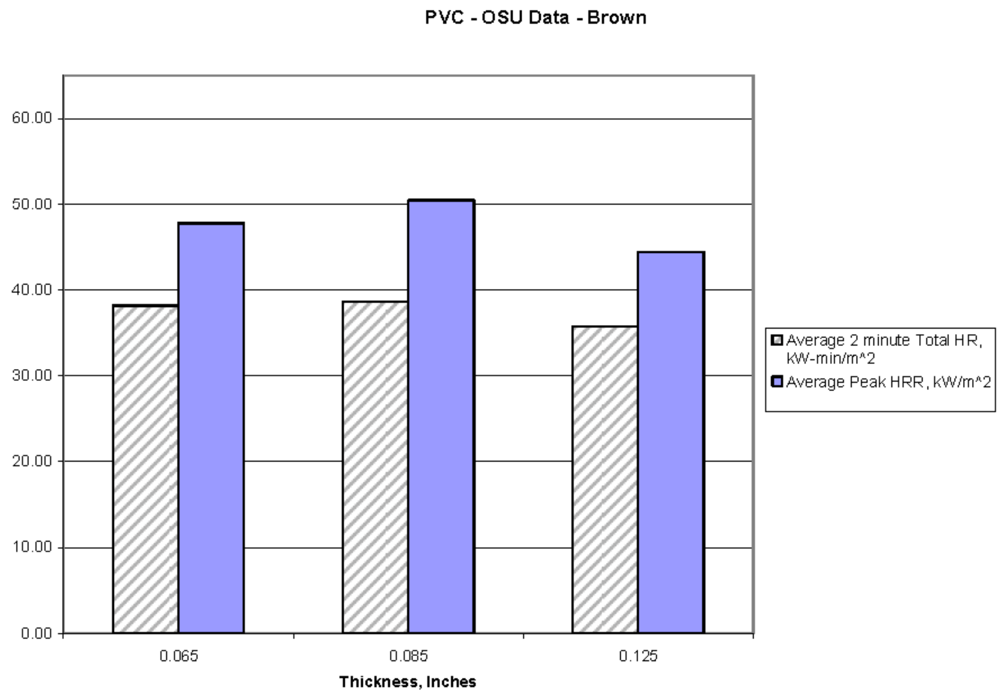


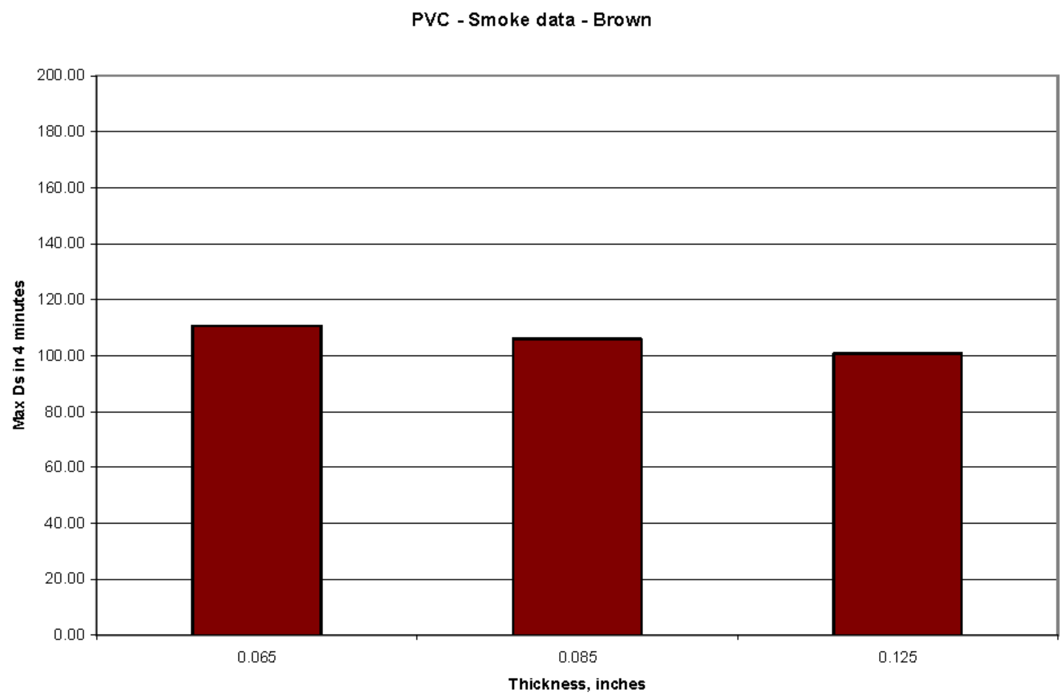
PVC Data

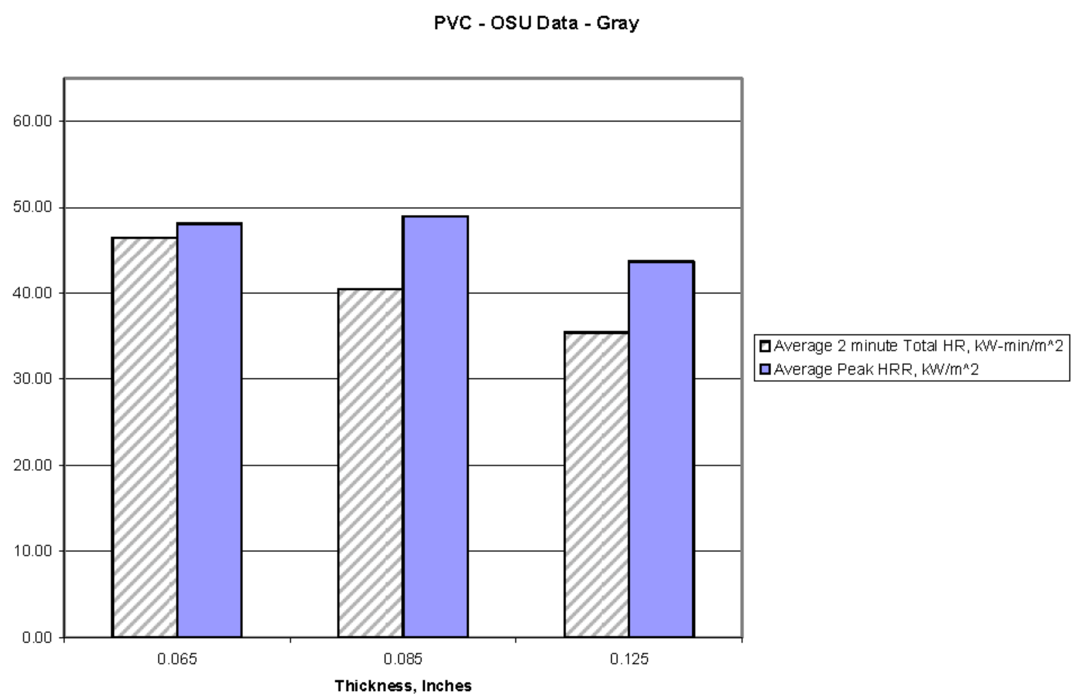
The following data are from PVC testing between 1996 and 2009. The colors shown are the colors for which data are available in three thicknesses, 0.065 inch, 0.085 inch, and 0.125 inch. The amount of data for each color varies. In each case there was as much or more OSU data as smoke data. Over this thickness range, there was not a strong effect of thickness on heat release rate. Total heat release and smoke indicated a slight decrease as thickness increased, consistent with laminate behavior in this thickness range and with slower ignition of thicker specimens.

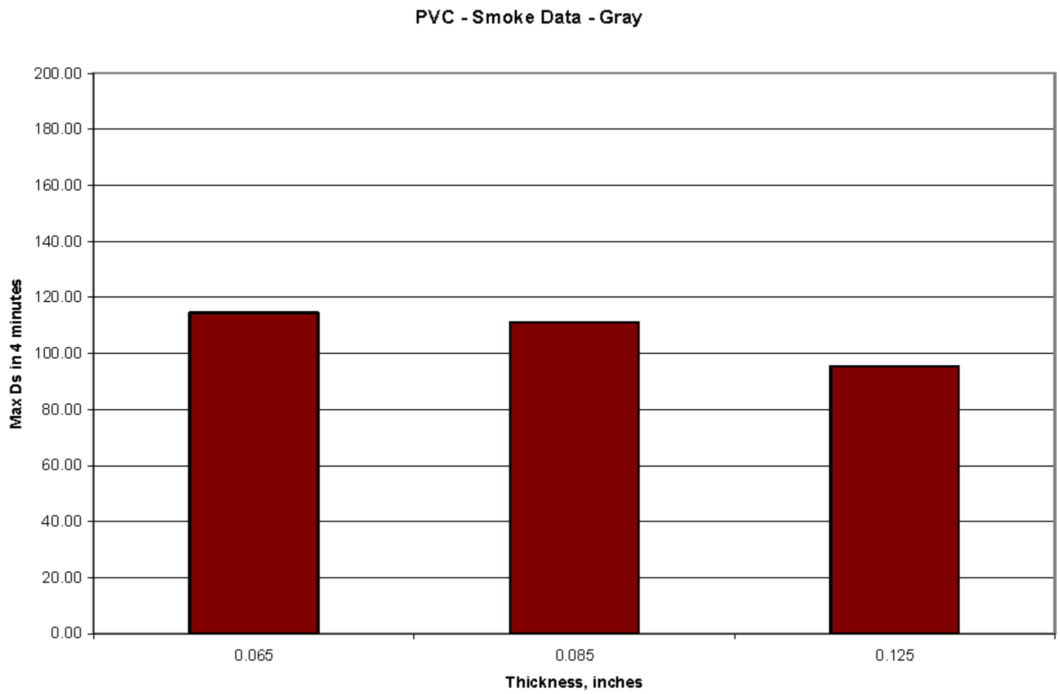
Number of sets tested for smoke in each color

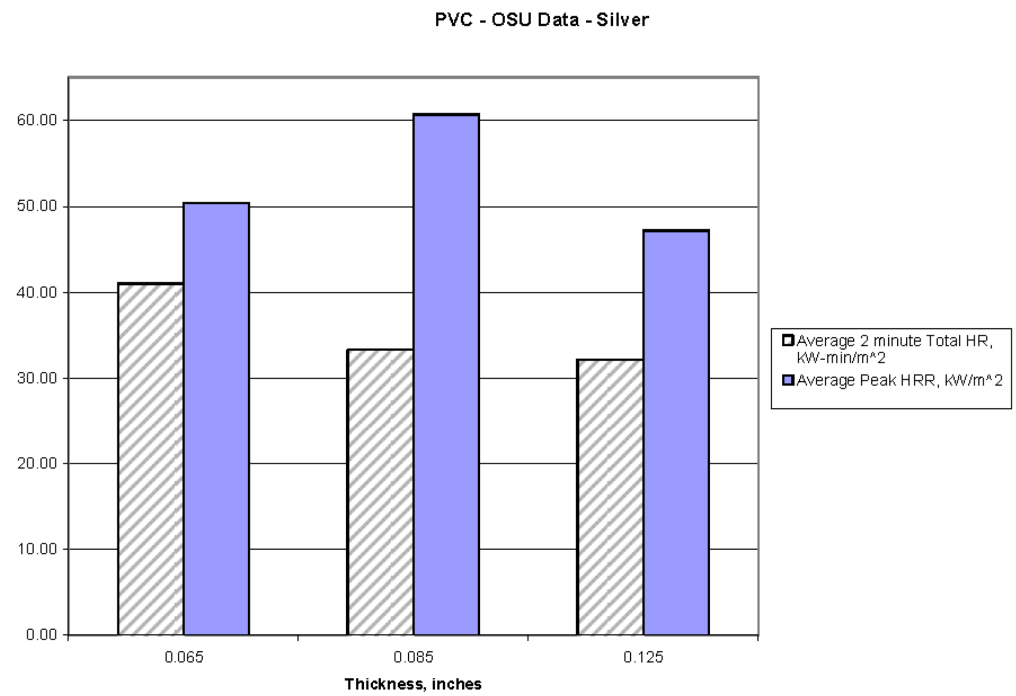
Color \ Thickness	0.065	0.085	0.125
Brown	57	18	17
Gray	89	63	63
Silver	6	1	7
White	102	56	14

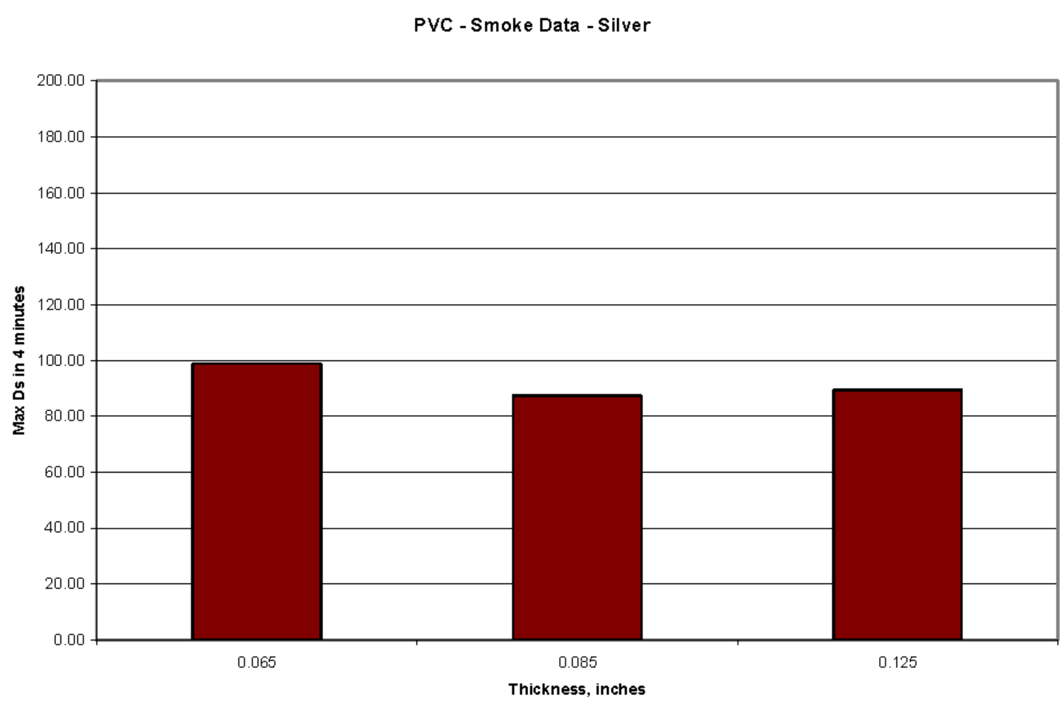


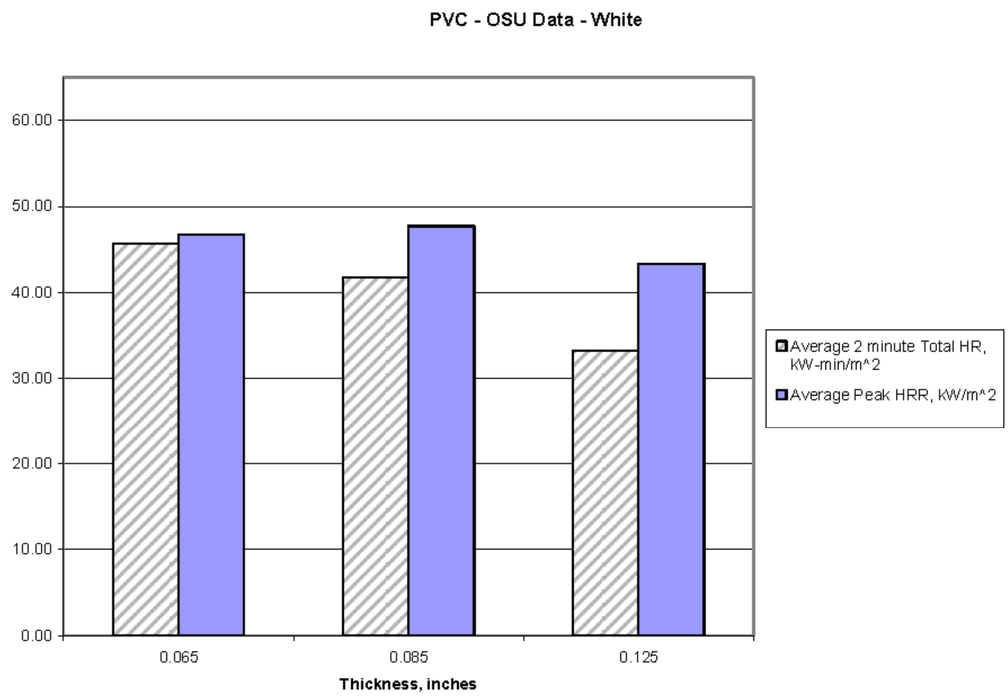

PVC - Smoke data - Brown
Max Ds in 4 minutes
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0.065
0.085
0.125
Thickness, inches

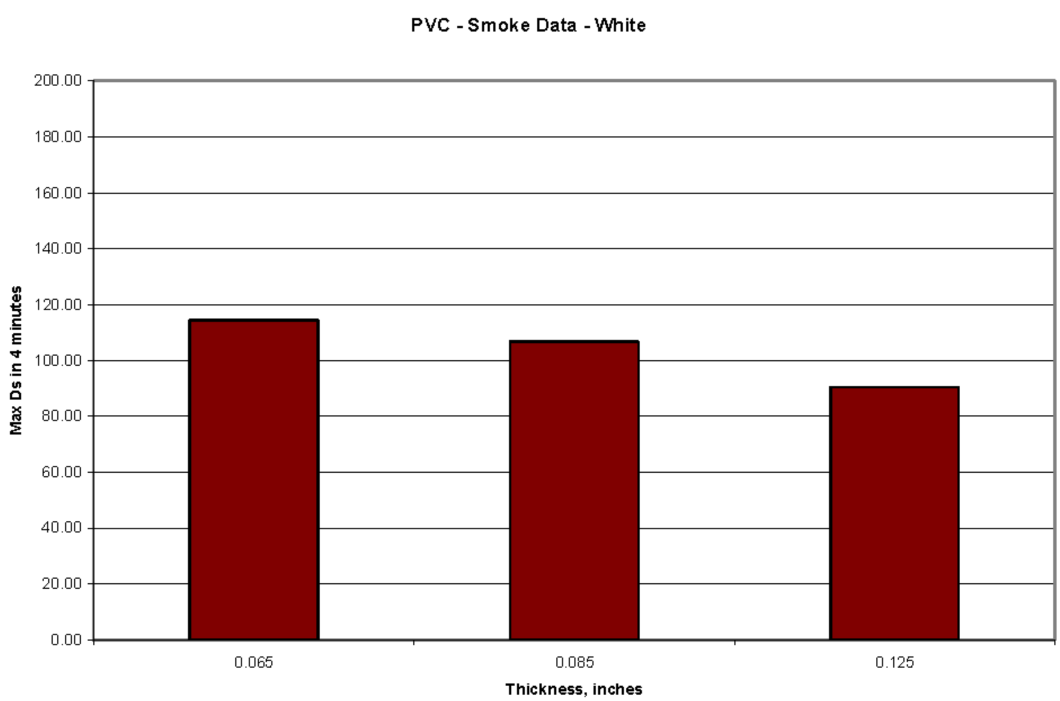

PVC - OSU Data - Gray
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.065
0.085
0.125
Thickness, Inches
Average 2 minute Total HR, kW-min/m^2
Average Peak HRR, kW/m^2


PVC - Smoke Data - Gray
Max Ds in 4 minutes
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0.065
0.085
0.125
Thickness, inches


PVC - OSU Data - Silver
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.065
0.085
0.125
Thickness, inches
Average 2 minute Total HR, kW-min/m^2
Average Peak HRR, kW/m^2


PVC - Smoke Data - Silver
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Max Ds in 4 minutes
0.065
0.085
0.125
Thickness, inches

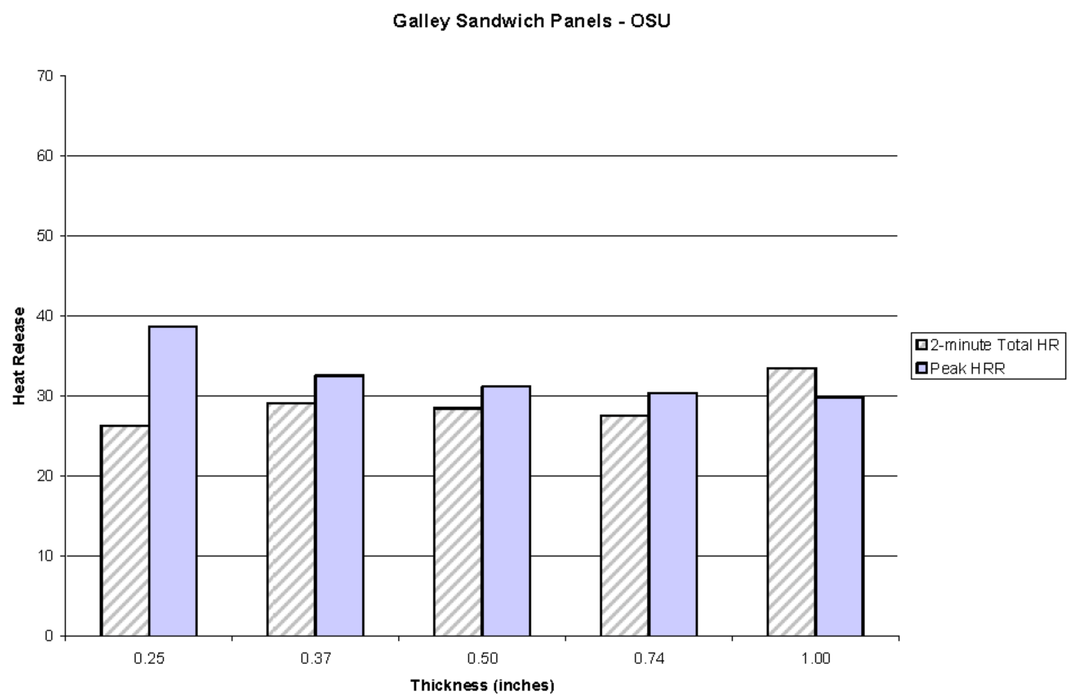

PVC - OSU Data - White
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.065
0.085
0.125
Thickness, inches
Average 2 minute Total HR, kW-min/m^2
Average Peak HRR, kW/m^2

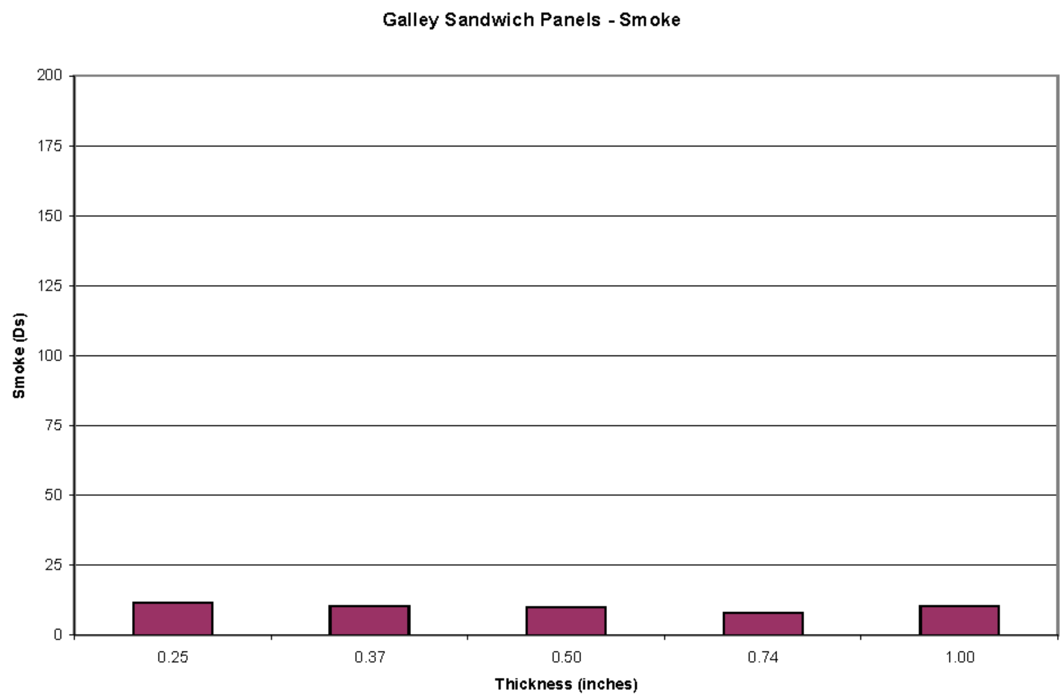

PVC - Smoke Data - White
Max Ds in 4 minutes
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0.065
0.085
0.125
Thickness, inches

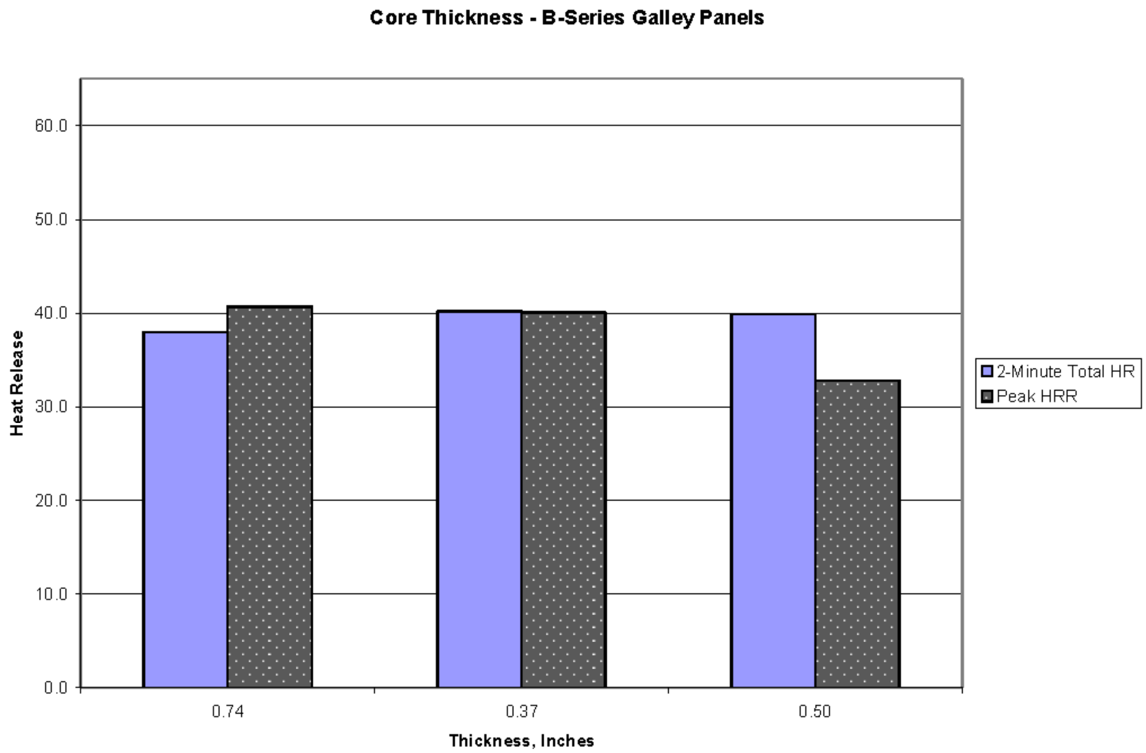
APPENDIX C – CORE THICKNESS DATA (TESTED AS PANELS)

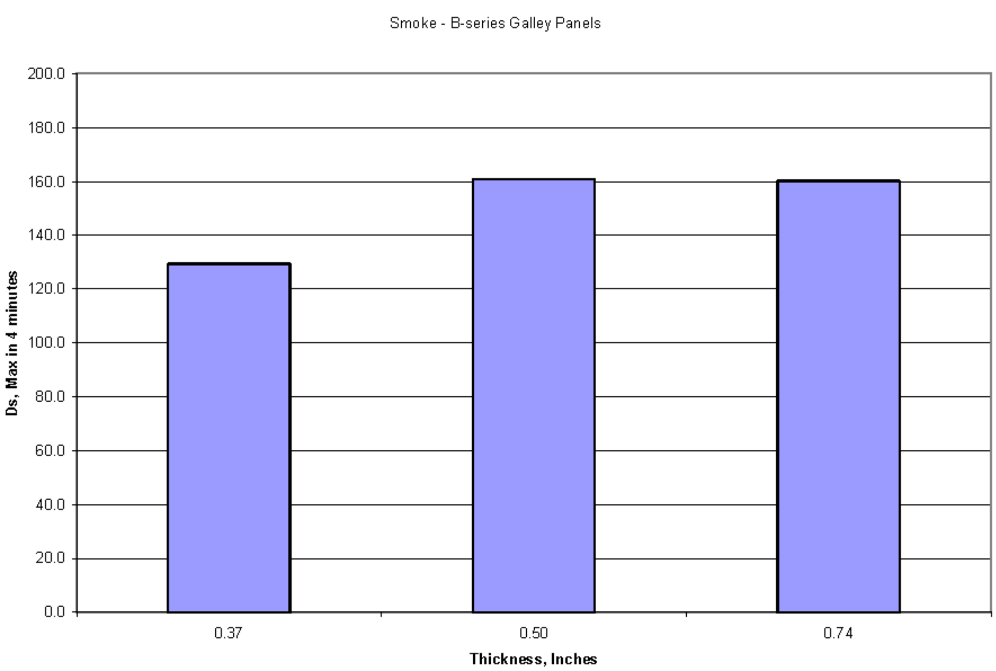
Galley Sandwich Panel Data from Certification Testing

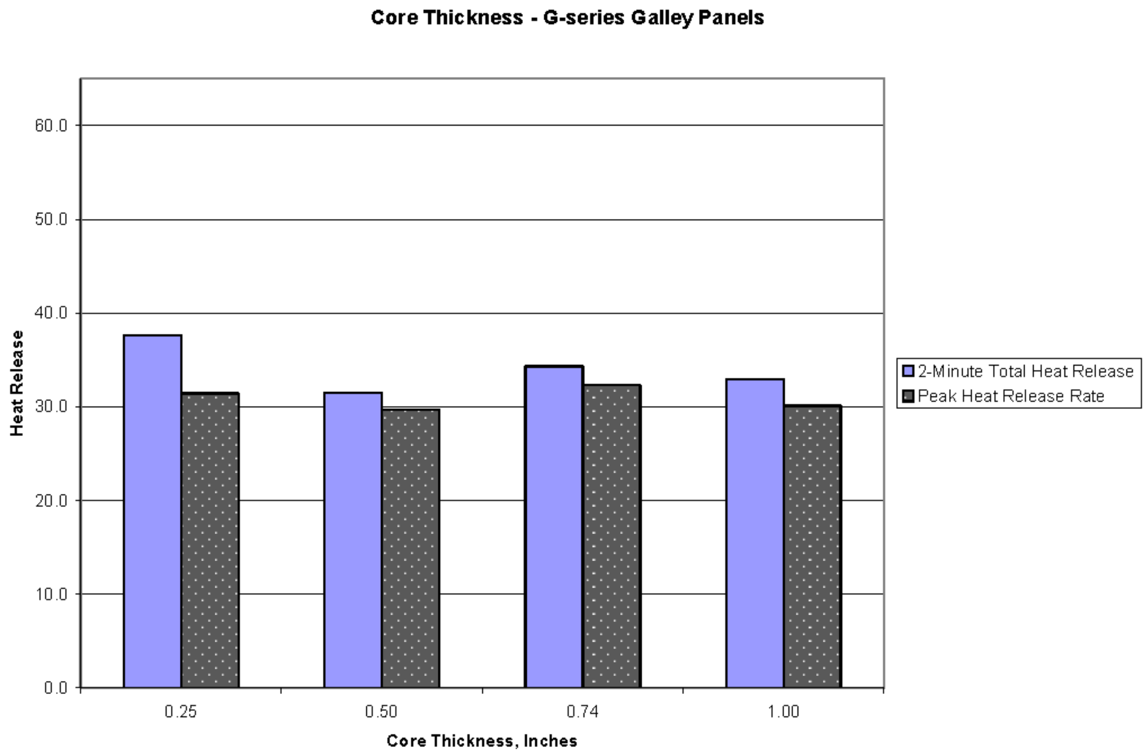
The following data are from galley certification testing of sandwich panels with 2-ply fiberglass/phenolic facesheets, the same Nomex honeycomb core of varying thickness, and the same decoratives. Each data point is an average of three test specimens. The data show that the thickness of honeycomb core as very little effect on the heat release, heat release rate, or smoke generation for the panel. Over this thickness range, there was very little effect of core thickness on total heat release, peak heat release rate or smoke.

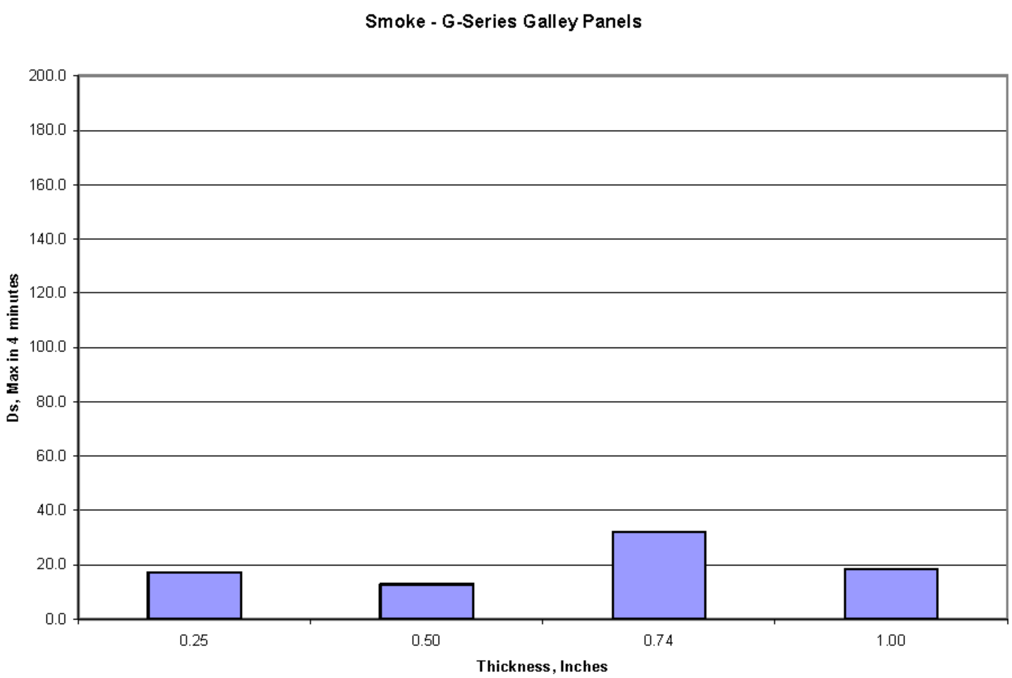


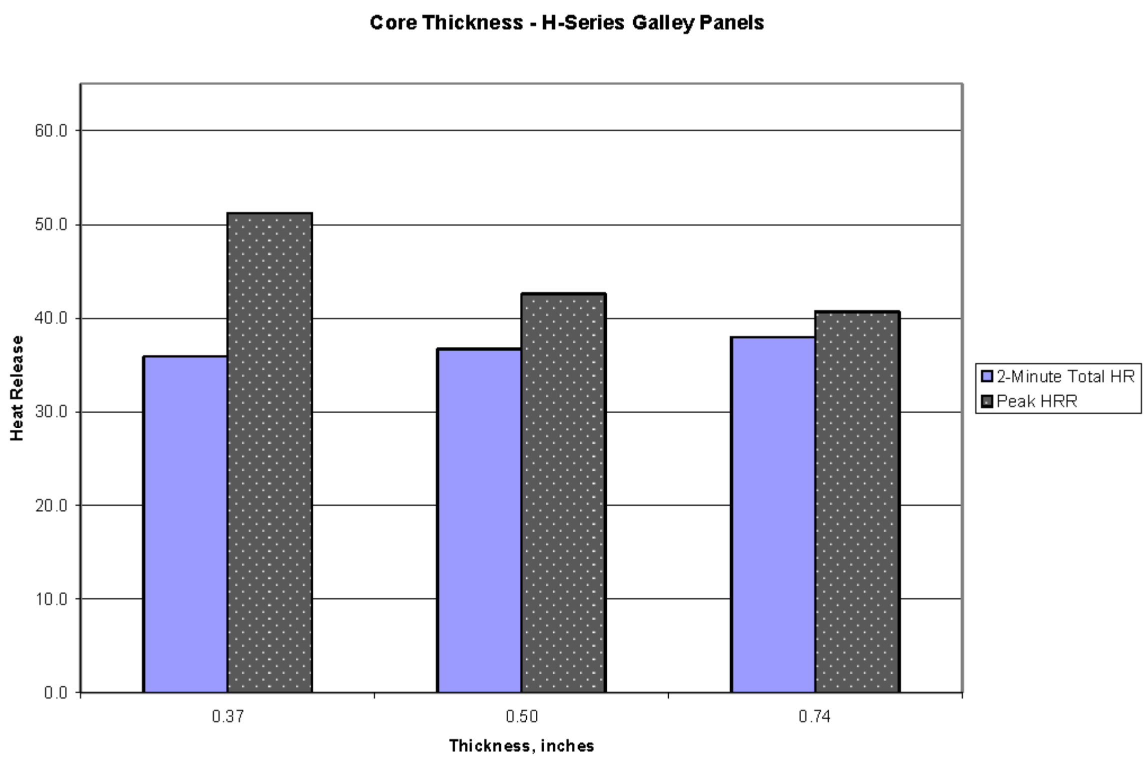

Galley Sandwich Panels - Smoke
Smoke (Ds)
200
175
150
125
100
75
50
25
0
0.25
0.37
0.50
0.74
1.00
Thickness (inches)

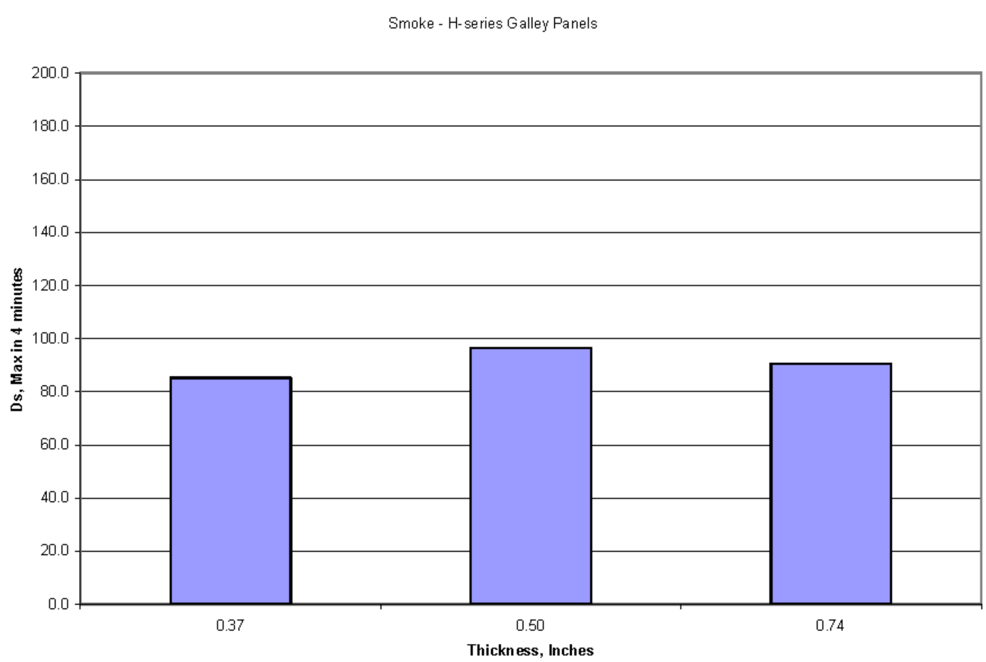

Core Thickness - B-Series Galley Panels
Heat Release
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.74
0.37
0.50
Thickness, Inches
2-Minute Total HR
Peak HRR


Smoke - B-series Galley Panels
Ds, Max in 4 minutes
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
0.37
0.50
0.74
Thickness, Inches


Core Thickness - G-series Galley Panels
Heat Release
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.25
0.50
0.74
1.00
Core Thickness, Inches
2-Minute Total Heat Release
Peak Heat Release Rate


Smoke - G-Series Galley Panels
Ds, Max in 4 minutes
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
0.25
0.50
0.74
1.00
Thickness, Inches


Core Thickness - H-Series Galley Panels
Heat Release
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.37
0.50
0.74
Thickness, inches
2-Minute Total HR
Peak HRR

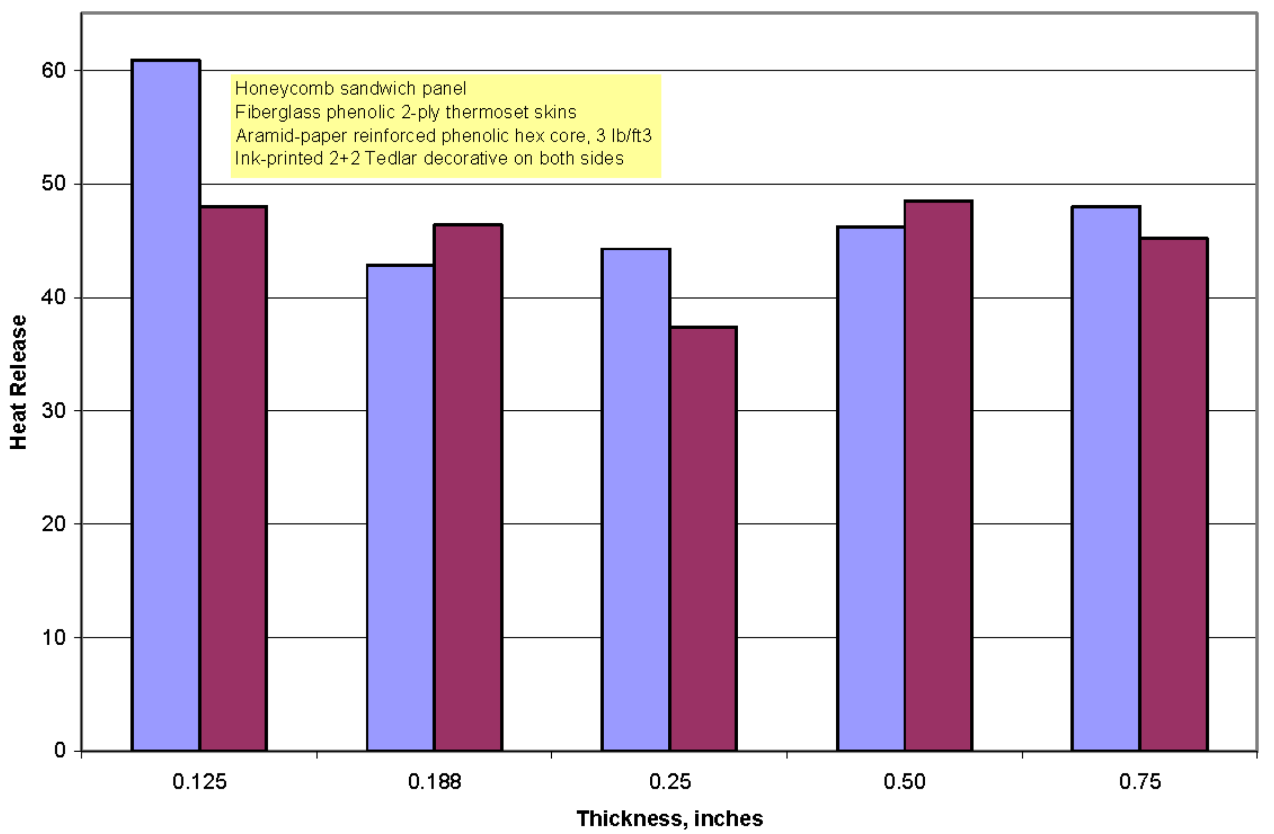

Smoke - H-series Galley Panels
Ds, Max in 4 minutes
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
0.37
0.50
0.74
Thickness, Inches

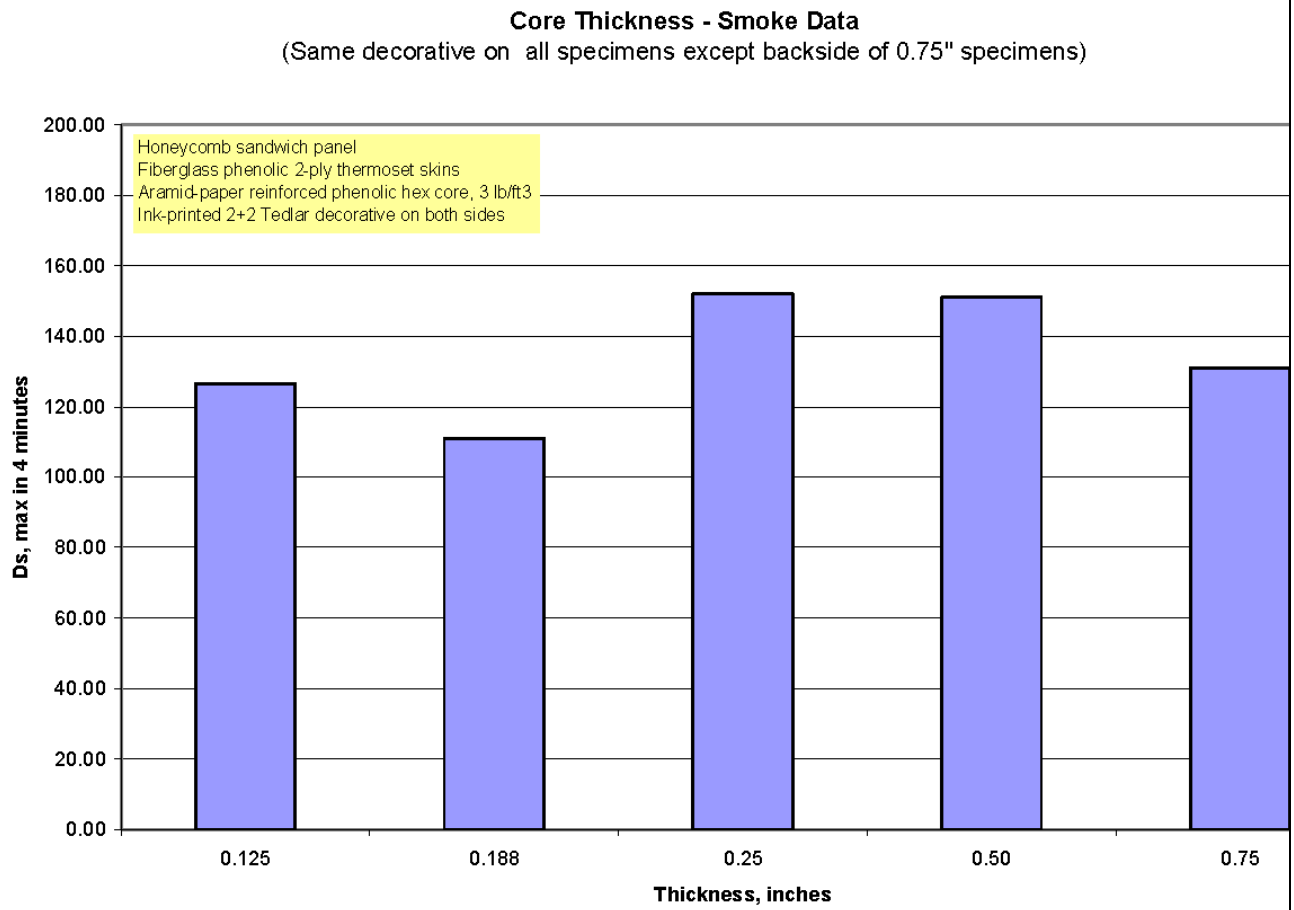
Boeing Sandwich Panel Data from Certification Testing – Nomex Core

The following data are from certification testing of sandwich panels with 2-ply fiberglass/phenolic facesheets, the same Nomex honeycomb core of varying thickness, and decorative laminates on both faces. Except for the 0.75 inch thick specimens, the same ink-printed decorative laminate was used on all specimens. Due to the specimen thickness, the decorative laminate on the backside of 0.75-inch specimens does not affect the test results. The core used has 1/8-inch cell size and 3 pcf density. Each data point is an average of three test specimens.

The data show that the thickness of honeycomb core as very little effect on the heat release, heat release rate, or smoke generation for the panel over this thickness range. The configuration with the thinnest core had higher 2-minute total heat release, consistent with heat release from the coolside facesheet making a greater contribution when the core is thin. Otherwise data for different thicknesses was essentially the same, within the normal variation of heat release and smoke results.

Core Thickness - Heat Release
(Same decorative on all specimens except backside of 0.75" specimens**)**

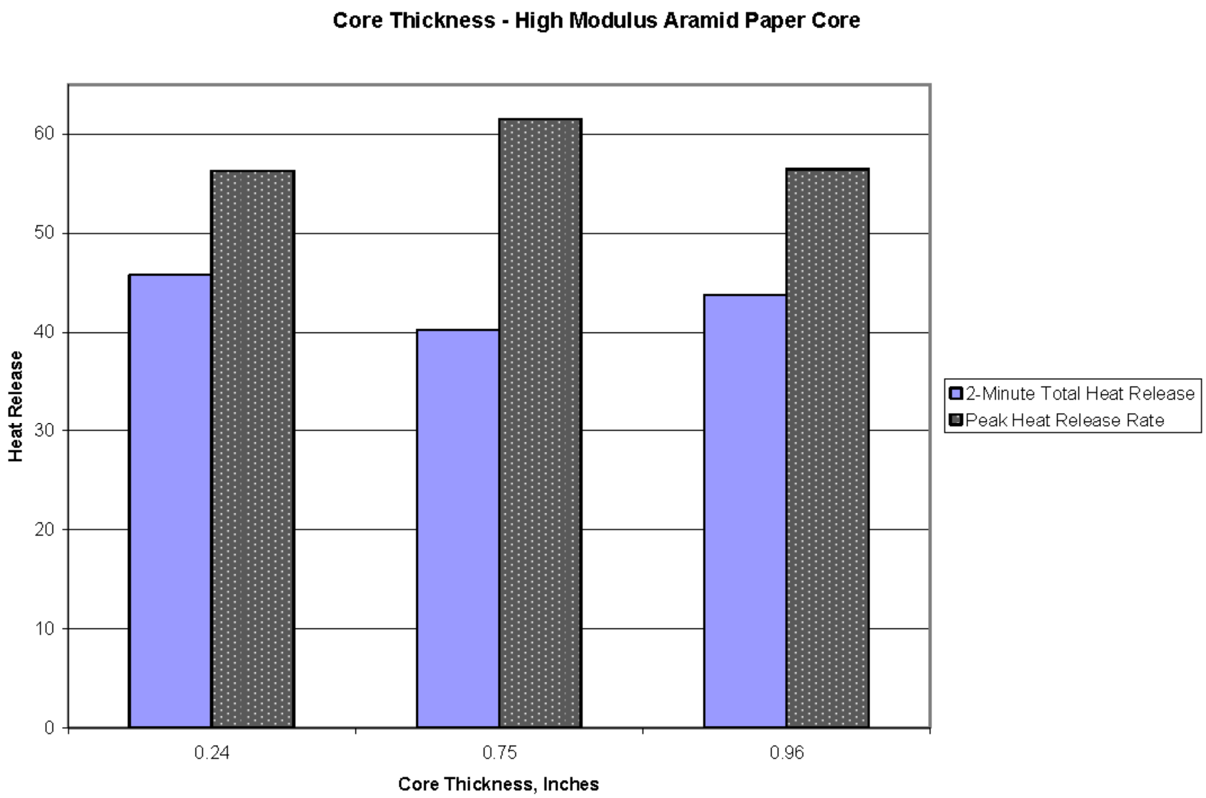




Boeing Sandwich Panel Data from Certification Testing – High Modulus Aramid Paper Core

The following data are from certification testing of sandwich panels with 3-ply carbon + fiberglass / phenolic facesheets, the same honeycomb core of varying thickness, and decorative laminates on both faces. The same ink-printed decorative laminate was used on the test surface of all specimens. The configuration with 0.24-inch core had Tedlar on the non-test surface. The other specimens had ink-printed decorative laminates on the non-test surface, but different patterns of ink. The core used has 1/8-inch cell size and 2.5 pcf density. Each data point is an average of three test specimens.

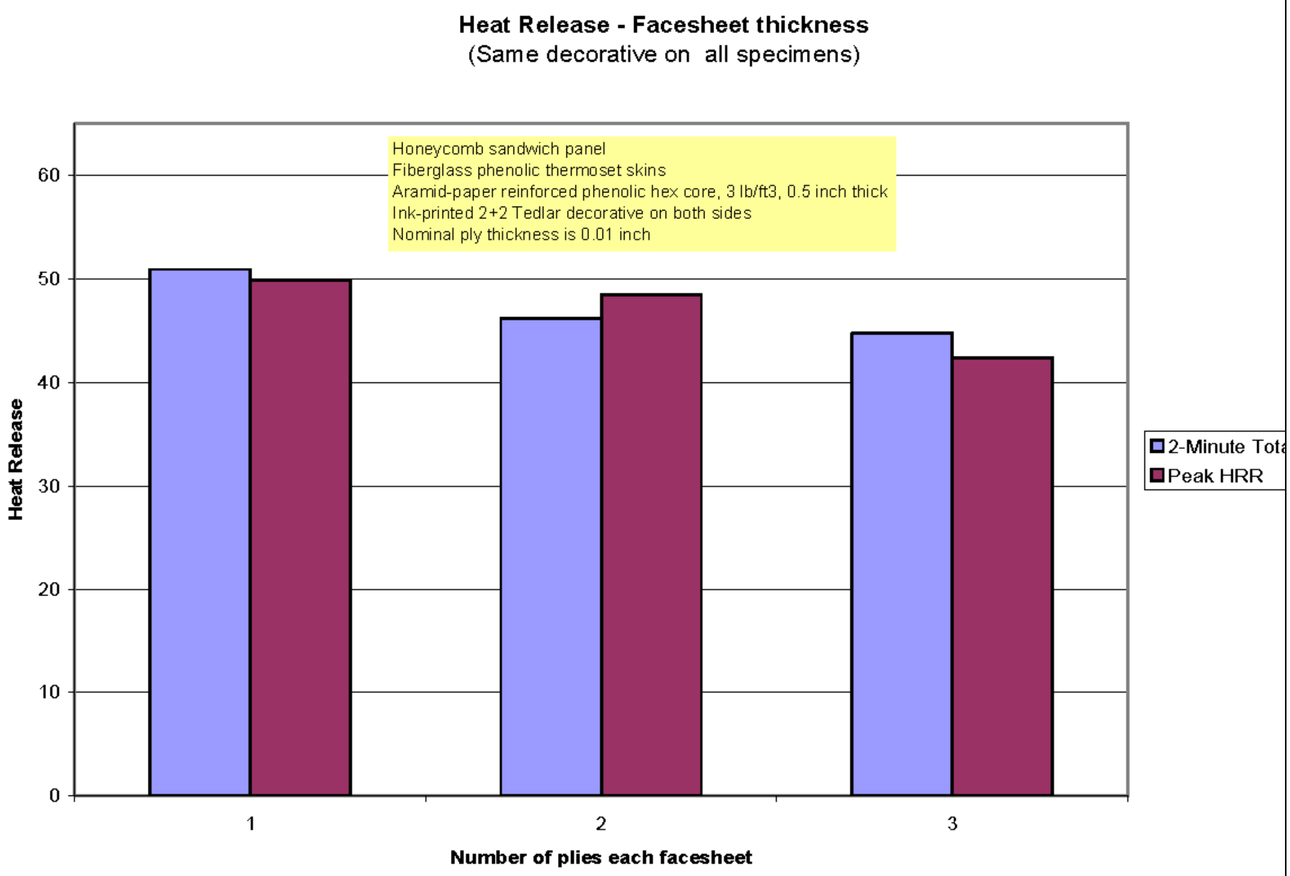
The data show that the thickness of honeycomb core as no significant effect on the 2-minute total heat release or peak heat release rate of the panel over this thickness range. The data for different thicknesses was essentially the same, within the normal variation of heat release results.

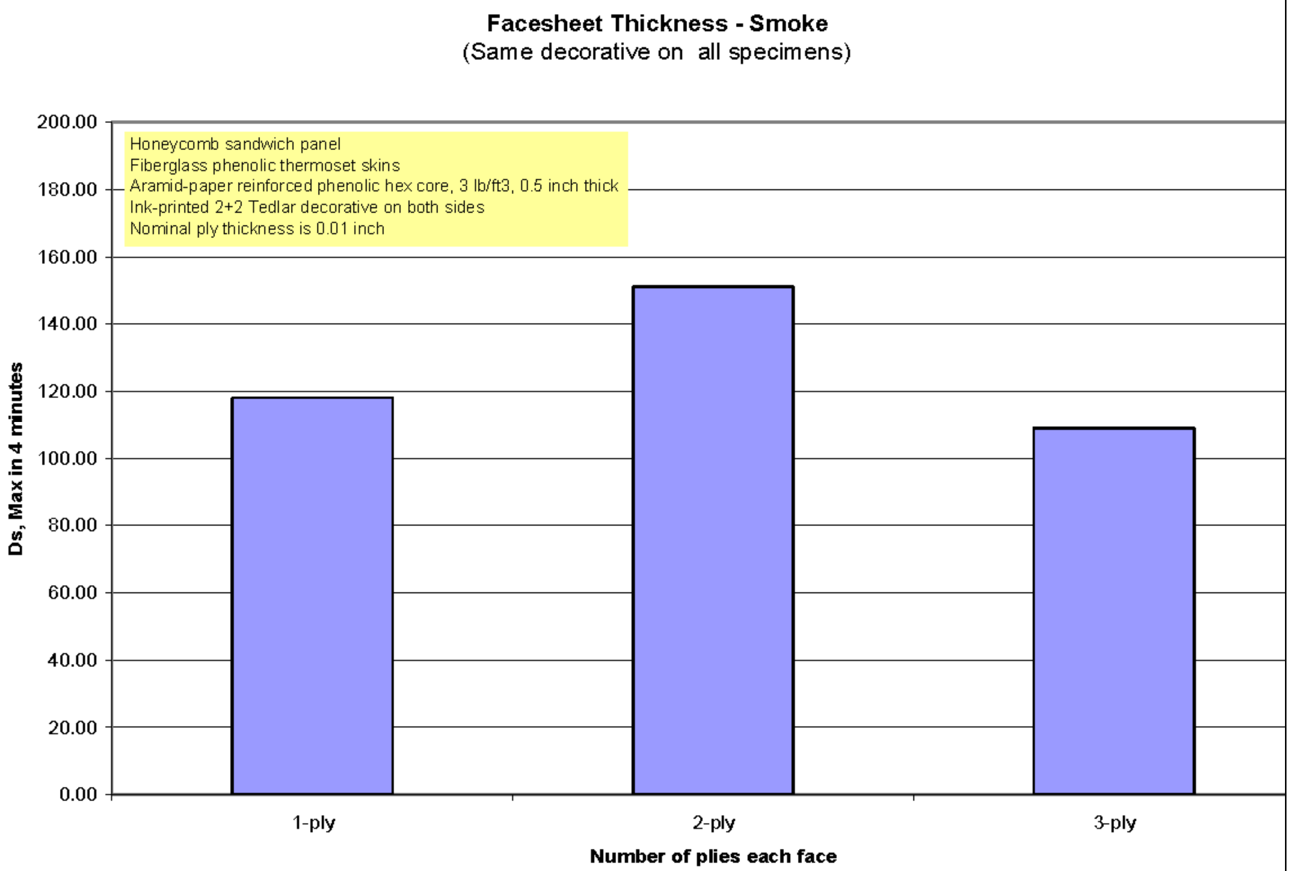

Core Thickness - High Modulus Aramid Paper Core
Heat Release
0
10
20
30
40
50
60
0.24
0.75
0.96
Core Thickness, Inches
2-Minute Total Heat Release
Peak Heat Release Rate

APPENDIX D – HONEYCOMB PANEL FACESHEET THICKNESS DATA

The following data are from certification testing of sandwich panels with fiberglass/phenolic facesheets, the same Nomex honeycomb core, and the same ink-printed decorative laminates on both faces. The only difference between the configurations is the number of plies in each facesheet. The core used has 1/8-inch cell size and 3 pcf density. Each data point is an average of three test specimens.

The data show that the thickness of the facesheet has very little effect on the heat release or heat release rate for the panel. Both 2-minute total heat release and peak heat release rate appear to show a very slight decrease as thickness increased, consistent with slower ignition of specimens with thicker facesheets. The smoke data is less well behaved, but the 2-ply data which is higher than the other two configurations was run several months later. There is no technical basis to expect a panel with 2-ply facesheets to smoke significantly more than an otherwise identical panel with 1-ply or 3-ply facesheet. This is indicative of variability in the test.




Facesheet Thickness - Smoke
(Same decorative on all specimens)
Honeycomb sandwich panel
Fiberglass phenolic thermoset skins
Aramid-paper reinforced phenolic hex core, 3 lb/ft3, 0.5 inch thick
Ink-printed 2+2 Tedlar decorative on both sides
Nominal ply thickness is 0.01 inch
Ds, Max in 4 minutes
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
1-ply
2-ply
3-ply
Number of plies each face

APPENDIX E—ITEMS 3 AND 4: CORE DENSITY AND CORE CELL SIZE

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM PROPOSAL

Part 2, Reference Items #3 and #4, “CORE DENSITY” AND “CORE CELL SIZE”

Revision – A, dated 2011 Oct 5

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11	NC						
12	NC						
13	A						
14	A						
15	A						
16	A						
17	A						
18	A						

REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
NC	Initial release.	2011-Apr-12	P. Sattayatam
A	Added test results and updated analysis and conclusion.	2011-Oct-5	P. Sattayatam

1 INTRODUCTION

1.1 For Flammability test data in accordance with 14 CFR 25.853 (a) Bunsen Burner Test Requirements

Core Cell Size - Data from testing ANY core cell size/shape substantiates other core cell sizes/shapes of the same material, provided the core material is made from phenolic aramid (e.g. Nomex® and Kevlar®) paper, phenolic fiberglass or aluminum.

Core Density - Data from a lower density honeycomb core substantiates a higher density core, provided the core is made from the same core materials and the test subject panels are made with the same facesheet (skins).

Core Types and their materials can be:

1. A Phenolic Resin and an aramid (e.g. Nomex® and Kevlar®) paper
2. A Phenolic Resin and a Fiberglass core
3. An Aluminum core

Flammability test data from the lower density core of the same type substantiates the results from higher density core when tested in accordance with 14 CFR 25.853 (a) and is currently established industry practice.

1.2 For Flammability test data in accordance with 14 CFR 25.853 (d) Heat Release and Smoke Test Requirements

Core Cell Size - data from the smallest and largest cell sizes substantiates all cell sizes in between.

Core Density - data from the lowest density honeycomb core and the highest density honeycomb core substantiates all the densities in between a higher density core, provided the core is made from the same core materials and the panels are made with the same facesheets.

Core Types and their materials can be:

1. A Phenolic Resin and an aramid (e.g. Nomex® and Kevlar®) paper
2. A Phenolic Resin and a Fiberglass core
3. An Aluminum core

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, "Policy Statement on Flammability Testing of Interior Materials" [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA's technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Items #3 and #4 have been reviewed by the industry team and are submitting the following concurrence, justification and proposal.

2 INDUSTRY TEAM LEADER AND SUPPORT TEAM

During an industry meeting on 24 September 2009 in Huntington Beach, CA, and the FAA Materials Fire Test Working Group meeting on 21 October 2009 in Atlantic City, NJ, the following individuals have volunteered to form the industry team for this reference item:

2.1 TEAM LEADER

- Scott Campbell (C&D ZODIAC)
- Panade Sattayatam (C&D ZODIAC)

2.2 SUPPORT TEAM

This list is by no means final, but represents a snapshot of the currently active industry participants. Additional remarks, suggestions, corrections and contributions from other individuals are very much encouraged.

- Anthony Perugini (AIM AVIATION, INC)
- Michael Jensen (BOEING)
- Ian Lulham (BOMBARDIER)
- Ley Richardson (DUPONT)
- Klaus Boesser (SELL)
- Daniel Boesser (SELL)
- Mike Waldrop (FALCON JET)
- Francisco Landroni (EMBRAER)

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on 20 August, 2009. Attachment 2, Part 2, reference items #3 and #4 read (see Figure 1):

ITEM #3

- 14 CFR 25.853 (a): “*Data from testing a lower density honeycomb core substantiates a higher density honeycomb core, provided the core is made from phenolic aramid (e.g., Nomex ® and Kevlar®) paper, phenolic fiberglass, or aluminum.*”
- 14 CFR 25.853 (d): “*Data from testing a core's lightest and heaviest densities substantiates all densities in between.*”

ITEM #4

- 14 CFR 25.853 (a): “*Data from testing ANY core cell size/shape substantiates other core sell sizes/shapes of the same material, provided the core material is made from phenolic aramid (e.g. Nomex® and Kevlar®) paper, phenolic fiberglass or aluminum*.”
- 14 CFR 25.853 (d): “*Data from testing a core's smallest and largest cell sizes substantiates all cell sizes in between.*”

Part 2, methods of compliance that require supporting data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
3	Core, density	Data from testing a lower density honeycomb core substantiates a higher density honeycomb core, provided the core is made from phenolic aramid (e.g., Nomex® and Kevlar®) paper, phenolic fiberglass, or aluminum).	Data from testing a core’s lightest and heaviest densities substantiates all densities in between.
4	Core, cell size	Data from testing ANY core cell size/shape substantiates other core sell sizes/shapes of the same material, provided the core is made from phenolic aramid (e.g., Nomex® and Kevlar®) paper, phenolic fiberglass, or aluminum).	Data from testing a core’s smallest and largest cell sizes substantiates all cell sizes in between.

Figure 1: Attachment 2, Part 2, Reference Item #3 and #4

No equivalent entry exists for reference items #3 and #4 in attachment 2, Part 1.

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of the terms 'honeycomb core', 'core cell size', 'core density' and 'same'.

3.2.1 HONEYCOMB CORE

Sheets of phenolic aramid papers (Nomex®, Kevlar®), phenolic fiberglass, or aluminum joined together to form a honeycomb pattern used as lightweight core in sandwiched panels.

3.2.2 CORE CELL SIZE

This is the distance between the parallel surfaces of a cell typically hexagonal in shape. For over expanded core, it is the widest distance between parallel faces of the cell.

3.2.3 CORE DENSITY

The mass per unit volume of core (e.g., lb/ft^3)

3.2.4 SAME

The term 'same' in the context of this item refers to a honeycomb core from the same manufacturer or specification.

Also it should be clarified that the different core materials are unique and should be considered separately. For example, different densities of Aluminum core do not substantiate Nomex® core.

Further, the statement *"made from phenolic aramid (Nomex® and Kevlar®) paper"* should be *"(Nomex® or Kevlar®) paper"*. Kevlar® paper core does not substantiate Nomex® paper core. Modified, to add clarity, we recommend the statement as below:

- 14 CFR 25.853 (a): *"Data from testing ANY core cell size/shape in a given panel construction and within a specific thickness range substantiates other core cell sizes/shapes of the same material, provided the core material is made from phenolic aramid (e.g. Nomex® and Kevlar®) paper, phenolic fiberglass or aluminum."*

To keep the same consistency for Heat Release and Smoke Density Test Requirements, we recommend the statement as shown below:

- 14 CFR 25.853 (d): *"Data from the smallest and largest cell sizes from panels in a given panel construction and within a specific thickness range substantiates all cell sizes in between."*

4 VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

The use of this MOC has been grouped by the FAA into Part 2 for both 14 CFR 25.853 (a) and (d). This means that the FAA will require additional supporting data to accept this method for Vertical Burn, Heat Release and Smoke Density testing.

The industry team agrees with the FAA’s position on both 14 CFR 25.853 (a) and (d) with additional specific language as modified in Section 3.2.4. The use of items #3 and #4 for aircraft interiors flammability testing according to 14 CFR 25.853 (a) and (d) as described on the FAA memo are currently well established industry practice.

5 DATA / ANALYSIS

5.1 EXISTING TEST DATA

The industry has called upon its members to submit any type of existing flammability test data to support core density and core cell size for 14 CFR 25.853 (a) and (d). CDZ will forward the results when collated.

5.2 TEST CHAMBER VARIABILITY

CDZ proposed and will run all tests in the same lab using the same equipment. All tests among each study will use the same skin materials (and hopefully the same lot) so that strictly core density and core cell size will be observed.

5.3 PROPOSAL OF TESTS TO BE PERFORMED

CDZ proposes testing 60 second Bunsen burner, heat release and smoke density tests as manufactured .50” thick panels with 2-ply phenolic fiberglass skins.
1 set = 3 test specimens.

5.3.1 BOMBARDIER SUPPLIED PANELS

Core Density Study (Panel thickness and cell size constant)

Panels	Density	Cell Size	Honeycomb Core Type	Skin Type	Construction ID
2ply/.5" thick core/2ply	3 lb/sq.ft.	.125"	Nomex	Phenolic/glass	1
2ply/.5" thick core/2ply	4.5 lb/sq.ft.	.125"	Nomex	Phenolic/glass	5
2ply/.5" thick core/2ply	6 lb/sq.ft.	.125"	Nomex	Phenolic/glass	4

Cell Size Study (Panel thickness and core density constant)

Panels	Density	Cell Size	Honeycomb Core Type	Skin Type	Construction ID
2ply/.5" thick core/2ply	3 lb/sq.ft.	.125"	Nomex	Phenolic/glass	1
2ply/.5" thick core/2ply	3 lb/sq.ft.	.19"	Nomex	Phenolic/glass	2
2ply/.5" thick core/2ply	3 lb/sq.ft.	.19" OX	Nomex	Phenolic/glass	3

5.3.2 C&D ZODIAC AND DUPONT SUPPLIED PANELS

Core Density Study (Panel thickness and cell size constant, Nomex and Kevlar honeycomb core)

Panels	Density	Cell Size	Honeycomb Core Type	Skin Type	Construction ID
2ply/.5" thick core/2ply	1.8#	.125"	Nomex	Phenolic/glass	A
2ply/.5" thick core/2ply	6#	.125"	Nomex	Phenolic/glass	B
2ply/.5" thick core/2ply	4.5#	.125"	Kevlar	Phenolic/glass	C*
2ply/.5" thick core/2ply	6#	.125"	Kevlar	Phenolic/glass	D*
2ply/.5" thick core/2ply	1.8#	.19"	Nomex	Phenolic/glass	E
2ply/.5" thick core/2ply	4#	.19"	Nomex	Phenolic/glass	F
2ply/.5" thick core/2ply	3#	.19"	Nomex	Phenolic/glass	G
2ply/.5" thick core/2ply	4#	.19"	Nomex	Phenolic/glass	H

*Bunsen burner study only.

Cell Size Study (Panel thickness and core density constant)

Panels	Density	Cell Size	Honeycomb Core Type	Skin Type	Construction ID
2ply/.5" thick core/2ply	2#	.25"	Nomex	Phenolic/glass	I
2ply/.5" thick core/2ply	2#	.5"	Nomex	Phenolic/glass	J
2ply/.5" thick core/2ply	3#	.125"	Nomex	Phenolic/glass	K
2ply/.5" thick core/2ply	3#	.375"	Nomex	Phenolic/glass	L
2ply/.5" thick core/2ply	4#	.19"	Nomex	Phenolic/glass	F
2ply/.5" thick core/2ply	4#	.25"	Nomex	Phenolic/glass	M

5.4 TEST RESULTS

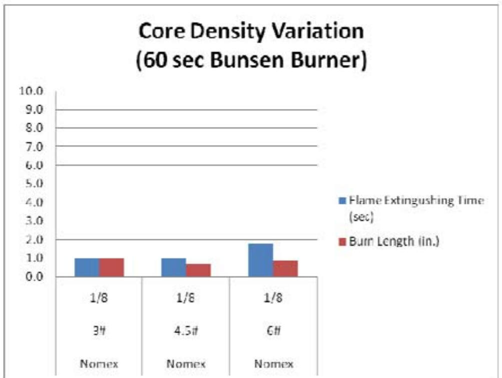
Bombardier Test Data

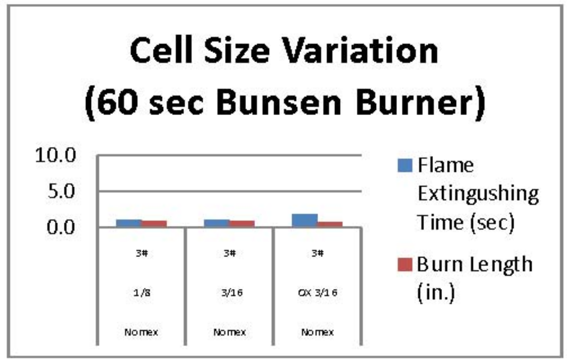
60sec Vertical Burn						
Construction ID	**Core Material**	**Core Cell Size**	**Core Density**	**Flame Extinguishing Time (sec)**	**Burn Length (in.)**	**Drips (sec)**
1	Nomex	1/8	3#	1.0	0.9	No Drips
2	Nomex	3/16	3#	1.0	0.9	No Drips
3	Nomex	OX 3/16	3#	1.8	0.8	No Drips
4	Nomex	1/8	6#	1.8	0.9	No Drips
5	Nomex	1/8	4.5#	1.0	0.7	No Drips

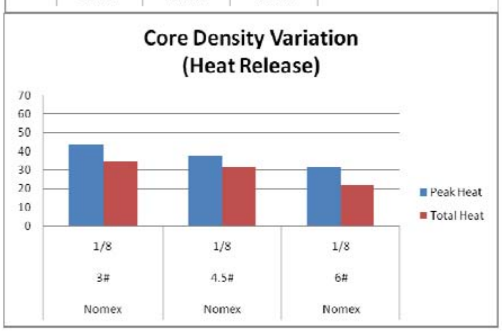
Heat Release and Smoke Density						
Construction ID	**Core Material**	**Core Cell Size**	**Core Density**	**Peak Heat**	**Total Heat**	**Specific Smoke Density**
1	Nomex	1/8	3#	43.6	34.5	0.72
2	Nomex	3/16	3#	47	39.2	0.69
3	Nomex	OX 3/16	3#	32.8	36.6	0.76
4	Nomex	1/8	6#	31.5	22.1	1.04
5	Nomex	1/8	4.5#	37.7	31.6	1.41

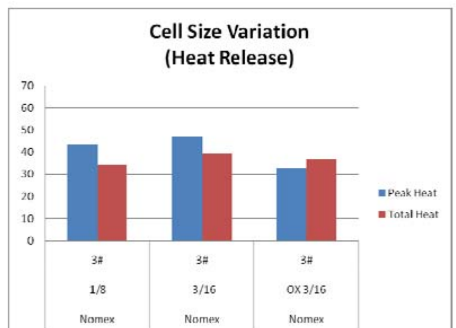
1 set (3 specimens) tested for each Construction ID
Results are an average of 1 test set.

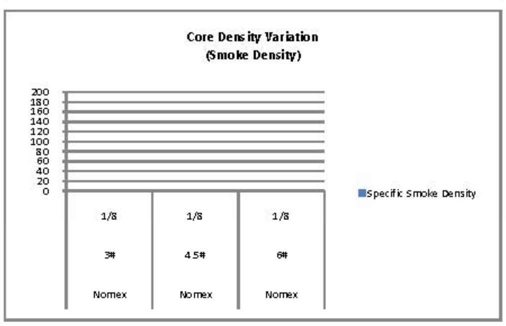
Graphical representation of Bombardier data sorted by Core Density Variation and Cell Size Variation

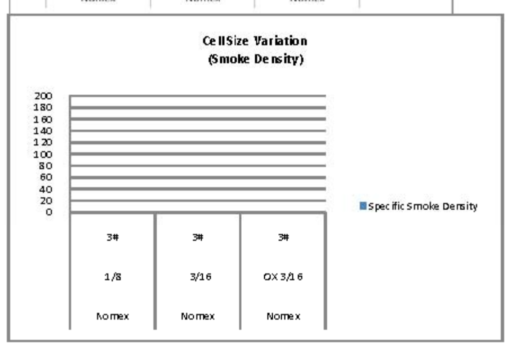












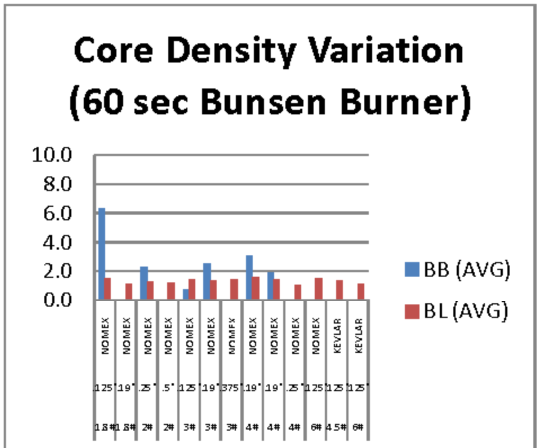
CDZ/DuPont Data

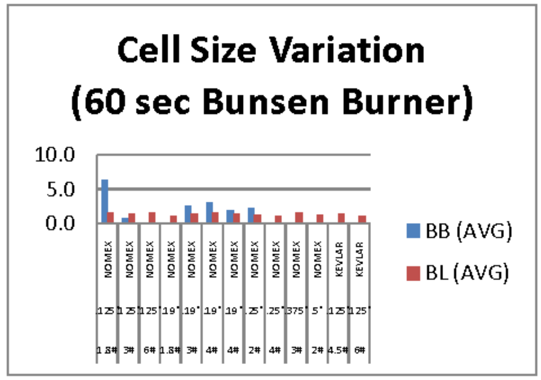
60sec Vertical Burn						
Construction ID	**Core Material**	**Core Cell Size**	**Core Density**	**Flame Extinguishing Time (sec)**	**Burn Length (in.)**	**Drips (sec)**
A	Nomex	.125"	1.8#	6.3	1.5	No Drips
B	Nomex	.125"	6#	0.0	1.5	No Drips
C	Kevlar	.125"	4.5#	0.0	1.3	No Drips
D	Kevlar	.125"	6#	0.0	1.1	No Drips
E	Nomex	.19"	1.8#	0.0	1.1	No Drips
F	Nomex	.19"	4#	3.0	1.6	No Drips
F	Nomex	.19"	4#	1.9	1.4	No Drips
G	Nomex	.19"	3#	2.5	1.3	No Drips
I	Nomex	.25"	2#	2.3	1.3	No Drips
J	Nomex	.5"	2#	0.0	1.2	No Drips
K	Nomex	.125"	3#	0.8	1.4	No Drips
L	Nomex	.375"	3#	0.0	1.5	No Drips
M	Nomex	.25"	4#	0.0	1.1	No Drips

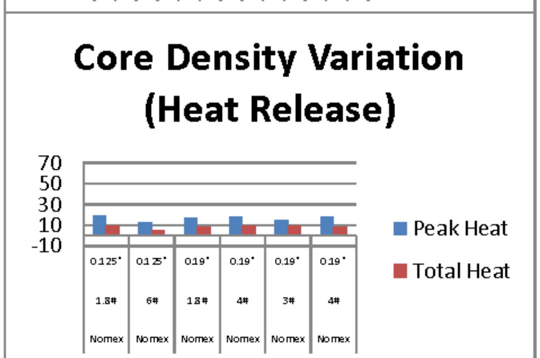
Heat Release and Smoke Density						
Construction ID	**Core Material**	**Core Cell Size**	**Core Density**	**Peak Heat**	**Total Heat**	**Specific Smoke Density**
A	Nomex	.125"	1.8#	19	10	13
B	Nomex	.125"	6#	13	5	7
C	Kevlar	.125"	4.5#	-	-	-
D	Kevlar	.125"	6#	-	-	-
E	Nomex	.19"	1.8#	17	9	12
F	Nomex	.19"	4#	18	10	6
F	Nomex	.19"	4#	18	9	9
G	Nomex	.19"	3#	15	10	8
I	Nomex	.25"	2#	15	10	10
J	Nomex	.5"	2#	18	8	16
K	Nomex	.125"	3#	13	6	14
L	Nomex	.375"	3#	21	11	11
M	Nomex	.25"	4#	11	3	19

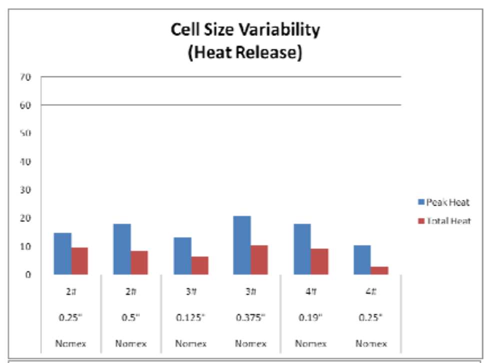
1 set (3 specimens) tested for each Construction ID
Results are an average of 1 test set.

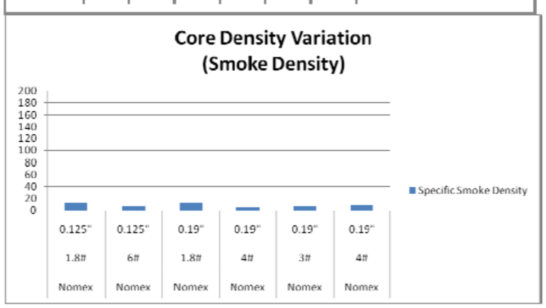
Graphical representation of CDZ/DuPont data sorted by Core Density Variation and Cell Size Variation

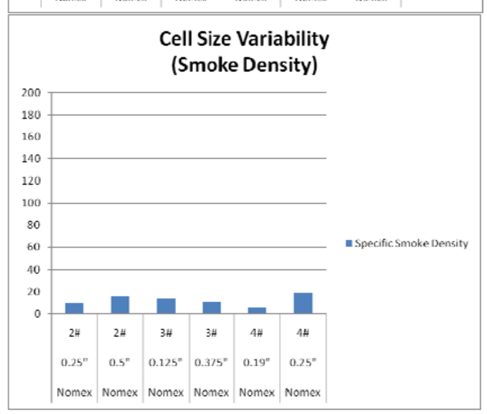












5.5 ANALYSIS OF TEST RESULTS

A minor trend was observed in the core density study with the lighter densities yielding slightly higher heat release/ smoke values than the progressively heavier cores. However, the heat release differences were all within +/- 5 points of the series averages suggesting an insignificant impact as well as the very low smoke values. The Bunsen burner burn lengths were all equivalent.

The data didn't provide any solid trends for the cell size study though the data shows that the cell size does not significantly impact heat release, smoke or Bunsen burner.

6 CONCLUSION

The industry team agrees with the FAA's position on 14 CFR 25.853 (a) and (d) and has added additional language.
Based on the panel test results (vertical burn, heat release, smoke density), we may conclude that variations in core density may have a minor influence on test results though within normal heat release and smoke test results variations. We may also conclude that cell size has no appreciable influence in increasing/decreasing passing trends and thus not appreciably affecting test results for panels systems where thickness, number of skin plies, skin ply material/resin system and core material are identical.

7 ABBREVIATIONS

FAA	=	Federal Aviation Administration
MOC	=	Methods of Compliance
CFR	=	Code of Federal Regulations
CDZ	=	C&D Zodiac

8 REFERENCES

[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

[2] n.n., *14 CFR Part 25, [Docket No. 24594; Amendment No. 25-61], Improved Flammability Standards for Materials Used in the Interiors of Transport Category Airplane Cabins,* Department of Transportation, Federal Aviation Administration, July 1986.

[3] n.n., *14 CFR Part 25, [Docket No. 24594; Amendment No. 25-66], Improved Flammability Standards for Materials Used in the Interiors of Transport Category Airplane Cabins*, Department of Transportation, Federal Aviation Administration, August 1988.

[4] O’Bryant, Michael J., *QA Task Group Performance Evaluation Report 2004 – 2005*, The Boeing Co., Seattle, 2005.

[5] Marker, Timothy, *DOT/FAA/AR-TN01/112, Heat Release and Flammability Testing of Surrogate Panels*, Department of Transportation, Federal Aviation Administration, December 2001.

APPENDIX F—ITEM 5A: PAINT SYSTEMS

FAA Memorandum
ANM-115-09-xxx “”Policy Statement on Flammability Testing of Interior Materials”
Part 2, reference no. 5 „**paint systems**”

white... pearl, warm white, cloud, smoke, oyster, blanc granite, ivory, snow white, swan, texas white, chalk, white dawn, shell, feather, creamy, light sand, oriental silk, edelweiss...

grey... pepper, dove grey, dolphin, platinum, spring, tin, electric grey, pebble, conger, shark, moonbeam, moonshadow, moondust, skyline grey, moonmetal, frozen grey, dream grey, light grey, cool silver, foggy, soft sand, snow grey, iron grey, warm fog, ...

beige... light beige, white beige, medium beige, Isabelle beige, cream beige, vanilla beige, eritrea beige, brown beige, olive beige, marmor beige, neutral beige, scallop beige, cream, sand, pale sand, walnut, porcellaine, oatmeal, champagne, morning glow, ...

blue... light blue, dark blue, water blue, ice blue, night blue, cockpit blue, lavender, skyblue, navy blue, cobalt, cosmos, azure, steel blue, marine blue, ozon, thunderblue, blueblack, blue mist, shadow blue, raincloud, bayberry, midnight, space, aubergine, ...

yellow & orange... yellow, orange, tabac, lemon, sun, apricot, candis, banana, mais, papaya, pale, mimosa, mustard, grapefruit, tearose, sunset, melon, tangerine, post-it, mandarin, champagne, ...

red... burgundy, bougainville, salmon, bordeaux, wild rose, lachs, plum, sunset rose, magenta, pelargonium, ...

Influence of paint colour
on Bunsen burner, heat release and smoke density criteria of cabin interior components

issue 3 , page **1** (of **21**)

Mar 28, 2012

Table of revisions

issue	date of issue	remarks
1	**Apr 22, 2010**	**Initial issue**
2	**Jun 30, 2011**	Various changes due to • Comments from FAA, Jeff Gardlin • Discussions during Materials Fire Test Working Group Meetings June/2010, Oct/2010, Mar/2011
3	**Mar 28, 2012**	para. 6: Test results included. para. 7: “Discussion” included. para. 8: “Conclusion and Recommendation” included.

FAA Memorandum
ANM-115-09-xxx “”Policy Statement on Flammability Testing of Interior Materials”
Part 2, reference no. 5 „**paint systems**”

For many years, industry has been justifying fire properties of painted cabin interior components, applied with various colours, ‘by similarity’ (i.e. the substantiation of one paint colour by using previous test data from another colour within the same paint product). In fact: ‘Similarity of colours’ has been one of the most undisputed proceedings since the beginning of fire properties testing. As a matter of course, this proceeding has been based upon initial material respective product qualifications of certain products at various manufacturers and users, as well as upon wide experiences from quality control.

Due to a lack of standardization across industry justification practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-xxx (“Policy Statement on Flammability Testing of Interior Materials”; current version status: August 20, 2009).
FAA memorandum ANM-115-09-xxx, part 2, reference 5, asks to provide supporting data before accepting

- that tests with one colour substantiates any other colour with the same paint chemistry,
- that tests of a painted part substantiates an unpainted part with the same construction.

In August 2009, a team has been established which shall gather a suitable approach to support the thesis of ANM-115-09-xxx, part 2, reference 5, i.e.

- to identify leader and support team
- to clear terms,
- to develop the standard to meet,
- to agree upon practice and plan (by November 2009),
- to achieve FAA agreement upon practice and plan (by December 2009),
- to perform the plan,
- to gather results and draw conclusions,
- to achieve industry agreement on conclusions,
- to achieve FAA agreement on conclusions (by December 2010),
- to close project (by January 2011).

1. INDUSTRY TEAM LEADER AND SUPPORT TEAM

Among others, the following individuals have contributed significantly to this paper:

- Weichert, Ingo (Airbus, Germany; team leader)
- Dunn, David & Slaton, Dan (Boeing, USA)
- Eberly, Dana (Airbus North America; formerly: Northwest/Delta Airlines, USA)
- Hunt, Brandon (Sherwin Williams, USA) (until Summer 2010)
- Karl, Hans-Juergen (Mankiewicz, Germany)
- Muth, Mike (Goodrich, USA)
- Rumeau, Eric (Mapaero, France)
- Statema, Reinder (HSH, Belgium)
- Campbell, Scott (C & D Zodiac, USA)
- Buedo-Leyva, Maribell (Lufthansa, Germany)
- Ta, Phuong (Goodrich, USA)
- Kaul, Nimisha (Dixie Aerospace; formerly: Weber Zodiac, USA)
- Slaton, Daniel (Boeing, USA)
- et.al.

2. PROJECT DEFINITION

2.1 CURRENT PROPOSAL

Presently, ANM-115-09-xxx is available as an undated draft. The current version has been printed on August 20, 2009. Part 2, reference no. 5, reads:

Part 2, methods of compliance that require supporting data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
5	Paint/Ink systems	Test the part with same chemistry paint/ink system. Test of one color substantiates other colors of the same paint/ink system. Substantiate unpainted with painted panel.	Test of a part with one color substantiates any other color with the same paint/ink chemistry. Additionally, testing of a painted part substantiates an unpainted part with the same construction.

2.2 ANM-115-09 CHAPTER STRUCTURE DISCUSSION

It has been decided to divide part 2, item 5 into two subgroups:

- „5a – Paint“
- „5b – Decor laminates“

2.3 AMN-115-09 WORDING DISCUSSION

It has been agreed to propose modified wording for both, ‘Bunsen’ column and ‘HR/SD’ column:

Reference Number	Feature / Construction	25.853 (a) Bunsen Burner Test Requirement/ Similarity	25.853 (d) Heat Release and Smoke Test Requirement/ Similarity
5a	paint colour	**Test of a part with one colour substantiates any other colour with the same paint chemistry.**	
	backside paint	**Test,** **or use other applicable MoC** [e.g. FASE (part 1, ref. 9)]	**An item tested with paint on the backside (non-test surface) substantiates the identical construction without paint on the backside surface.**

2.4 CLARIFICATION OF TERMS

2.4.1 Top Coat

The top coat is the visible coating of a component. It provides, among others, colour and surface texture.

2.4.2 Base Coat (Primer)

The base coat (primer) is an intermediate layer. Typically, it is applied onto a technical surface prior to applying the top coat. A Primer may, or may not, be applied.

2.4.3 Paint System

A paint system is an aligned and harmonized couple of top coat and base coat (primer).

2.4.4 Paint Chemistry

The chemistry of a paint system is defined individually by every paint manufacturer. Reason is that, even under global headline category (e.g. polyurethane, epoxy, acrylic), no common formulation can be assumed.
Generally, paint chemistry addresses a certain defined ratio of binder, filler, solvents, hardener, additives - plus an amount of colour pigments, which may vary depending on the colour.

The full range of colours shall be provided “by same paint chemistry”, except for the colour pigments.

2.4.5 “same”

The industry team agrees that the term ‘same’ in the context of this item refers to a similar paint from

- the same manufacturer, and
- the same product family, and
- the same product built-up.

So when the FAA draft policy memo refers to “same paint system”, the only change being allowed in the context of this item would be the exclusive change from one colour to another, with all other product parameter staying the same.

The industry team therefore recommends that the term “same” in the context of this item be defined as “from the same manufacturer and same product family and same product built-up”.

3. DEFINE THE PROJECT

Apart from the general aspects (such as basic chemistry, paint layer thickness, etc.) potential influences of colour might be caused by several reasons:

- Chemical aspects, e.g. certain additives (inorganic, organic, ...), ...
- Physical aspects, e.g. variation due to different heat absorption due to colour differences
- Test method imponderables
- Inter-laboratory deviations
- ...

3.1 RANGE OF APPLICATION

Today’s standard cabin interior paint products are e.g.

- Mankiewicz Alexit 404-12, 346-55, 346-57, ...
- HSH Interplan 1083, ...
- Mapaero FRS40, FR2/55, ...
- Sherwin Williams Jet Flex

assuming that each of these products is based upon the same chemistry with just marginal changes (i.e. colour pigments), see above. These paints are first priority candidates for the approach proposed in this elaboration. However, further paints may be evaluated to this proposed testing, to ensure the MoC is acceptable for the specific paint system.

Non-standard paint systems are e.g. pearl effect paints, intumescent paints, etc. So far, these products will not be included into this study.
Powder coated metal is handled under part 1, reference 17.

It should be noted that it is very common for manufacturers and paint suppliers to develop aerospace material specifications to define requirements for the characteristics of a paint system. Controlling materials to a specification is a very robust way to align with CS/FAR 25.603 (“Materials”). Examples of paint systems, which have been qualified (and are controlled) according to a specification which is aligned with CS/FAR part 25 transport aircrafts, include ABS5650/ AIMS04-08-002, BMS10-83 (this is not an inclusive list).
It is recognized that this MoC can also be applicable to paint systems controlled by engineering type design besides a material specification (e.g. engineering drawings) after evaluation of results using this proposed testing.

The industry team also agrees that currently used materials may not need to be evaluated using the specific testing defined in this proposal. Many current aerospace materials have been qualified through rigorous qualification testing by the paint manufacturers and the aircraft manufacturers, which covers evaluation of the paint system to all requirements (e.g. stability, toughness, solvent resistance, and flammability). The evaluation for flammability properties is substantial and evaluates all the tints on a range of interior material substrates. This industry practice has provided the baseline data and knowledge to develop this proposal. For these currently qualified products, if the flammability qualification data demonstrates that there is no appreciable effect on colour, this data supports the application of MoC in lieu of the minimum testing defined in this proposal.

4. DATA/ ANALYSIS

4.1 EVALUATION OF TEST DATA

The industry team mutually concurs that Bunsen burner, heat release and smoke density criteria are primarily influenced by

- paint chemistry,
- paint layer thickness and, certainly,
- the substrate.

Thus, documentation of these parameter is mandatory precondition.

Prior to proposing tests, it was considered whether test data, which are already existing, could support the thesis that colour will not significantly influence fire properties. A table (as proposed below) was sent out to various manufacturers and users of paint.

Just few useable data have been identified. A significant amount of data is available, which bases upon (process control) samples painted in accordance to a released process specification (i.e. to apply a paint layer dry film thickness of about 50...100 µm / 2...4 mil). They show excellent results. However, precise paint layer thickness has not been provided. Thus, they cannot be used to support the colour thesis.

4.2 PROPOSED TEST PROGRAM

4.2.1 General aspects

Since, so far, evaluation of existing test data was not satisfactory, it appears necessary to perform Bunsen burner, heat release and smoke density tests.

The tests are not intended as benchmark between various paint product. Thus, vendor’s individual proceeding is accepted.

Samples and laboratories. To minimize influences resulting from test substrates and inter-laboratory variances, the following is recommended for qualification of each individual paint product:

- Test substrates shall be provided from one source per test series, to prevent from deviation caused by substrate. However, the intention of this proposal is not to maintain a benchmark between the various paint products.
- To ensure same dry film thickness for each colour, paint application by means of a paint robot is recommended. However, **it is essential to measure and report dry film thickness of each test sample**.
- For each paint product, tests shall be performed in one test laboratory (to prevent from inter-lab variances).
- For each paint product, test series should be performed within a certain period of time (e.g. within 5 days from start to finish), to prevent from creeping variances which might appear gradually...unnoticed.

It is proposed to perform at least 1 test sets (each consisting of at least 5 samples) for each test configuration. (It is recommended to manufacture more than 5 samples, to have some backup samples available).

Test method variances. A question, which addresses test method variances and scatter bands, is: *“How different would test results have to be from each other to distinguish the “critical colour”? Some degree of variation would exist from test to test even with all things, inclusive of colour, being equal.”* The team feels that this cannot be answered today. It is proposed to begin with test steps as per para. 4.2.2 and 4.2.3 of this elaboration prior to finally deciding in this matter. However, as a guiding value, an amount like the typical scatter band within one test laboratory (which is about 15...20 %) could be proposed.

Critical colours. Which colours, if any, might be assumed as ‘critical’? The team assumes that colours with a large amount of organic colour pigments (i.e. pure red, yellow, blue, ...) might, potentially, cause a larger impact upon fire properties than colours with inorganic colour pigments (e.g. white, black, ...).

For substantiation, pure mono-pigmented colours should be preferred, e.g.

	colour		colour additives			remarks
			organic	*in*organic	both	
A	black		X	---	---	e.g. RAL 9005 or similar

				X	---	
W	white		X		---	e.g. RAL9010 or similar
				X	---	
R	red		X	---	---	e.g. RAL 3000 or similar
			---	X	---	
B	blue		X	---	---	e.g. RAL 3009 or similar
				X	---	
Y	yellow		X	---	---	e.g. RAL 1018/1017 or similar
			---	X	---	

Note: Not each proposed colour may be available with both, organic and inorganic pigments/additives.

Assuming that pastel colours will always be a composition from various mono-pigmented colours, pastel colours should not be used for substantiation:

light grey	beige	rosé	light yellow	light blue	dark grey

Top coat, base coat (primer). The proposed proceeding shall primarily be applied for top coats. Base coats (primer) typically do not show a wide variety of colours. A proceeding for the substantiation of primer shall be proposed soonest.

The following test program is proposed. It would be appreciated if various test series could be launched in parallel. Even if absolute values might not be assigned to an individual product, the benefit of a parallel proceeding would - hopefully - be in confirming the relevance of the proposed proceeding.

The results from a test step should be considered prior to defining the next test step. Depending on the discussion of findings, further proceeding may be changed or enhanced.

4.2.2 1st step: Test of pure ‘black’, ‘white’, ‘red’, ‘blue’ and ‘yellow’ colour on an *inert* substrate

Application of (e.g.) 75 µm/ 3 mil of paint (dry film thickness) onto a 0.5 mm/ .04 inch aluminum sheet. The test shall demonstrate whether extreme colour variances generally influence fire properties.

It is assumed that pure white (inorganic), a pure blue, a pure yellow, a pure black and a pure red (all organics) will cover 95% of conventional colours.

4.2.3 2nd step: Test of pure ‘black’ and ‘white’ colour on a *critical* substrate

Application of (e.g.) 75 µm/ 3 mil of paint (dry film thickness) onto a heat release and smoke density compliant thermoplastic substrate, e.g.

- ~ 1.5 mm/ .12 inch polyetherimide (e.g. Ultem 9085),
- ~ 1.5 mm/ .12 inch heat release- compliant polycarbonate (e.g. Lexan XHR 6000).

The test shall demonstrate whether certain/extreme colours might absorb more heat than other colours and thus could influence burn dynamics of critical substrates.

PEI substrate is preferred, since it is assumed to be more homogenous than other substrates (e.g. phenolic laminate).

4.2.4 3rd step: Test of colours with much *organic* ingredients versus colours with much *inorganic* ingredients

Application of (e.g.) 75 µm/ 3 mil of paint (dry film thickness) onto a 0.5 mm/ .04 inch aluminum substrate. The test shall demonstrate whether organic ingredients (which are expected to contribute more to consumption than inorganic ones) cause fire properties which are different from the one caused by inorganic ingredients.
This step is optional, since the results from 1st step may already substantiate this aspect (depending whether organic as well as inorganic pigmented colours have been tested).

4.3 FURTHER TESTS (OTHER THAN HEAT RELEASE, SMOKE DENSITY, BUNSEN)

4.3.1 Microscale Combustion Calorimetry (MCC; ASTM D 7309)

It is proposed to perform MCC testing upon the paint colours chosen for test, to gain data which may support the heat release and smoke density testing. However, since experience with MCC so far is just limited, MCC results shall not override findings and results gained in the applicable Bunsen, OSU and NBS tests.

4.4 *PAINTED* SURFACE QUALIFIES *UNPAINTED* PART

Regarding heat release and smoke density, the industry team proposes to accept that an item tested with paint on the backside (non-test surface) substantiates the identical construction without paint on the backside surface.

Regarding Bunsen burner test, both painted as well as unpainted back sides shall be substantiated by test, unless another means of compliance (MoC) is applicable (e.g. FASE; see ANM-115-09-xxx, part 1, ref. 9).

5. TEST MATRIX (PROPOSAL)

Fire Properties Test Plan (FPTP). It is suggested that paint vendors establish, for each paint product, an individual FPTP, which names in detail the test configurations, test matrix (example/suggestion: see below), test laboratories, conformity documentation, test witness, etc.

Paint product “A___” from manufacturer “K___”

1st step:
Test of pure ‘black’, ‘white’, ‘red’, ‘blue’ and ‘yellow’ colour on an *inert* substrate

1 test sets per colour, each consisting of
5 Bunsen samples (60-s-vert), 5 heat release samples, 5 smoke density samples

ref.	Substrate	colour	paint layer thickness	b’l [mm] [inch]	b’t [s]	drb’t [s]	HRR [kW/m²]	HR [kW min/m²]	SD	MCC	Certificate, remark
1.a	**aluminum** sheet 1) __ mm __ mil	**black** org 2) RAL ... **)	__ µm __ mil								
1.b		**black** inorg 2) RAL... 3)	__ µm __ mil								
2.a		**white** org 2) RAL ... 3)	__ µm __ mil								
2.b		**white** inorg 2) RAL ... 3)	__ µm __ mil								
3.a		**red** org 2) RAL ... 3)	__ µm __ mil								
3.b		**red** inorg 2) RAL ... 3)	__ µm __ mil								
4.a		**blue** org 2) RAL ... 3)	__ µm __ mil								
4.b		**blue** inorg 2) RAL ... 3)	__ µm __ mil								
5.a		**yellow** org 2) RAL ... 3)	__ µm __ mil								
5.b		**yellow** inorg 2)	__ µm __ mil								

		RAL ... [3])									

1 µm ≈ .04 mil... 1 mil ≈ 25 µm.
b'l: burn length (60-s-vert Bunsen)... b't: burn time... drb't: burn time of drips... HRR: heat release rate/peak... HR: heat release total...
SD: smoke density. All values should be the average from at least five individual samples

[1]): recommendation: 0.5 mm/ .04 inch
[2]): if technically feasible/available.
[3]): report colour specification (e.g. RAL code)

Paint product “A___” from manufacturer “K___”

<u>2nd step:</u>
Test of pure ‘black’ and ‘white’ colour on a *critical* substrate (polyetherimide, or another thermoplastic material which is heat release and smoke density compliant)

1 test sets per colour, each consisting of
5 Bunsen samples (60-s-vert), 5 heat release samples, 5 smoke density samples

ref.	**Substrate**	**colour**	**paint layer thickness**	**b'l** [mm] [inch]	**b't** [s]	**drb't** [s]	**HRR** [kW/m²]	**HR** [kW min/m²]	**SD**	**MCC**	Certificate, remark
2.1.a	**PEI** sheet __ mm __ mil	**black** <org> [2]) RAL ... [3])	__ µm __ mil								
2.2.a		**white** <inorg> [2]) RAL ... [3])	__ µm __ mil								

1 µm ≈ .04 mil... 1 mil ≈ 25 µm.
b'l: burn length (60-s-vert Bunsen)... b't: burn time... drb't: burn time of drips... HRR: heat release rate/peak... HR: heat release total...
SD: smoke density. All values should be the average from at least three individual samples

[2]): specify/report whether colour is organic or inorganic
[3]): report colour specification (e.g. RAL code)

6. TEST RESULTS

Currently, heat release, smoke density and micro-scale calorimeter tests have been performed (in the FAA Technical Center laboratories) on four paint products.

6.1 PAINT APPLIED ON ALUMINUM

The following heat release and smoke density results have been found with paint applied on 0.04 inch (0.5 mm) aluminium sheets. MCC results have been found on bare paint (without being applied onto a substrate).

paint product "**alpha**"

HRR (peak)

	black	white	red	red	blue	blue	yellow	yellow	average	stdDev	stdDev
	org	inorg	org	inorg	org	inorg	org	inorg		from average values	from all
specimen 1	12	10,7	15,6	9,9	12,3	---	15,3	24,1			
specimen 2	14	10,5	11	10,3	21,9	---	11,5	25,6			
specimen 3	11	14,6	12,8	10,9	13,1	---	18,8	22,5			
specimen 4	17	14,4	14,6	12,4	14	---	13,4	26,9			
specimen 5	20	11,4	18,5	9,1	11,7	---	11,6	23,6			
avg	**15**	**12**	**15**	**11**	**15**	**---**	**14**	**25**	15,3	4,6	4,9
stdDev	3,7	2	2,8	1,2	4,2	---	3	1,7			

HR (total)

	black	white	red	red	blue	blue	yellow	yellow	average	stdDev	stdDev
	org	inorg	org	inorg	org	inorg	org	inorg		from average values	from all
specimen 1	13,5	10,7	11,9	8,5	12,1	---	8,2	13,2			
specimen 2	13,8	12,1	11,9	5	8,7	---	13,4	16,1			
specimen 3	5,8	16	12,4	8,3	13,4	---	14,9	14,8			
specimen 4	13,1	13,5	11,1	11,5	15,3	---	12,3	14,3			
specimen 5	15	11,4	13,1	8,6	12	---	8,2	13,3			
avg	**12**	**13**	**12**	**8**	**12**	**---**	**11**	**14**	11,7	1,9	2,8
stdDev	3,7	2,1	0,7	2,3	2,4	---	3,1	1,2			

smoke

	black	white	red	red	blue	blue	yellow	yellow	average	stdDev	stdDev
	org	inorg	org	inorg	org	inorg	org	inorg		from average values	from all
specimen 1	8,9	12,9	11,6	5,3	4,8	---	9,9	5,6			
specimen 2	9,7	14,3	12,2	5,6	3,3	---	12,2	4,4			
specimen 3	8,8	14	13,2	6,6	3,3	---	9,4	5,8			
specimen 4	11,1	12,6	12,5	6,6	3,4	---	12,8	3,7			
specimen 5	8,9	15,5	14	6,6	3,4	---	10,4	4,4			
avg	**9**	**14**	**13**	**6**	**4**	**---**	**11**	**5**	8,9	4	3,9
stdDev	1	1,2	0,9	0,6	0,7	---	1,5	0,9			

MCC

average values from 3 specimen

	black	white	red	red	blue	blue	yellow	yellow	average		stdDev
	org	inorg	org	inorg	org	inorg	org	inorg			all specimen
char %	1	1	1	1	1	1	1	1	**1**		0
HRC	137	142	137	155	151	---	139	139	**143**		7,2
HRR	77	66	105	80	83	---	100	71	**83**		14,4
HR	10	11	11	12	12	---	12	11	**11**		0,8
HR gas	1	1	1	1	1	1	1	1	**1**		0
Tp °C	1	1	1	1	1	1	1	1	**1**		0

paint product "**bravo**"

HRR (peak)

	black	white	red	red	blue	blue	yellow	yellow	average	stdDev	stdDev
	org	inorg	org	inorg	org	inorg	org	inorg		from *average values*	from *all*
specimen 1	26,6	8,3	16	26,6	7,7	---	---	31,8			
specimen 2	14,8	13,3	16,9	23,4	6,3	---	---	39,3			
specimen 3	13,3	16,1	28,8	32,9	12,2	---	---	46,3			
specimen 4	17,2	21	20,8	27,9	15,3	---	---	49,2			
specimen 5	15,3	22,4	26,3	21,1	15,6	---	---	36,2			
avg	**17**	**16**	**22**	**26**	**11**	**---**	**---**	**41**	**22,2**	10,6	10,8
stdDev	5,3	5,8	5,7	4,5	4,3	---	---	7,2			

HR (total)

	black	white	red	red	blue	blue	yellow	yellow	average	stdDev	stdDev
	lamp		qui		phth						
	org	inorg	org	inorg	org	inorg	org	inorg		from *average values*	from *all*
specimen 1	11,8	1	6,4	7,2	1,8	---	---	3,4			
specimen 2	10,8	2,8	9,7	6,3	-0,8	---	---	9,9			
specimen 3	4,2	6	14	9	5,6	---	---	16,1			
specimen 4	11	10,2	6,9	8,8	10,2	---	---	11,9			
specimen 5	13,9	2,9	12,9	6,8	6,4	---	---	7,9			
avg	**10**	**5**	**10**	**8**	**5**	**---**	**---**	**10**	**8**	2,4	4,1
stdDev	3,6	3,6	3,4	1,2	4,3	---	---	4,7			

smoke

	black	white	red	red	blue	blue	yellow	yellow	average	stdDev	stdDev
	org	inorg	org	inorg	org	inorg	org	inorg		from *average values*	from *all*
specimen 1	1	1	1	1	1	---	1	1			
specimen 2	1	1	1	1	1	---	1	1			
specimen 3	1	1	1	1	1	---	1	1			
specimen 4	1	1	1	1	1	---	1	1			
specimen 5	1	1	1	1	1	---	1	1			
avg	**1**	**1**	**1**	**1**	**1**	**---**	**1**	**1**	1		0
stdDev	0	0	0	0	0	---	0	0		0	

MCC

average values from 3 specimen

	black	white	red	red	blue	blue	yellow	yellow	average		stdDev
	org	inorg	org	inorg	org	inorg	org	inorg			all specimen
char %	1	1	1	1	1	---	1	1	**1**		0
HRC	1	1	1	1	1	---	1	1	**1**		0
HRR	1	1	1	1	1	---	1	1	**1**		0
HR	1	1	1	1	1	---	1	1	**1**		0
HR gas	1	1	1	1	1	---	1	1	**1**		0
Tp °C	1	1	1	1	1	---	1	1	**1**		0

paint product **"charlie"**

HRR (peak)

	black	white	red	red	blue	blue	yellow	yellow	average	stdDev	stdDev
	org	inorg	org	inorg	org	inorg	org	inorg		from average values	from all
specimen 1	57,9	38,6	44,2	---	49,1	---	39	45			
specimen 2	52	41,4	46,8	---	50,1	---	37	53,6			
specimen 3	50,3	36,7	45,7	---	43,6	---	38,8	47,8			
specimen 4	---	---	---	---	---	---	---	---			
specimen 5	---	---	---	---	---	---	---	---			
avg	**53**	**39**	**46**	**---**	**48**	**---**	**38**	**49**	**45,5**	5,9	6,1
stdDev	4	2,4	1,3	---	3,5	---	1,1	4,4			

HR (total)

	black	white	red	red	blue	blue	yellow	yellow	average	stdDev	stdDev
	org	inorg	org	inorg	org	inorg	org	inorg		from average values	from all
specimen 1	31,4	17,4	22,7	---	28,3	---	17,4	23			
specimen 2	25,8	19,2	21,7	---	26,3	---	17,6	25,8			
specimen 3	28,1	19	25,4	---	20,3	---	20,4	26,2			
specimen 4	---	---	---	---	---	---	---	---			
specimen 5	---	---	---	---	---	---	---	---			
avg	**28**	**19**	**23**	**---**	**25**	**---**	**18**	**25**	**23**	3,8	4,2
stdDev	2,8	1	1,9	---	4,2	---	1,7	1,7			

smoke

	black	white	red	red	blue	blue	yellow	yellow	average	stdDev	stdDev
	org	inorg	org	inorg	org	inorg	org	inorg		from average values	from all
specimen 1	---	---	---	---	---	---	---	---			
specimen 2	---	---	---	---	---	---	---	---			
specimen 3	---	---	---	---	---	---	---	---			
specimen 4	---	---	---	---	---	---	---	---			
specimen 5	---	---	---	---	---	---	---	---			
avg	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	#DIV/0!	#DIV/0!	#DIV/0!
stdDev	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!			

MCC

average values from 3 specimen

	black	white	red	red	blue	blue	yellow	yellow	average		stdDev
	org	inorg	org	inorg	org	inorg	org	inorg			all specimen
char %	1	30	15	---	17	---	15	21	**17**		9,5
HRC	1	191	185	---	229	---	242	194	**174**		87,6
HRR	1	131	134	---	144	---	139	143	**115**		56,2
HR		18	21	---	21	---	20	20	**20**		1,2
HR gas		26	25	---	25	---	24	25	**25**		0,7
Tp °C		392	358	---	408	---	336	370	**373**		28,2

paint product **"delta"**

HRR (peak)

	black	white	red	red	blue	blue	yellow	yellow	average	stdDev	stdDev
	org	inorg	org	inorg	org	inorg	org	inorg		from *average values*	from *all*
specimen 1	53,6	17,1	20,6	---	10,6	---	19,3	---			
specimen 2	8,4	16,4	17,4	---	10,6	---	21,7	---			
specimen 3	20,6	17,1	17,8	---	11,2	---	17,1	---			
specimen 4	---	---	---	---	---	---	---	---			
specimen 5	---	---	---	---	---	---	---	---			
avg	**28**	**17**	**19**	**---**	**11**	**---**	**19**	**---**	**18,8**	6,1	10,5
stdDev	23,4	0,4	1,7	---	0,3	---	2,3	---			

HR (total)

	black	white	red	red	blue	blue	yellow	yellow	average	stdDev	stdDev
	org	inorg	org	inorg	org	inorg	org	inorg		from *average values*	from *all*
specimen 1	9,2	10,1	7,4	---	4,4	---	9,8	---			
specimen 2	-6	9	7,8	---	7,7	---	11,5	---			
specimen 3	11,1	8,3	6,6	---	5	---	9,9	---			
specimen 4	---	---	---	---	---	---	---	---			
specimen 5	---	---	---	---	---	---	---	---			
avg	**5**	**9**	**7**	**---**	**6**	**---**	**10**	**---**	**7,4**	2,1	4,2
stdDev	9,4	0,9	0,6	---	1,8	---	1	---			

smoke

	black	white	red	red	blue	blue	yellow	yellow	average	stdDev	stdDev
	org	inorg	org	inorg	org	inorg	org	inorg		from *average values*	from *all*
specimen 1	30,4	28,4	25,8	---	21,1	---	24,8	---			
specimen 2	29,2	22,9	29,7	---	20,5	---	23,8	---			
specimen 3	30	19,4	25,8	---	14,5	---	23,4	---			
specimen 4	---	---	---	---	---	---	---	---			
specimen 5	---	---	---	---	---	---	---	---			
avg	**30**	**24**	**27**	**---**	**19**	**---**	**24**	**---**	**24,8**	4,1	4,6
stdDev	0,6	4,5	2,3	---	3,6	---	0,7	---			

MCC

average values from 3 specimen

	black	white	red	red	blue	blue	yellow	yellow	average		stdDev
	org	inorg	org	inorg	org	inorg	org	inorg			all specimen
char %	25	43	18	---	23	---	---	36	**29**		10,2
HRC	155	118	171	---	158	---	---	116	**144**		25
HRR	94	73	94	---	101	---	---	78	**88**		11,9
HR	14,3	11,3	15,9	---	14,5	---	---	10,2	**13**		2,4
HR gas	19,2	20	19,5	---	18,8	---	---	16,2	**19**		1,5
Tp °C	432	351	443	---	427	---	---	326	**396**		53,4

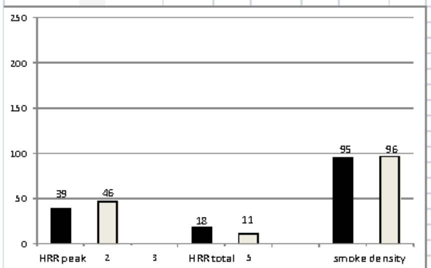
6.2 PAINT APPLIED ONTO THERMOPLASTIC SHEET

The following heat release and smoke density results have been found with paint applied on 0.09 inch (2,3 mm) thermoplastic sheets (polycarbonate Lexan XHR6006).

paint product "alpha" on polycarbonate

		HRR	@sec	HR	Ds	@sec
black (org)	2.1a-1	34,8	166	15,6	91,1	239
RAL 9010		36,6	192	20	97,3	239
Lexan XHR 600		41,3	128	23,3	83,8	239
0,093"/ ___ mm		39,4	251	12,3	95,4	239
		40,7	139	17,7	114,4	239
average		**39**		**18**	**96**	
std'dev		2,8		4,2	11,3	

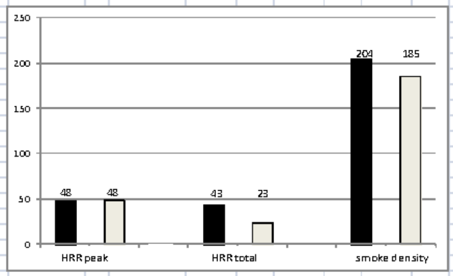
		HRR	@sec	HR	Ds	@sec
white (inorg)	2.2b-1	59,1	187	11,9	124,2	238
RAL 9010		42,1	159	16,4	89,2	239
Lexan XHR 6006		38,6	168	10,3	44,8	161
0,093"/ ___ mm		53,4	176	6,3	90,4	239
		38,1	153	8,3	128,8	237
average		**46**		**11**	**95**	
std'dev		9,5		3,8	33,8	



paint product "bravo" on polycarbonate

		HRR	@sec	HR	Ds	@sec
black (org)	2.1a-1	48		43	204,0	
RAL 9010						
Lexan XHR 600						
0,093"/ ___ mm						
average		**48**		**43**	**204**	
std'dev		#DIV/0!		#DIV/0!	#DIV/0!	

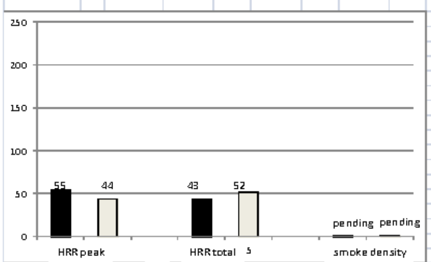
		HRR	@sec	HR	Ds	@sec
white (inorg)	2.2b-1	48		23	185,0	
RAL 9010						
Lexan XHR 6006						
0,093"/ ___ mm						
average		**48**		**23**	**185**	
std'dev		#DIV/0!		#DIV/0!	#DIV/0!	



paint product "charlie" on polycarbonate

		HRR	@sec	HR	Ds	@sec
black (inorg)	2.1a-1	55		43	0,0	
RAL 9010						
Lexan XHR 600						
0,093"/ ___ mm						
average		**55**		**43**	**0**	
std'dev		#DIV/0!		#DIV/0!	#DIV/0!	

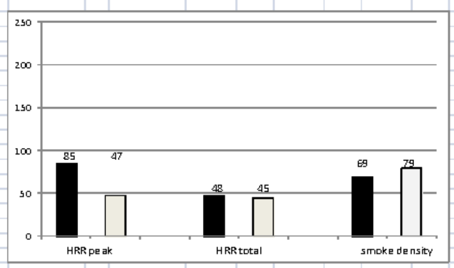
		HRR	@sec	HR	Ds	@sec
white (inorg)	2.2b-1	44		52	0,0	
RAL 9010						
Lexan XHR 6006						
0,093"/ mm						
average		**44**		**52**	**0**	
std'dev		#DIV/0!		#DIV/0!	#DIV/0!	



paint product "delta" on polycarbonate

		HRR	@sec	HR	Ds	@sec
black (inorg)	2.1a-1	85		48	61,6	
RAL 9010					80,4	
Lexan XHR 600					65,8	
0,093"/ ___ mm						
average		**85**		**48**	**69**	
std'dev		#DIV/0!		#DIV/0!	9,9	

		HRR	@sec	HR	Ds	@sec
white (inorg)	2.2b-1	47		45	84,5	
RAL 9010					84,4	
Lexan XHR 6006					67,7	
0,093"/ mm						
average		**47**		**45**	**79**	
std'dev		#DIV/0!		#DIV/0!	9,7	



7. DISCUSSION

In developing the approach to evaluate the impact of paint colour on flammability properties, the industry team defined a test matrix that attempted to eliminate many test variables to understand the direct influence of paint colour. The team also had a goal at minimizing the number of tests. The key variables that were considered to have the most potential for variation included paint thickness, panel substrate, OSU test variation, and pigment loading levels. To minimize variation in these areas, the following test approach was defined:

- Paint Thickness: A targeted thickness of 75 microns (3 mil) was used.
- Panel Substrate: Aluminum sheet was used to minimize panel contribution from a non-metallic panel.
- OSU Test Variation: Testing was performed with the same OSU machine (FAA Technical Center).
- Pigment Loading Levels: White, Black and the primary colours were used to attempt to cover the full range of the colours. This approach also ensured that higher pigment loading levels were evaluated suspected as being a worse case. When applicable, both organic and inorganic pigments were evaluated.

The general chemistry of paint systems is similar, containing a base resin, hardener, solvents and pigment combinations, although the detailed chemistry formulations are unique to specific products. For this reason, four different paint products were evaluated. The effect of colour was evaluated for each paint system independently from the other manufactures to eliminate the variation due to unique chemistry formulations across manufacturers.

The data generated on the four products showed some variation in OSU results for different colours within a paint product. Although some colours for some paint systems had bigger differences than expected, the industry team also felt the differences were within the typical variation expected with OSU. There was also a wide range of standard deviation across colours and paint systems indicating the inherent variability when performing OSU tests. When comparing the range of averages and standard deviations within each paint product to the other products, there is no obvious consistency between colours within the different paint products. Some products have high values for a specific colour that is not the highest for other products. Some colours have higher standard deviations than the same colour in another product. When looking at each system individually, some products show a different overall range of variation in OSU peak between the highest and lowest colours, with some products ranging from 15 to 30 while others range from 10 to 20.

Although the test approach attempted to eliminate sources of error, further discussion by the industry team acknowledged that there were still sources of variation other than paint colour that influenced the results as described below:

a. The effect of the paint thickness tolerance on the test samples added an unknown source of variation. Different paint thickness on each sample likely contributed to the data scatter. There is also a measurement capability tolerance when measuring paint thickness. The sensitivity in the measurement approach results in not knowing the precise thickness of paint on an individual sample which contributes to data scatter.
b. Differences in the paint application process used by the four suppliers providing the samples likely contributed to differences in paint thickness tolerance, surface quality, mixing and curing processes. These factors may be contributing to sample variation.

c. Using an aluminum substrate reduced the potential combustion contribution from a non-metallic panel, but the thermal interaction between the paint layer and the aluminum sheet may be contributing more variation in the data scatter. Peak OSU results may be more sensitive and variable when tested on aluminum providing greater standard deviation. Some suppliers have reviewed local qualification data of paint systems and there is no obvious correlation between data on standard honeycomb panels and the data on aluminum sheet, indicating different synergist effects.
d. The OSU machine has inherent variation and with the minimum number of samples tested, the overall contribution to data scatter from the OSU machine variation is not known. Historically though, testing additional samples will change the average results and standard deviation, but it is random as to whether there will be a decrease or increase of the data scatter.

8. CONCLUSION AND RECOMMENDATION

Considering the limited data generated, the sources of variation involved, testing worse case colours, and that the variation is generally within the natural variation observed with OSU testing, the industry is proposing that a HRR/HR/SD margin of 55/55/180 be adopted for colour similarity for heat release and smoke density testing. The industry team acknowledges that the worse case conditions (primary colours) are not commonly used and the predominant colours of paint used in the cabin are white/beige/grey variations that have a similar pigmentation approach. The 55/55/180 margin will provide a MoC that provides a more conservative approach than has been used as industry practice for many years, and significantly simplifies and standardizes the compliance process.

APPENDIX G—ITEM 5B: DECORATIVE LAMINATE COLOR

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM FINAL REPORT

Part 1, Reference Item #5b, “Decorative Laminate Color”

Revision – B, dated 2011-August-12

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REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
N/C	Official Release	2010-Sep-02	Michael C. Miler
A	Addition of historical test data, analysis and conclusion	2011-Mar-29	Michael C. Miler
B	Final Report. Addition of controlled flammability studies, analysis and conclusion. Modified definition of decorative laminate to standardize across all MOCs	2011-Aug-12	Michael C. Miler

1 INTRODUCTION

Decorative Laminate color similarity (e.g. the substantiation of one decorative laminate color by using previous flammability test data from another decorative laminate color within the same decorative laminate type) for aircraft interiors flammability testing according to 14 CFR 25.853 (a) and (d) is currently a well established industry practice. The argument used for decorative laminate color similarity is that changes exclusively in color within the same decorative laminate type have no appreciable effect on the results of flammability testing (vertical burn, heat release and smoke emission).

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials” [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA’s technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Item 5b has been reviewed by the industry team and is submitting the following concurrence, justification and final report.

2 INDUSTRY TEAM LEADER AND SUPPORT TEAM

During an initial industry meeting on September 24, 2009 in Huntington Beach, CA, and subsequent FAA Materials Fire Test Working Group and Flammability Standardization Working Group (FSTG) meetings, the following individuals have volunteered to form the industry team for this reference item:

2.1 TEAM LEADER

- Miler, Michael C. (Schneller LLC)

2.2 SUPPORT TEAM

- Bösser, Klaus (Sell GmbH)
- Bronner, Samantha (Boeing)
- Buedo Leyva, Maribell (Lufthansa Technik AG)
- Buoniconti, Ralph (SABIC Innovative Plastics)
- Campbell, Scott (C&D Zodiac)
- Danker, George (Unifrax)
- Del Pinto, Jim (C&D Zodiac)
- Eberly, Dana (Northwest Airlines)
- Fayerweather, Diane (C&D Zodiac)
- Freeman, Dan (Boeing)
- Fritzl, Raimund (Isovolta AG)
- Hurst, Cheryl (American Airlines)
- Jensen, Michael (Boeing)
- Karl, Hans (Mankiewicz)
- Kauffman, Jym (Kydex LLC)
- Landroni, Francisco (Embraer)
- Langer, Dirk (Sell GmbH)
- Le Neve, Serge (CEAT)
- Livengood, Thomas (B/E Aerospace)
- Moeller, Marco (Recaro)
- Muth, Mike (Goodrich)
- Niitsu, Gilberto (Embraer)
- Pon, David (Driessen)
- Rathbun, Jason (Schneller LLC)
- Ronnqvist, Eva (AIM Aviation)
- Schumillas, Katrin (Lufthansa Technik AG)
- Slaton, Dan (Boeing)
- Spencer, Martin (Heath Tecna)
- Story, Charles W. C. (Magee Plastics Co.)
- Zimmerman, Patrick (3M)

This list is by no means final, but represents a snapshot of the involved industry participants. Additional remarks, suggestions, corrections and contributions from other individuals were encouraged and have been reflected in this report.

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on August 20, 2009. Attachment 2, Part 2, reference item #5 reads (see Figure 1):

- 14 CFR 25.853 (a): *“Test the part with same chemistry paint/ink system. Test of one color substantiates other colors of the same paint/ink system. Substantiate unpainted with painted panel.”*
- 14 CFR 25.853 (d): *“Test of a part with one color substantiates any other color with the same paint/ink chemistry. Additionally, testing of a painted part substantiates an unpainted part with the same construction.”*

Part 2, methods of compliance that require supporting data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
5	Paint/Ink systems	Test the part with same chemistry paint/ink system. Test of one color substantiates other colors of the same paint/ink system. Substantiate unpainted with painted panel.	Test of a part with one color substantiates any other color with the same paint/ink chemistry. Additionally, testing of a painted part substantiates an unpainted part with the same construction.

Figure 1: Attachment 2, Part 2, Reference Item #5

No equivalent entry exists for reference item #5 in attachment 2, Part 1.

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of the terms ‘color’, ‘decorative laminate’ and ‘same’ should be provided so that confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

3.2.1 COLOR

The industry team agrees that color used in the context of this item refers to the visual appearance of a decorative laminate used in the interiors of transport category airplanes. In contrast to texture, color is a visual phenomenon. It describes the overall look or appearance of a decorative laminate, including base color, print colors, pearl effects, text, images, patterns and designs. Color is not only limited to a single color. A surface without any prints and one base color would be considered solid-color. A surface with one base color and one or multiple print colors would be considered multi-colored or printed. The use of the term color is currently well established industry practice. Other words used sometimes within the industry for the term color are design, pattern, appearance, print or pearl effects.

Color in decorative laminates is the result of pigments in the embossing resin and printing inks on the surface layer selectively absorbing incoming light and reflecting only the desired wavelengths that correspond to the pigment color. Pigments in decorative laminates are typically used both in the embossing resin layer as carrier of the base color and in the ink systems used to print the surface layer.

Inks used in decorative laminates are typically a liquid containing a mixture of various pigments and other ingredients (such as solvents, resins, lubricants or pearl effects) used for printing on a thin surface layer to produce an image, text or designs.

The industry team therefore recommends that the term 'color' in the context of this item be defined as: "The complete visual appearance of a decorative laminate used in the interiors of transport category airplanes, including base color, print colors, pearl effects, text, images, patterns or designs".

3.2.2 DECORATIVE LAMINATE

The industry team agrees that 'decorative laminate' is a polymer-based, single or multilayer, thin-gage, non self-supporting colored decorative sheet that may include additional non-polymer based reinforcing layers and contains at least one layer of a fluoropolymer-based film material.

Decorative Laminates are constructed of one or more layers [single or multilayer] of thin-gauge [thin gauge] plastic sheet [polymer-based] that may include additional layers of fiberglass or metallic sheet [additional non-polymer based reinforcing layers] and typically contain at least one layer of a fluoropolymer-based film material. Decorative laminates are always applied using an adhesive on top of an existing surface (substrate) and therefore never form 'self-supporting' parts [non-self-supporting]. They may be integrally pigmented or printed with water or solvent based inks to create a decorative color or pattern [colored]. Multi-layered sheets are bonded together during the manufacturing process using thin gauge adhesives or heat and pressure and may include embossing resins for accepting mechanically applied textures.

The use of decorative laminate as a decorative type in the interior of transport category airplanes is currently well established industry practice (state-of-the-art). Decorative laminates are typically being used on the following surfaces: sidewalls, lavatories, galleys, closets, linings, partitions, bin doors and ceilings. Other words used sometimes within the industry for the term decorative laminate are Tedlar, Decorative Tedlar Laminate (DTL), Declam, Airdec, Panlam, AerFilm, Flexdec, Decor, Decorative Film wallpaper or wall covering.

Decorative laminates as defined in the context of this item refer to decorative laminates made with currently available materials used in the manufacture of current state-of-the-art decorative sheets that have been used in the interior of transport category airplanes over the past 20 years. Any decorative laminates that go beyond the scope of this item would be considered novel or unusual. It is neither the intent of this proposal to make any statements about the applicability of this MOC to such novel or unusual decorative laminates nor to lay out a qualification program by which such novel or unusual decorative laminates may be validated against this MOC.

The industry team therefore recommends that the term 'Decorative Laminate' in the context of this item be defined as: "polymer-based, single or multilayer thin-gage, non self-supporting colored decorative sheet that may include additional non-polymer based reinforcing layers and contains at least one layer of a fluoropolymer-based film material".

3.2.3 TEDLAR

The industry team agrees that 'Tedlar' is a polymer-based, single layer, solid-color, thin-gage, non self-supporting film made out of polyvinyl fluoride (PVF).

Tedlar is not a multilayer material. It consists of a single, cast or extruded film layer of PVF that is integrally colored without any prints and one base color by the use of pigments during its manufacturing process (solid-color). Tedlar is always applied on top of an existing surface (substrate) and therefore never forms 'self-supporting' parts.

The use of Tedlar as a decorative type in the interior of transport category airplanes is currently well established industry practice (state-of-the-art). Tedlar is typically being used as an alternative to paint on the interior side of the following surfaces: overhead stowage bins, galleys and closets. Other words used sometimes within the industry for the term Tedlar are PVF, PVF film or Tedlar film.

The industry team therefore recommends that the term 'Tedlar' in the context of this item be defined as: "polymer-based, single layer, solid-color, thin-gage, non self-supporting film made out of polyvinyl fluoride (PVF)".

3.2.4 SAME

The industry team agrees that the term 'same' in the context of this item refers to a similar decorative type from:

- the same manufacturer, and
- the same product family, and
- the same product build-up.

So when the FAA draft policy memo refers to the "same ink system", the only change being allowed in the context of this item would be the <u>exclusive</u> change from one color to another, with all other product parameters staying the same.

The industry team therefore recommends that the term 'same' in the context of this item be defined as: "From the same manufacturer and same product family and same product build-up".

3.3 REFERENCE NUMBER STRUCTURE AND CONTENT

Additionally, during the initial industry meetings on 24 September 2009 in Huntington Beach, CA, and the FAA Materials Fire Test Working Group meeting on 21 October 2009 in Atlantic City, NJ, an industry consensus quickly emerged to restructure the current scope and content of attachment 2, Part 2, reference item #5.

3.3.1 SPLIT PAINT AND INK SYSTEMS

In the current FAA draft policy memo, reference item #5 encompasses two different decorative types used in the interiors of transport category airplanes, 'paint systems' and 'ink systems' (to be replaced by 'decorative laminate', see section 3.3.2). The industry team recognizes that substantial differences exist between both decorative types in many areas, such as basic product-build up and chemistry, manufacturing processes, application methods, control of application process and areas of application.

Because of these differences, the argumentation for color similarity and the route to pursue substantiating data for both decorative types is expected to differ significantly from each other. The industry team agrees that it would not contribute to the overall stated goal of standardization of flammability requirements to have two such distinctly different decorative types grouped together under one reference item.

The industry team therefore recommends splitting attachment 2, Part 2, reference item #5 into 2 separate items and changing the title of the original feature:

- #5a: *"Paint Color"*
- #5b: *"Decorative Laminate Color"*

The FAA will be asked to update the structure and title of the reference numbers accordingly.

3.3.2 REPLACE INK SYSTEM WITH DECORATIVE LAMINATE

The term 'ink system' used in this item needs to be differentiated against the meaning of similar terms used throughout the FAA draft policy memo, such as 'decorative', 'decorative type', 'decorative Tedlar laminate', 'Tedlar', 'laminates', 'decorative laminates', 'thermoplastics' and 'elastomers'.

The industry team agrees that the term 'ink system' in the context of this item specifically refers to inks used in decorative laminates in the interior of transport category airplanes as discussed in section 3.2.1. As inks are parts of the overall color of a decorative laminate, the terms 'ink system' and 'decorative laminate color' can be used interchangeably.

In order to be consistent with the terminology used in the industry proposals for reference items #13 (Texture) and #14 (Decorative Laminate Orientation), the industry team therefore recommends that the term 'ink system' in the context of this item be replaced by 'decorative laminate color', both in the title of the feature as well as the descriptive text.

3.3.3 REMOVE SUBSTANTIATION OF UNPAINTED WITH PAINTED

In the current FAA draft policy memo, reference item #5 uses the sentence *"Substantiate unpainted with painted panel*s*"* for 14 CFR 25.853 (a) and "*Additionally, testing of a painted part substantiates an unpainted part with the same construction"* for 14 CFR 25.853 (d).

As currently worded, both phrases are only applicable for 'paint systems' but not to decorative laminates. Due to the recommended restructuring of reference item #5 in paragraph 3.3.1, both phrases now become obsolete for newly created reference item #5b.

Additionally, the industry team agrees that for decorative laminates the substantiation of 'undecorated' with 'decorated' panels for aircraft interiors flammability testing according to 14 CFR 25.853 (a) and (d) is currently <u>not</u> an established industry practice and should <u>not</u> be supported. Industry observations have been shared in which a panel decorated with decorative laminate will perform better in 14 CFR 25.853 (d) Heat Release and Smoke Emission testing than its undecorated counterpart.

The industry team therefore recommends removing both sentences from the scope of reference item #5b. The FAA will be asked to update the content of the reference numbers accordingly.

3.3.4 MERGE TEDLAR WITH DECORATIVE LAMINATE COLOR

In the current FAA draft policy memo, reference item #12 (Tedlar) is a separate entry and has been grouped by the FAA into Part 2 for both 14 CFR 25.853 (a) and (d). This means that the FAA will require additional supporting data to accept this method for Vertical Burn, Heat Release and Smoke Density testing.

The industry team believes that based on the definition of Tedlar as listed in paragraph 3.2.3 it falls within the category of decorative laminates as defined in paragraph 3.2.2. Similar to that definition, Tedlar is polymer-based, single layer, thin-gage, non self-supporting decorative sheet that is made entirely out of a fluoropolymer-based film (PVF). It consists of a single, cast or extruded layer of PVF film that is integrally colored by the use of pigments during its manufacturing process. No printing inks are used in the manufacturing of Tedlar films.

The industry team agrees that Tedlar falls within the category of decorative laminates. Therefore, Tedlar color similarity (e.g. the substantiation of one Tedlar color by using previous flammability test data from another Tedlar color within the same Tedlar type) is a special case of decorative laminate color similarity (e.g. the substantiation of one decorative laminate color by using previous flammability test data from another decorative laminate color within the same decorative laminate type) and can be substantiated by the data submitted for reference item #5b.

The industry team therefore deleting attachment 2, Part 2, reference item #12 for 14 CFR 25.853 (a) and (d) and merge it under reference item #5b.

4 VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

The use of this MOC has been grouped by the FAA into Part 2 for both 14 CFR 25.853 (a) and (d). This means that the FAA will require additional supporting data to accept this method for Vertical Burn, Heat Release and Smoke Density testing.

The industry team believes that sufficient data exists to substantiate the acceptance of this MOC for 14 CFR 25.853 (a) and (d) and move it to Part 1. The use of decorative laminate color similarity (e.g. the substantiation of one decorative laminate color by using previous flammability test data from another decorative laminate color within the same decorative laminate type) for aircraft interiors flammability testing according to 14 CFR 25.853 (a) and (d) is currently well established industry practice. The argument used for decorative laminate color similarity is that changes exclusively in color within the same decorative laminate type have no appreciable effect on the results of flammability testing (vertical burn, heat release and smoke emission).

Decorative laminates that meet the flammability requirements for 14 CFR 25.853 (a) and (d) have been manufactured for over 20 years. During this timeframe, the industry has collected an overwhelming amount of flammability test data for these materials. Historically, no significant effects of decorative laminate color on flammability test results have been observed on decorative laminate types used in the interiors of transport category airplanes.

The substantiation for decorative laminate color similarity is based on the non-appreciable effect of the pigments in the embossing resin and printing inks on flammability testing. The argument being made is that changes in color of decorative laminates have no appreciable effect on the results of flammability testing as there is only a small amount of pigment used in the overall composition of a decorative laminate. Similarly, the substantiation for Tedlar color similarity is based on the non-appreciable effect of the pigments in the PVF film on flammability testing. The argument that can be made that since Tedlar contains no printing inks, even lower amounts of pigments are used in the overall construction of a Tedlar when compared to a multilayer decorative laminate.

4.2 PROPOSED STANDARD TO MEET

Split attachment 2, Part 2, reference item #5 into 2 separate items and change the title of the original feature:

- #5a: *“Paint Color”*
- #5b: *“Decorative Laminate Color”*

Delete attachment 2, Part 2, reference item #12 for 14 CFR 25.853 (a) and (d) and merge it under reference item #5b.

Move attachment 2, Part 2, reference item #5b for 14 CFR 25.853 (a) and (d) to attachment 2, Part1 and delete reference item #5b from attachment 2, Part 2.

Modify attachment 2, Part 1, reference item #5b to read the following:

- 14 CFR 25.853 (a): *“~~Test the part with same chemistry paint/ink system.~~ Data from testing one color of a decorative laminate substantiates ~~a panel with~~ the same decorative laminate in a different color. ~~Substantiate unpainted with painted panel.~~”*
- 14 CFR 25.853 (d): *“Data from testing one color of a decorative laminate substantiates ~~a panel with~~ the same decorative laminate in a different color. ~~Additionally, testing of a painted part substantiates an unpainted part with the same construction.~~”*

5 DATA / ANALYSIS

5.1 EXISTING TEST DATA

The industry has called upon its members to submit any type of existing flammability test data to support decorative laminate color similarity for 14 CFR 25.853 (a) and (d). Two different types of data packages have been submitted by the 3 major decorative laminate manufacturers (Boeing, Isovolta, Schneller) to support the substantiation for decorative laminate color similarity:

- Historical QC flammability test data that has been recorded by two decorative laminate manufacturers for quality control purposes. This data is based on a variety of different panel substrates, colors and product families.
- Controlled flammability studies that have been specifically designed by one decorative laminate manufacturer to investigate the effect of decorative laminate color on the results of flammability testing.

5.1.1 HISTORICAL QC FLAMMABILITY TEST DATA

Decorative laminates that meet the flammability requirements for 14 CFR 25.853 (a) and (d) have been manufactured for over 20 years. During this timeframe, the industry has collected an overwhelming amount of flammability test data for quality control purposes for these materials. The following table presents an overview of the total amount of historical QC (Quality Control) flammability test data that is available from two major decorative laminate manufacturers:

Product Familiy	Manufacturer A 1996-2010	Manufacturer B 2000 - 2009
Product A (Film Laminate)	44,936	4,619
Product B (Reinforced Laminate)	12,884	2,044
Total*	57,820	6,663

*Average of 3 individual runs

Table 1: Total Quantity of Historical QC Flammability Test Data

Two major decorative laminate manufacturers have submitted proprietary historical QC flammability data packages to the FAA. Because color similarity only applies within the same decorative laminate type, it is important to be able to filter the historical flammability data for exclusive changes from one color to another, with all other product parameters staying the same. All submitted data packages allow isolating for the influence of parameters such as:

- Product family
- Adhesive system
- Test facility
- Panel substrate

To limit the shear amount of data to a manageable analysis, both manufacturers limited their reporting to:

- One product family (film laminates)
- One adhesive type (heat activated adhesive)

- One panel substrate for each test (aluminum, 2-ply phenolic prepreg or phenolic honeycomb)

For a detailed overview and analysis of the available data, please refer to section 5.2.1. If requested, additional data for other combinations of product family, adhesive type and substrate panel can be made available to the FAA for further analysis.

5.1.2 CONTROLLED FLAMMABILITY STUDIES

Two separate controlled flammability studies to investigate the effect of decorative laminate color on the results of flammability testing have specifically been designed by one manufacturer. All three studies were designed for different product families with the goal to investigate different objectives and product characteristics. In contrast to the historical flammability QC test data, the amount of data points is very limited. Because of this limited amount of test data and the original study design, it is important to examine each controlled flammability study individually and not compare it directly amongst each other or against the historical flammability QC test data. The data generated provides support to the industry proposal that changes exclusively in color within the same decorative laminate type have no appreciable effect on the results of flammability testing and support the use of decorative laminate color similarity (e.g. the substantiation of one decorative laminate color by using previous flammability test data from another decorative laminate color within the same decorative laminate type).

For a detailed overview and analysis of the available data, please refer to section 5.2.2.

5.2 TEST RESULTS

5.2.1 HISTORICAL QC FLAMMABILITY TEST DATA

The following figures represent a graphical overview of the historical QC test results from two manufacturers. Each manufacturer has been assigned a random letter (A or B) to ensure anonymity. 4 separate figures are available for each individual manufacturer, displaying the results for 60s Burn Length, Peak Heat Release, Total Heat Release and Smoke Density testing. No data is displayed for Drip Time and Extinguishing Time as it is always zero.

Within each figure, the leftmost column in gray displays the results for average and standard deviation across all colors. The remaining 9 columns display the results for average and standard deviation within the following 9 individual color bands: black, blue, brown, gray, green, red, silver, white and yellow. The colors of the individual columns of each color band correspond to their actual colors to support a quick visual comparison. Direct comparisons should only be made within the same product family for the same manufacturer, i.e. different colors within one figure. The numbers on the bottom of each column indicate the number of test sets that have been preformed in total within each color band. Each test is the average of three individual runs.

Following observations can be made from this small subset of the entire available historical QC flammability test data from both manufacturers:

- Several colors only yield a very minimal amount of data points.
- As soon as a critical number of data points is reached (e.g. > 70), the flammability test results become very consistent and fall within two or three points of each other.

- Data from both manufacturers is complementary in that no individual decorative laminate color can apparently be singled out to have an appreciable effect on the results of flammability testing.

For a more detailed overview of the test data, please refer to Appendix A.

5.2.1.1 MANUFACTURER A

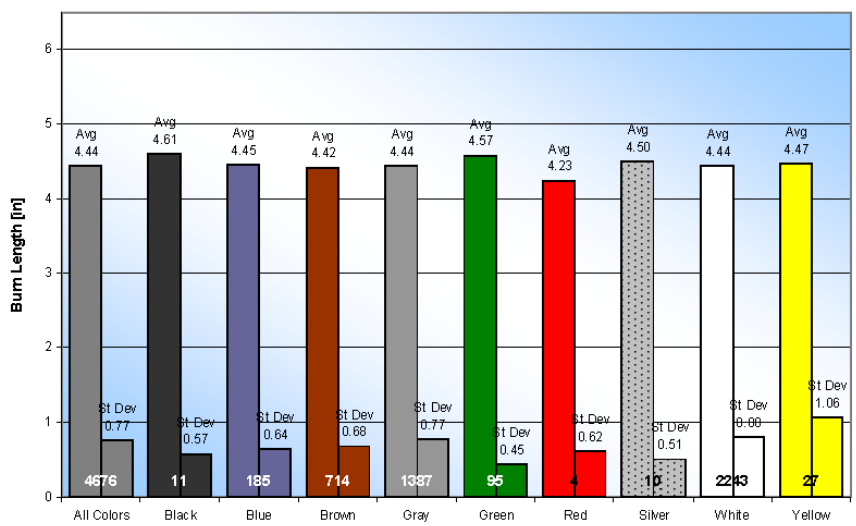

Figure 2: Burn Length, Manufacturer A, Product A, HAA

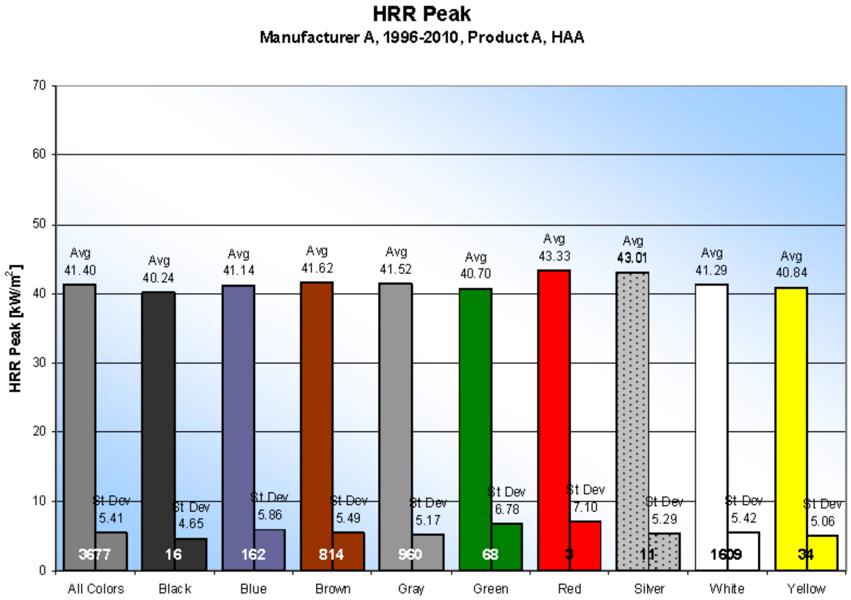

Figure 3: HRR Peak, Manufacturer A, Product A, HAA

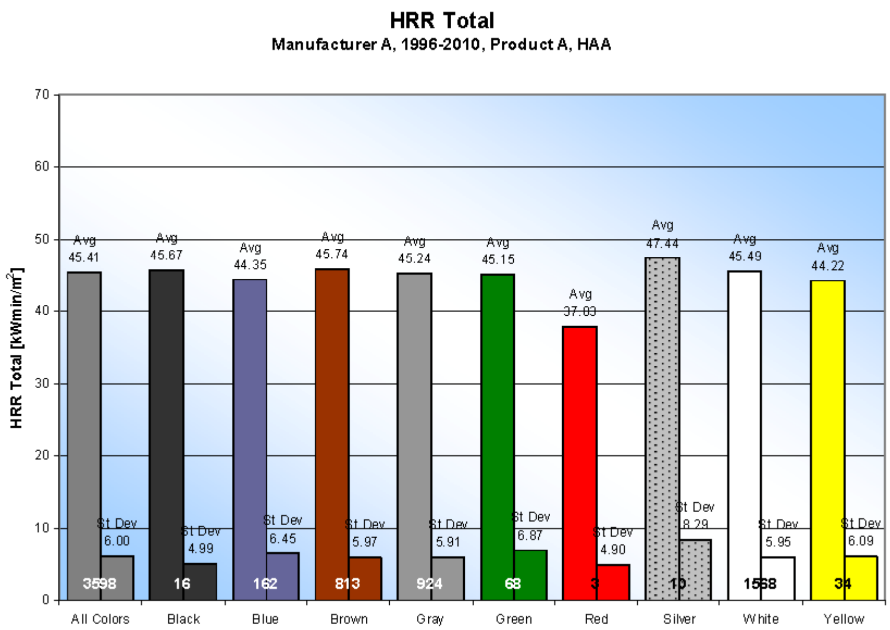

Figure 4: HRR Total, Manufacturer A, Product A, HAA

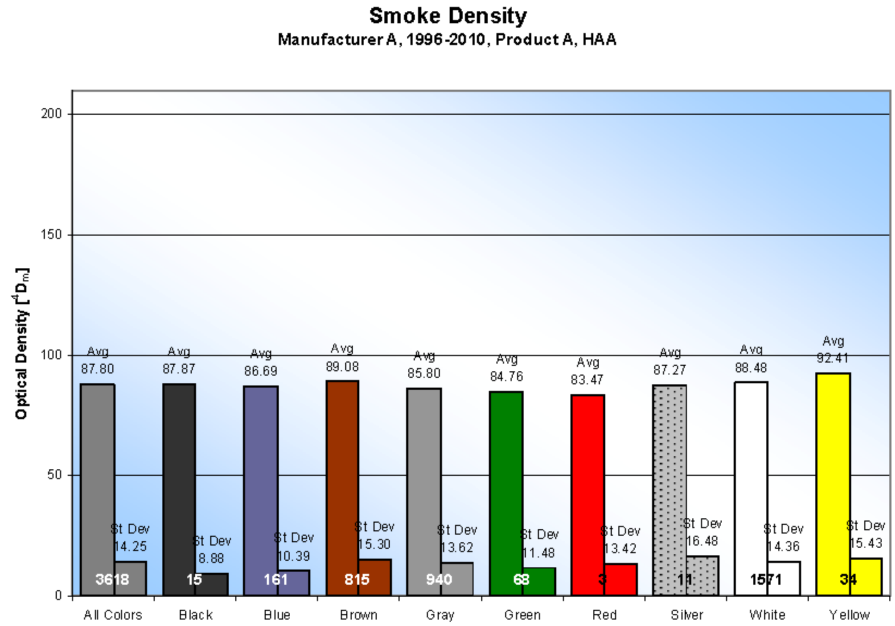

Figure 5: Smoke Density, Manufacturer A, Product A, HAA

5.2.1.2 MANUFACTURER B

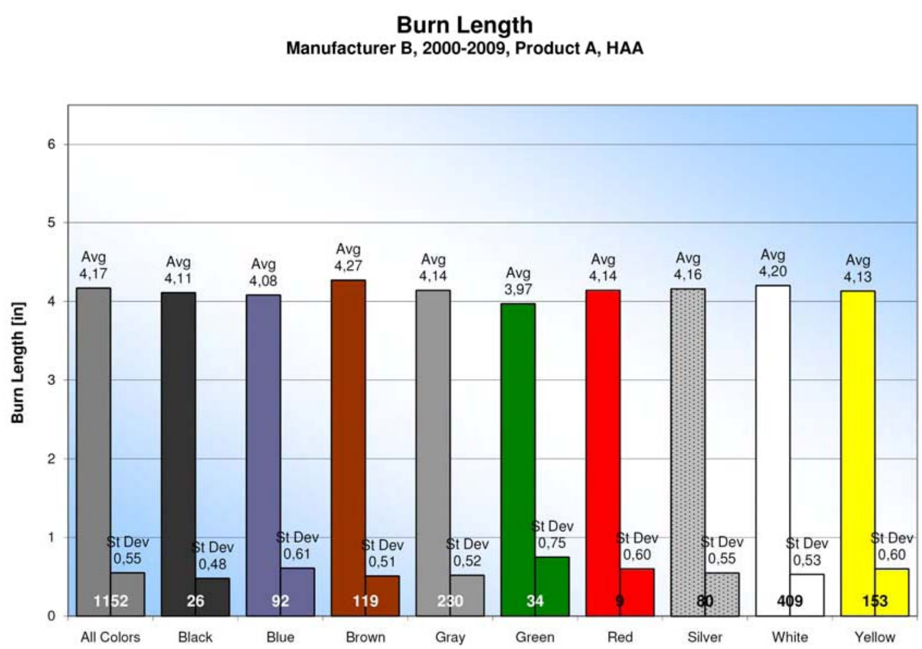

Figure 6: Burn Length, Manufacturer B, Product A, HAA

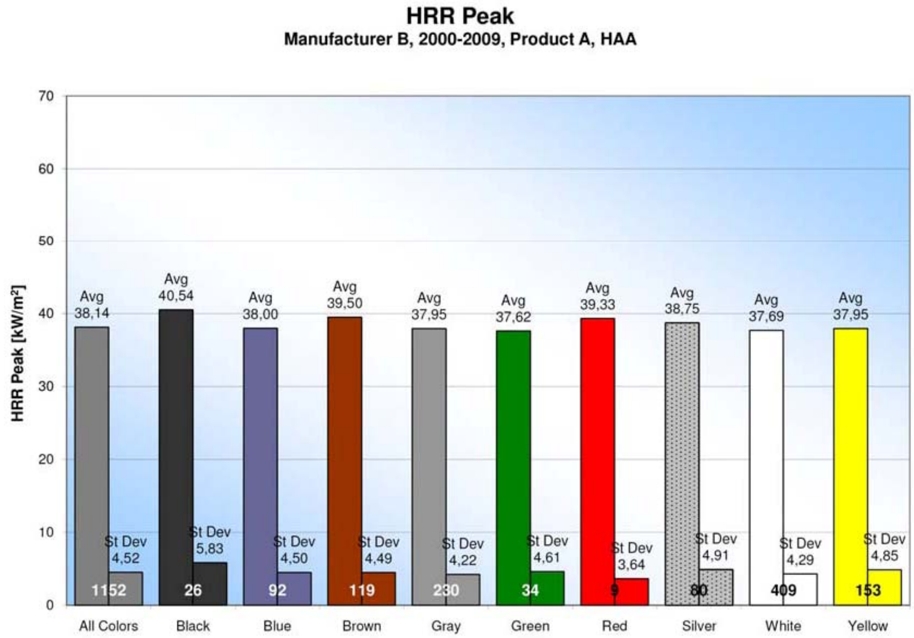

Figure 7: HRR Peak, Manufacturer B, Product A, HAA

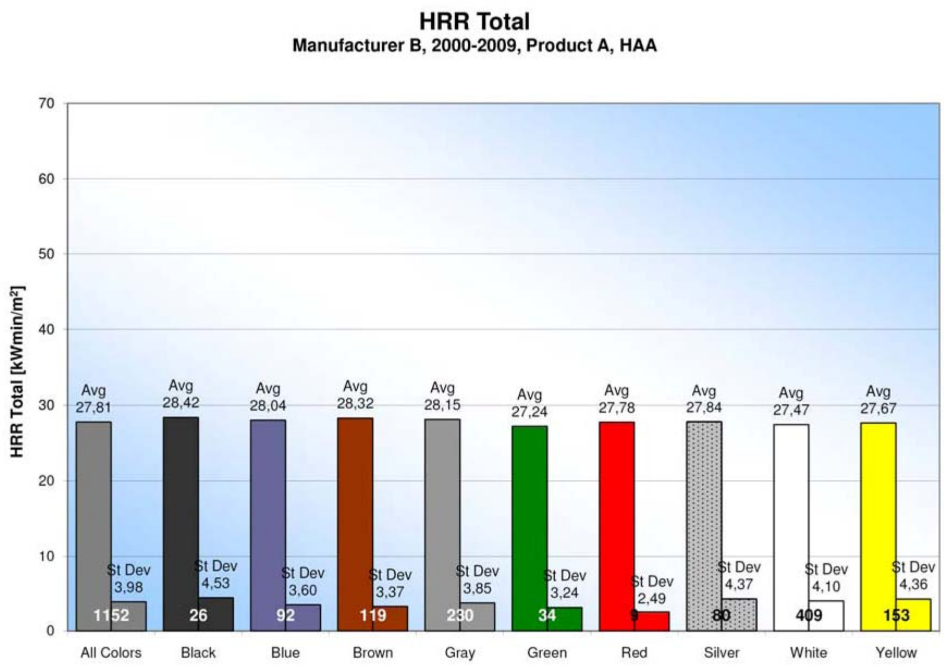

Figure 8: HRR Total, Manufacturer B, Product A, HAA

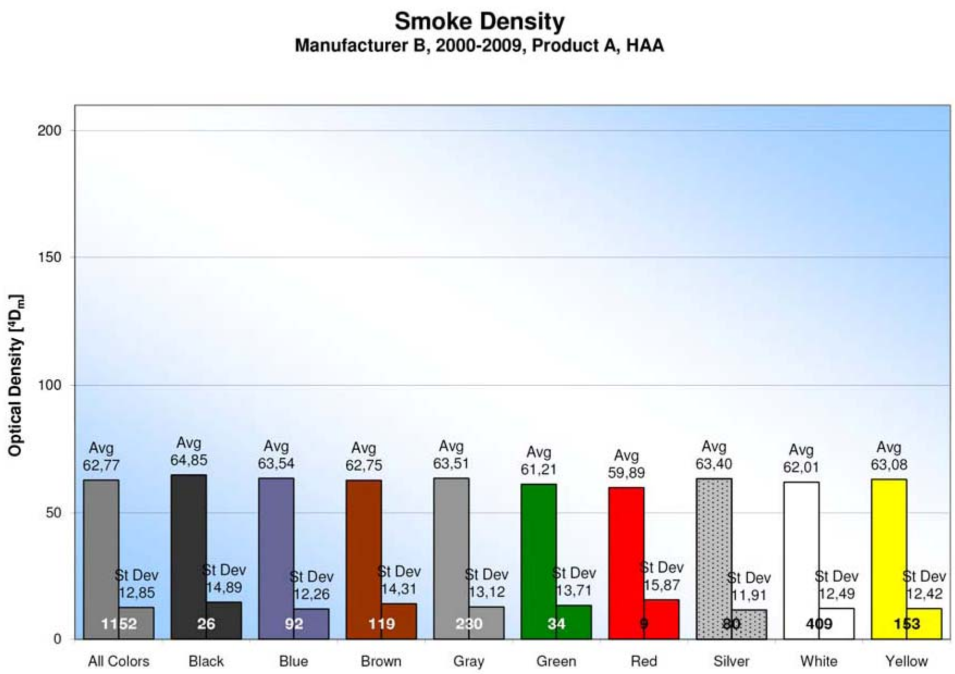

Figure 9: Smoke Density, Manufacturer B, Product A, HAA

5.2.2 CONTROLLED FLAMMABILITY STUDIES

The following figures represent a graphical overview of the test results from 3 separate controlled flammability studies from manufacturer C.

5.2.2.1 COLOR STUDY USING SOLVENT-BASED INK

A controlled flammability study was conducted to determine the effect of different solvent-based ink colors and pearl effects on flammability. 60s Vertical Burn tests were performed on fiberglass/epoxy sandwich panels with a 3 lb Nomex honeycomb core. The decorative laminates consisted of non-formable white polyvinyl fluoride (PVF) film, screen printed with different ink colors and various pearl effects. A non-printed PVF film without any ink colors or pearl effects was selected as control specimen. All decorative laminates used in this study were representative of standard state-of-the-art materials that were used in production.

The following figures represent a graphical overview of the test results from this study. 2 separate figures are available. Figure 10 displays an overview of the results for average Burn Length across different combinations of print inks and pearl effects. Figure 11 focuses on the influence of added gold and silver pearl effects on average Burn Length when compared to ordinary non-pearl pigments. No data is displayed for Drip Time and Extinguishing Time as it is always zero. Direct comparisons should only be made within the same product family for the same manufacturer, i.e. different colors within one figure.

Initially, individual ink colors were tested separately, and then additional testing was performed for gold powder and silver pearl in combination with blue, magenta, and yellow inks. The results shown in Figure 10 and Figure 11 indicate that the effect of ink color on 60s Burn Length results is very small and of a similar magnitude to variation between individual substrate panels. Comparison of the control specimens without print to the printed specimens shows that the Burn Length of the control specimens falls in the middle of the values for printed specimens. The average Burn Length for the control specimens without print is 5.5”. The average for all the printed specimens is 5.7”.

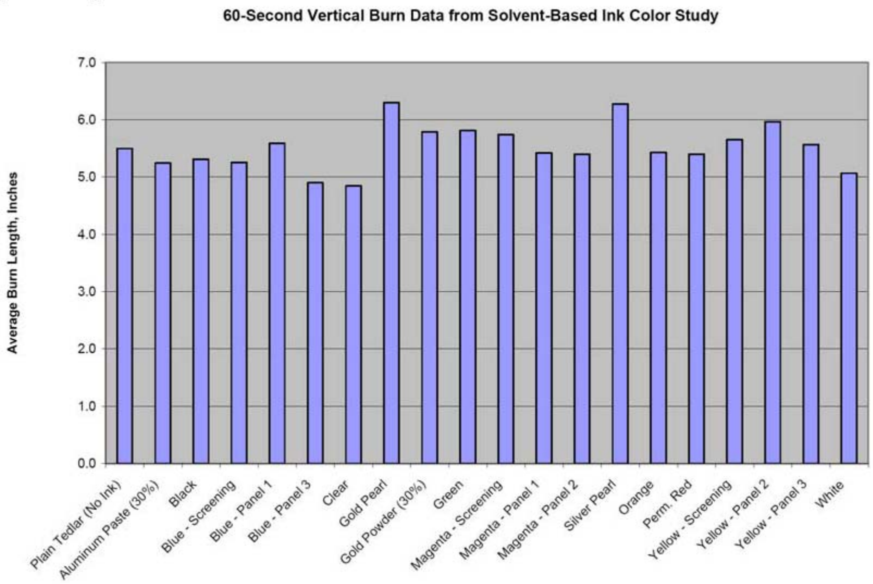

Figure 10: Burn Length, Manufacturer C, Solvent-Based Ink Study

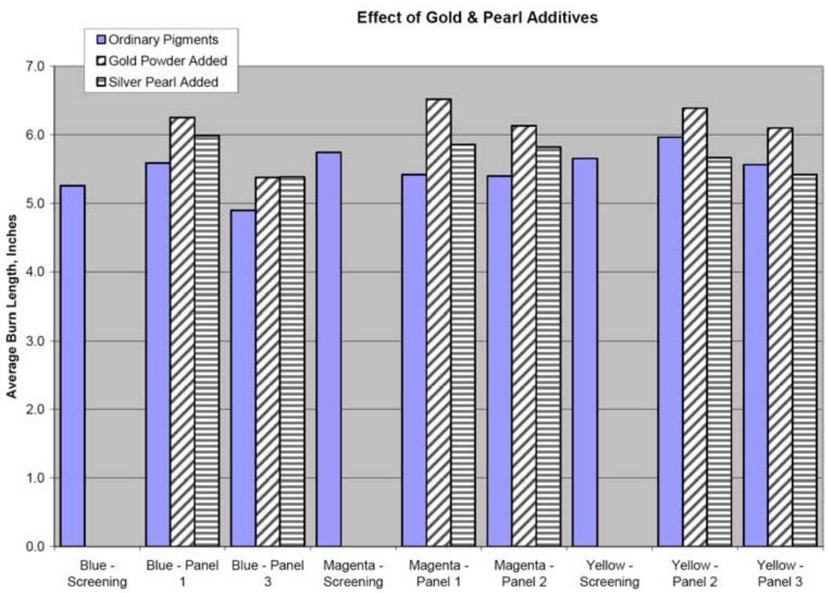

Figure 11: Burn Length, Manufacturer C, Solvent-Based Ink Study

5.2.2.2 BLUE-SHADE RED COLOR STUDY

A controlled flammability study was conducted on a new color decorative laminate shade to determine the effect of different ink colors on flammability. 60s Vertical Burn, Peak Heat Release, Total Heat Release and Smoke Density tests were performed on the actual decorative laminate shade material. A non-printed decorative laminate shade without any ink colors was selected as control specimen. All decorative laminates used in this study were representative of standard state-of-the-art materials that were used in production.

The following figures represent a graphical overview of the test results from this study. 2 separate figures are available. Figure 12 displays an overview of the results for average Burn Length across different combinations of print inks. Figure 13 displays an overview of the results for average Peak Heat Release, Total Heat Release and Smoke Density across different combinations of print inks. No data is displayed for Drip Time and Extinguishing Time as it is always zero. Direct comparisons should only be made within the same product family for the same manufacturer, i.e. different colors within one figure.

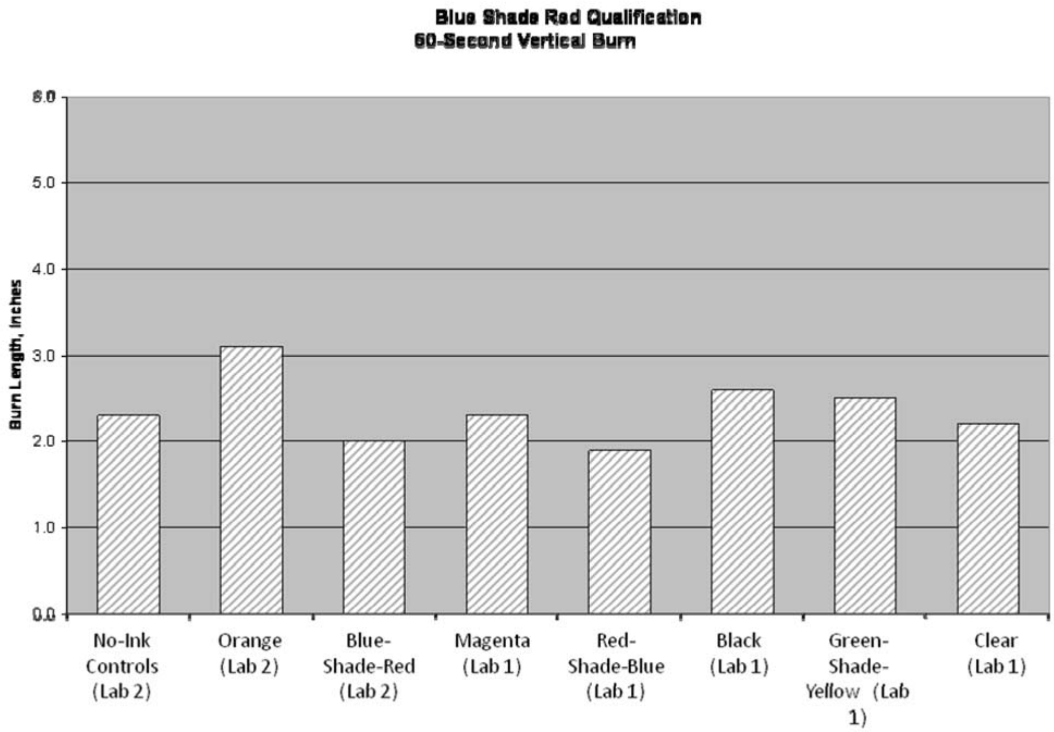

Figure 12: Burn Length, Manufacturer C, Blue-Shade Red Study

As shown in Figure 12, the addition of print inks does not have a significant effect on the Burn Length results. The control specimens have a 2.3" Burn Length and the printed specimens averaged 2.4". The Burn Length for the control specimens falls in the middle of the test results for specimens with ink, which ranges from 1.9" to 3.1".

Figure 13 summarizes the results for Peak Heat Release, Total Heat Release and Smoke Density. For Total Heat Release, the average values range from 51 to 57. Peak Heat Release values range from 48.1 to 43.4. For Smoke Density, the values range from 134.8 to 97.9.

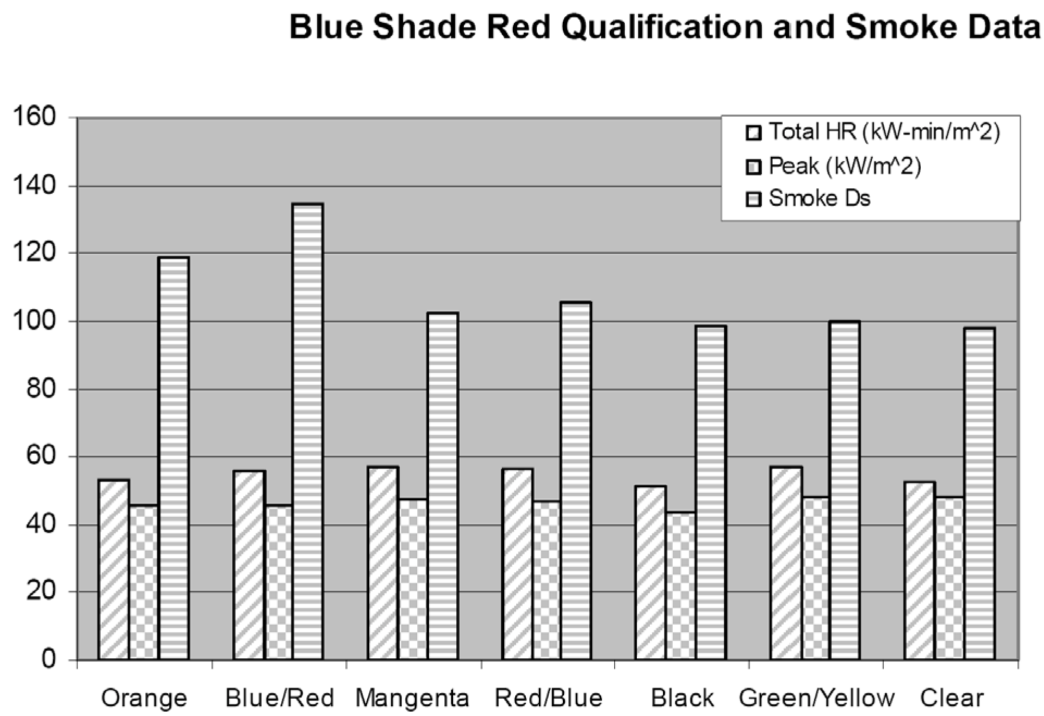

Figure 13: HRR Total, HRR Peak and Smoke Density, Manufacturer C, Blue-Shade Red Study

5.3 ANALYSIS OF TEST RESULTS

5.3.1 HISTORICAL QC FLAMMABILITY TEST DATA

An apparent initial view of the test results provided in the graphical overview in section 5.2.1 yields no significant differences in the flammability test results for each individual color. In order to further support these visual findings, additional statistical methods will be used with the goal to provide a meaningful comparison that shows whether decorative laminate color has an appreciable effect on the results of flammability testing.

A statistical analysis of test results from manufacturer A and B was conducted with the General Linear Model (GLM), using a non-balanced 1-factor Analysis of Variance (ANOVA) to determine equivalence of means between two data sets. The selected response variable was color, with 9 factor levels each (9 different color bands). Minitab® 16 was used to analyze the data.

5.3.1.1 NORMALITY AND HOMOGENEITY

Normality and homogeneity of variance are assumptions of the ANOVA model. A visual comparison of the residual plots for HRR Peak, HRR Total and NBS shows that both preconditions are validated. The residual plots for Burn Length for both manufacturers display an apparently skewed distribution of residuals and a significant amount of outliers. These results however are not unexpected, given the subjective method that is used to determine Burn Length. Given the very high number of data points that is used in this ANOVA model, normality of the residuals becomes less critical and should not be detrimental to further analysis.

For a more detailed overview of normality and homogeneity of variance, please refer to the residual probability plots Appendix A, section 9, Figure 16 through Figure 25.

5.3.1.2 ANOVA TABLE

The ANOVA table displays two statistics that can help to evaluate whether pairs of means are different: p-values and R^2.

One statistic in the ANOVA table is the p-value (P) at 95% confidence. There is a p-value for each term in the model. The p-values provided with the individual hypothesis tests can be used to determine whether pairs of means are different:

- If the p-value for a comparison is ≤ the chosen α-level, the difference between the means is statistically significant.
- If the p-value is > the chosen α-level, the difference between means is not statistically significant.

3 out of 6 p-values for the factor color show a p-value larger than the chosen α-level ($\alpha = 0.05$) for the test data from both manufacturers (see Figure 14). One p-value (HRR Total, manufacturer A, p = 0.044) comes very close to the chosen α-level and barely misses the threshold. The remaining two p-values (NBS, manufacturer A, p = 0.000 and HRR Peak, manufacturer B, p = 0.001) can be traced back to several colors which only yield a very minimal amount (< 10) of data points.

Overall, the observed differences between the means of colors are not statistically significant at 95% confidence for the majority of the test data presented. For an interpretation of the remaining values, please refer to section 5.4.1.

R^2 is a measure of how well the model fits the data. These values can help to select the model with the best fit:

- R^2 describes the amount of variation in the observed response values that is explained by the predictor(s).
- R^2 can be used to estimate the influence of an individual response when compared to the sum of squares for all terms (incl. error) in the model.

The R^2 values show a no appreciable contribution of color to the overall difference in means when compared to the sum of squares for all terms (incl. error) in the model (see Figure 14).

Summary of ANOVA Table												
	Seq. Sum of Squares				R^2				p-value (>0.05)			
	Burn Length	Total HRR	Peak HRR	^4D_m	Burn Length	Total HRR	Peak HRR	^4D_m	Burn Length	Total HRR	Peak HRR	^4D_m
Manufacturer A												
Color	2.5	570.8	189.0	7434.3	**0.1%**	**0.4%**	**0.2%**	**1.0%**	**0.826**	**0.044**	**0.597**	**0.000**
Error	2740.1	128821.1	107570.5	726792.9	99.9%	99.6%	99.8%	99.0%				
Total	2742.7	129391.9	107759.5	734227.2	100.0%	100.0%	100.0%	100.0%				
Manufacturer B												
Color	4.2	135.8	517.0	736.9	**1.2%**	**0.7%**	**2.2%**	**0.4%**	**0.083**	**0.379**	**0.001**	**0.814**
Error	343.0	18068.0	22944.1	189285.7	98.8%	99.3%	97.8%	99.6%				
Total	347.2	18203.8	23461.1	190022.6	100.0%	100.0%	100.0%	100.0%				

Figure 14: Summary of ANOVA Table, Manufacturers A & B

5.3.1.3 GROUPING

Grouping was checked using the Bonferroni Method and 95% confidence. The grouping information generated by the Bonferroni method displays, in a summarized format, groups of factor level means that are not significantly different. If a level mean is not in a group, then its mean is significantly different from that group.

The Bonferroni table contains columns of letters that group the factor levels:

- Levels that share a letter are not significantly different.
- Conversely, if they do not share a letter, the level means are significantly different.

All grouping comparisons between the means of different colors share the same letter in the Bonferroni table for the test data from both manufacturers. Therefore, the observed difference between the means of different colors is not statistically significant. If requested, detailed grouping data can be made available to the FAA for further analysis.

5.3.1.4 CONFIDENCE INTERVAL

Confidence intervals generated by the Bonferroni method at 95% confidence were used to determine whether two means are different:

- If an interval does not contain zero, there is a statistically significant difference between the corresponding means.

- If the interval does contain zero, the difference between the means is not statistically significant.

All pairwise comparisons among levels of color, with one color subtracted from another, yield results with an interval containing zero for the test data from both manufacturers. Therefore, the observed difference between the means of different colors is not statistically significant. If requested, detailed confidence interval data can be made available to the FAA for further analysis.

5.3.2 CONTROLLED FLAMMABILITY STUDIES

An apparent initial view of the test results provided in the graphical overview in section 5.2.2 yields no significant differences in the flammability test results for each individual color. In order to further support these visual findings, additional statistical methods will be used with the goal to provide a meaningful comparison that shows whether decorative laminate color has an appreciable effect on the results of flammability testing.

5.3.2.1 BLUE-SHADE RED STUDY

A statistical analysis of test results from manufacturer C was conducted with the General Linear Model (GLM), using a non-balanced 1-factor Analysis of Variance (ANOVA) to determine equivalence of means between two data sets. The selected response variable was color, with 7 factor levels each (7 different colors). Minitab® 16 was used to analyze the data.

5.3.2.2 NORMALITY AND HOMOGENEITY

Normality and homogeneity of variance are assumptions of the ANOVA model. A visual comparison of the residual plots for HRR Peak and HRR Total shows that both preconditions are validated.

For a more detailed overview of normality and homogeneity of variance, please refer to the residual probability plots Appendix A, section 9, Figure 27 through Figure 28.

5.3.2.3 ANOVA TABLE

The ANOVA table displays two statistics that can help to evaluate whether pairs of means are different: p-values and R^2.

One statistic in the ANOVA table is the p-value (P) at 95% confidence. There is a p-value for each term in the model. The p-values provided with the individual hypothesis tests can be used to determine whether pairs of means are different:

- If the p-value for a comparison is ≤ the chosen α-level, the difference between the means is statistically significant.
- If the p-value is > the chosen α-level, the difference between means is not statistically significant.

All p-values for the factor color show a p-value larger than the chosen α-level ($\alpha = 0.05$) for the test data (see Figure 15). Therefore, the observed differences between the means of different colors are not statistically significant.

R^2 is a measure of how well the model fits the data. These values can help to select the model with the best fit:

- R^2 describes the amount of variation in the observed response values that is explained by the predictor(s).
- R^2 can be used to estimate the influence of an individual response when compared to the sum of squares for all terms (incl. error) in the model.

The R^2 values show a no appreciable contribution of color to the overall difference in means when compared to the sum of squares for all terms (incl. error) in the model (see Figure 15).

Summary of ANOVA Table						
	Seq. Sum of Squares		R^2		p-value (>0.05)	
	Total HRR	Peak HRR	Total HRR	Peak HRR	Total HRR	Peak HRR
Manufacturer C						
Color	242.9	119.5	**15.9%**	**15.0%**	**0.082**	**0.104**
Error	1288.0	678.7	84.1%	85.0%		
Total	1530.9	798.1	100.0%	100.0%		

Figure 15: Summary of ANOVA Table, Manufacturers C, Blue-Shade Red Study

5.3.2.4 GROUPING

Grouping was checked using the Bonferroni Method and 95% confidence. The grouping information generated by the Bonferroni method displays, in a summarized format, groups of factor level means that are not significantly different. If a level mean is not in a group, then its mean is significantly different from that group.

The Bonferroni table contains columns of letters that group the factor levels:

- Levels that share a letter are not significantly different.
- Conversely, if they do not share a letter, the level means are significantly different.

All grouping comparisons between the means of different colors share the same letter in the Bonferroni table for the test data. Therefore, the observed difference between the means of different colors is not statistically significant. If requested, detailed grouping data can be made available to the FAA for further analysis.

5.3.2.5 CONFIDENCE INTERVAL

Confidence intervals generated by the Bonferroni method at 95% confidence were used to determine whether two means are different:

- If an interval does not contain zero, there is a statistically significant difference between the corresponding means.
- If the interval does contain zero, the difference between the means is not statistically significant.

All pairwise comparisons among levels of color, with one color subtracted from another, yield results with an interval containing zero for the test data. Therefore, the observed difference between the means of different colors is not statistically significant. If requested, detailed confidence interval data can be made available to the FAA for further analysis.

5.4 CONCLUSION

Both the apparent initial view of the test results in section 5.2 as well as the results of the statistical analysis of the test data in section 5.3 support that decorative laminate color has no appreciable effect on the results of flammability testing.

5.4.1 STATISTICAL VERSUS PRACTICAL SIGNIFICANCE

The results of statistical methods should only be used as one of many indicators to evaluate the overall influence of a specific factor on the results of flammability testing. Statistical methods should not be regarded as the sole hard criterion to evaluate the overall influence of a specific factor on the results of flammability testing.

Even if individual factor level means are significantly different from a statistical standpoint, the difference may not be of any practical importance. Only knowledge of the subject area of aircraft materials flammability testing and not statistics alone can be used to answer the question of whether decorative laminate color shows an appreciable effect on the results of flammability testing.

6 CONCLUSION

The industry team believes that sufficient data has been presented to substantiate the acceptance of this MOC for 14 CFR 25.853 (a) and (d) and move it to Part 1.

Based on industry discussion and the historical QC flammability test results and controlled flammability studies analyzed in paragraph 5 of this document, the industry team recommends revising the current proposal and providing further clarification of key terms as follows.

6.1 REVISED PROPOSAL

Split attachment 2, Part 2, reference item #5 into 2 separate items and change the title of the original feature:

- #5a: *"Paint Color"*
- #5b: *"Decorative Laminate Color"*

Delete attachment 2, Part 2, reference item #12 for 14 CFR 25.853 (a) and (d) and merge it under reference item #5b.

Move attachment 2, Part 2, reference item #5b for 14 CFR 25.853 (a) and (d) to attachment 2, Part1 and delete reference item #5b from attachment 2, Part 2.

Modify attachment 2, Part 1, reference item #5b to read the following:

- 14 CFR 25.853 (a): *"~~Test the part with same chemistry paint/ink system.~~ Data from testing one color of a decorative laminate substantiates ~~a panel with~~ the same decorative laminate in a different color. ~~Substantiate unpainted with painted panel.~~"*
- 14 CFR 25.853 (d): *"Data from testing one color of a decorative laminate substantiates ~~a panel with~~ the same decorative laminate in a different color. ~~Additionally, testing of a painted part substantiates an unpainted part with the same construction.~~"*

Include the definition of all terms as listed in paragraph 3.2 ('color', 'decorative laminate' and 'same') in a commentary or list of significant key terms in the FAA draft policy memo and enforce their consistent use throughout the policy.

7 ABBREVIATIONS

ANOVA	=	Analysis of Variance
CFR	=	Code of Federal Regulations
FAA	=	Federal Aviation Administration
FSTG	=	FAA Flammability Standardization Working Group
GLM	=	General Linear Model
HAA	=	Heat Activated Adhesive
MOC	=	Methods of Compliance
PSA	=	Pressure Sensitive Adhesive
QC	=	Quality Control

8 REFERENCES

[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

9 APPENDIX A: DETAILED TEST DATA

9.1 MANUFACTURER A

Manufacturer A										
	Product A									
	Black	Blue	Brown	Gray	Green	Red	Silver	White	Yellow	Total
Burn Length										
Count	11	185	714	1387	95	4	10	2243	27	4676
Percent	0%	4%	15%	30%	2%	0%	0%	48%	1%	100%
Average	4.61	4.45	4.42	4.44	4.57	4.24	4.50	4.44	4.47	4.44
StDev	0.57	0.64	0.68	0.77	0.45	0.62	0.51	0.80	1.06	0.77
Min	3.30	0.19	0.14	0.14	3.30	3.54	3.70	0.05	0.19	0.05
Max	5.40	5.53	5.80	5.70	5.50	5.00	5.40	5.75	5.38	5.80
$\Delta_{Max-Min}$	2.10	5.34	5.67	5.56	2.20	1.46	1.70	5.70	5.20	5.70
HRR Peak										
Count	16	162	814	960	68	3	11	1609	34	3677
Percent	0%	4%	22%	26%	2%	0%	0%	44%	1%	100%
Average	40.24	41.14	41.62	41.52	40.70	43.33	43.01	41.29	40.84	41.41
StDev	4.65	5.86	5.50	5.17	6.78	7.10	5.29	5.42	5.06	5.41
Min	32.60	23.20	27.20	26.50	24.60	35.80	34.20	21.30	26.90	35.80
Max	49.30	62.10	60.80	57.50	59.50	49.90	51.30	59.80	54.10	62.10
$\Delta_{Max-Min}$	16.70	38.90	33.60	31.00	34.90	14.10	17.10	38.50	27.20	38.90
HRR Total										
Count	16	162	813	924	68	3	10	1568	34	3598
Percent	0%	5%	23%	26%	2%	0%	0%	44%	1%	100%
Average	45.67	44.36	45.74	45.24	45.15	37.83	47.44	45.49	44.22	45.41
StDev	4.99	6.45	5.97	5.91	6.87	4.90	8.29	5.95	6.09	6.00
Min	31.10	21.60	24.10	12.30	23.10	32.30	37.90	16.70	28.20	37.90
Max	51.20	64.70	63.90	63.20	58.10	41.60	63.10	62.50	60.60	64.70
$\Delta_{Max-Min}$	20.10	43.10	39.80	50.90	35.00	9.30	25.20	45.80	32.40	50.90
[4]D_m										
Count	15	161	815	940	68	3	11	1571	34	3618
Percent	0%	4%	23%	26%	2%	0%	0%	43%	1%	100%
Average	87.87	86.69	89.08	85.80	84.76	83.47	87.27	88.48	92.41	87.80
StDev	8.88	10.39	15.31	13.62	11.48	13.42	16.48	14.36	15.43	14.25
Min	67.70	51.10	31.70	20.80	47.40	72.70	48.80	32.20	60.60	72.70
Max	97.80	116.40	142.70	138.90	110.10	98.50	104.90	142.90	122.90	142.90
$\Delta_{Max-Min}$	30.10	65.30	111.00	118.10	62.70	25.80	56.10	110.70	62.30	118.10

Figure 16: Test Results, Manufacturer A, Product A

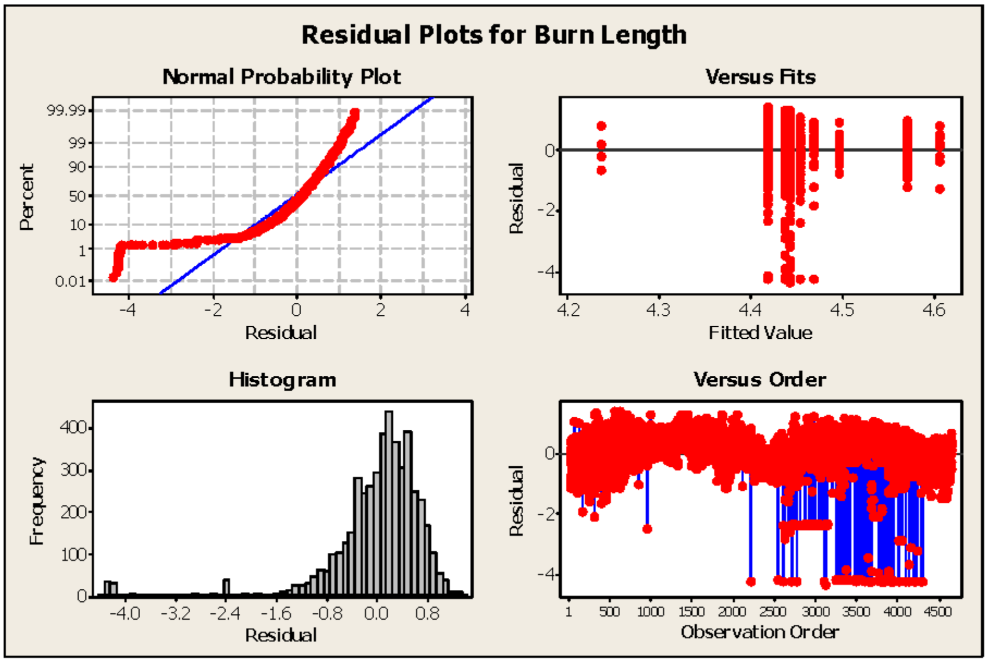

Figure 17: Minitab® Residual 4-in-1 Plot (Burn Length), Manufacturer A

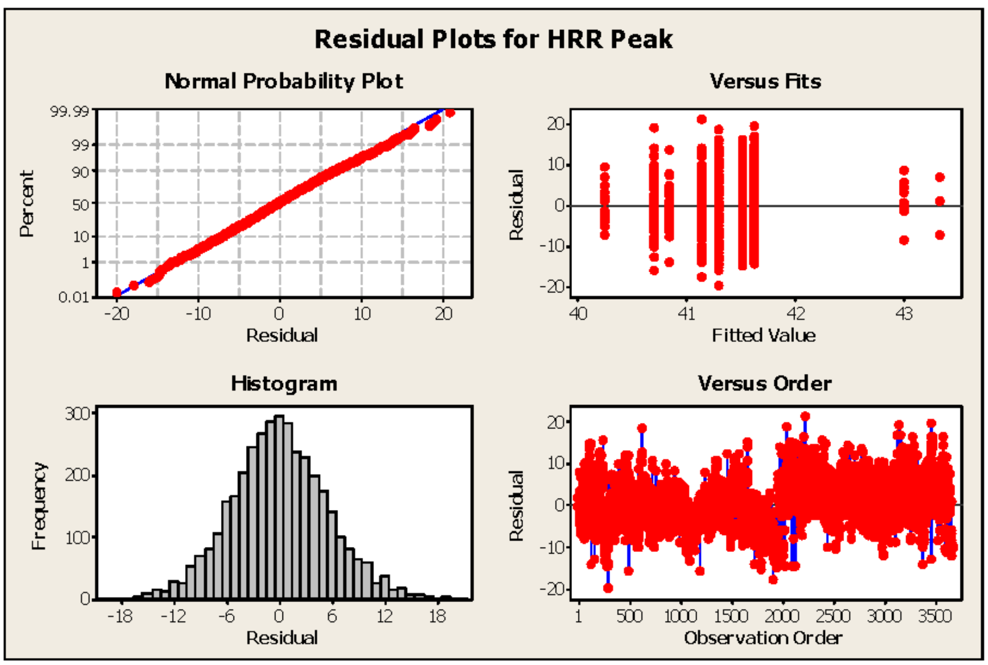

Figure 18: Minitab® Residual 4-in-1 Plot (HRR Peak), Manufacturer A

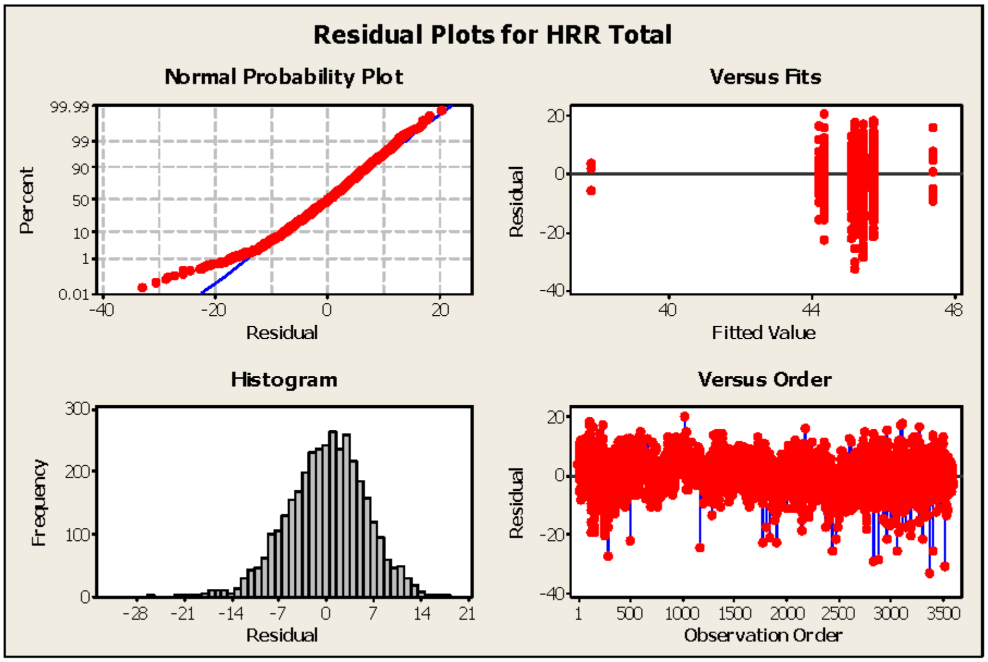

Figure 19: Minitab® Residual 4-in-1 Plot (HRR Total), Manufacturer A

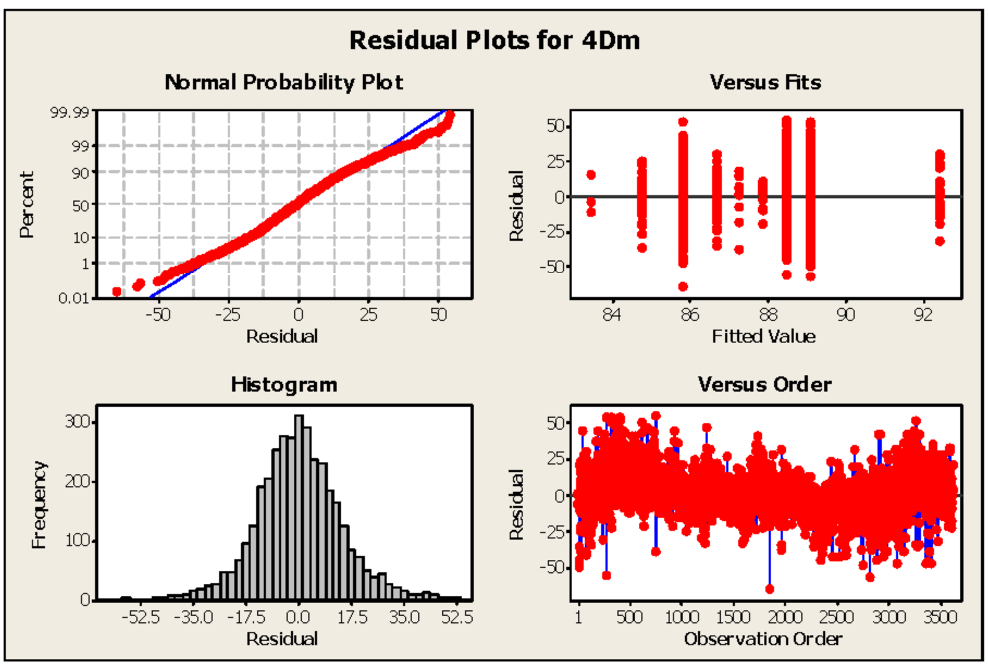

Figure 20: Minitab® Residual 4-in-1 Plot (NBS), Manufacturer A

9.2 MANUFACTURER B

Manufacturer B										
	Product A									
	Black	Blue	Brown	Gray	Green	Red	Silver	White	Yellow	Total
Burn Length										
Count	26	92	119	230	34	9	80	409	153	1152
Percent	2%	8%	10%	20%	3%	1%	7%	36%	13%	100%
Average	4.11	4.08	4.27	4.14	3.97	4.14	4.16	4.20	4.13	4.17
StDev	0.48	0.61	0.51	0.52	0.75	0.60	0.55	0.53	0.60	0.55
Min	3.39	1.77	2.52	2.24	1.58	3.31	1.57	1.57	1.97	1.57
Max	5.04	5.08	5.12	5.08	5.08	4.88	5.08	5.12	5.08	5.12
$\Delta_{Max-Min}$	1.65	3.31	2.60	2.83	3.50	1.58	3.50	3.54	3.11	3.54
HRR Peak										
Count	26	92	119	230	34	9	80	409	153	1152
Percent	2%	8%	10%	20%	3%	1%	7%	36%	13%	100%
Average	40.54	38.00	39.50	37.95	37.62	39.33	38.75	37.69	37.95	38.14
StDev	5.83	4.50	4.49	4.22	4.61	3.64	4.91	4.29	4.85	4.52
Min	31.00	29.00	30.00	26.00	28.00	36.00	25.00	28.00	22.00	36.00
Max	54.00	52.00	53.00	53.00	47.00	45.00	52.00	56.00	53.00	56.00
$\Delta_{Max-Min}$	23.00	23.00	23.00	27.00	19.00	9.00	27.00	28.00	31.00	31.00
HRR Total										
Count	26	92	119	230	34	9	80	409	153	1152
Percent	2%	8%	10%	20%	3%	1%	7%	36%	13%	100%
Average	28.42	28.04	28.32	28.15	27.24	27.78	27.84	27.47	27.67	27.81
StDev	4.53	3.60	3.37	3.85	3.24	2.49	4.37	4.10	4.36	3.98
Min	18.00	21.00	21.00	17.00	19.00	23.00	16.00	11.00	6.00	23.00
Max	37.00	36.00	39.00	40.00	32.00	31.00	39.00	42.00	40.00	42.00
$\Delta_{Max-Min}$	19.00	15.00	18.00	23.00	13.00	8.00	23.00	31.00	34.00	34.00
$^{4}D_m$										
Count	26	92	119	230	34	9	80	409	153	1152
Percent	2%	8%	10%	20%	3%	1%	7%	36%	13%	100%
Average	64.85	63.54	62.75	63.51	61.21	59.89	63.40	62.01	63.08	62.77
StDev	14.89	12.26	14.31	13.12	13.71	15.87	11.91	12.49	12.42	12.85
Min	35.00	19.00	17.00	14.00	19.00	37.00	14.00	20.00	26.00	37.00
Max	86.00	93.00	95.00	107.00	79.00	80.00	86.00	98.00	98.00	107.00
$\Delta_{Max-Min}$	51.00	74.00	78.00	93.00	60.00	43.00	72.00	78.00	72.00	93.00

Figure 21: Test Results, Manufacturer B, Product A

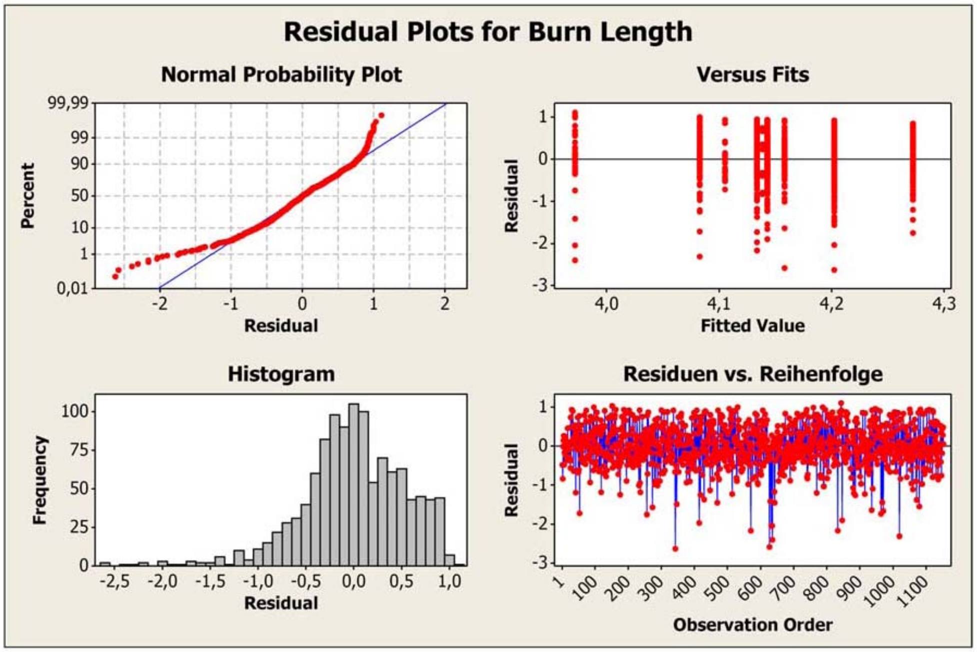

Figure 22: Minitab® Residual 4-in-1 Plot (Burn Lenght), Manufacturer B

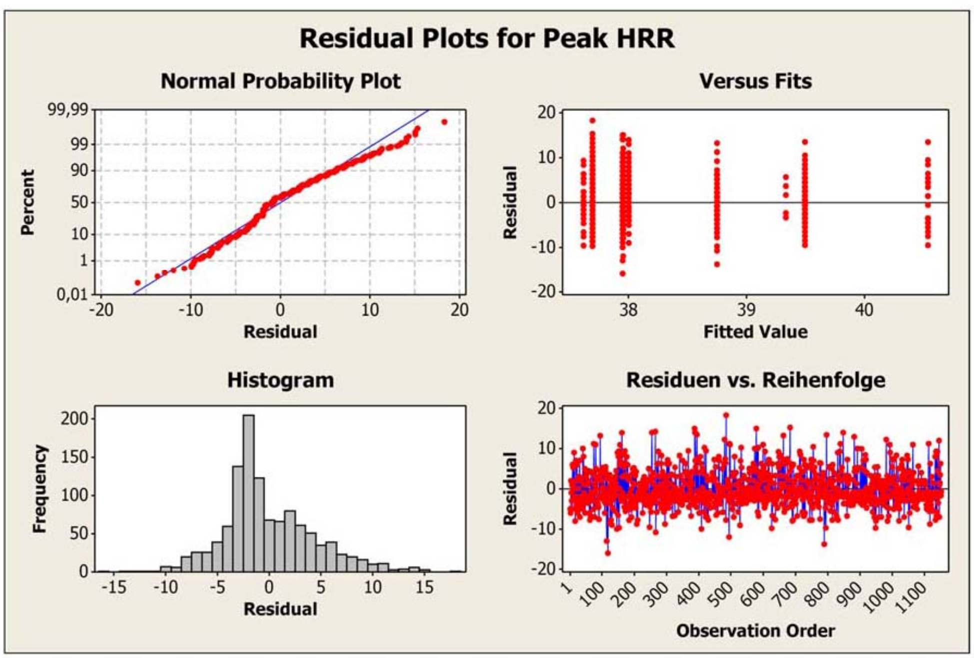

Figure 23: Minitab® Residual 4-in-1 Plot (HRR Peak), Manufacturer B

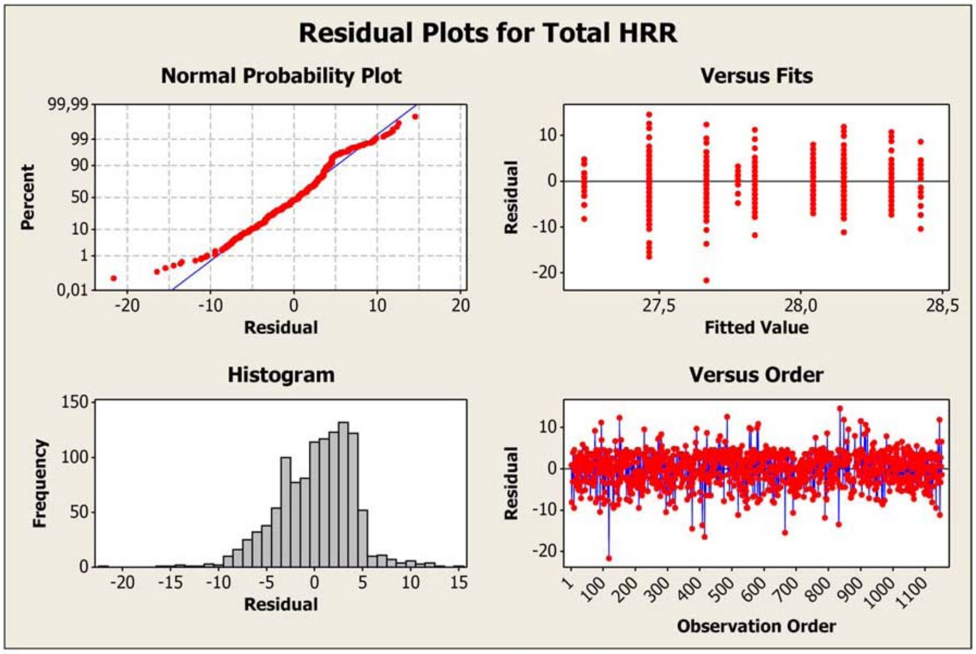

Figure 24: Minitab® Residual 4-in-1 Plot (HRR Total), Manufacturer B

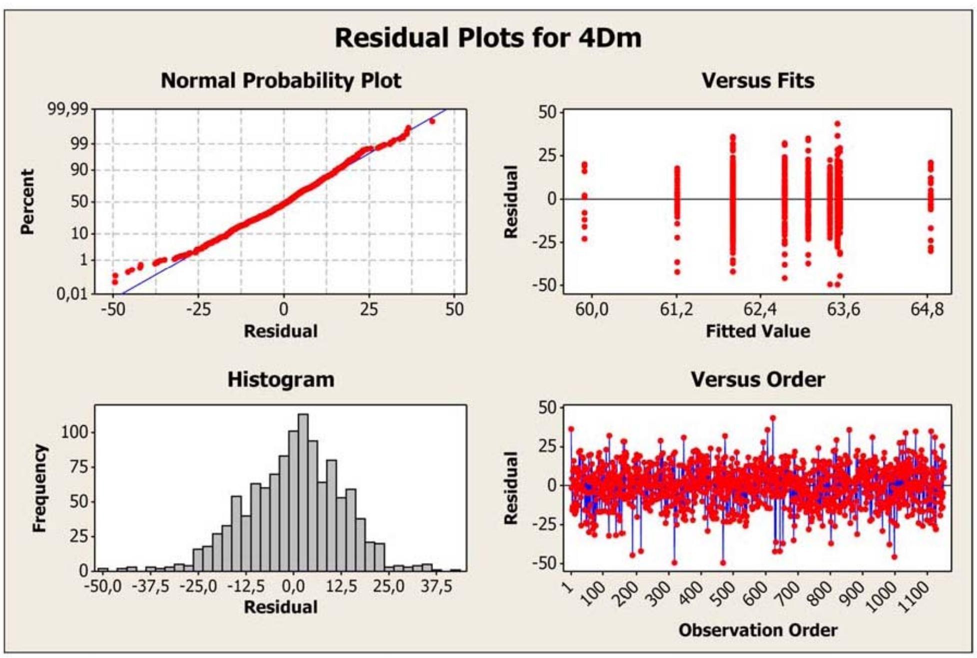

Figure 25: Minitab® Residual 4-in-1 Plot (NBS), Manufacturer B

9.3 MANUFACTURER C

Manufacturer C								
	Blue-Shade Red Study							
	black	bluered	clear	greenye	magenta	orange	redblue	Total
HRR Peak								
Count	6	20	6	6	6	20	6	70
Percent	9%	29%	9%	9%	9%	29%	9%	100%
Average	43.48	45.61	48.11	48.11	47.76	45.58	46.80	46.14
StDev	1.67	3.13	3.48	4.74	3.98	3.37	1.47	3.40
Min	40.94	38.84	42.51	40.94	43.56	39.36	44.61	38.84
Max	45.66	50.39	53.01	53.01	54.58	51.44	48.29	54.58
$\Delta_{Max-Min}$	4.72	11.55	10.50	12.07	11.02	12.08	3.68	12.08
HRR Total								
Count	6	20	6	6	6	20	6	70
Percent	9%	29%	9%	9%	9%	29%	9%	100%
Average	51.14	55.82	52.26	56.82	57.01	53.39	56.16	54.64
StDev	4.36	4.23	2.41	5.00	1.68	5.63	4.08	4.71
Min	46.29	47.35	49.59	48.92	55.37	41.03	51.99	41.03
Max	57.81	63.16	55.35	62.81	59.85	60.89	63.17	63.17
$\Delta_{Max-Min}$	11.52	15.81	5.76	13.89	4.48	19.86	11.18	19.86

Figure 26: Test Results, Manufacturer C, Blue-Shade Red Study

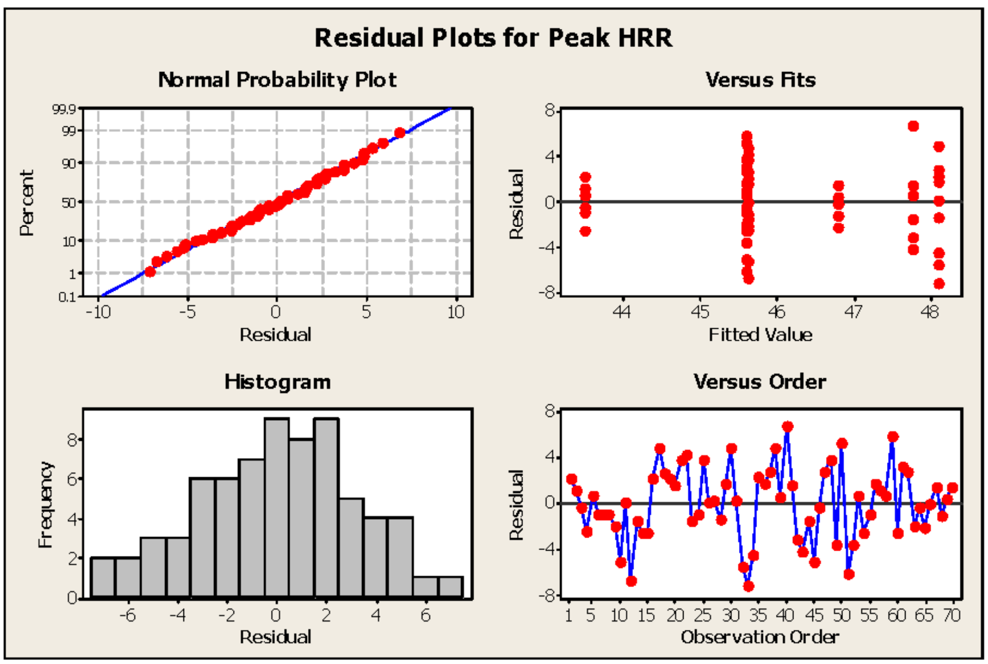

Figure 27: Minitab® Residual 4-in-1 Plot (HRR Peak), Manufacturer C, Blue-Shade Red Study

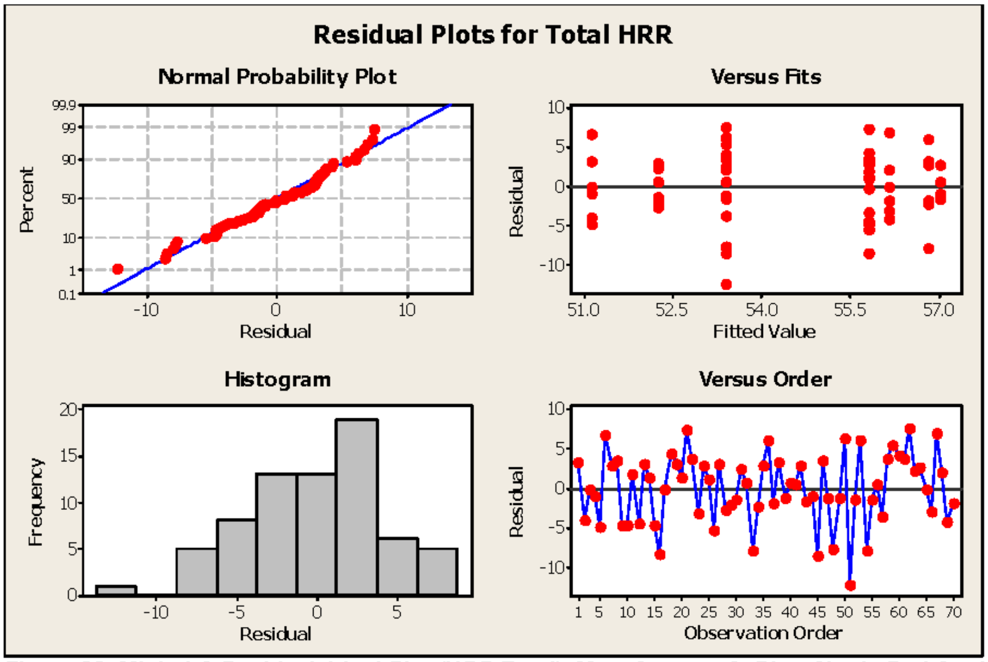

Figure 28: Minitab® Residual 4-in-1 Plot (HRR Total), Manufacturer C, Blue-Shade Red Study

APPENDIX H—ITEM 7: FIBER-REINFORCED CLOTH

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, "Policy Statement on Flammability Testing of Interior Materials"

INDUSTRY TEAM PROPOSAL

Part 2, Reference Items #7 "Fiber Reinforced Cloth"

Revision – NC, dated 2011 March 25

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7	NC								
8	NC								
9	NC								
10	NC								

REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
NC	Initial release.	2011-Mar-25	Martin Spencer

1 INTRODUCTION

The purpose of this proposal is to demonstrate that different weaves of fiber reinforced cloths for a specific weight and resin system has no effect on 60 second vertical ignition, heat release and smoke density values.

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials” [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA’s technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Item 7 has been reviewed by the industry team and are submitting the following concurrence, justification and proposal.

2 INDUSTRY TEAM LEADER AND SUPPORT TEAM

During an industry meeting on 24 September 2009 in Huntington Beach, CA, and the FAA Materials Fire Test Working Group meeting on 21 October 2009 in Atlantic City, NJ, the following individuals have volunteered to form the industry team for this reference item:

2.1 TEAM LEADER

- Spencer, Martin (MarlinEngineering)

2.2 SUPPORT TEAM

- Michael Jensen (The Boeing Company)
- Pacher, Mary O. (The Boeing Company)
- Keith Couilliard (The Boeing Company)
- Ingo Weichert (Airbus)
- Klaus Boesser (SELL)
- Eddie Cortez (Driessen)

This list is by no means final, but represents a snapshot of the currently active industry participants. Additional remarks, suggestions, corrections and contributions from other individuals are very much encouraged.

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on 20 August, 2009.

3.1.1 REFERENCE ITEM #7

Attachment 2, Part 2, reference item #7, Fiber Reinforced Cloth, reads as follows (see **Error! Reference source not found.** 1):

Part 2, methods of compliance that require supporting data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
7	Fiber reinforcement cloth	Test of one fiber reinforcement cloth of a given weight class in a given resin type (e.g., phenolic, epoxy, etc.) substantiates other fiber reinforcement cloth of the same weight class and fiber type provided the weave is the only change. This applies to cloth made from fiberglass, aramid, or carbon. For example, fiberglass weaves 1581, 7781, and 181 are all equivalent within a given weight class.	Weaves within same weight class are equivalent.

Figure 1: Attachment 2, Part 2, Reference Item #7

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of terms ‘should be provided so that confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

During team discussions, there were no terms mentioned within this section that the team felt as being unclear or needing changing.

4 VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

The use of the Item #7 MOC has been grouped by the FAA into Part 2 for 14 CFR 25.853(a) and (d). As such both require supporting data.

4.2 PROPOSED STANDARD TO MEET

Proposed MOC defined attachment 2, Part 2, reference item #7 is acceptable.

5 DATA / ANALYSIS

5.1 EXISTING TEST DATA

No existing test data will used in support of this proposal therefore new test data will be generated.

5.2 NEW TEST DATA

Test samples will be manufactured into 3 ply press cured laminates in accordance with the table shown below. At least two weaves from each weight class/resin system will be manufactured Each construction will be tested for vertical ignition, however only the phenolic resin samples will be tested for heat release and smoke density due to the inability for epoxy and polyester to meet these requirements. A minimum of 3 samples will be tested in each set.

Material/Weight/Style	Epoxy Resin	Phenolic Resin	Polyester Resin
Fiberglass 8.8oz 8 Harness (7781)	TEST F1 only	TEST F1, HR, SD	TEST F1 only
Fiberglass 8.69oz 4 Harness (1543)	TEST F1 only		TEST F1 only
Fiberglass 8.51oz 4 Harness (8800)		TEST F1, HR, SD	

Material/Weight/Style	Epoxy Resin	Phenolic Resin	Polyester Resin
Aramid 5.10oz Plain (352)	TEST F1 only	TEST F1, HR, SD	
Aramid 5.10oz Crowfoot (353))	TEST F1 only	TEST F1, HR, SD	
Carbon 5.80oz Plain (282)	TEST F1 only	TEST F1, HR, SD	
Carbon 5.80oz 2/2 Twill	TEST F1 only	TEST F1, HR, SD	

All testing will be conducted at the FAA Fire Test Center in Atlantic City to avoid any inter laboratory issues.

5.3 ANALYSIS OF NEW TEST DATA

The data provided will be analyzed to determine whether it appears to be sufficient to support use of different weaves within the same fabric weight and resin system. If it appears sufficient, the data will be summarized and provided in support of this MOC. If it does not appear sufficient, additional data will be generated to fill areas lacking data. If, once the data appear to be sufficiently complete, the data do not appear to support this, the proposal will be modified as needed.

6 CONCLUSION

To be added after test data analysis

6.1 REVISED PROPOSAL

To be revised after testing

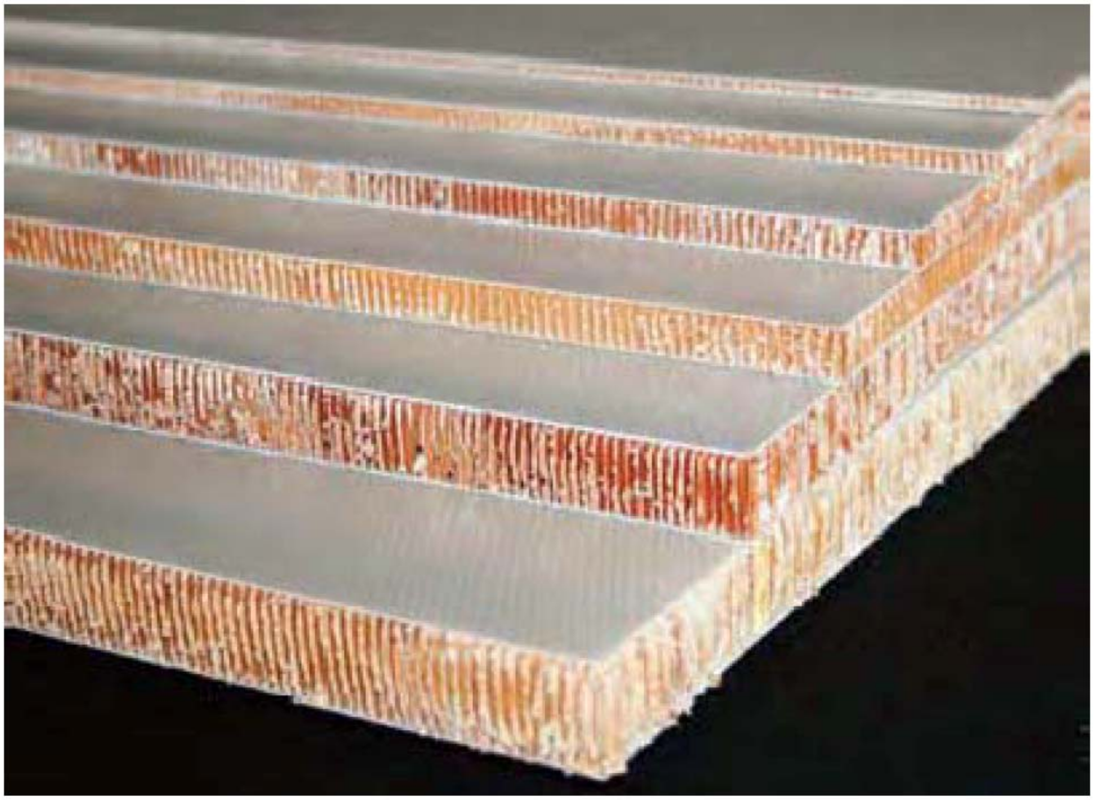
7 ABBREVIATIONS

FAA	=	Federal Aviation Administration
MOC	=	Methods of Compliance
CFR	=	Code of Federal Regulations

8 REFERENCES

[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

APPENDIX I—ITEM 9: FASE



Part 1, Item 9:
Face Sheet Testing
(FASE – Face as Separate Entity)

1. INTRODUCTION

For many years, cabin interior components have primarily been tested for flammability compliance by separate entities, each with their own interpretation of aviation flammability regulations. FAA draft policy memo, ANM-115-09-xxx is part of a joint effort between the FAA and the cabin interiors industry to standardize the means of compliance to aviation flammability requirements.

A draft of ANM-115-09-xxx was released by the FAA in the 3rd quarter of 2009, with 2 main categories of cabin interior materials. Sandwich panel face testing (FASE – Face as Separate Entity) falls into the first category of materials that have methods of compliance that are acceptable to the FAA, without any need for supporting test data.

The purpose of this document is to clarify this method of compliance for sandwich panel face testing (FASE – Face as Separate Entity).

2. TEAM LEADER AND SUPPORT TEAM

During a meeting on October 27, 2010, in Atlantic City NJ., the following volunteers joined the “Skin testing (FASE – Face as Separate Entity)” team:

- Ke-winn Chan, team leader
- Mary Pacher
- Panade Sattayatam
- Michael Jensen
- Scott Campbell
- Ingo Weichert

3. PROJECT DEFINITION

3.1 Current Proposal

Presently, ANM-115-09-xxx is available as an undated draft. The current version has been printed on August 20, 2009. Part 1, reference no. 9, reads:

Part 1, acceptable methods without additional data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
9	Skin testing (FASE - Face As Separate Entity)	Data may be collected from each face of a sandwich panel independently. **Note:** The test coupon is a completed sandwich panel. The data from each face may be used to substantiate a panel construction when the panel thickness is greater than 0.25" and the thickness is the only difference between the core materials.	Not applicable.

3.2 Definition of Terms

- Sandwich Panel - A rigid panel fabricated using face sheets on either side of a core material.
- Face Sheet - Either reinforced thermoset resins or metal.
- Core Material – A rigid foam or a honeycomb structure made of aluminum, Ultem®, or phenolic resin reinforced with Nomex®, Kevlar®, or fiberglass)

4. VALIDATION OF INDUSTRY PRACTICE

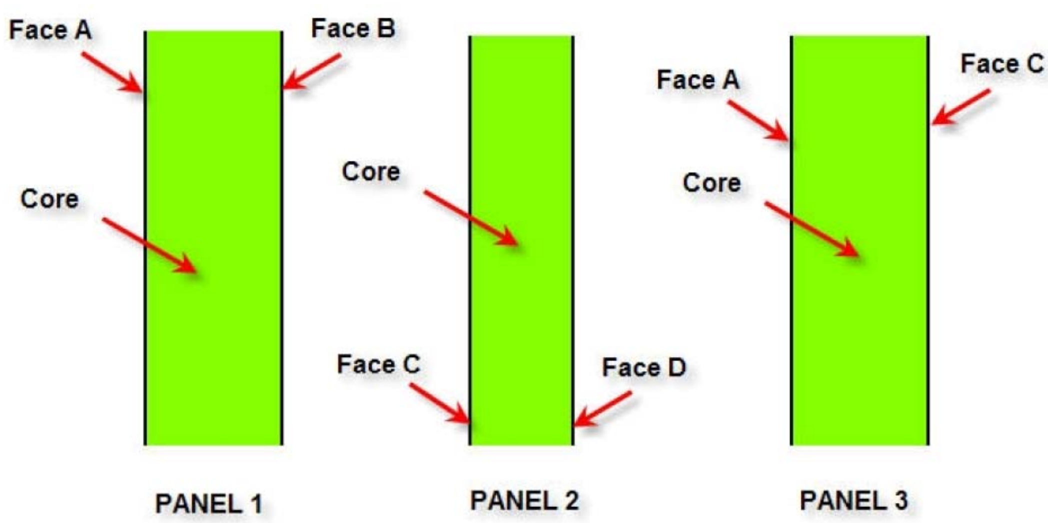
4.1 Industry Proposal Discussion

The following is provided to clarify the use of this MOC, Face as a Separate Entity (FASE).

For 14 CFR 25.853(a) Bunsen burner test requirements only, data collected from each face of a sandwich panel may be applied independently to other sandwich panels, provided the following conditions are true:

- The core material for all panels is identical except for thickness,
- Each panel is 0.25 inches thick or greater.

An example of this Method of Compliance is shown in Figure 1.



Certification data from Panel 1, Face A and Panel 2 Face C, can be used to substantiate panel 3 provided the core material for all three panels is identical except for thickness and each panel is 0.25 inches thick or greater.

Figure 1 – Example of application of FASE

5. CONCLUSION

Industry agrees with Issue Paper Item number 9 and suggests adding the information above to clarify the use of this MOC.

APPENDIX J—ITEM 10: SURFACE FILLERS

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM PROPOSAL

Part 2, Reference Items #10 “Surface Fillers”

Revision – A, dated 2011-September 1

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9	A								
10	A								
11	A								
12	A								
13	A								
14	A								

REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
NC	Initial release	2011-Apr-12	Martin Spencer
A	Updated report per FAA comments	2011-SEP-1	Scott Campbell

1 INTRODUCTION

The purpose of this proposal is to determine to what extent surface fillers can be applied without affecting the ignition, heat release and smoke density test values.

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials” [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA’s technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Items 6 have been reviewed by the industry team and are submitting the following concurrence, justification and proposal.

2 INDUSTRY TEAM LEADER AND SUPPORT TEAM

During an industry meeting on 24 September 2009 in Huntington Beach, CA, and the FAA Materials Fire Test Working Group meeting on 21 October 2009 in Atlantic City, NJ, the following individuals have volunteered to form the industry team for this reference item:

2.1 TEAM LEADER

- Spencer, Martin (MarlinEngineering)

2.2 SUPPORT TEAM

- Mary Pacher (The Boeing Company)
- Shawn Clark (Recaro)
- David Julin (B/E Aerospace)
- Dirk Langer (SELL)
- Klaus Boesser (SELL)
- Dan Slaton (The Boeing Company)
- Chuck Storey (McGee Plastics)
- Michael Jensen (The Boeing Company)
- Scott Campbell (C&D Zodiac)

This list is by no means final, but represents a snapshot of the currently active industry participants. Additional remarks, suggestions, corrections and contributions from other individuals are very much encouraged.

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on 20 August, 2009.

3.1.1 REFERENCE ITEM #6

Attachment 2, Part 2, reference item #10, Surface Fillers, reads as follows (see **Error! Reference source not found.** 1):

Part 2, methods of compliance that require supporting data

Reference Number	Feature / Construction	25.853(a)Bunsen Burner Test Requirements/Similarity	25.853(d) Heat Release and Smoke Test Requirements/Similarity
10	Surfacing materials (pin-hole filler, sweep and sand, Bondo)	No test required when surfacing material is controlled within an approved process specification to assure conformance to flammability requirements, or that these materials do not contribute to the propagation of a fire.	No test required when surfacing material is controlled within an approved process specification to assure conformance to flammability requirements, or that these materials do not contribute to the propagation of a fire.

Figure 1: Attachment 2, Part 2, Reference Item #10

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of terms 'should be provided so that confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

Pin Hole Filler – a material that is used locally to fill small pin holes left during the manufacturing process

Sweep and Sand – the action of applying a thin film of filler material with a wide blade and then sanding the material down to just leave filler material between fibers

Bondo – a generic term for all putty like materials typically used to fair mismatched surfaces. Normally a 2-part material.

Approved Process Specification – An engineering specification or a set of process instructions on the design drawing that define and control the application of the surface filler material. The document must specify the maximum limits of the application (weight per square area). The approved process specification or drawing shall be released using the approved company procedure for type design documents.

4 VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

The use of the Item #10 MOC has been grouped by the FAA into Part 2 for 14 CFR 25.853(a) and (d). As such both require supporting data.

4.2 PROPOSED STANDARD TO MEET

This proposal is meant to address materials that are used over a wide area of a panel surface. It is not meant for small area use of materials to repair localized defects or to fair in mismatched edges which would be considered under the size criteria for heat release. Following much discussion within the team, it was felt that the MoC as written could not easily be applied. The suggestion was to generate a standard process to enable an applicant to generate their own data for establishing the threshold amount of surfacing material that could be applied. It was also felt that the only accurate method of measuring the amount of material was weight per square area. The use of thickness and area are subjective, very difficult to inspect and leaves a lot of misinterpretation.

5 DATA / ANALYSIS

5.1 EXISTING TEST DATA

No existing test data will used in support of this proposal.

5.2 NEW TEST DATA DEVELOPMENT

The following describes the method to determine an acceptable density of surfacing material that can be applied to substrates without the need for additional testing. This process shall be repeated for each surfacing filler product.

Manufacture a nominal 0.50” (12mm) thick Nomex honeycomb sandwich panels with 2 plies each side of standard Phenolic prepreg. Panels should be built using the same manufacturing method (press cure or vacuum bag layup). It is highly recommended that the same panel is used for all tests.

A minimum of 3 samples of each configuration will be tested. Test can be engineering tests, i.e. no FAA witness is required.

1. Test baseline panel with no filler applied

2. Test panel with filler applied at the maximum amount (Weight per square area) allowed per the approved process specification (see definition).

3. Test a minimum of 1 set of samples at an intermediate density application.

If the surface filler maximum density yields values that show appreciable fire properties differences from the bare panel, then a lower maximum density needs to be defined.

5.3 ANALYSIS OF NEW TEST DATA

The results of the testing shall be analyzed. To be acceptable, the vertical burn, heat release and smoke results of the panels with surface filler shall be determined to have no statistically significant effect when compared to the bare panel
Before this MOC can be used for certification purposes, the analysis needs to have been performed and validated.

Appendix A provides examples of current industry test programs used to validate the use of surface fillers. These examples provide validation of the test approach being proposed.

6 CONCLUSION

This MOC provides acceptable guidance to validate the use of surface materials using approved process specifications

6.1 REVISED PROPOSAL

The following updated proposal will be used to demonstrate the use of surface materials. Attachment 2, Part 2, reference item #10, Surface Fillers, reads as follows (see **Error! Reference source not found.**2):

Part 2, methods of compliance that require supporting data

Reference Number	Feature / Construction	25.853(a)Bunsen Burner Test Requirements/Similarity	25.853(d) Heat Release and Smoke Test Requirements/Similarity
10	Surfacing materials (pin-hole filler, sweep and sand, Bondo)	No test required when surfacing material is controlled within an approved process specification that has been validated using the method described within this MOC.	No test required when surfacing material is controlled within an approved process specification that has been validated using the method described within this MOC.

Figure 2: Attachment 2, Part 2, Reference Item #10

7 ABBREVIATIONS

FAA	=	Federal Aviation Administration
MOC	=	Methods of Compliance
CFR	=	Code of Federal Regulations

8 REFERENCES

[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

Appendix A

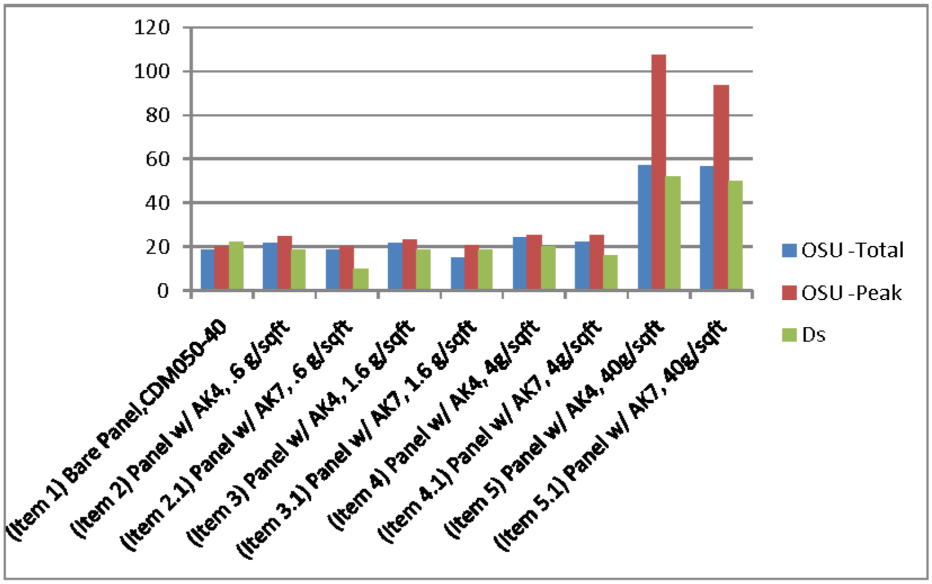
Example Summary of Surfacer Data supplied by C&D that supports this MOC

<u>High level summary and graphical analysis</u>

Data shows that surfacer applied within CDZ specification limits (0- 4 gms) does not affect fire properties. Data also shows that the surfacer does not protect the panel (fails when applied 10x the specification limit)

AKEMI 4 & 7 PANEL FILLER STUDY

ID	OSU OSU -Total	OSU -Peak	Smoke Ds
(Item 1) Bare Panel,CDM050-40	18.3	20.2	22.3
(Item 2) Panel w/ AK4, .6 g/sqft	21.8	24.5	18.7
(Item 2.1) Panel w/ AK7, .6 g/sqft	18.6	20.2	10
(Item 3) Panel w/ AK4, 1.6 g/sqft	21.8	23.1	18.3
(Item 3.1) Panel w/ AK7, 1.6 g/sqft	15	20.7	18.3
(Item 4) Panel w/ AK4, 4g/sqft	24	25.4	20
(Item 4.1) Panel w/ AK7, 4g/sqft	21.9	25.1	16
(Item 5) Panel w/ AK4, 40g/sqft	57	107.2	51.7
(Item 5.1) Panel w/ AK7, 40g/sqft	56.7	93.4	49.7



<u>**Detailed data**</u>

(Individual graphs available upon request)

ID	BB After Flame (sec)	Burn Length (in)	OSU Total	Peak	Smoke Ds
Bare Panel	0	1.6	10.5	15.7	20
CDM050-40	0	1.5	16.1	19.9	26
(Item 1)	0	1.5	28.2	25.1	21
AVG	**0**	**1.5**	**18.3**	**20.2**	**22.3**
Panel w/ AK4	4.1	1.7	19.9	25	21
.6 g/sqft	0	1.7	25	24.5	22
(Item 2)	0	1.8	20.4	23.9	13
AVG	**1.4**	**1.7**	**21.8**	**24.5**	**18.7**
Panel w/ AK7	0	1.8	11.6	16.9	11
.6 g/sqft	0	1.5	21.1	22.1	9
(Item 2.1)	0	1.7	23.1	21.7	10
AVG	**0**	**1.7**	**18.6**	**20.2**	**10**
Panel w/ AK4	0	1.6	20.3	24.1	15
1.6					
g/sqft	4.3	1.8	26.6	23	22

(item 3)	2.5	1.6	18.6	22.1	18
AVG	**2.3**	**1.7**	**21.8**	**23.1**	**18.3**
Panel w/ AK7	4.8	1.7	11	16.3	19
1.6g/sqft	2	1.7	14.5	19.6	18
(item 3.1)	4.6	1.7	19.4	26.2	18
AVG	**3.8**	**1.7**	**15**	**20.7**	**18.3**

Panel w/ AK4	0	1.6	24	28.1	17
4g/sqft	0	1.7	25	22.4	16
(Item 4)	0	1.7	23.1	25.7	27
AVG	**0**	**1.7**	**24**	**25.4**	**20**
Panel w/ AK7	0	1.6	21.4	30.2	16
4g/sqft	0	1.7	23.5	23.2	16
(Item 4.1)	0	1.7	20.9	21.9	16
AVG	**0**	**1.7**	**21.9**	**25.1**	**16**

Panel w/ AK4			63.6	140.6	71
40g/sqft			51.5	107.2	53
(Item 5)	COMPLETELY CONSUMED		55.9	73.8	31
AVG	**FAIL**	**FAIL**	**57**	**107.2**	**51.7**
Panel w/ AK7	0	2.4	60.1	95.9	48
40g/sqft	0	2.8	49.2	69.6	46
(Item 5.1)	2.6	2.8	60.8	114.6	55
AVG	**0.9**	**2.7**	**56.7**	**93.4**	**49.7**

APPENDIX K—ITEM 11: BACKSIDE DECORATIVE

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM PROPOSAL

Part 2, Reference Items #11 “Backside Decorative”

Revision – B, dated 2011-November 7

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12	B								
13	B								
A1-A91	B								

REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
NC	Initial release	2010-Feb-28	Martin Spencer
A	Included comments and notes from Cologne, Atlantic City and Savannah meetings	2011-Mar 25	Martin Spencer
B	Added supporting data	2011-NOV 7	Scott Campbell

1 INTRODUCTION

The purpose of this proposal is to determine that a panel that has backside decorative can be used to substantiate a panel without backside decorative test for 60 second vertical ignition, heat release and smoke density from given that all other parameters are identical.

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials” [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA’s technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Items 6 have been reviewed by the industry team and are submitting the following concurrence, justification and proposal.

2 INDUSTRY TEAM LEADER AND SUPPORT TEAM

During an industry meeting on 24 September 2009 in Huntington Beach, CA, and the FAA Materials Fire Test Working Group meeting on 21 October 2009 in Atlantic City, NJ, the following individuals have volunteered to form the industry team for this reference item:

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This list is by no means final, but represents a snapshot of the currently active industry participants. Additional remarks, suggestions, corrections and contributions from other individuals are very much encouraged.

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on 20 August, 2009.

3.1.1 REFERENCE ITEM #11

Attachment 2, Part 2, reference item #11, Backside Decorative, reads as follows:

Part 2, methods of compliance that require supporting data

Reference Number	Feature / Construction	25.853(a)Bunsen Burner Test Requirements/Similarity	25.853(d) Heat Release and Smoke Test Requirements/Similarity
11	Backside decorative	Test of a panel with a backside decorative substantiates a panel with a backside that has no decorative	Test of a panel with a backside decorative substantiates a panel with a backside that has no decorative

Figure 1: Attachment 2, Part 2, Reference Item #11

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of terms ‘should be provided so that confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

Decorative - for the purpose of this MOC the term “decorative” implies any finish applied to the back of a panel e.g. paint, Decorative Tedlar Laminates (DTL), co-cured bondable Tedlar.

4 VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

The use of the Item #11 MOC has been grouped by the FAA into Part 2 for 14 CFR 25.853(a) and (d). As such both require supporting data.

4.2 PROPOSED STANDARD TO MEET

- Proposed MOC defined attachment 2, Part 2, reference item #11 is acceptable.

5 DATA / ANALYSIS

5.1 EXISTING TEST DATA

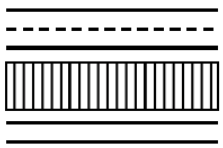
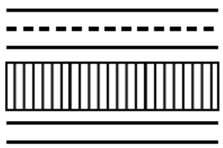
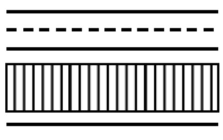
No existing test data will used in support of this proposal therefore new test data will be generated.

5.2 NEW TEST DATA

Test samples will manufactured using .250" thick 3.0 # Nomex honeycomb core with a 1 ply phenolic face sheet each side. Various decorative finishes will then be applied to one side. Each construction will be tested for vertical ignition, heat release and smoke density. A minimum of 3 samples will be tested in each set.

.

Test Sample	Construction
1	THERMOPLASTIC DECORATIVE ADHESIVE FACE SHEET .250" 3.0 pcf NOMEX HONEYCOMB CORE FACE SHEET
2	THERMOPLASTIC DECORATIVE ADHESIVE FACE SHEET .250" 3.0 pcf NOMEX HONEYCOMB CORE FACE SHEET ADHESIVE THERMOPLASTIC DECORATIVE
3	THERMOPLASTIC DECORATIVE ADHESIVE FACE SHEET .250" 3.0 pcf NOMEX HONEYCOMB CORE FACE SHEET FOIL BACKED DECORATIVE

4		THERMOPLASTIC DECORATIVE ADHESIVE FACE SHEET .250" 3.0 pcf NOMEX HONEYCOMB CORE FACE SHEET FIBER REINFORCED DECORATIVE
5		THERMOPLASTIC DECORATIVE ADHESIVE FACE SHEET .250" 3.0 pcf NOMEX HONEYCOMB CORE FACE SHEET PAINT
6		THERMOPLASTIC DECORATIVE ADHESIVE FACE SHEET .250" 3.0 pcf NOMEX HONEYCOMB CORE FACE SHEET BONDABLE TEDLAR

All testing was conducted at Heath Tecna to avoid any inter laboratory issues. All items except item 3 (backed with décor containing aluminum foil) were manufactured and tested. This type of décor was not available at the time of testing.

A summary of the test results are shown in the table on the next page. Individual heat release and smoke graphs are included in Appendix A.

HEATHTECNA
AIRCRAFT INTERIOR SOLUTIONS

FLAMMABILITY TEST RESULTS
MOC Part 2 Item #11
Backside Decorative

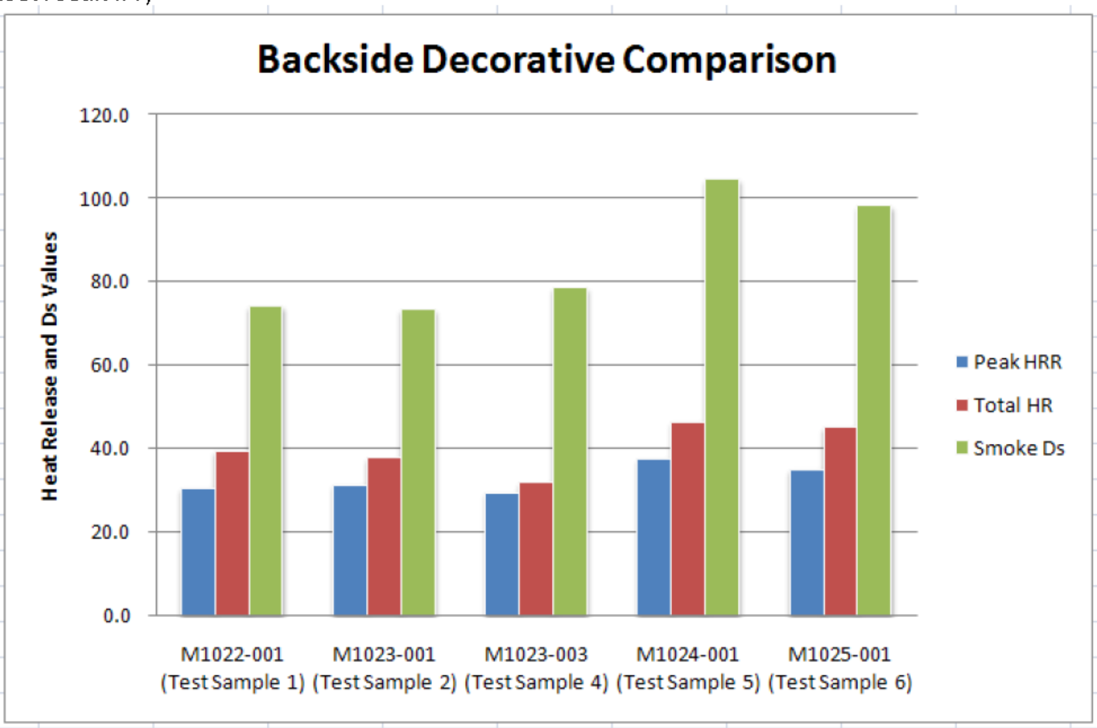
MI Number	Part Description	Material Identification	Ignition (Burn Length/Extinguish Time/Drip Time)	Heat Release (Peak/2 min. Total)	Smoke Density (Ds)
M1022-001	DECORATIVE ONE SIDE (TEST SAMPLE 1)	HMS D2-001-AN215-10.010 DECORATIVE SCOTCHWELD 10 ADHESIVE HMS B1-002-1-23 FACE SHEET .250" HMS B3-201-4-1-3.0 CORE HMS B1-002-1-23 FACE SHEET	3.3/0.0/0 3.1/0.0/0 3.0/0.0/0 **3.1/0.0/0**	27.0/53.1 31.7/42.1 27.7/39.2 33.4/40.1 31.9/42.7 **30.5/39.5**	117 59 77 63 98 **89**
M1023-001	DECORATIVE TWO SIDES (TEST SAMPLE 2)	HMS D2-001-AN215-18.010 DECORATIVE SCOTCHWELD 10 ADHESIVE HMS B1-002-1-23 FACE SHEET .250" HMS B3-201-4-1-3.0 CORE HMS B1-002-1-23 FACE SHEET SCOTCHWELD 10 ADHESIVE HMS D2-001-AN215-10.010 DECORATIVE	3.0/0.0/0 2.5/0.0/0 2.9/0.0/0 **2.8/0.0/0**	29.6/34.7 32.3/38.9 32.0/38.1 31.8/38.8 31.0/38.2 **31.3/37.7**	66 56 69 84 92 **73**
M1023-003	DECORATIVE ONE SIDE GLASS FIBER REINFORCED DECORATIVE WITH PSA ADHESIVE ONE SIDE (TEST SAMPLE 4)	HMS D2-001-AN215-18.010 DECORATIVE SCOTCHWELD 10 ADHESIVE HMS B1-002-1-23 FACE SHEET .250" HMS B3-201-4-1-3.0 CORE HMS B1-002-1-23 FACE SHEET 55466 SCHNELLER AERTRIM LW	3.0/0.0/0 2.7/0.0/0 2.6/0.0/0 **2.8/0.0/0**	26.3/29.1 28.7/29.9 33.4/36.5 33.1/37.3 23.3/25.3 **29.4/31.8**	81 75 75 91 71 **79**
M1024-001	DECORATIVE ONE SIDE PAINT ONE SIDE (TEST SAMPLE 5)	HMS D2-001-AN215-18.010 DECORATIVE SCOTCHWELD 10 ADHESIVE HMS B1-002-1-23 FACE SHEET .250" HMS B3-201-4-1-3.0 CORE HMS B1-002-1-23 FACE SHEET HMS D1-001-2-2-105 PAINT	2.4/0.0/0 2.9/0.0/0 2.2/0.0/0 **2.5/0.0/0**	37.4/45.2 38.6/48.3 34.6/42.8 40.7/52.5 36.2/45.6 **37.6/46.6**	78 123 113 84 125 **106**
M1025-001	DECORATIVE ONE SIDE BONDABLE TEDLAR ONE SIDE (TEST SAMPLE 6)	HMS D2-001-AN215-18.010 DECORATIVE SCOTCHWELD 10 ADHESIVE HMS B1-002-1-23 FACE SHEET .250" HMS B3-201-4-1-3.0 CORE HMS B1-002-1-23 FACE SHEET TCW20BE8 TEDLAR	2.4/0.0/0 2.0/0.0/0 2.6/0.0/0 **2.3/0.0/0**	38.2/49.7 30.4/41.7 37.7/46.5 31.7/38.1 36.9/51.1 **35.0/45.2**	116 115 79 85 96 **98**

5.3 ANALYSIS OF NEW TEST DATA

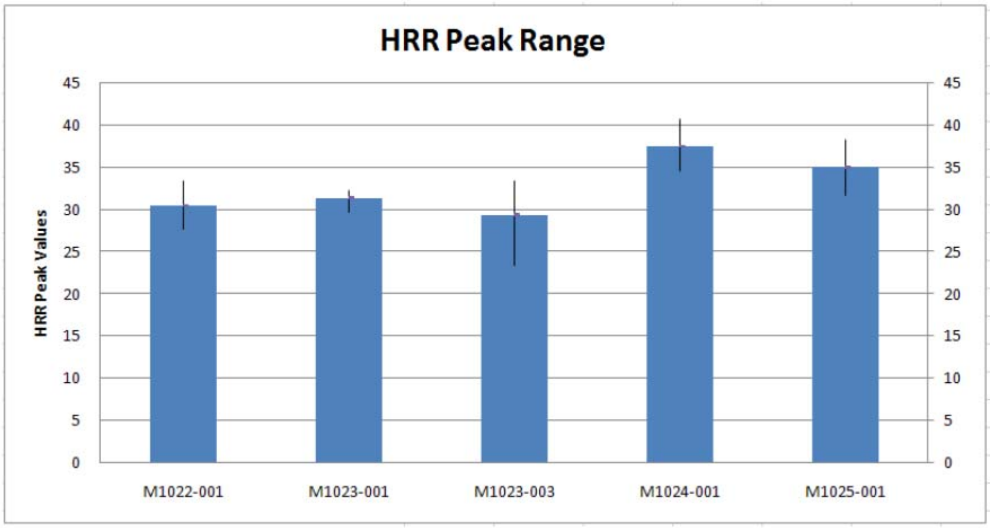
The .25" thick honeycomb panel with 1 ply each side of phenolic fiberglass represents a worse-case heat release and smoke configuration for back side decoratives to be consumed during the test. Test sample 1 represents a panel with a nominal non-reinforced decorative laminate on the test side without any backside treatment. Test samples 2, 4, 5 and 6 add different types of decorative to the backside. Each configuration with a backside decorative showed to be the same (considering OSU and smoke scatter band) or worse than Test sample 1 (no backside decorative). Test sample 4 did have an average OSU total 8 points below Test sample 1, but well within the range of data and standard deviations shown in the charts on page 12.

The OSU standard deviations noted in the charts below (pg 12) indicate for normal distribution that 1 Standard deviation represents +/- 2 to 4.7 and 2 standard deviations +/- 4 to 9.4 from the mean average. (Note that the smoke average for Test sample 1 would be 74 without the 1st result).

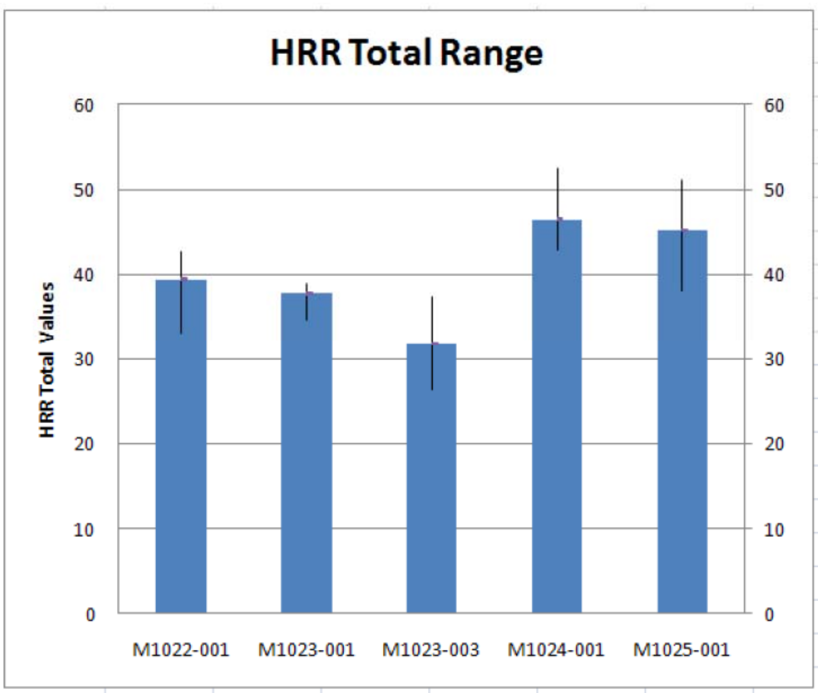
The chart below illustrates the trend (Note- Sample 1 smoke average calculated without test result #1)



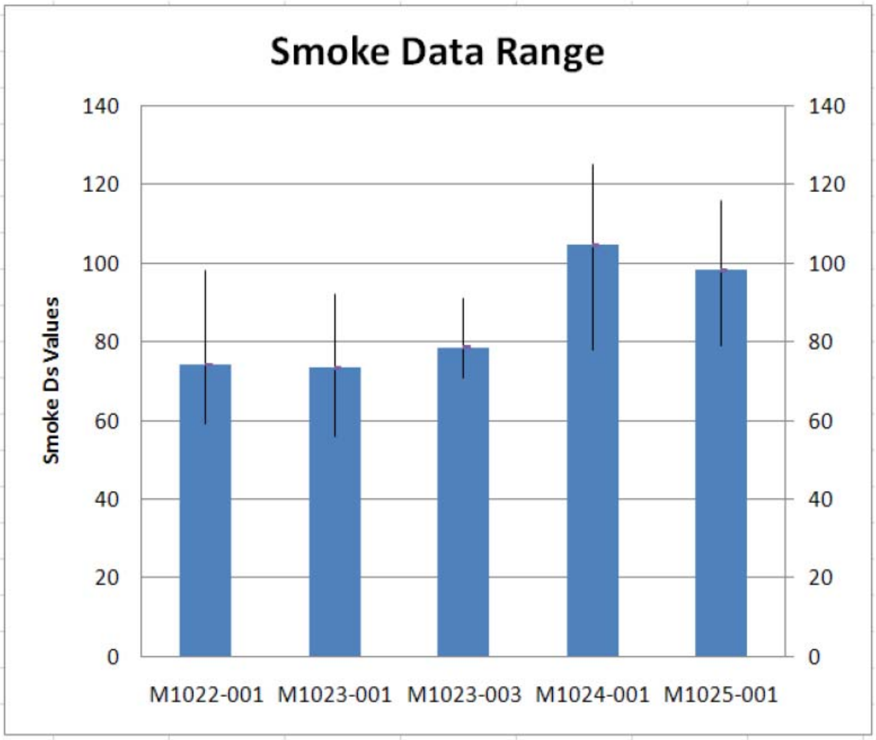
The next charts show the range of data and Standard Deviations.



STDEV	2.4	1.0	3.7	2.1	3.3



STDEV	3.4	1.6	4.3	3.2	4.7



STDEV	32.1	12.9	7.0	19.8	15.1

6 CONCLUSION

The data provided shows that panels tested with a backside decorative (decorative laminate, paint, or thin film Tedlar) substantiates panels without a backside decorative.

7 ABBREVIATIONS

FAA	=	Federal Aviation Administration
MOC	=	Methods of Compliance
CFR	=	Code of Federal Regulations

8 REFERENCES

[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

APPENDIX A
DATA & GRAPHS

FAA Memorandum
ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”
Part 2, Reference Item #11, “**Backside Decorative**”

BUNSEN BURNER TEST DATA SHEET

TEST PLAN #	MOC PART 2 ITEM 11
TEST SPECIMEN ID #	M1022-001
MANUFACTURER:	HEATH TECNA
MATERIAL DESCRIPTION:	
TEST LOCATION:	HEATH TECNA, BELLINGHAM
TEST DATE:	10/20/11
TESTED BY:	T. Rochon
WITNESSED BY:	
CONDITIONING:	MINIMUM 24 HRS AT 70° ± 5° F, 50% ± 5% RELATIVE HUMIDITY
FLAME TEMP:	1550° F

TEST METHOD / **TEST REQUIREMENTS (MAX. AVERAGE)**

FAR/JAR PART 25, APPENDIX F, PART I

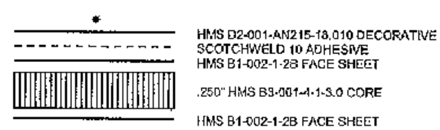
	Test Code	Test Type	Burn Length	Flame Extinguish Time	Drip Extinguish Time	Burn Rate	Flame Penetration	After Glow
☒	F1	60 sec Ignition Vertical Test	6.0 Inches	15.0 Sec.	3.0 Sec.	-	-	-
☐	F2	12 sec Ignition Vertical Test	8.0 Inches	15.0 Sec.	5.0 Sec.	-	-	-
☐	F3	15 sec Ignition Horizontal Test 2.5 inch/min	-	-	-	2.5 In./Min.	-	-
☐	F4	15 sec Ignition Horizontal Test 4 inch/min	-	-	-	4.0 In./Min.	-	-
☐	F5	30 sec Ignition – 45 Degree	-	15.0 Sec.	-	-	NONE	10.0 Sec.
☐	F6	30 sec Ignition -- 60 Degree	3.0 Inches	30.0 Sec.	3.0 Sec.	-	-	-

TEST RESULTS

Sample #	Burn Length	Flame Exting	Drip Exting	Burn Rate	Flame Pene-tration	After Glow	Test Direction
1	3.3	0.0	N.D.				
2	3.1	0.0	N.D.				
3	3.0	0.0	N.D.				
AVG.	3.1	0.0	0				

PASS ☒ FAIL ☐

SKETCH



*TEST SIDE

COMMENTS

HEATHTECNA
AIRCRAFT INTERIOR SOLUTIONS

HEAT RELEASE TEST DATA SHEET	TEST PLAN #	TEST SPECIMEN ID #
	MOC PART 2 ITEM 11	M1022-001

MANUFACTURER:	MATERIAL DESCRIPTION:
HEATH TECNA	

TEST LOCATION:	TEST DATE:	TESTED BY:	WITNESSED BY:
HEATH TECNA, BELLINGHAM	10/18/11	T. Rochon	

CONDITIONING:	CALIBRATION FACTOR:	HEAT FLUX:
MINIMUM 24 HRS AT 70° ± 5° F, 50% ± 5% RELATIVE HUMIDITY	0.2499 kW/mV	3.46 W/cm^2

TEST METHOD

FAR/JAR PART 25, APPENDIX F, PART IV

TEST REQUIREMENTS (MAX. AVERAGE)

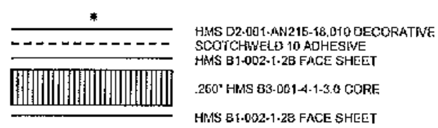
PEAK HEAT RELEASE RATE DURING 5.0 MINUTE PERIOD	65.0 kW/m^2
TOTAL HEAT RELEASE AFTER 2.0 MINUTES	65.0 kW • min./m^2

TEST RESULTS

Sample #	Peak (kW/m^2)	2 min Total (kW • min./m^2)	Time to Peak Value (s)
1	27.6	33.3	51
2	31.7	42.1	51
3	27.7	39.2	82
4	33.4	40.1	70
5	31.9	42.7	74
AVG	**30.5**	**39.5**	**66**

PASS ☒ FAIL ☐

SKETCH



*TEST THIS SURFACE FOR HEAT RELEASE

OBSERVATIONS

SAGGING	YES ☐ NO ☒	DELAMINATION	YES ☐ NO ☒
MELTING	YES ☐ NO ☒	OTHER BEHAVIOR	YES ☐ NO ☒

COMMENTS

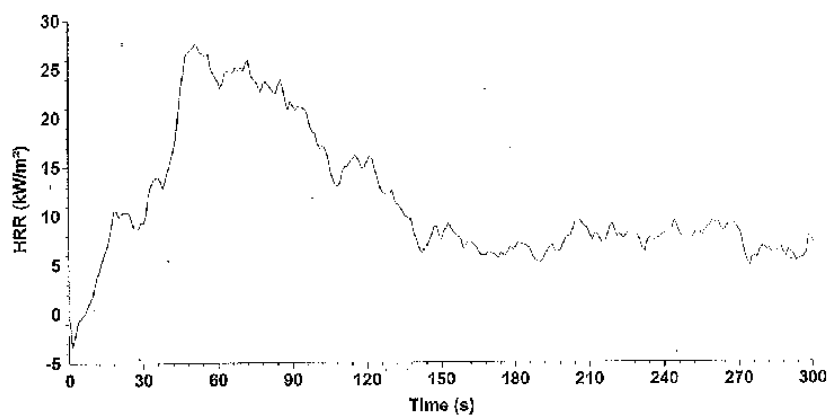
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description: M1022-001-1
Thickness (mm) : 6.5
Density (kg/m^3) : 1
Surface area (m^2) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100143.CSV

HRR Results

Specimen #	Peak HRR (kW/m^2)	Time to peak HRR (s)	2-min THR ($kW \cdot min/m^2$)
1	27.6	51	33.3

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

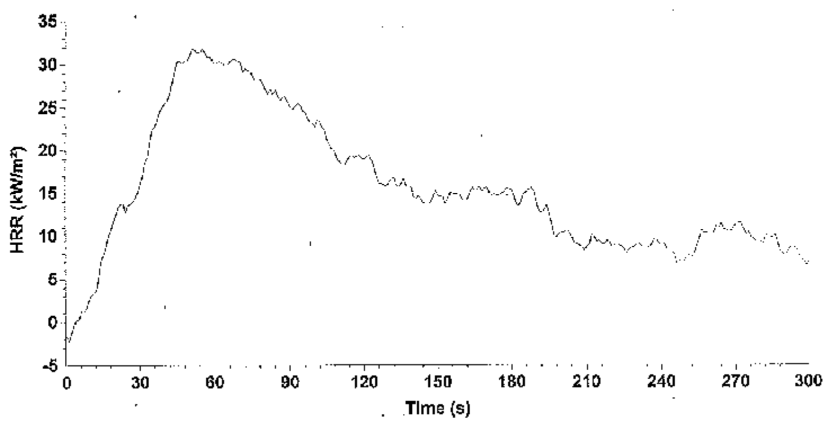
OSUCalc Test Report

Laboratory	: HEATH TECNA
Sample description	: M1022-001-2
Thickness (mm)	: 6.5
Density (kg/m³)	: 1
Surface area (m²)	: 0.02323
Number of tests	: 1 test performed on 18 October 2011
File name	: C:\OSUCALC\DATA\11100144.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	31.7	51	42.1

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

Report produced with the Fire Testing Technology OSUCalc software page 1

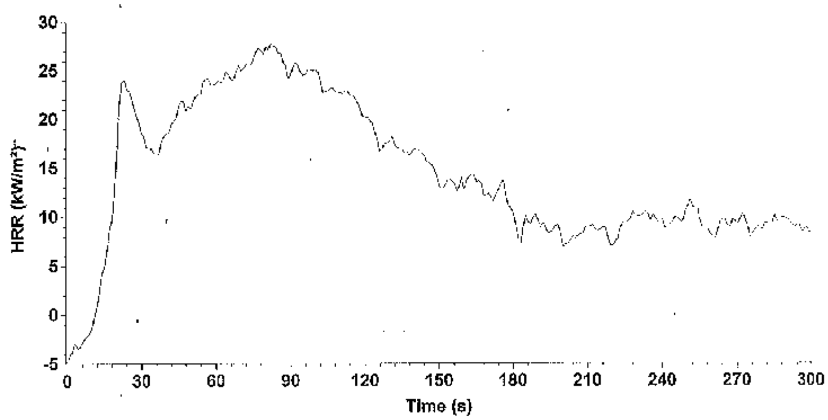
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description : M1022-001-3
Thickness (mm) : 6.5
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100145.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	27.7	82	39.2

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

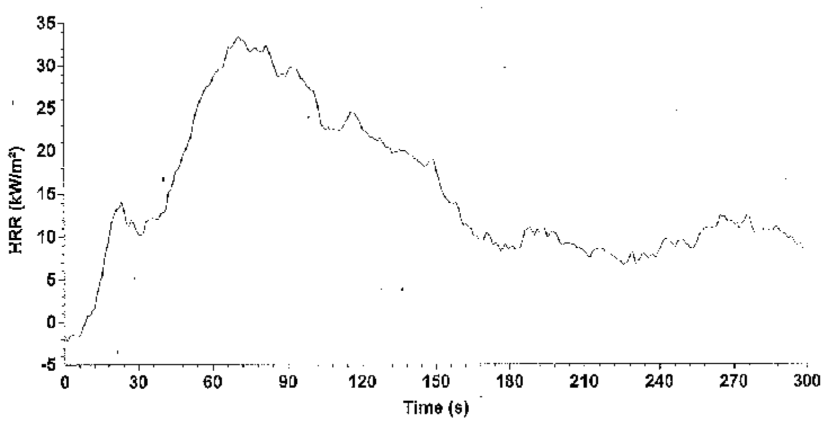
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description : M1022-001-4
Thickness (mm) : 6.5
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100146.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	33.4	70	40.1

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

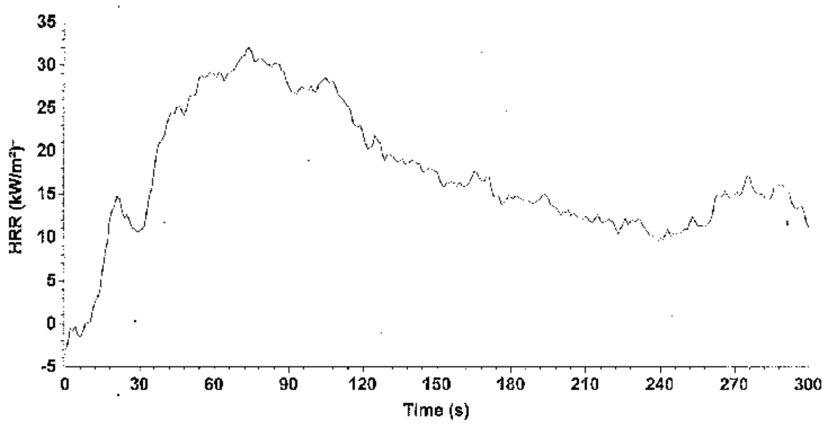
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description : M1022-001-5
Thickness (mm) : 6.5
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\I1100147.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	31.9	74	42.7

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

HEATHTECNA
AIRCRAFT INTERIOR SOLUTIONS

SMOKE DENSITY TEST DATA SHEET	**TEST PLAN #** MOC PART 2 ITEM 11	**TEST SPECIMEN ID #** M1022-001

MANUFACTURER:	**MATERIAL DESCRIPTION:**
HEATH TECNA	

TEST LOCATION:	**TEST DATE:**	**TESTED BY:**	**WITNESSED BY:**
HEATH TECNA, BELLINGHAM	10/20/11	R. Polly	

CONDITIONING:	**HEAT FLUX:**
MINIMUM 24 HRS AT 70° ± 5° F, 50% ± 5% RELATIVE HUMIDITY	2.49 W/cm^2

TEST METHOD

FAR/JAR PART 25, APPENDIX F, PART V

TEST REQUIREMENTS (MAX. AVERAGE)

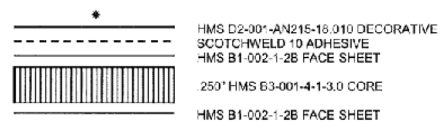
MAX Ds DURING 4.0 MINUTE PERIOD <200

TEST RESULTS

Sample #	Maximum Ds During 4.0 Minute Period
1	147
2	59
3	77
4	63
5	98
AVG	**89**

PASS ☒ FAIL ☐

SKETCH



*TEST THIS SURFACE FOR SMOKE DENSITY

COMMENTS

Report produced with the Fire Testing Technology SmokeBox software page 1

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 20 2011
Specimen description	: M1022-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100146.SBA
Test number in series	: 1
Thickness (mm)	: 6.5
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

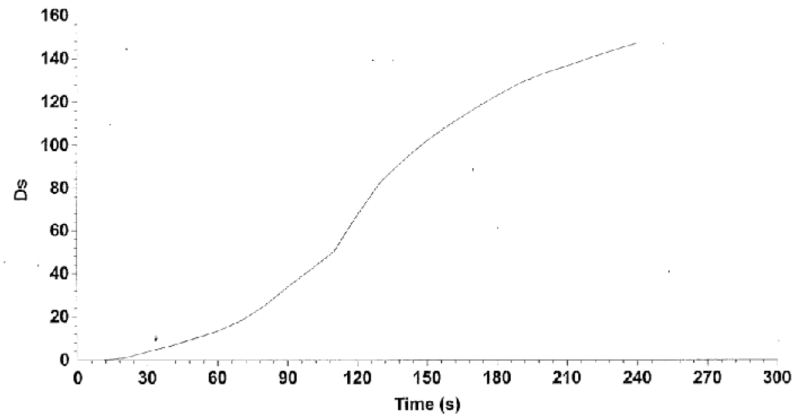
Maximum specific optical density	: 146.88
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 99.17
Corrected maximum specific optical density	: 146.4

Additional Parameters

Time to Ds=16.	: 1 minutes 05 seconds (65 s)
Smoke obscuration index	: 78.3

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100146.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	93.6	3.764
60	79.3	13.27
90	55.5	33.74
120	30.9	67.4
150	16.9	101.9
180	11.8	122.6
210	9.32	136.1
240	7.74	146.7

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 20 2011
Specimen description	: M1022-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100147.SBA
Test number in series	: 2
Thickness (mm)	: 6.5
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

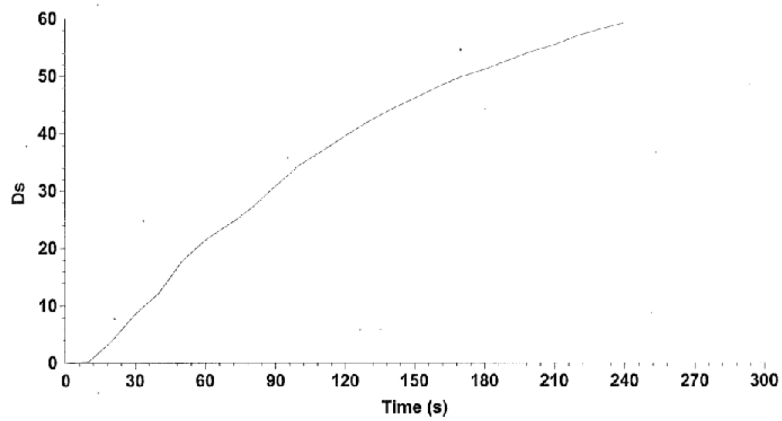
Maximum specific optical density	: 59.37
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 98.96
Corrected maximum specific optical density	: 58.77

Additional Parameters

Time to Ds=16	: 47 s
Smoke obscuration index	: 13.8

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100147.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	86.1	8.602
60	68.8	21.45
90	58.4	30.82
120	50.1	39.57
150	44.7	46.11
180	41	51.12
210	38.1	55.37
240	35.6	59.21

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 20 2011
Specimen description	: M1022-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100148.SBA
Test number in series	: 3
Thickness (mm)	: 6.5
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

Maximum specific optical density	: 76.59
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 99.27
Corrected maximum specific optical density	: 76.17

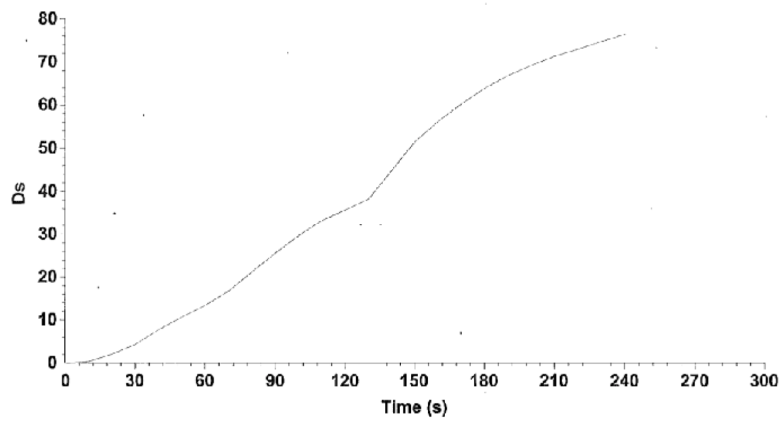
Additional Parameters

Time to Ds=16	: 1 minutes 09 seconds (69 s)
Smoke obscuration index	: 16.7

Comments:

Report produced with the Fire Testing Technology SmokeBox software page 3

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100148.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	92.8	4.269
60	79.2	13.35
90	64	25.62
120	53.6	35.7
150	40.8	51.44
180	32.9	63.79
210	28.8	71.26
240	26.4	76.38

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 20 2011
Specimen description	: M1022-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100149.SBA
Test number in series	: 2
Thickness (mm)	: 6.5
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

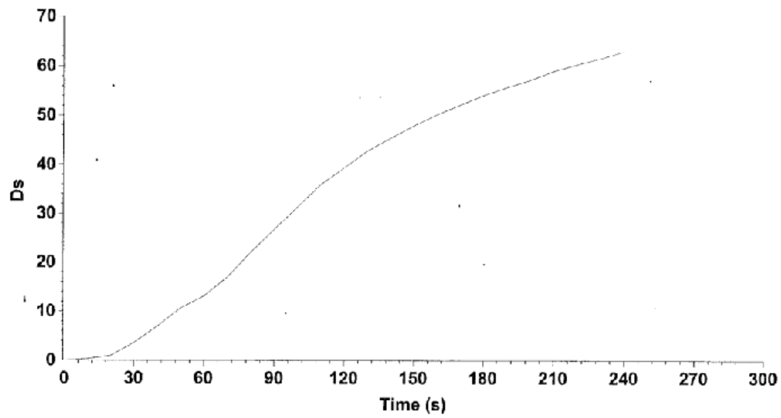
Maximum specific optical density	: 63.14
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 98.82
Corrected maximum specific optical density	: 62.46

Additional Parameters

Time to Ds=16	: 1 minutes 08 seconds (68 s)
Smoke obscuration index	: 11.8

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100149.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	94	3.57
60	79.6	13.05
90	62.8	26.64
120	50.4	39.31
150	43.4	47.86
180	38.9	54.07
210	35.7	58.98
240	33.4	62.93

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 20 2011
Specimen description	: M1022-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100150.SBA
Test number in series	: 5
Thickness (mm)	: 6.5
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

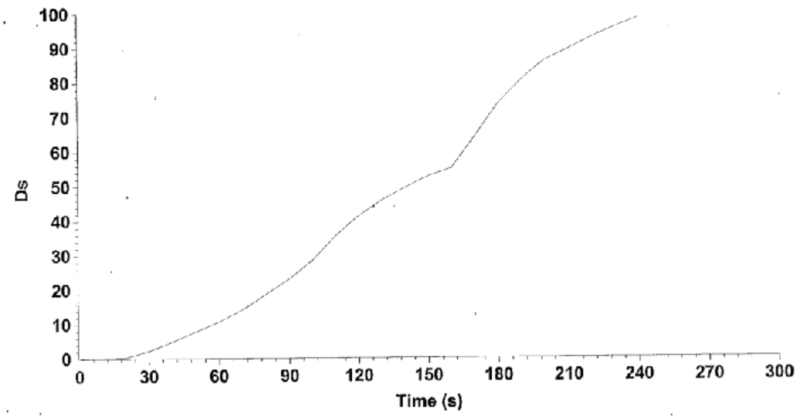
Maximum specific optical density	: 98.42
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 98.64
Corrected maximum specific optical density	: 97.63

Additional Parameters

Time to Ds=16	: 1 minutes 14 seconds (74 s)
Smoke obscuration index	: 25.6

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100150.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	96.1	2.252
60	83	10.71
90	66.8	23.12
120	48.6	41.39
150	39.9	52.7
180	27.7	73.5
210	21.1	89.23
240	18	98.26

BUNSEN BURNER TEST DATA SHEET	**TEST PLAN #** MOC PART 2 ITEM 11	**TEST SPECIMEN ID #** M1023-001

MANUFACTURER: HEATH TECNA	**MATERIAL DESCRIPTION:**

TEST LOCATION: HEATH TECNA, BELLINGHAM	**TEST DATE:** 10/20/11	**TESTED BY:** T. Rochon	**WITNESSED BY:**

CONDITIONING: MINIMUM 24 HRS AT 70° ± 5° F, 50% ± 5% RELATIVE HUMIDITY	**FLAME TEMP:** 1550° F

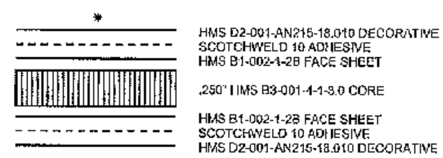
TEST METHOD			**TEST REQUIREMENTS (MAX. AVERAGE)**					
FAR/JAR PART 25, APPENDIX F, PART I								
	Test Code	Test Type	Burn Length	Flame Extinguish Time	Drip Extinguish Time	Burn Rate	Flame Penetration	After Glow
☒	F1	60 sec Ignition Vertical Test	6.0 Inches	15.0 Sec.	3.0 Sec.	-	-	-
☐	F2	12 sec Ignition Vertical Test	8.0 Inches	15.0 Sec.	5.0 Sec.	-	-	-
☐	F3	15 sec Ignition Horizontal Test 2.5 inch/min	-	-	-	2.5 In./Min.	-	-
☐	F4	15 sec Ignition Horizontal Test 4 inch/min	-	-	-	4.0 In./Min.	-	-
☐	F5	30 sec Ignition – 45 Degree	-	15.0 Sec.	-	-	NONE	10.0 Sec.
☐	F6	30 sec Ignition – 60 Degree	3.0 Inches	30.0 Sec.	3.0 Sec.	-	-	-

TEST RESULTS

Sample #	Burn Length	Flame Exting	Drip Exting	Burn Rate	Flame Penetration	After Glow	Test Direction
1	3.0	0.0	N.D.				
2	2.5	0.0	N.D.				
3	2.9	0.0	N.D.				
AVG.	2.8	0.0	0				

PASS ☒	FAIL ☐

SKETCH



*TEST SIDE

COMMENTS

HEATHTECNA
AIRCRAFT INTERIOR SOLUTIONS

HEAT RELEASE TEST DATA SHEET	TEST PLAN # MOC PART 2 ITEM 11	TEST SPECIMEN ID # M1023-001

MANUFACTURER: HEATH TECNA	MATERIAL DESCRIPTION:

TEST LOCATION: HEATH TECNA, BELLINGHAM	TEST DATE: 10/18/11	TESTED BY: T. Rochon	WITNESSED BY:

CONDITIONING: MINIMUM 24 HRS AT 70° ± 5° F, 50% ± 5% RELATIVE HUMIDITY	CALIBRATION FACTOR: 0.2499 kW/mV	HEAT FLUX: 3.46 W/cm²

TEST METHOD

FAR/JAR PART 25, APPENDIX F, PART IV

TEST REQUIREMENTS (MAX. AVERAGE)

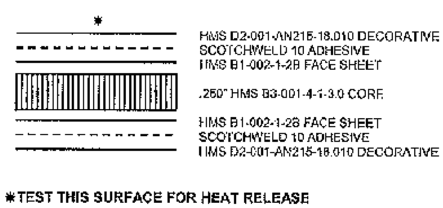
PEAK HEAT RELEASE RATE DURING 5.0 MINUTE PERIOD	65.0 kW/m²
TOTAL HEAT RELEASE AFTER 2.0 MINUTES	65.0 kW • min./m²

TEST RESULTS

Sample #	Peak (kW/m²)	2 min Total (kW • min./m²)	Time to Peak Value (s)
1	29.6	34.7	46
2	32.3	38.9	69
3	32.0	38.1	65
4	31.8	38.8	48
5	31.0	38.2	66
AVG	31.3	37.7	59

PASS ☒ FAIL ☐

SKETCH



OBSERVATIONS

SAGGING	YES ☐ NO ☒	DELAMINATION	YES ☐ NO ☒
MELTING	YES ☐ NO ☒	OTHER BEHAVIOR	YES ☐ NO ☒

COMMENTS

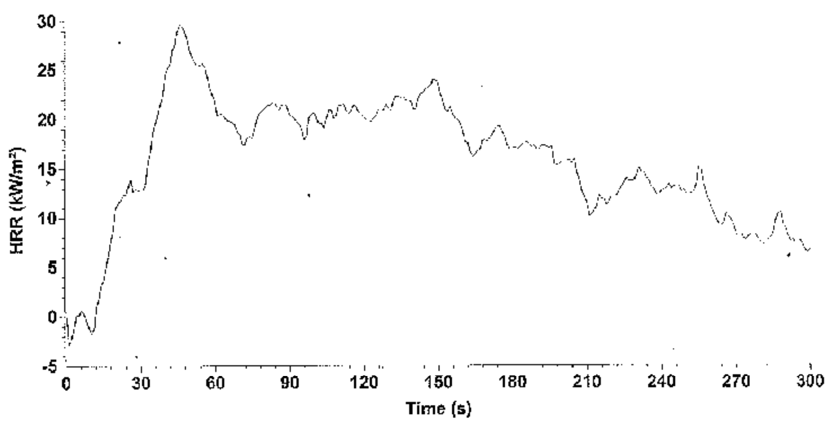
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description : M1023-001-1
Thickness (mm) : 7.2
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100148.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	29.6	46	34.7

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

Report produced with the Fire Testing Technology OSUCalc software page 1

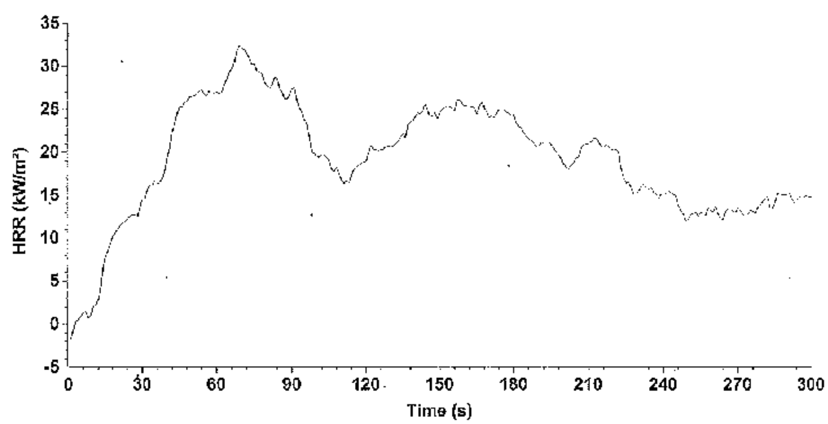
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description : M1023-001-2
Thickness (mm) : 7.2
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100149.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	32.3	69	38.9

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

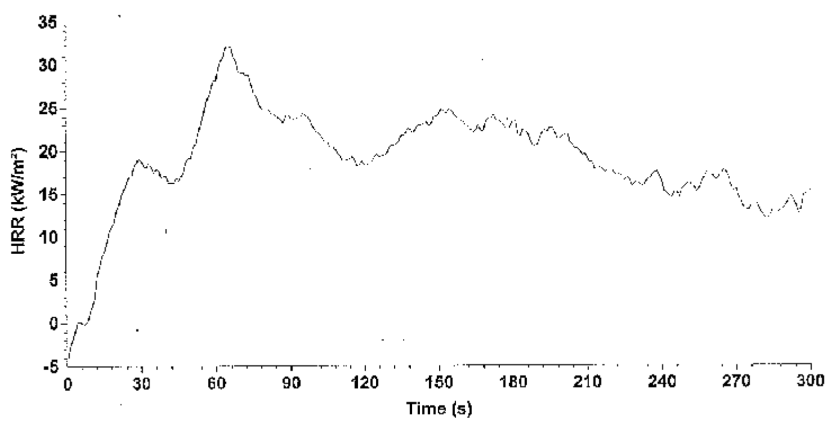
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description : M1023-001-3
Thickness (mm) : 7.2
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100150.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	32.0	65	38.1

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

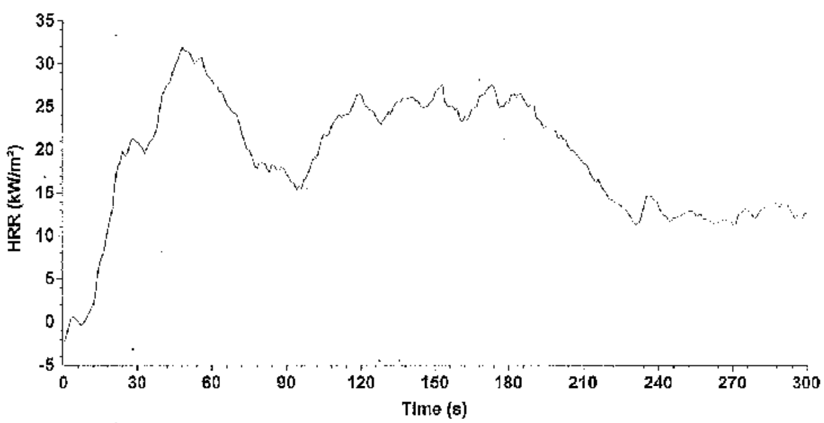
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description : M1023-001-4
Thickness (mm) : 7.2
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100151.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	31.8	48	38.8

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

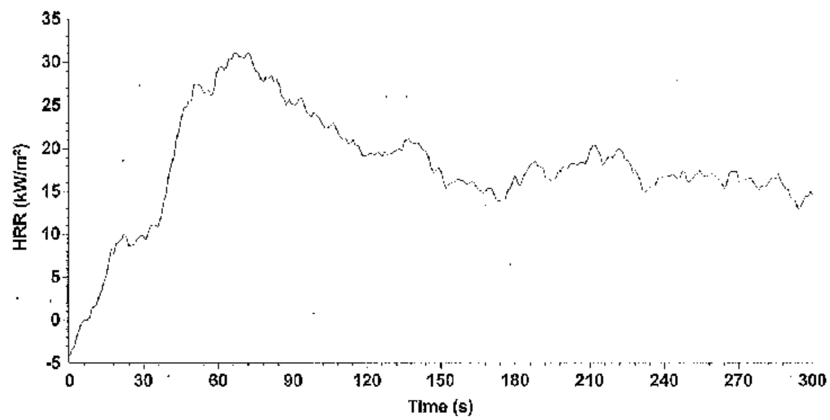
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description : M1023-001-5
Thickness (mm) : 7.2
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100152.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	31.0	66	38.2

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

HEATHTECNA
AIRCRAFT INTERIOR SOLUTIONS

SMOKE DENSITY TEST DATA SHEET

TEST PLAN #	MOC PART 2 ITEM 11
TEST SPECIMEN ID #	M1023-001
MANUFACTURER:	HEATH TECNA
MATERIAL DESCRIPTION:	
TEST LOCATION:	HEATH TECNA, BELLINGHAM
TEST DATE:	10/21/11
TESTED BY:	R. Polly
WITNESSED BY:	
CONDITIONING:	MINIMUM 24 HRS AT 70° ± 5° F, 50% ± 5% RELATIVE HUMIDITY
HEAT FLUX:	2.48 W/cm^2

TEST METHOD

FAR/JAR PART 25, APPENDIX F, PART V

TEST REQUIREMENTS (MAX. AVERAGE)

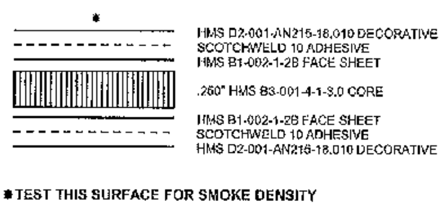
MAX Ds DURING 4.0 MINUTE PERIOD <200

TEST RESULTS

Sample #	Maximum Ds During 4.0 Minute Period
1	66
2	56
3	69
4	84
5	92
AVG	73

PASS ☒   FAIL ☐

SKETCH



COMMENTS

Smoke Density Chamber Single Specimen Report

Standard : ASTM E 662
Laboratory : Heath Tecna Inc.
Date of test : Oct. 20 2011

Specimen description : M1023-001
Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100151.SBA
Test number in series : 1

Thickness (mm) : 7.3
Initial mass (g) : Not Recorded
Final mass (g) : Not Recorded
Mass in drip tray (g) : Not Recorded
Mass loss (g) :
Mass loss (%) :

Test mode : Flaming
Test duration : 4 minutes (240 s)
Conditioned? : Yes
Conditioning temp. (°C) : 23
Conditioning RH (%) : 50

Test Results

Maximum specific optical density : 66.11
Time to maximum specific optical density : 4 minutes 01 seconds (241 s)
Clear beam transmission (%) : 98.13
Corrected maximum specific optical density : 65.03

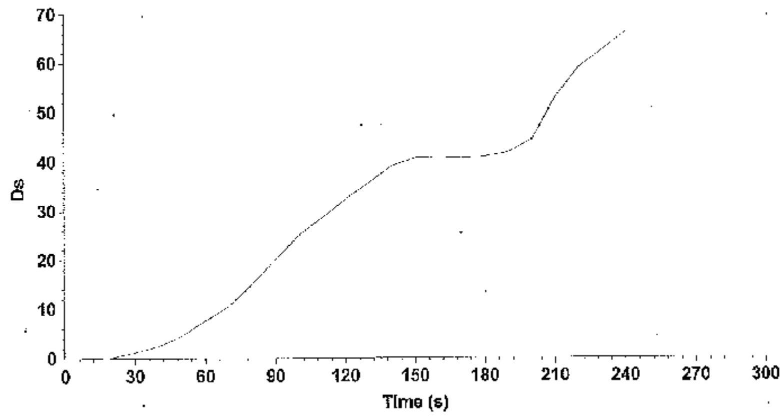
Additional Parameters

Time to Ds=16 : 1 minutes 22 seconds (82 s)
Smoke obscuration index : 12.1

Comments:

Report produced with the Fire Testing Technology SmokeBox software page 3

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100151.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	97.9	1.226
60	87.6	7.599
90	70.6	19.96
120	56.9	32.35
150	49.2	40.67
180	49	40.89
210	39.8	52.78
240	31.6	66.07

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 20 2011
Specimen description	: M1023-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100152.SBA
Test number in series	: 2
Thickness (mm)	: 7.3
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

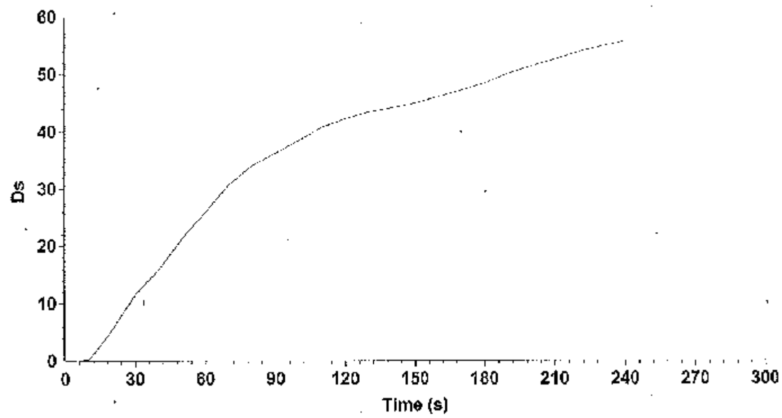
Maximum specific optical density	: 55.68
Time to maximum specific optical density	: 3 minutes 59 seconds (239 s)
Clear beam transmission (%)	: 98.08
Corrected maximum specific optical density	: 54.57

Additional Parameters

Time to Ds=16	: 40 s
Smoke obscuration index	: 18.2

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100152.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	81.7	11.61
60	63.6	25.95
90	53.2	36.2
120	47.9	42.2
150	45.7	44.85
180	43	48.36
210	40.1	52.43
240	37.9	55.59

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 20 2011
Specimen description	: M1023-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100153.SBA
Test number in series	: 3
Thickness (mm)	: 7.3
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

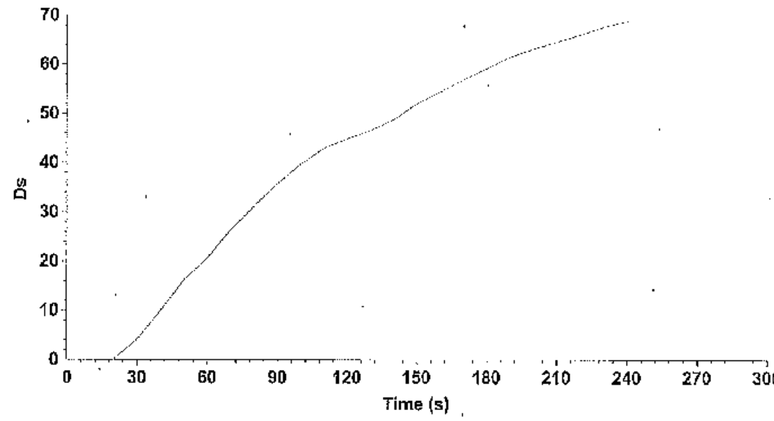
Maximum specific optical density	: 69.16
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 97.87
Corrected maximum specific optical density	: 67.92

Additional Parameters

Time to Ds=16	: 50 s
Smoke obscuration index	: 19.9

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100153.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	93	4.146
60	69.7	20.72
90	53.6	35.78
120	45.7	44.84
150	40.4	51.99
180	35.6	59.21
210	32.4	64.6
240	30.1	68.81

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1023-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100154.SBA
Test number in series	: 4
Thickness (mm)	: 7.3
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

Maximum specific optical density	: 83.66
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 99.03
Corrected maximum specific optical density	: 83.1

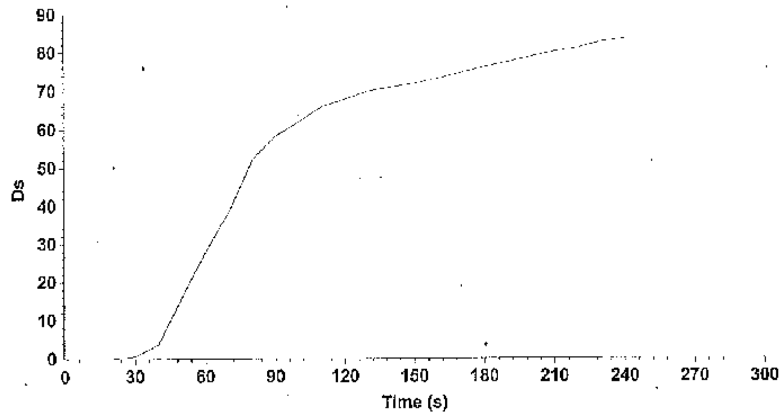
Additional Parameters

Time to Ds=16	: 50 s
Smoke obscuration index	: 51

Comments:

Report produced with the Fire Testing Technology SmokeBox software page 3

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100154.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	99	0.6019
60	61.4	28
90	36.2	58.22
120	30.7	67.69
150	28.6	71.81
180	26.6	75.98
210	24.8	79.99
240	23.4	83.35

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1023-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100155.SBA
Test number in series	: 5
Thickness (mm)	: 7.3
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

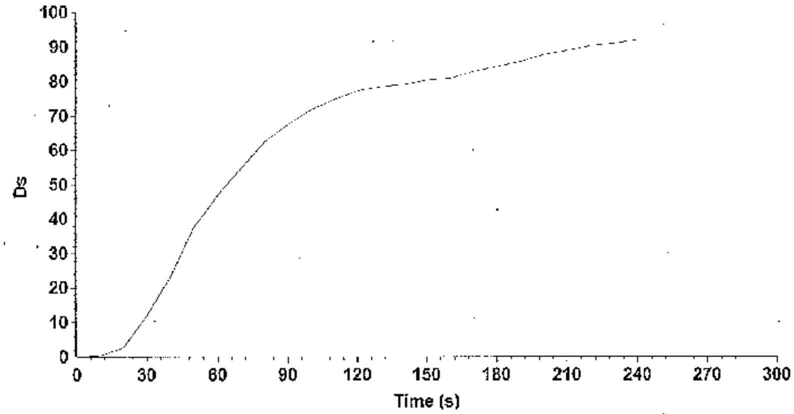
Maximum specific optical density	: 91.93
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 99.01
Corrected maximum specific optical density	: 91.36

Additional Parameters

Time to Ds=16	: 35 s
Smoke obscuration index	: 77

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100155.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	81.2	11.9
60	44.1	46.95
90	30.8	67.52
120	26	77.25
150	24.6	80.31
180	23	84.15
210	21.3	88.79
240	20.2	91.83

BUNSEN BURNER TEST DATA SHEET	**TEST PLAN #** MOC PART 2 ITEM 11	**TEST SPECIMEN ID #** M1023-003

MANUFACTURER:	**MATERIAL DESCRIPTION:**
HEATH TECNA	

TEST LOCATION:	**TEST DATE:**	**TESTED BY:**	**WITNESSED BY:**
HEATH TECNA, BELLINGHAM	10/20/11	T. Rochon	

CONDITIONING:	**FLAME TEMP:**
MINIMUM 24 HRS AT 70° ± 5° F, 50% ± 5% RELATIVE HUMIDITY	1550° F

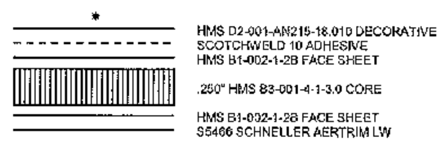
TEST METHOD			**TEST REQUIREMENTS (MAX. AVERAGE)**					
FAR/JAR PART 25, APPENDIX F, PART I								
	Test Code	Test Type	Burn Length	Flame Extinguish Time	Drip Extinguish Time	Burn Rate	Flame Penetration	After Glow
☒	F1	60 sec Ignition Vertical Test	6.0 Inches	15.0 Sec.	3.0 Sec.	-	-	-
☐	F2	12 sec Ignition Vertical Test	8.0 Inches	15.0 Sec	5.0 Sec.	-	-	-
☐	F3	15 sec Ignition Horizontal Test 2.5 inch/min	-	-	-	2.5 In./Min.	-	-
☐	F4	15 sec Ignition Horizontal Test 4 inch/min	-	-	-	4.0 In./Min.	-	-
☐	F5	30 sec Ignition – 45 Degree	-	15.0 Sec.	-	-	NONE	10.0 Sec.
☐	F6	30 sec Ignition – 60 Degree	3.0 Inches	30.0 Sec.	3.0 Sec.	-	-	-

TEST RESULTS

Sample #	Burn Length	Flame Exting	Drip Exting	Burn Rate	Flame Pene-tration	After Glow	Test Direction
1	3.0	0.0	N.D.				
2	2.7	0.0	N.D.				
3	2.6	0.0	N.D.				
AVG.	2.8	0.0	0				

PASS ☒ FAIL ☐

SKETCH



*TEST SIDE

COMMENTS

FAA Memorandum
ANM-115-09-XXX, "Policy Statement on Flammability Testing of Interior Materials"
Part 2, Reference Item #11, "**Backside Decorative**"

HEATHTECNA
AIRCRAFT INTERIOR SOLUTIONS

HEAT RELEASE TEST DATA SHEET	TEST PLAN #: MOC PART 2 ITEM 11	TEST SPECIMEN ID #: M1023-003

MANUFACTURER:	MATERIAL DESCRIPTION:
HEATH TECNA	

TEST LOCATION:	TEST DATE:	TESTED BY:	WITNESSED BY:
HEATH TECNA, BELLINGHAM	10/18/11	T. Rochon	

CONDITIONING:	CALIBRATION FACTOR:	HEAT FLUX:
MINIMUM 24 HRS AT 70° ± 5° F, 50% ± 5% RELATIVE HUMIDITY	0.2499 kW/mV	3.46 W/cm²

TEST METHOD

FAR/JAR PART 25, APPENDIX F, PART IV

TEST REQUIREMENTS (MAX. AVERAGE)

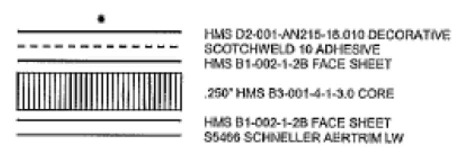
PEAK HEAT RELEASE RATE DURING 5.0 MINUTE PERIOD	65.0 kW/m²
TOTAL HEAT RELEASE AFTER 2.0 MINUTES	65.0 kW • min./m²

TEST RESULTS

Sample #	Peak (kW/m²)	2 min Total (kW • min./m²)	Time to Peak Value (s)
1	28.3	29.1	20
2	28.7	29.8	124
3	33.4	36.5	63
4	33.1	37.3	112
5	23.3	26.3	51
AVG	29.4	**31.8**	74

PASS ☒ FAIL ☐

SKETCH



*TEST THIS SURFACE FOR HEAT RELEASE

OBSERVATIONS

SAGGING	YES ☐ NO ☒	DELAMINATION	YES ☐ NO ☒
MELTING	YES ☐ NO ☒	OTHER BEHAVIOR	YES ☐ NO ☒

COMMENTS

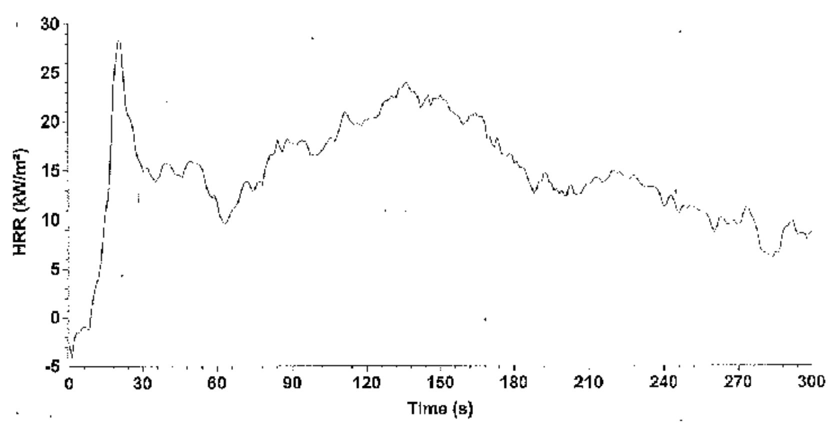
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description: M1023-003-1
Thickness (mm) : 6.8
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100133.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	28.3	20	29.1

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

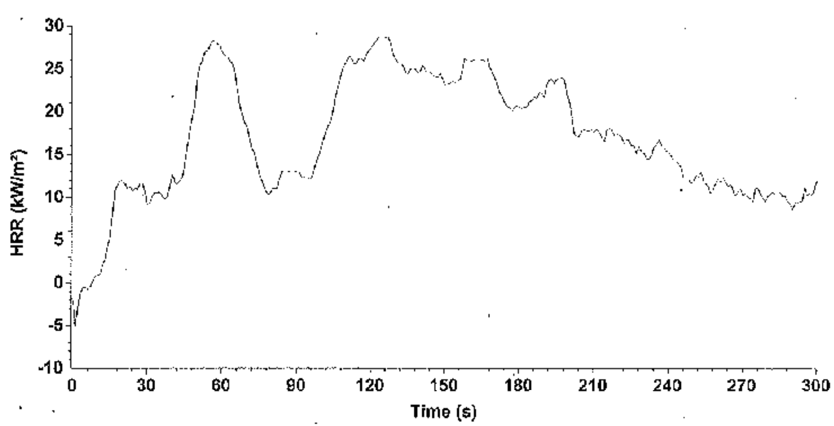
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description: M1023-003-2
Thickness (mm) : 6.8
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100134.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	28.7	124	29.8

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

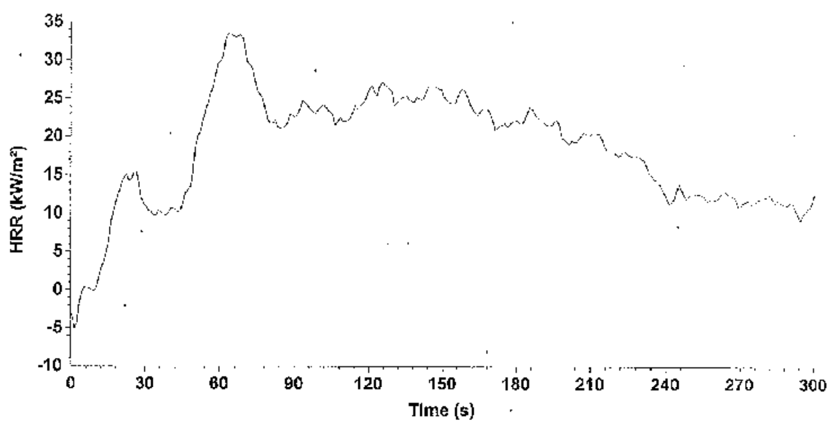
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description : M1023-003-3
Thickness (mm) : 6.8
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100135.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	33.4	63	36.5

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

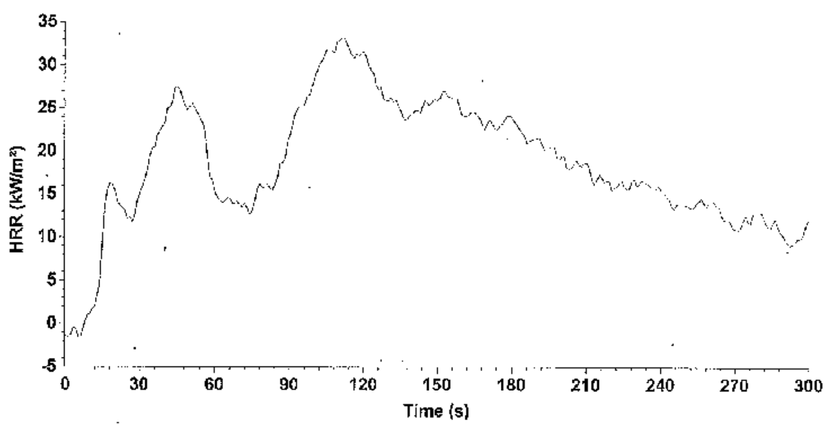
OSUCalc Test Report

Laboratory	: HEATH TECNA
Sample description	: M1023-003-4
Thickness (mm)	: 6.8
Density (kg/m³)	: 1
Surface area (m²)	: 0.02323
Number of tests	: 1 test performed on 18 October 2011
File name	: C:\OSUCALC\DATA\11100136.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	33.1	112	37.3

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

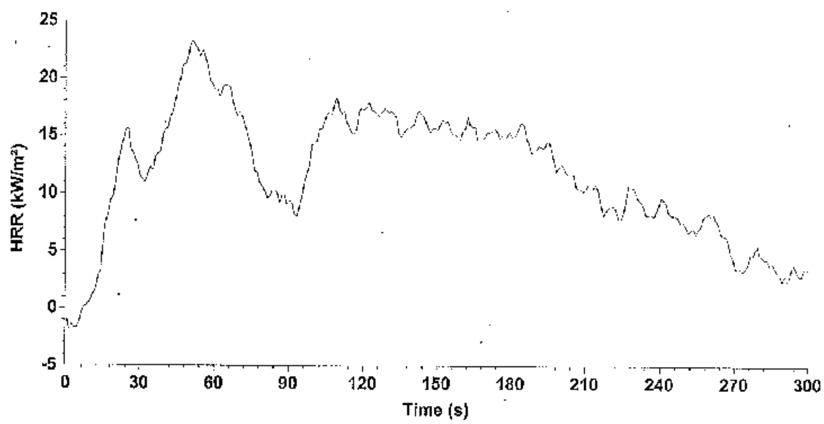
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description : M1023-003-5
Thickness (mm) : 6.8
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100137.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	23.3	51	26.3

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

HEATHTECNA
AIRCRAFT INTERIOR SOLUTIONS

SMOKE DENSITY TEST DATA SHEET	TEST PLAN # MOC PART 2 ITEM 11	TEST SPECIMEN ID # M1023-003

MANUFACTURER:	MATERIAL DESCRIPTION:
HEATH TECNA	

TEST LOCATION:	TEST DATE:	TESTED BY:	WITNESSED BY:
HEATH TECNA, BELLINGHAM	10/21/11	R. Polly	

CONDITIONING:	HEAT FLUX:
MINIMUM 24 HRS AT 70° ± 5° F, 50% ± 5% RELATIVE HUMIDITY	2.48 W/cm^2

TEST METHOD

FAR/JAR PART 25, APPENDIX F, PART V

TEST REQUIREMENTS (MAX. AVERAGE)

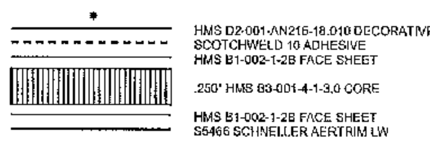
MAX Ds DURING 4.0 MINUTE PERIOD <200

TEST RESULTS

Sample #	Maximum Ds During 4.0 Minute Period
1	81
2	75
3	75
4	91
5	71
AVG	79

PASS ☒	FAIL ☐

SKETCH



*TEST THIS SURFACE FOR SMOKE DENSITY

COMMENTS

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1023-003
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100156.SBA
Test number in series	: 1
Thickness (mm)	: 7.2
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

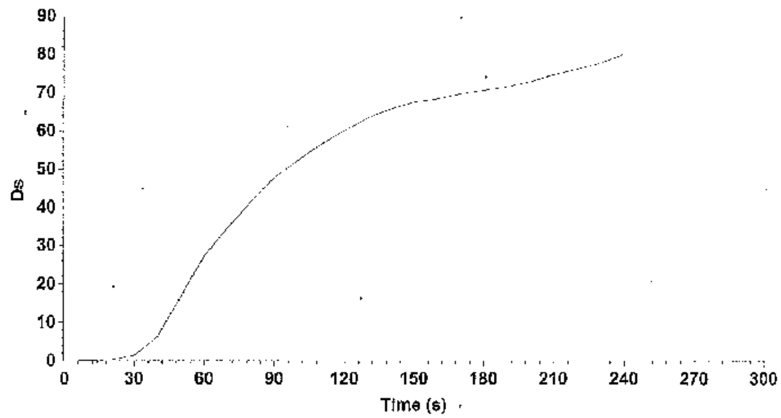
Maximum specific optical density	: 80.58
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 98.56
Corrected maximum specific optical density	: 79.75

Additional Parameters

Time to Ds=16	: 49 s
Smoke obscuration index	: 39.4

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100156.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	97.6	1.391
60	61.9	27.46
90	43.4	47.9
120	35.1	60.1
150	30.8	67.49
180	29.2	70.59
210	27.1	74.77
240	24.7	80.24

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1023-003
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100157.SBA
Test number in series	: 2
Thickness (mm)	: 7.2
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

Maximum specific optical density	: 74.95
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 98.35
Corrected maximum specific optical density	: 74

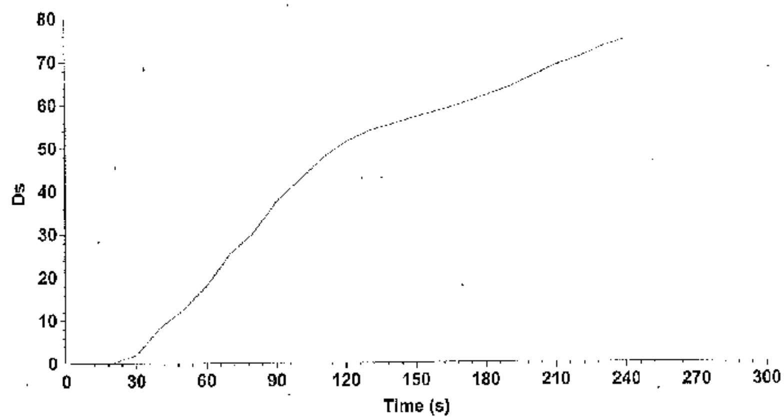
Additional Parameters

Time to Ds=16	: 56 s
Smoke obscuration index	: 21.7

Comments:

Report produced with the Fire Testing Technology SmokeBox software page 3

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100157.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	96.7	1.923
60	73.2	17.92
90	52	37.45
120	41	51.16
150	37	56.97
180	34	61.81
210	30.1	68.82
240	27.1	74.79

Report produced with the Fire Testing Technology SmokeBox software page 1

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1023-003
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100158.SBA
Test number in series	: 3
Thickness (mm)	: 7.2
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

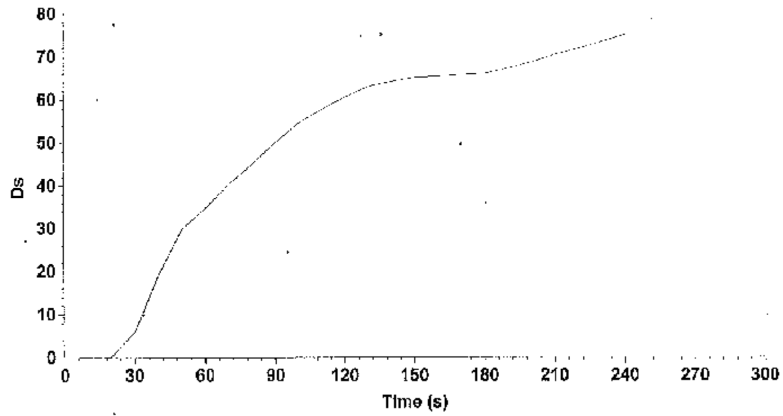
Maximum specific optical density	: 74.98
Time to maximum specific optical density	: 4 minutes (240 s)
Clear beam transmission (%)	: 96.86
Corrected maximum specific optical density	: 73.15

Additional Parameters

Time to Ds=16	: 38 s
Smoke obscuration index	: 47.7

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100158.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	90.2	5.928
60	54.5	34.76
90	41.8	50.01
120	34.8	60.49
150	32.2	65.02
180	31.6	65.95
210	29.3	70.29
240	27	74.98

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1023-003
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100159.SBA
Test number in series	: 4
Thickness (mm)	: 7.2
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

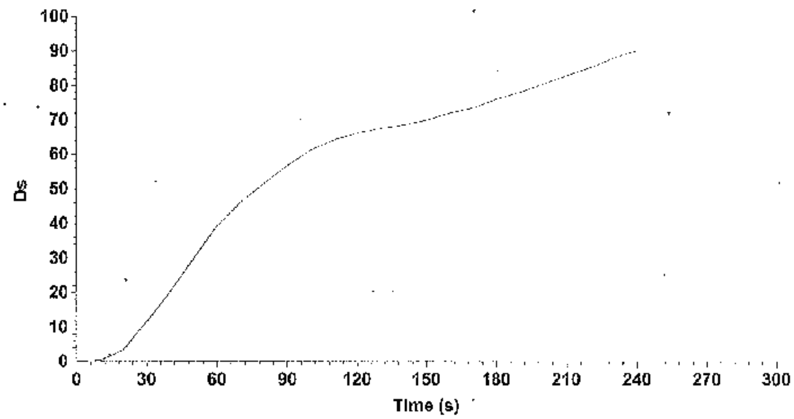
Maximum specific optical density	: 90.93
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 98.82
Corrected maximum specific optical density	: 90.26

Additional Parameters

Time to Ds=16	: 35 s
Smoke obscuration index	: 55.9

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100159.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	81.5	11.7
60	50.1	39.61
90	37.1	56.86
120	31.5	66.27
150	29.5	70.04
180	26.5	76.17
210	23.5	83.05
240	20.7	90.33

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1023-003
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100160.SBA
Test number in series	: 5
Thickness (mm)	: 7.2
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

Maximum specific optical density	: 71.11
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 99.76
Corrected maximum specific optical density	: 70.97

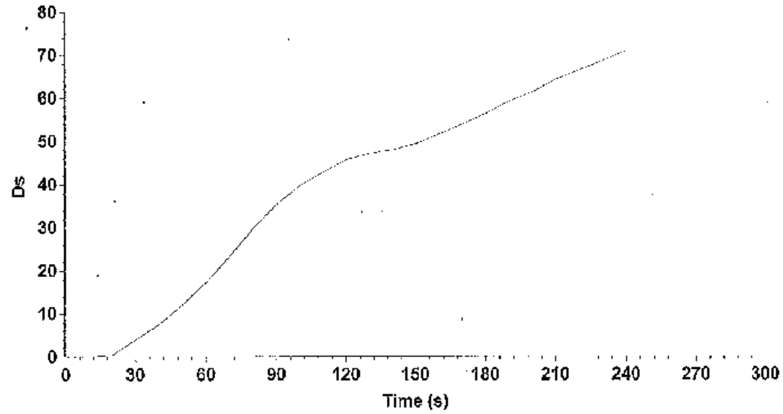
Additional Parameters

Time to Ds=16	: 58 s
Smoke obscuration index	: 17.6

Comments:

Report produced with the Fire Testing Technology SmokeBox software page 3

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100160.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	93.4	3.894
60	73.9	17.37
90	53.9	35.47
120	45.1	45.65
150	42.3	49.29
180	37.5	56.23
210	32.6	64.19
240	29.1	70.82

FAA Memorandum
ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”
Part 2, Reference Item #11, “**Backside Decorative**”

BUNSEN BURNER TEST DATA SHEET	**TEST PLAN #** MOC PART 2 ITEM 11	**TEST SPECIMEN ID #** M1024-001

MANUFACTURER:	**MATERIAL DESCRIPTION:**
HEATH TECNA	

TEST LOCATION:	**TEST DATE:**	**TESTED BY:**	**WITNESSED BY:**
HEATH TECNA, BELLINGHAM	10/20/11	T. Rochon	

CONDITIONING:	**FLAME TEMP:**
MINIMUM 24 HRS AT 70° ± 5° F, 50% ± 5% RELATIVE HUMIDITY	1550° F

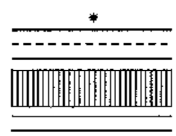
TEST METHOD			**TEST REQUIREMENTS (MAX. AVERAGE)**					
FAR/JAR PART 25, APPENDIX F, PART I								
	Test Code	Test Type	Burn Length	Flame Extinguish Time	Drip Extinguish Time	Burn Rate	Flame Penetration	After Glow
☒	F1	60 sec Ignition Vertical Test	6.0 Inches	15.0 Sec.	3.0 Sec.	-	-	-
☐	F2	12 sec Ignition Vertical Test	8.0 Inches	15.0 Sec.	5.0 Sec.	-	-	-
☐	F3	15 sec Ignition Horizontal Test 2.5 Inch/min	-	-	-	2.5 In./Min.	-	-
☐	F4	15 sec Ignition Horizontal Test 4 Inch/min	-	-	-	4.0 In./Min.	-	-
☐	F5	30 sec Ignition – 45 Degree	-	15.0 Sec.	-	-	NONE	10.0 Sec.
☐	F6	30 sec Ignition – 60 Degree	3.0 Inches	30.0 Sec.	3.0 Sec.	-	-	-

TEST RESULTS

Sample #	Burn Length	Flame Exting	Drip Exting	Burn Rate	Flame Pene-tration	After Glow	Test Direction
1	2.4	0.0	N.D.				
2	2.9	0.0	N.D.				
3	2.2	0.0	N.D.				
AVG.	2.5	0.0	0				

PASS ☒ FAIL ☐

SKETCH



*TEST SIDE

COMMENTS

HEATHTECNA
AIRCRAFT INTERIOR SOLUTIONS

HEAT RELEASE TEST DATA SHEET	TEST PLAN # MOC PART 2 ITEM 11	TEST SPECIMEN ID # M1024-001

MANUFACTURER: HEATH TECNA	MATERIAL DESCRIPTION:

TEST LOCATION: HEATH TECNA, BELLINGHAM	TEST DATE: 10/18/11	TESTED BY: T. Rochon	WITNESSED BY:

CONDITIONING: MINIMUM 24 HRS AT 70° ± 5° F, 50% ± 5% RELATIVE HUMIDITY	CALIBRATION FACTOR: 0.2499 kW/mV	HEAT FLUX: 3.46 W/cm^2

TEST METHOD

FAR/JAR PART 25, APPENDIX F, PART IV

TEST REQUIREMENTS (MAX. AVERAGE)

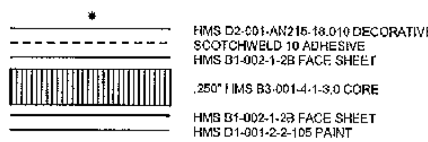
PEAK HEAT RELEASE RATE DURING 5.0 MINUTE PERIOD	65.0 kW/m^2
TOTAL HEAT RELEASE AFTER 2.0 MINUTES	65.0 kW • min./m^2

TEST RESULTS

Sample #	Peak (kW/m^2)	2 min Total (kW • min./m^2)	Time to Peak Value (s)
1	37.4	45.2	76
2	38.6	46.3	67
3	34.6	42.8	75
4	40.7	52.5	75
5	36.2	45.6	60
AVG	**37.5**	**46.5**	**71**

PASS ☒ FAIL ☐

SKETCH



*TEST THIS SURFACE FOR HEAT RELEASE

OBSERVATIONS

SAGGING	YES ☐ NO ☒	DELAMINATION	YES ☐ NO ☒
MELTING	YES ☐ NO ☒	OTHER BEHAVIOR	YES ☐ NO ☒

COMMENTS

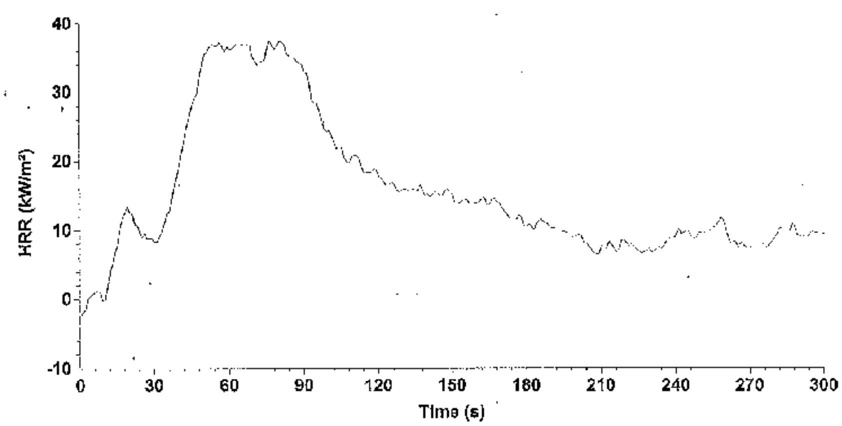
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description : M1024-001-1
Thickness (mm) : 6.5
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100138.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	37.4	76	45.2

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

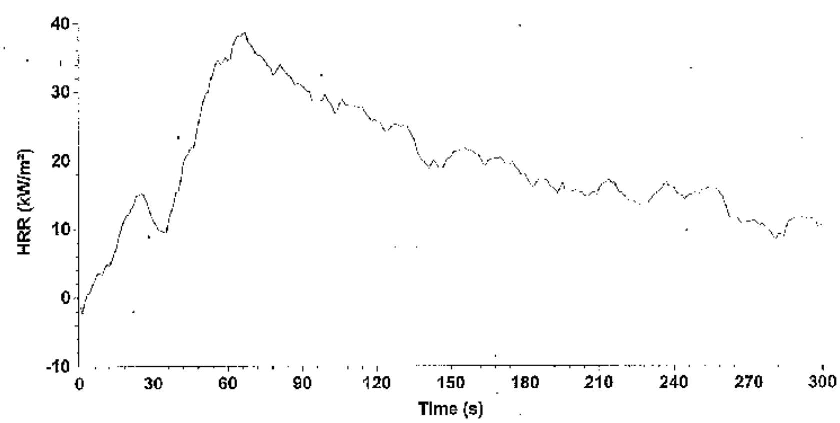
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description: M1024-001-2
Thickness (mm) : 6.5
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100139.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	38.6	67	46.3

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

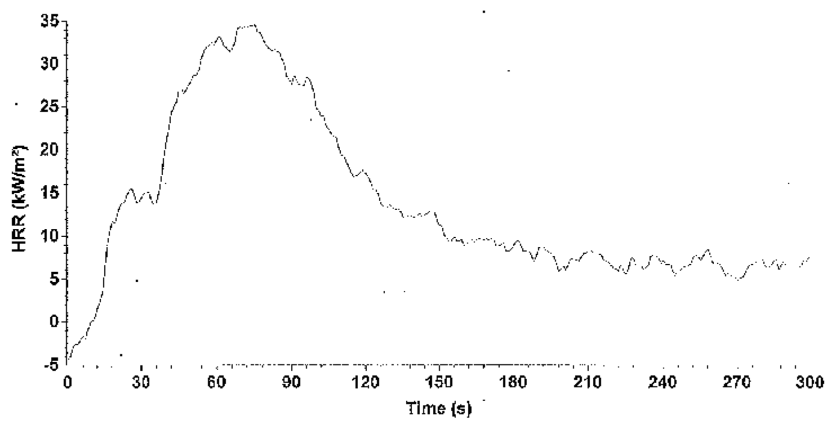
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description: M1024-001-3
Thickness (mm) : 6.5
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100140.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	34.6	75	42.8

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

Report produced with the Fire Testing Technology OSUCalc software page 1

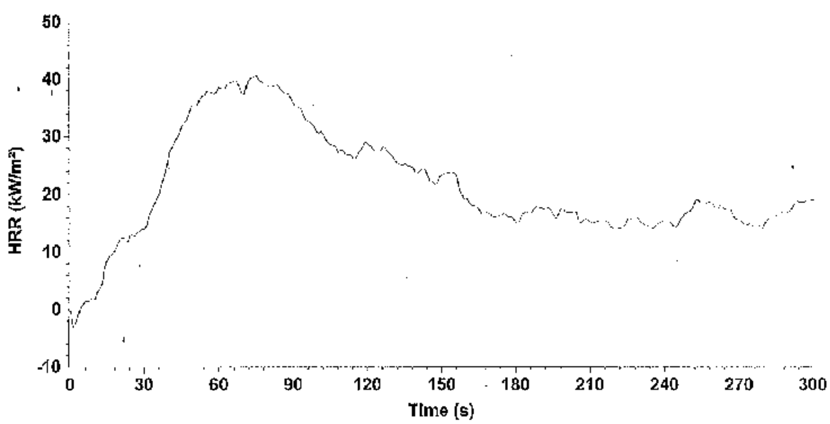
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description: M1024-001-4
Thickness (mm) : 6.5
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100141.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	40.7	75	52.5

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

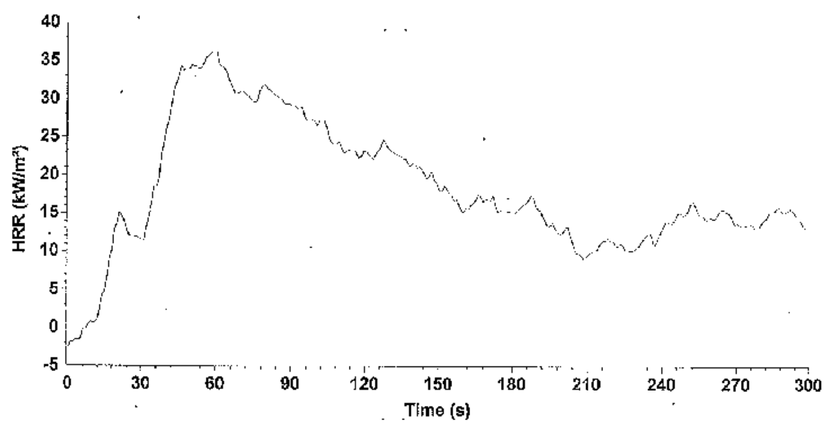
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description : M1024-001-5
Thickness (mm) : 6.5
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100142.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	36.2	60	45.6

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

HEATHTECNA
AIRCRAFT INTERIOR SOLUTIONS

SMOKE DENSITY TEST DATA SHEET	TEST PLAN # MOC PART 2 ITEM 11	TEST SPECIMEN ID # M1024-001

MANUFACTURER: HEATH TECNA	MATERIAL DESCRIPTION:

TEST LOCATION: HEATH TECNA, BELLINGHAM	TEST DATE: 10/21/11	TESTED BY: R. Polly	WITNESSED BY:

CONDITIONING: MINIMUM 24 HRS AT 70° ± 5° F, 50% ± 5% RELATIVE HUMIDITY	HEAT FLUX: 2.48 W/cm^2

TEST METHOD

FAR/JAR PART 25, APPENDIX F, PART V

TEST REQUIREMENTS (MAX. AVERAGE)

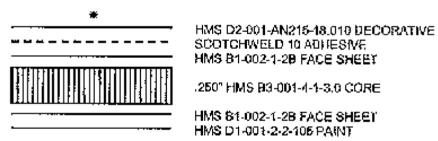
MAX Ds DURING 4.0 MINUTE PERIOD <200

TEST RESULTS

Sample #	Maximum Ds During 4.0 Minute Period
1	78
2	123
3	113
4	84
5	125
AVG	105

PASS ☒ FAIL ☐

SKETCH



*TEST THIS SURFACE FOR SMOKE DENSITY

COMMENTS

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1024-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100161.SBA
Test number in series	: 1
Thickness (mm)	: 6.5
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes 10 seconds (250 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

Maximum specific optical density	: 78.28
Time to maximum specific optical density	: 4 minutes 12 seconds (252 s)
Clear beam transmission (%)	: 98.05
Corrected maximum specific optical density	: 77.15

Additional Parameters

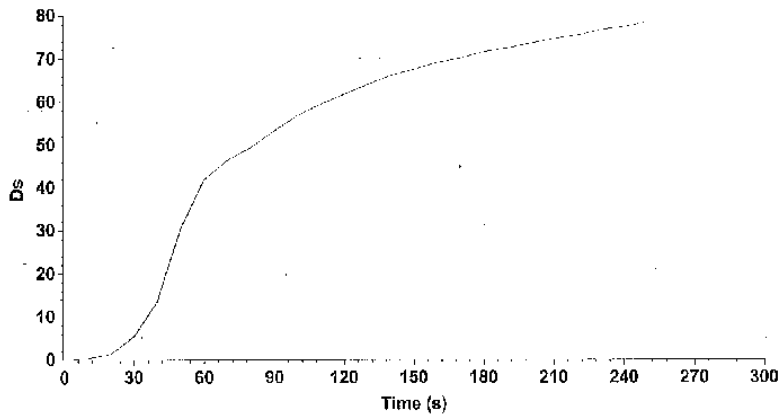
Time to Ds=16	: 41 s
Smoke obscuration index	: 55.4

Comments:

Report produced with the Fire Testing Technology SmokeBox software

page 3

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100161.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	91	5.432
60	48.1	41.91
90	39.5	53.22
120	34.1	61.71
150	30.8	67.43
180	28.8	71.44
210	27.3	74.41
240	26	77.15

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1024-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100162.SBA
Test number in series	: 2
Thickness (mm)	: 6.5
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

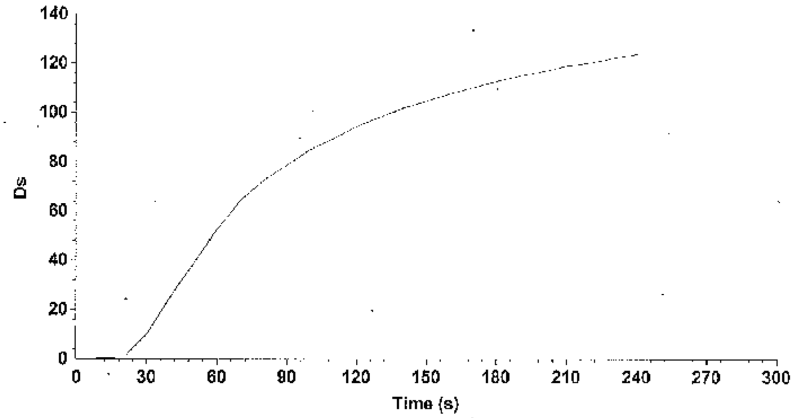
Maximum specific optical density	: 123.71
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 98.81
Corrected maximum specific optical density	: 123.02

Additional Parameters

Time to Ds=16	: 34 s
Smoke obscuration index	: 124.4

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\I1100162.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	83.8	10.15
60	40.1	52.45
90	25.4	78.62
120	19.3	94.31
150	16.2	104.5
180	14	112.5
210	12.6	118.8
240	11.6	123.6

Report produced with the Fire Testing Technology SmokeBox software page 1

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1024-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\I1100163.SBA
Test number in series	: 3
Thickness (mm)	: 6.5
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

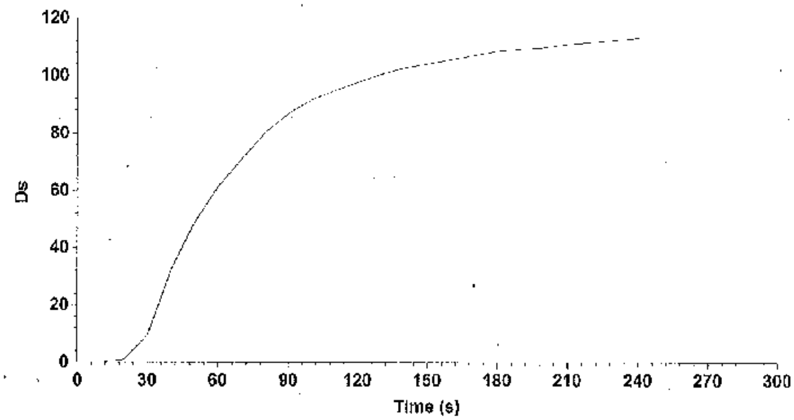
Maximum specific optical density	: 113.15
Time to maximum specific optical density	: 4 minutes (240 s)
Clear beam transmission (%)	: 97.95
Corrected maximum specific optical density	: 111.97

Additional Parameters

Time to Ds=16	: 33 s
Smoke obscuration index	: 157

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100163.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	84.9	9.377
60	34.2	61.54
90	21.9	87.04
120	18.2	97.8
150	16.3	104.1
180	15.1	108.5
210	14.4	111
240	13.9	113.2

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1024-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100164.SBA
Test number in series	: 4
Thickness (mm)	: 6.5
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

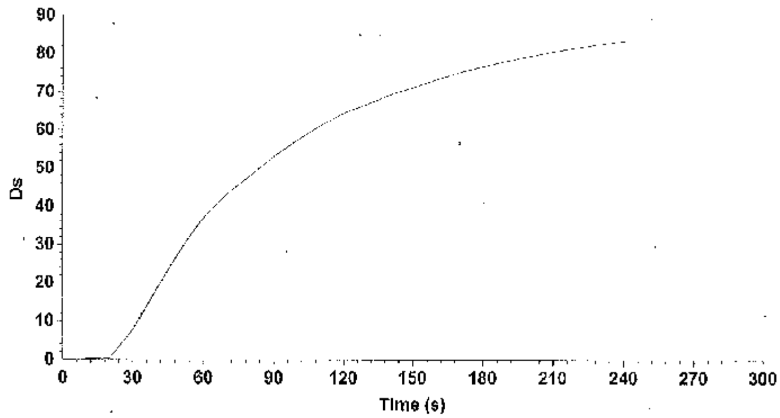
Maximum specific optical density	: 83.52
Time to maximum specific optical density	: 3 minutes 59 seconds (239 s)
Clear beam transmission (%)	: 99.61
Corrected maximum specific optical density	: 83.3

Additional Parameters

Time to Ds=16	: 36 s
Smoke obscuration index	: 52.4

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100164.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	87.5	7.656
60	52.2	37.3
90	39.5	53.2
120	32.4	64.57
150	28.9	71.23
180	26.2	76.72
210	24.5	80.66
240	23.3	83.47

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1024-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100165.SBA
Test number in series	: 5
Thickness (mm)	: 6.5
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

Maximum specific optical density	: 124.73
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 99.04
Corrected maximum specific optical density	: 124.17

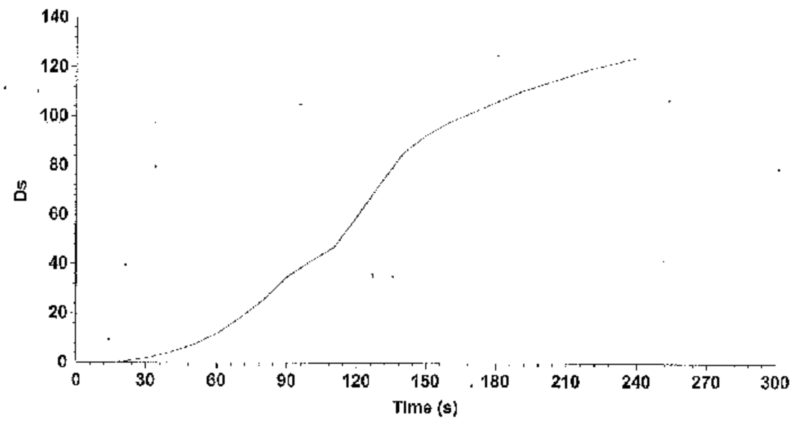
Additional Parameters

Time to Ds=16	: 1 minutes 07 seconds (67 s)
Smoke obscuration index	: 56.8

Comments:

Report produced with the Fire Testing Technology SmokeBox software page 3

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100165.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	96.8	1.871
60	81.4	11.8
90	54.4	34.93
120	35.3	59.75
150	19.9	92.63
180	15.7	106.1
210	13.1	116.5
240	11.4	124.3

BUNSEN BURNER TEST DATA SHEET

TEST PLAN # MOC PART 2 ITEM 11
TEST SPECIMEN ID # M1025-001

MANUFACTURER: HEATH TECNA
MATERIAL DESCRIPTION:

TEST LOCATION: HEATH TECNA, BELLINGHAM
TEST DATE: 10/20/11
TESTED BY: T. Rochon
WITNESSED BY:

CONDITIONING: MINIMUM 24 HRS AT 70° ± 5° F, 50% ± 5% RELATIVE HUMIDITY
FLAME TEMP: 1550° F

TEST METHOD / TEST REQUIREMENTS (MAX. AVERAGE)

FAR/JAR PART 25, APPENDIX F, PART I

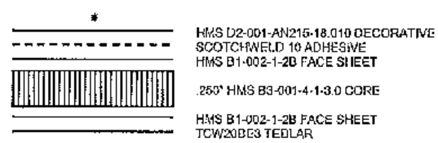
	Test Code	Test Type	Burn Length	Flame Extinguish Time	Drip Extinguish Time	Burn Rate	Flame Penetration	After Glow
☒	F1	60 sec Ignition Vertical Test	6.0 inches	15.0 Sec.	3.0 Sec.	-	-	-
☐	F2	12 sec Ignition Vertical Test	8.0 inches	15.0 Sec.	5.0 Sec.	-	-	-
☐	F3	15 sec Ignition Horizontal Test 2.5 inch/min	-	-	-	2.5 In./Min.	-	-
☐	F4	15 sec Ignition Horizontal Test 4 inch/min	-	-	-	4.0 In./Min.	-	-
☐	F5	30 sec Ignition – 45 Degree	-	15.0 Sec.	-	-	NONE	10.0 Sec.
☐	F6	30 sec Ignition – 60 Degree	3.0 Inches	30.0 Sec.	3.0 Sec.	-	-	-

TEST RESULTS

Sample #	Burn Length	Flame Exting	Drip Exting	Burn Rate	Flame Pene-tration	After Glow	Test Direction
1	2.4	0.0	N.D.				
2	2.0	0.0	N.D.				
3	2.6	0.0	N.D.				
AVG.	2.3	0.0	0				

PASS ☒ FAIL ☐

SKETCH



*TEST SIDE

COMMENTS

HEATHTECNA
AIRCRAFT INTERIOR SOLUTIONS

HEAT RELEASE TEST DATA SHEET	TEST PLAN #: MOC PART 2 ITEM 11	TEST SPECIMEN ID #: M1025-001

MANUFACTURER:	MATERIAL DESCRIPTION:
HEATH TECNA	

TEST LOCATION:	TEST DATE:	TESTED BY:	WITNESSED BY:
HEATH TECNA, BELLINGHAM	10/18/11	T. Rochon	

CONDITIONING:	CALIBRATION FACTOR:	HEAT FLUX:
MINIMUM 24 HRS AT 70° ± 5° F, 50% ± 5% RELATIVE HUMIDITY	0.2499 kW/mV	3.46 W/cm^2

TEST METHOD

FAR/JAR PART 25, APPENDIX F, PART IV

TEST REQUIREMENTS (MAX. AVERAGE)

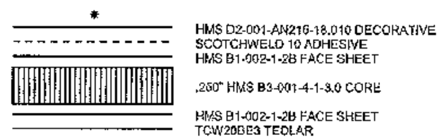
PEAK HEAT RELEASE RATE DURING 5.0 MINUTE PERIOD	65.0 kW/m^2
TOTAL HEAT RELEASE AFTER 2.0 MINUTES	65.0 kW • min./m^2

TEST RESULTS

Sample #	Peak (kW/m^2)	2 min Total (kW • min./m^2)	Time to Peak Value (s)
1	38.2	48.7	71
2	30.4	41.7	49
3	37.7	46.5	79
4	31.7	38.1	72
5	36.9	51.1	80
AVG	35.0	45.2	70

PASS ☒ FAIL ☐

SKETCH



*TEST THIS SURFACE FOR HEAT RELEASE

OBSERVATIONS

SAGGING	YES ☐ NO ☒	DELAMINATION	YES ☐ NO ☒
MELTING	YES ☐ NO ☒	OTHER BEHAVIOR	YES ☐ NO ☒

COMMENTS

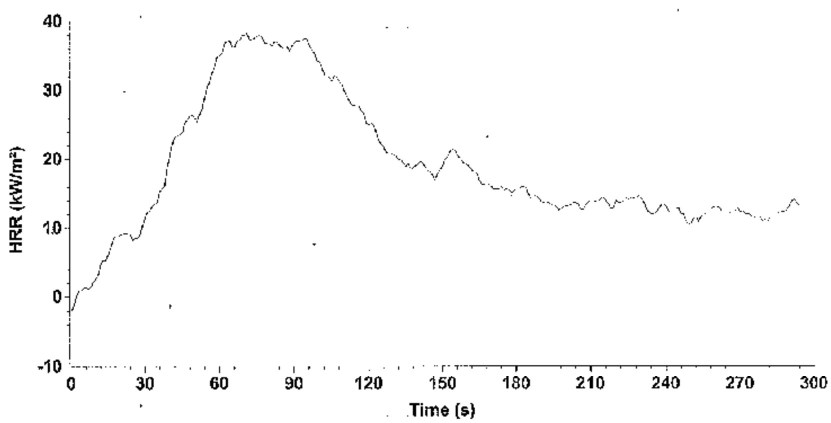
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description : M1025-001-1
Thickness (mm) : 6.8
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100153.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	38.2	71	48.7

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

Report produced with the Fire Testing Technology OSUCalc software page 1

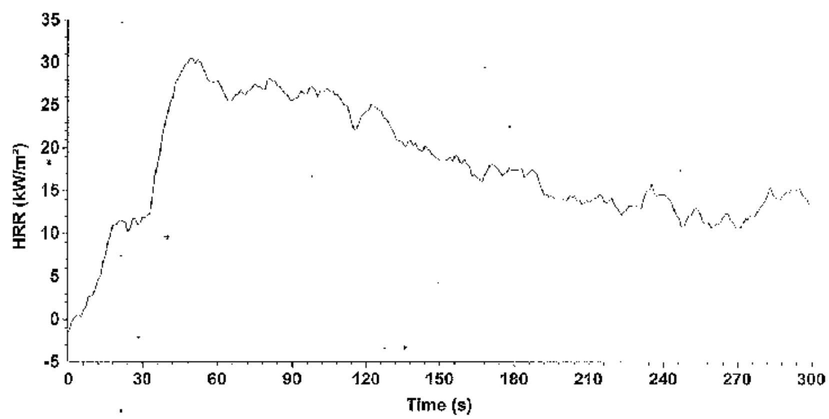
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description : M1025-001-2
Thickness (mm) : 6.8
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100154.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	30.4	49	41.7

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

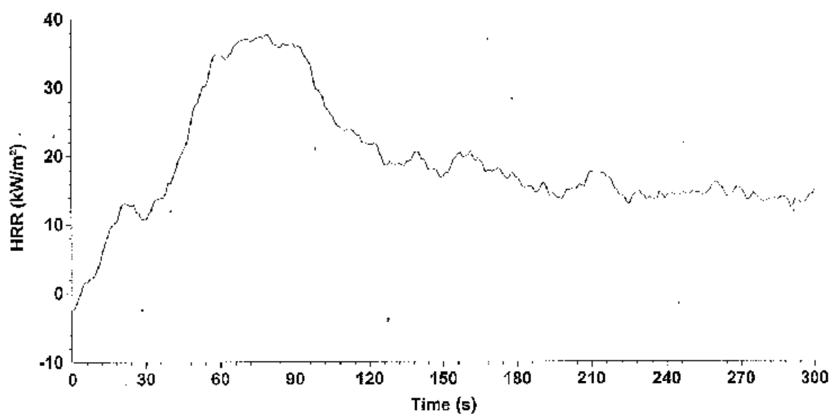
OSUCalc Test Report

Laboratory : HEATH TECNA
Sample description: M1025-001-3
Thickness (mm) : 6.8
Density (kg/m³) : 1
Surface area (m²) : 0.02323
Number of tests : 1 test performed on 18 October 2011
File name : C:\OSUCALC\DATA\11100155.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	37.7	79	46.5

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

Report produced with the Fire Testing Technology OSUCalc software page 1

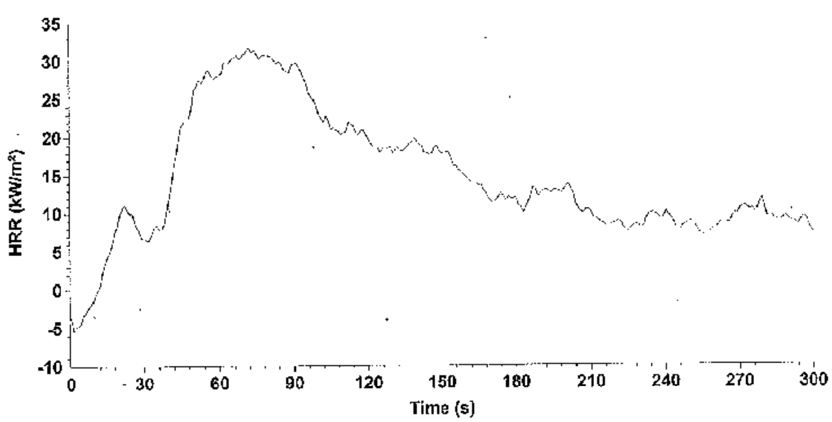
OSUCalc Test Report

Laboratory	: HEATH TECNA
Sample description	: M1025-001-4
Thickness (mm)	: 6.8
Density (kg/m³)	: 1
Surface area (m²)	: 0.02323
Number of tests	: 1 test performed on 18 October 2011
File name	: C:\OSUCALC\DATA\11100156.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	31.7	72	38.1

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

Report produced with the Fire Testing Technology OSUCalc software page 1

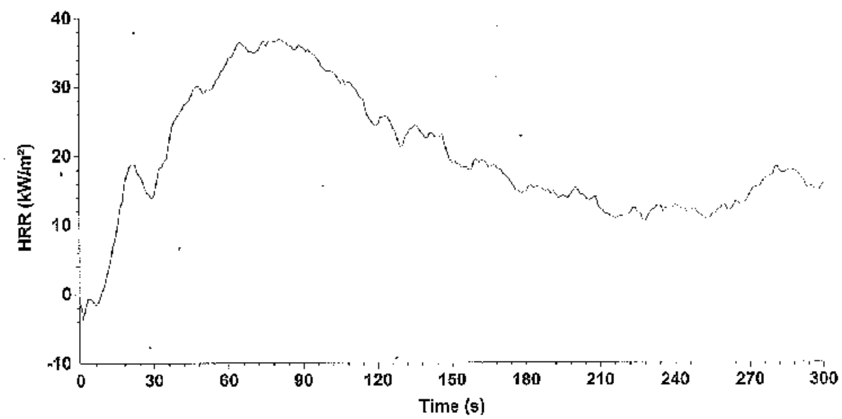
OSUCalc Test Report

Laboratory	: HEATH TECNA
Sample description	: M1025-001-5
Thickness (mm)	: 6.8
Density (kg/m³)	: 1
Surface area (m²)	: 0.02323
Number of tests	: 1 test performed on 18 October 2011
File name	: C:\OSUCALC\DATA\11100157.CSV

HRR Results

Specimen #	Peak HRR (kW/m²)	Time to peak HRR (s)	2-min THR (kW·min/m²)
1	36.9	80	51.1

(THR calculation ignores all negative heat release rates)



These results relate only to the behaviour of the specimens of the product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

HEATHTECNA
AIRCRAFT INTERIOR SOLUTIONS

SMOKE DENSITY TEST DATA SHEET	TEST PLAN # MOC PART 2 ITEM 11	TEST SPECIMEN ID # M1025-001
MANUFACTURER: HEATH TECNA	MATERIAL DESCRIPTION:	

TEST LOCATION:	TEST DATE:	TESTED BY:	WITNESSED BY:
HEATH TECNA, BELLINGHAM	10/21/11	R. Polly	

CONDITIONING:	HEAT FLUX:
MINIMUM 24 HRS AT 70° ± 5° F, 50% ± 5% RELATIVE HUMIDITY	2.48 W/cm^2

TEST METHOD

FAR/JAR PART 25, APPENDIX F, PART V

TEST REQUIREMENTS (MAX. AVERAGE)

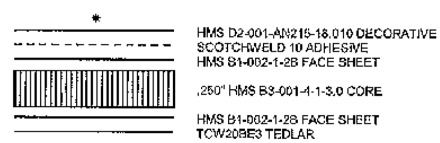
MAX Ds DURING 4.0 MINUTE PERIOD <200

TEST RESULTS

Sample #	Maximum Ds During 4.0 Minute Period
1	116
2	115
3	79
4	85
5	96
AVG	98

PASS ☒ FAIL ☐

SKETCH



*TEST THIS SURFACE FOR SMOKE DENSITY

COMMENTS

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1025-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100166.SBA
Test number in series	: 1
Thickness (mm)	: 6.7
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

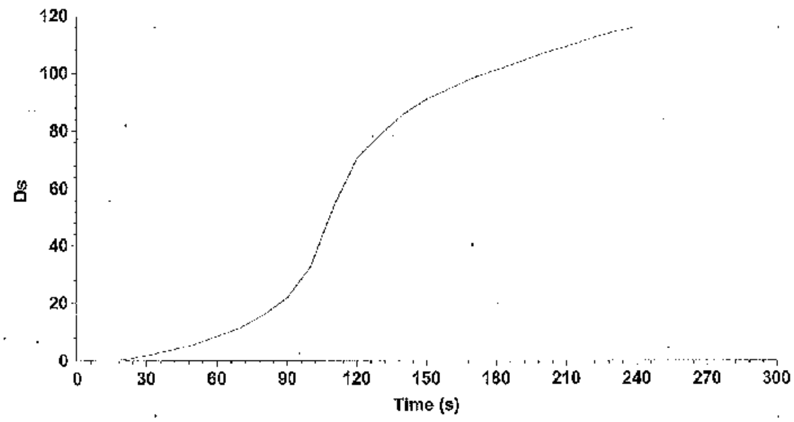
Maximum specific optical density	: 116.19
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 98.43
Corrected maximum specific optical density	: 115.29

Additional Parameters

Time to Ds=16	: 1 minutes 20 seconds (80 s)
Smoke obscuration index	: 56.8

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100166.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	96.9	1.776
60	86.3	8.451
90	68.3	21.83
120	29.2	70.61
150	20.5	90.82
180	17.2	100.9
210	14.9	109
240	13.3	115.8

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1025-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100167.SBA
Test number in series	: 2
Thickness (mm)	: 6.7
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

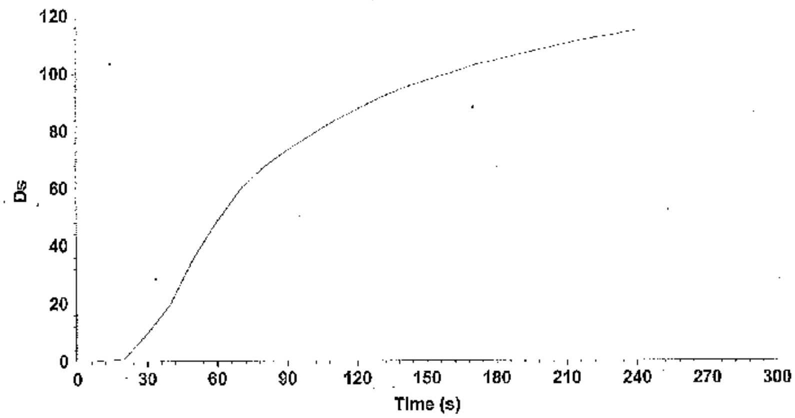
Maximum specific optical density	: 114.81
Time to maximum specific optical density	: 4 minutes (240 s)
Clear beam transmission (%)	: 98.93
Corrected maximum specific optical density	: 114.2

Additional Parameters

Time to Ds=16	: 37 s
Smoke obscuration index	: 99.4

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100167.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	84.4	9.701
60	42.9	48.45
90	27.9	73.27
120	21.7	87.51
150	18.2	97.55
180	16.2	104.4
210	14.6	110.2
240	13.5	114.8

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1025-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100168.SBA
Test number in series	: 3
Thickness (mm)	: 6.7
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

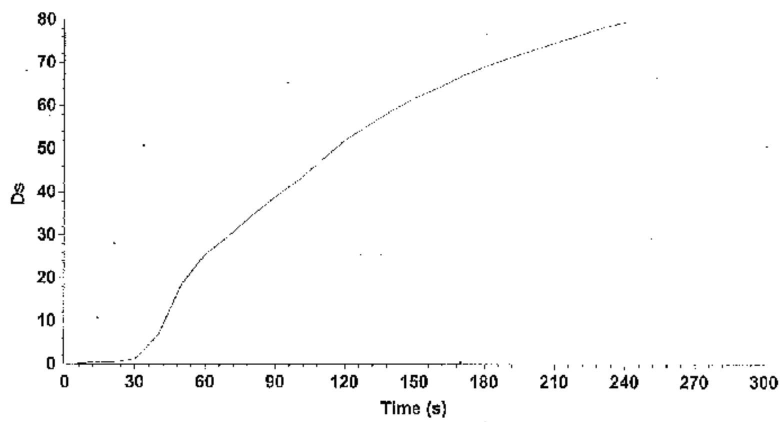
Maximum specific optical density	: 79.47
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 99.05
Corrected maximum specific optical density	: 78.92

Additional Parameters

Time to Ds=16	: 47 s
Smoke obscuration index	: 32.1

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100168.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	98	1.146
60	64.1	25.48
90	50.8	38.88
120	40.4	51.93
150	34.1	61.67
180	30	68.95
210	27.3	74.44
240	25.1	79.28

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1025-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100169.SBA
Test number in series	: 4
Thickness (mm)	: 6.7
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

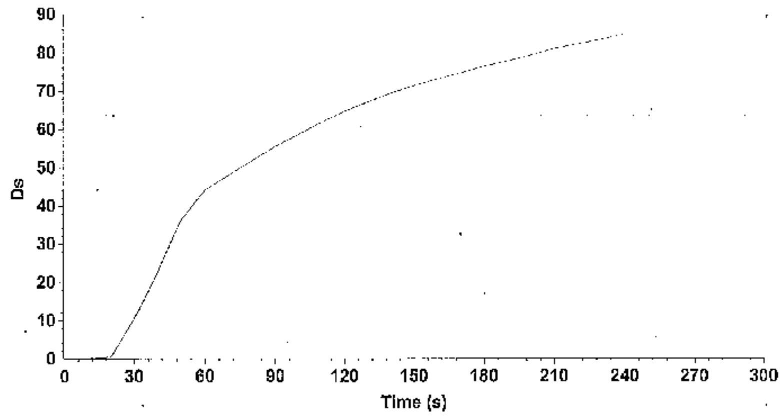
Maximum specific optical density	: 84.88
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 99.13
Corrected maximum specific optical density	: 84.37

Additional Parameters

Time to Ds=16	: 34 s
Smoke obscuration index	: 67.6

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100169.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	83.3	10.49
60	46.2	44.22
90	38	55.51
120	32.4	64.66
150	28.8	71.38
180	26.4	76.35
210	24.4	80.97
240	22.8	84.77

Smoke Density Chamber Single Specimen Report

Standard	: ASTM E 662
Laboratory	: Heath Tecna Inc.
Date of test	: Oct. 21 2011
Specimen description	: M1025-001
Test name	:
File name	: C:\SMOKEBOX\DATA\ASTME662\11100170.SBA
Test number in series	: 5
Thickness (mm)	: 6.7
Initial mass (g)	: Not Recorded
Final mass (g)	: Not Recorded
Mass in drip tray (g)	: Not Recorded
Mass loss (g)	:
Mass loss (%)	:
Test mode	: Flaming
Test duration	: 4 minutes (240 s)
Conditioned?	: Yes
Conditioning temp. (°C)	: 23
Conditioning RH (%)	: 50

Test Results

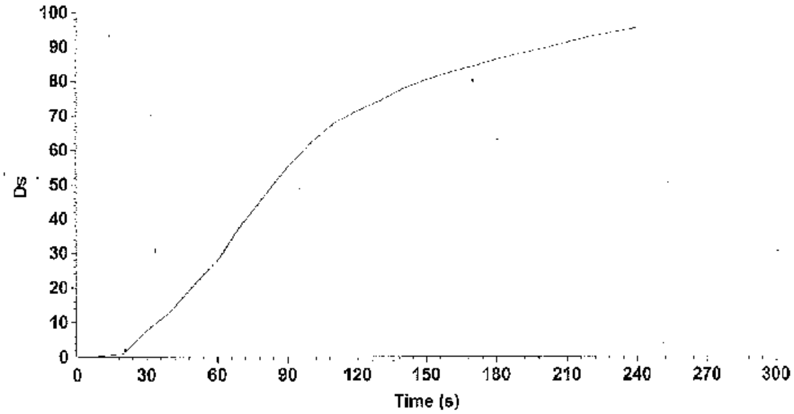
Maximum specific optical density	: 95.63
Time to maximum specific optical density	: 4 minutes 01 seconds (241 s)
Clear beam transmission (%)	: 99.28
Corrected maximum specific optical density	: 95.22

Additional Parameters

Time to Ds=16	: 45 s
Smoke obscuration index	: 50.3

Comments:

Specific Optical Density Graph



Test name :
File name : C:\SMOKEBOX\DATA\ASTME662\11100170.SBA

Tabulated Results

Time (s)	T (%)	Ds
0	100.0	0.0
30	87.6	7.595
60	61.5	27.84
90	38.3	55.03
120	28.8	71.29
150	24.6	80.29
180	22.2	86.19
210	20.4	91.12
240	18.9	95.38

APPENDIX L—ITEM 12: TEDLAR

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, "Policy Statement on Flammability Testing of Interior Materials"

INDUSTRY TEAM PROPOSAL

Part 1, Reference Item #12, "Tedlar"

Revision – A, dated 2011-July-20

CONTENTS

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6	A								
7	A								
8	A								
9	A								
10	A								
11	A								

REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
NC	Original Issue	2010-Dec-14	Michael C. Miler
A	Modified definition of decorative laminate to standardize across all MOCs	2011-Jul-20	Michael C. Miler

1 INTRODUCTION

Tedlar color similarity (e.g. the substantiation of one Tedlar color by using previous flammability test data from another Tedlar color within the same Tedlar type) for aircraft interiors flammability testing according to 14 CFR 25.853 (a) and (d) is currently a well established industry practice. The argument used for Tedlar color similarity is that changes exclusively in color within the same Tedlar type have no appreciable effect on the results of flammability testing (vertical burn, heat release and smoke emission).

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials” [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA’s technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Item 12 has been reviewed by the industry team and is submitting the following concurrence, justification and proposal.

2 INDUSTRY TEAM LEADER AND SUPPORT TEAM

During an industry meeting on September 24, 2009 in Huntington Beach, CA, and the FAA Materials Fire Test Working Group meeting on October 21, 2009, in Atlantic City, NJ, and the FAA Flammability Standardization Working Group (FSTG) meeting on 12 January 12, 2010, in Clearwater, FL, and the FSTG meeting on March 2, 2010, in Seattle, WA, and the FAA Materials Fire Test Working Group meeting on June 23, 2010, in Cologne, Germany, and the Sixth Triennial International Aircraft Fire and Cabin Safety Research Conference on October 27, 2010, in Atlantic City, NJ, and the FSTG meeting on November 16, 2010, in Huntington Beach, CA, following individuals have volunteered to form the industry team for this reference item:

2.1 TEAM LEADER

- Miler, Michael C. (Schneller LLC)

2.2 SUPPORT TEAM

- Bösser, Klaus (Sell GmbH)
- Bronner, Samantha (Boeing)
- Buedo Leyva, Maribell (Lufthansa Technik AG)
- Buoniconti, Ralph (SABIC Innovative Plastics)
- Danker, George (Unifrax)
- Dawson, Ethel (Accufleet)
- Del Pinto, Jim (C&D Zodiac)
- Eberly, Dana (Northwest Airlines)
- Fayerweather, Diane (C&D Zodiac)
- Freeman, Dan (Boeing)
- Fritzl, Raimund (Isovolta AG)
- Hurst, Cheryl (American Airlines)
- Jensen, Michael (Boeing)
- Karl, Hans (Mankiewicz)
- Kauffman, Jym (Kydex LLC)
- Landroni, Francisco (Embraer)
- Langer, Dirk (Sell GmbH)
- Lee, Mabel (C&D Zodiac)
- Le Neve, Serge (CEAT)
- Livengood, Thomas (B/E Aerospace)
- Moeller, Marco (Recaro)
- Muth, Mike (Goodrich)
- Niitsu, Gilberto (Embraer)
- Pon, David (Driessen)
- Rathbun, Jason (Schneller LLC)
- Ronnqvist, Eva (AIM Aviation)
- Schumillas, Katrin (Lufthansa Technik AG)
- Slaton, Dan (Boeing)
- Spencer, Martin (Heath Tecna)
- Story, Charles W. C. (Magee Plastics Co.)
- Zimmerman, Patrick (3M)

This list is by no means final, but represents a snapshot of the currently active industry participants. Additional remarks, suggestions, corrections and contributions from other individuals are very much encouraged.

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on August 20, 2009. Attachment 2, Part 2, reference item #12 reads (see Figure 1):

- 14 CFR 25.853 (a): *"Testing of Tedlar® material on a decorative panel substantiates the same panel construction with the same type and thickness of Tedlar® with a different color."*
- 14 CFR 25.853 (d): *"Testing of Tedlar® material on a decorative panel substantiates the same panel construction with the same type and thickness of Tedlar® with a different color."*

Part 2, methods of compliance that require supporting data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
12	Tedlar	Testing of Tedlar® material on a decorative panel substantiates the same panel construction with the same type and thickness of Tedlar® with a different color.	Testing of Tedlar® material on a decorative panel substantiates the same panel construction with the same type and thickness of Tedlar® with a different color.

Figure 1: Attachment 2, Part 2, Reference Item #12

No equivalent entry exists for reference item #12 in attachment 2, Part 1.

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of the terms 'Tedlar', 'color' and 'same' should be provided so that confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

3.2.1 TEDLAR

The industry team agrees that 'Tedlar' is a single layer, solid-color, thin-gage, non self-supporting film made out of polyvinyl fluoride (PVF).

Tedlar is not a multilayer material. It consists of a single, cast or extruded film layer of PVF that is integrally colored by the use of pigments during its manufacturing process. Tedlar is always applied on top of an existing surface (substrate) and therefore never forms 'self-supporting' parts.

The use of Tedlar as a decorative type in the interior of transport category airplanes is currently well established industry practice (state-of-the-art). Tedlar is typically being used as an alternative to paint on the interior side of the following surfaces: overhead stowage bins, galleys and closets. Other words used sometimes within the industry for the term Tedlar are PVF, PVF film or Tedlar film.

The industry team therefore recommends that the term ‘Tedlar’ in the context of this item be defined as: “single layer, solid-color, thin-gage, non self-supporting film made out of polyvinyl fluoride (PVF)”.

3.2.2 COLOR

The industry team agrees that color used in the context of this item refers to the visual appearance of a Tedlar used in the interiors of transport category airplanes. In contrast to texture, color is a visual phenomenon. It describes the overall look or appearance of a Tedlar, limited to <u>one single base color</u>. Unlike other multilayer decorative laminates as defined in reference item #5b (Decorative Laminate Color), color in Tedlar does not include additional print colors, text, images, patterns and designs besides the integrally pigmented base color. The use of the term color is currently well established industry practice. Other words used sometimes within the industry for the term color are design, pattern, appearance or print.

Color in Tedlar is the result of pigments added to the PVF film during its manufacturing process selectively absorbing incoming light and reflecting only the desired wavelengths that correspond to the pigment color. Unlike other multilayer decorative laminates as defined in reference item #5b (Decorative Laminate Color), no printing inks are used during the manufacturing of Tedlar films. Therefore, Tedlar color is always limited to one integrally pigmented base color.

The industry team therefore recommends that the term ‘color’ in the context of this item be defined as: “The complete visual appearance of a Tedlar used in the interiors of transport category airplanes, limited to one integrally pigmented base color”.

3.2.3 SAME

The industry team agrees that the term ‘same’ in the context of this item refers to a similar decorative type from:

- the same manufacturer, and
- the same product family, and
- the same product build-up.

So when the FAA draft policy memo refers to the “same color”, the only change being allowed in the context of this item would be the <u>exclusive</u> change from one color to another, with all other product parameters staying the same.

The industry team therefore recommends that the term ‘same’ in the context of this item be defined as: “From the same manufacturer and same product family and same product build-up”.

4 VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

The use of this MOC has been grouped by the FAA into Part 2 for both 14 CFR 25.853 (a) and (d). This means that the FAA will require additional supporting data to accept this method for Vertical Burn, Heat Release and Smoke Density testing.

The industry team believes that sufficient data exists to substantiate the acceptance of this MOC for 14 CFR 25.853 (a) and (d) and merge it under reference item #5b (Decorative Laminate Color). Based on the definition of Tedlar as listed in paragraph 3.2.1, the industry team agrees that Tedlar falls within the category of decorative laminates as defined in reference item #5b. In that reference item, decorative laminates are defined as a "polymer-based, single or multilayer, thin-gage, non self-supporting colored decorative sheet that may include additional non-polymer based reinforcing layers and typically contains at least one layer of a fluoropolymer-based film material".

Similar to the definition of decorative laminates, Tedlar is polymer-based, single layer, thin-gage, non self-supporting material that is made entirely out of a fluoropolymer-based film (PVF). It consists of a single, cast or extruded layer of PVF film that is integrally colored by the use of pigments during its manufacturing process. No printing inks are used in the manufacturing of Tedlar films.

The substantiation for decorative laminate color similarity is based on the non-appreciable effect of the pigments in the embossing resin and printing inks on flammability testing. The argument that can be made is that changes in color of decorative laminates have no appreciable effect on the results of flammability testing because only a small amount of pigment is used in the overall composition of a decorative laminate. Similarly, the substantiation for Tedlar color similarity is based on the non-appreciable effect of the pigments in the PVF film on flammability testing. The argument that can be made that since Tedlar contains no printing inks, even lower amounts of pigments are used in the overall construction of a Tedlar when compared to a multilayer decorative laminate.

Based on the argumentation listed above, the industry team agrees that Tedlar falls within the category of decorative laminates. Therefore, Tedlar color similarity (e.g. the substantiation of one Tedlar color by using previous flammability test data from another Tedlar color within the same Tedlar type) is a special case of decorative laminate color similarity (e.g. the substantiation of one decorative laminate color by using previous flammability test data from another decorative laminate color within the same decorative laminate type) and can be substantiated by the data submitted for reference item #5b.

4.2 PROPOSED STANDARD TO MEET

Delete attachment 2, Part 2, reference item #12 for 14 CFR 25.853 (a) and (d) and merge it under reference item #5b (Decorative Laminate Color).

5 DATA / ANALYSIS

See data submitted for reference item #5b (Decorative Laminate Color).

6 CONCLUSION

The industry team agrees that Tedlar falls within the category of decorative laminates. Tedlar color similarity therefore is a special case of decorative laminate color similarity and can be substantiated by the data submitted for reference item #5b (Decorative Laminate Color).

The industry team believes that sufficient data has been presented under reference item #5b to substantiate the acceptance of this MOC for 14 CFR 25.853 (a) and (d).

Based on industry discussion, the industry team recommends deleting reference item #12 from the current proposal and merge it under reference item #5b (Decorative Laminate Color).

6.1 REVISED PROPOSAL

Delete attachment 2, Part 2, reference item #12 for 14 CFR 25.853 (a) and (d) and merge it under reference item #5b (Decorative Laminate Color).

Include the definition of all terms as listed in paragraph 3.2 (‘color’, ‘Tedlar’ and ‘same’) in a commentary or list of significant key terms in the FAA draft policy memo and enforce their consistent use throughout the policy.

7 ABBREVIATIONS

CFR	=	Code of Federal Regulations
FAA	=	Federal Aviation Administration
FSTG	=	FAA Flammability Standardization Working Group
MOC	=	Methods of Compliance
PVF	=	Polyvinyl Fluoride

8 REFERENCES

[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

APPENDIX M—ITEM 13: TEXTURE

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM PROPOSAL

Part 1, Reference Item #13, “Texture”

Revision – A, dated 2011-July-20

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REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
N/C	Official Release	2010-May-03	Michael C. Miler
A	Modified definition of decorative laminate to standardize across all MOCs	2011-Jul-20	Michael C. Miler

1 INTRODUCTION

Texture similarity (e.g. the substantiation of one texture by using previous flammability test data from another texture within the same decorative type) for aircraft interiors flammability testing according to 14 CFR 25.853 (a) and (d) is currently well established industry practice. The argument used for texture similarity is that changes exclusively in texture within the same decorative type have no appreciable effect on the results of flammability testing (vertical burn, heat release and smoke density).

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials” [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA’s technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Item 13 has been reviewed by the industry team and is submitting the following concurrence, justification and proposal.

2 INDUSTRY TEAM LEADER AND SUPPORT TEAM

During an industry meeting on September 24, 2009, in Huntington Beach, CA, and subsequent FAA Materials Fire Test Working Group and the FAA Flammability Standardization Working Group (FSTG) meetings, the following individuals have volunteered to form the industry team for this reference item:

2.1 TEAM LEADER

- Miler, Michael C. (Schneller LLC)

2.2 SUPPORT TEAM

- Bösser, Klaus (Sell GmbH)
- Bronner, Samantha (Boeing)
- Buedo Leyva, Maribell (Lufthansa Technik AG)
- Buoniconti, Ralph (SABIC Innovative Plastics)
- Danker, George (Unifrax)
- Del Pinto, Jim (C&D Zodiac)
- Eberly, Dana (Northwest Airlines)
- Fayerweather, Diane (C&D Zodiac)
- Fritzl, Raimund (Isovolta AG)
- Hurst, Cheryl (American Airlines)
- Jensen, Michael (Boeing)
- Kauffman, Jym (Kydex LLC)
- Landroni, Francisco (Embraer)
- Langer, Dirk (Sell GmbH)
- Le Neve, Serge (CEAT)
- Livengood, Thomas (B/E Aerospace)
- Muth, Mike (Goodrich)
- Pon, David (Driessen)
- Rathbun, Jason (Schneller LLC)
- Schumillas, Katrin (Lufthansa Technik AG)
- Slaton, Dan (Boeing)
- Spencer, Martin (Heath Tecna)
- Story, Charles W. C. (Magee Plastics Co.)
- Zimmerman, Patrick (3M)

This list is by no means final, but represents a snapshot of the involved industry participants. Additional remarks, suggestions, corrections and contributions from other individuals were encouraged and have been reflected in this report.

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on August 20, 2009. Attachment 2, Part 1, reference item #13 reads (see Figure 1):

- 14 CFR 25.853 (a): *“Data from testing one texture of a decorative type substantiates a panel with the same decorative type with a different texture.”*
- 14 CFR 25.853 (d): *“Data from testing one texture of a decorative type substantiates a panel with the same decorative type that has a different texture.*

Part 1, acceptable methods without additional data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
13	Texture	Data from testing one texture of a decorative type substantiates a panel with the same decorative type with a different texture.	Data from testing one texture of a decorative type substantiates a panel with the same decorative type that has a different texture.

Figure 1: Attachment 2, Part 1, Reference Item #13

No equivalent entry exists for reference item #13 in attachment 2, Part 2.

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of the terms ‘texture’, ‘decorative type’ and ‘same’ should be provided so that confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

3.2.1 TEXTURE

The industry team agrees that texture in the context of this item refers to the physical surface structure of a decorative type that is created by a mechanically structured transfer tool used in the interior of transport category airplanes. Texture is a physical characteristic of a surface. It describes the way a surface feels to touch. Texture in this context is limited to a tactile characteristic and not a visual phenomenon. A surface without texture would be considered smooth. The use of the term texture is currently well established industry practice. Other words used sometimes within the industry for the term texture are structure, pattern, grain, impression or emboss.

Texture only influences the physical surface structure and appearance of a decorative type. It does not change the build-up or chemical composition of the finished product. Although different texturing methods exist, all typically involve the transfer of an embossed pattern by the use of a mechanically structured transfer tool. The embossing process itself is purely mechanical in nature and does not involve a change in build-up or chemical composition of the surface.

The industry team therefore recommends that the term 'texture' in the context of this item be defined as: "The physical surface structure of a decorative type that is created by a mechanically structured transfer tool used in the interiors of transport category airplanes".

3.2.2 DECORATIVE TYPE

The term 'decorative type' used in this item needs to be differentiated against the meaning of similar terms used throughout the FAA draft policy memo, such as 'decorative', 'decorative laminate', 'decorative tedlar laminate', 'Tedlar', 'laminates', 'paint/ink systems', 'thermoplastics' and 'elastomers'.

A decorative type in the context of this item is a product that is used as an aesthetic and/or functional surface for various components in the interior of transport category airplanes. The industry team agrees that 'decorative type' only includes the following decoratives currently being used in aircraft interiors (state-of-the-art):

- Decorative Laminate ,
- Non-Textile Flooring (NTF), and
- Thermoplastic Sheet.

Following decorative types are specifically excluded from this item, as they are known to display anisotropic flammability properties depending on surface texture:

- Decoratives with natural grains and woven products:
  - Leather (leather, coated leather)
  - Wood (solid wood, wood veneers)
  - Fabrics (seat covers, carpets, curtains)

The industry team therefore recommends that the term 'decorative type' in the context of this item be limited to: "Decorative Laminate, Non-Textile Flooring (NTF) and Thermoplastic Sheet".

3.2.3 DECORATIVE LAMINATE

The industry team agrees that 'decorative laminate' is a polymer-based, single or multilayer, thin-gage, non self-supporting colored decorative sheet that may include additional non-polymer based reinforcing layers and typically contains at least one layer of a fluoropolymer-based film material.

Decorative Laminates are constructed of one or more layers [single or multilayer] of thin-gauge [thin gauge] plastic sheet [polymer-based] that may include additional layers of fiberglass or metallic sheet [additional non-polymer based reinforcing layers] and typically contain at least one layer of a fluoropolymer-based film material. Decorative laminates are always applied using an adhesive on top of an existing surface (substrate) and therefore never form 'self-supporting' parts [non-self-supporting]. They may be integrally pigmented or printed with water or solvent based inks to create a decorative color or pattern [colored]. Multi-layered sheets are bonded together during the manufacturing process using thin gauge adhesives or heat and pressure and may include embossing resins for accepting mechanically applied textures.

The use of decorative laminate as a decorative type in the interior of transport category airplanes is currently well established industry practice (state-of-the-art). Decorative laminates are typically being used on the following surfaces: sidewalls, lavatories, galleys, closets, linings, partitions, bin doors and ceilings. Other words used sometimes within the industry for the term decorative laminate are Tedlar, Decorative Tedlar Laminate (DTL), Declam, Airdec, Panlam, AerFilm, Flexdec, Decor, Decorative Film wallpaper or wall covering.

Decorative laminates as defined in the context of this item only refer to currently available, state-of-the-art decorative sheets that have been used in the interior of transport category airplanes over the past 20 years. Any decorative laminates that go beyond the scope of this item would be considered novel or unusual. It is neither the intent of this proposal to make any statements about the applicability of this MOC to such novel or unusual decorative laminates nor to lay out a qualification program by which such novel or unusual decorative laminates may be validated against this MOC.

The industry team therefore recommends that the term ‘Decorative Laminate’ in the context of this item be defined as: “polymer-based, single or multilayer thin-gage, non self-supporting colored decorative sheet that may include additional non-polymer based reinforcing layers and typically contains at least one layer of a fluoropolymer-based film material”.

3.2.4 NON-TEXTILE FLOORING (NTF)

The industry team agrees that ‘Non-Textile Flooring’ (NTF) is a polymer-based, non-fibrous, non-carpet floor covering.

The use of NTF as a decorative type in the interior of transport category airplanes is currently well established industry practice (state-of-the-art). NTF are typically being used as flooring material on the following surfaces: lavatories, galleys and entryways. Other words used sometimes within the industry for the term NTF are floor mat, galley mat, floor cover, PVC mat, AerMat or plastic flooring.

The industry team therefore recommends that the term ‘Non-Textile Flooring’ (NTF) in the context of this item be defined as: “polymer-based, non-fibrous, non-carpet floor covering”.

3.2.5 THERMOPLASTIC SHEET

The industry team agrees that ‘Thermoplastic Sheet’ is a polymer-based, single or multilayer heavy-gage, self-supporting decorative sheet.

In contrast to decorative laminates, thermoplastic sheet are used to form ‘self-supporting’ parts and are therefore typically not applied on top of other substrates.

The use of thermoplastic sheet as a decorative type in the interior of transport category airplanes is currently well established industry practice (state-of-the-art). Thermoplastic sheet are typically being used on the following surfaces: food trays, arm caps, shrouds, literature pockets and consoles. Other words used sometimes within the industry for the term thermoplastic sheet are Kydex, AerForm, Ultem (PEI), Radel (PPSU), PEEK or plastic sheet.

The industry team therefore recommends that the term ‘Thermoplastic Sheet’ in the context of this item be defined as: “polymer-based, single or multilayer heavy-gage, self-supporting decorative sheet”.

3.2.6 SAME

The industry team agrees that the term ‘same’ in the context of this item refers to a similar decorative type from:

- the same manufacturer, and
- the same product family, and
- the same product build-up.

So when the FAA draft policy memo refers to the “same decorative type with a different texture”, the only change being allowed in the context of texture similarity would be the exclusive change from one texture to another, with all other product parameters as listed above staying the same.

The industry team therefore recommends that the term ‘same’ in the context of this item be defined as: “From the same manufacturer and same product family and same product build-up”.

4 VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

The use of texture similarity has been grouped by the FAA into Part 1 for both 14 CFR 25.853 (a) and (d). This means that the FAA considers the use of this MOC as an acceptable method without the need of additional supporting data.

The industry team concurs with the FAA’s position. The use of texture similarity (e.g. the substantiation of one texture by using previous flammability test data from another texture within the same decorative type) for aircraft interiors flammability testing according to 14 CFR 25.853 (a) and (d) is currently well established industry practice. The argument used for texture similarity is that changes exclusively in texture within the same decorative type have no appreciable effect on the results of flammability testing (vertical burn, heat release and smoke density).

4.2 PROPOSED STANDARD TO MEET

Accept MOC as is with further clarification of key terms.

5 DATA / ANALYSIS

Not applicable.

6 CONCLUSION

The industry team concurs with the FAA's position. Further clarification of key terms should be provided as follows.

6.1 REVISED PROPOSAL

Modify attachment 2, Part 1, reference item #13 to read the following:

- 14 CFR 25.853 (a): *"Data from testing one texture of a decorative type substantiates a panel with the same decorative type with a different texture."*
- 14 CFR 25.853 (d): *"Data from testing one texture of a decorative type substantiates a panel with the same decorative type with a different texture."*

Include the definition of all terms as listed in paragraph 3.2 ('texture', 'decorative type' and 'same') in a commentary or list of significant key terms in the FAA draft policy memo and enforce their consistent use throughout the policy.

7 ABBREVIATIONS

FAA	=	Federal Aviation Administration
FSTG	=	FAA Flammability Standardization Working Group
MOC	=	Methods of Compliance
CFR	=	Code of Federal Regulations
NTF	=	Non-Textile Flooring

8 REFERENCES

[1] Gardlin, Jeff, August 2009, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration.

APPENDIX N—ITEM 14: DECORATIVE LAMINATE ORIENTATION

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, "Policy Statement on Flammability Testing of Interior Materials"

INDUSTRY TEAM FINAL REPORT

Part 1, Reference Item #14, "Decorative Laminate Orientation"

Revision – B, dated 2011-July-20

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REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
N/C	Official Release	2010-Jul-17	Michael C. Miler
A	Final Report. Addition of test data, analysis and conclusion	2011-Apr-13	Michael C. Miler
B	Modified definition of decorative laminate to standardize across all MOCs	2011-Jul-20	Michael C. Miler

1 INTRODUCTION

The similarity of decorative laminate orientation (e.g. the substantiation of one orientation by using previous flammability test data from another orientation within the same decorative laminate) for aircraft interiors flammability testing according to 14 CFR 25.853 (a) and (d) is currently well established industry practice. The argument used for the similarity of decorative laminate orientation is that since decorative laminates do not display anisotropic flammability properties, changes exclusively in orientation within the same decorative laminate have no appreciable effect on the results of flammability testing (vertical burn, heat release and smoke density).

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials” [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA’s technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Item 14 has been reviewed by the industry team and is submitting the following concurrence, justification and final report.

2 INDUSTRY TEAM LEADER AND SUPPORT TEAM

During an initial industry meeting on September 24, 2009, in Huntington Beach, CA, and subsequent FAA Materials Fire Test Working Group and Flammability Standardization Task Group (FSTG) meetings, the following individuals have volunteered to form the industry team for this reference item:

2.1 TEAM LEADER

- Miler, Michael C. (Schneller LLC)

2.2 SUPPORT TEAM

- Bösser, Klaus (Sell GmbH)
- Bronner, Samantha (Boeing)
- Buedo Leyva, Maribell (Lufthansa Technik AG)
- Buoniconti, Ralph (SABIC Innovative Plastics)
- Campbell, Scott (C&D Zodiac)
- Danker, George (Unifrax)
- Del Pinto, Jim (C&D Zodiac)
- Eberly, Dana (Northwest Airlines)
- Fayerweather, Diane (C&D Zodiac)
- Freeman, Dan (Boeing)
- Fritzl, Raimund (Isovolta AG)
- Hurst, Cheryl (American Airlines)
- Jensen, Michael (Boeing)
- Kauffman, Jym (Kydex LLC)
- Landroni, Francisco (Embraer)
- Langer, Dirk (Sell GmbH)
- Le Neve, Serge (CEAT)
- Livengood, Thomas (B/E Aerospace)
- Muth, Mike (Goodrich)
- Pon, David (Driessen)
- Rathbun, Jason (Schneller LLC)
- Schumillas, Katrin (Lufthansa Technik AG)
- Slaton, Dan (Boeing)
- Spencer, Martin (Heath Tecna)
- Story, Charles W. C. (Magee Plastics Co.)
- Zimmerman, Patrick (3M)

This list is by no means final, but represents a snapshot of the involved industry participants. Additional remarks, suggestions, corrections and contributions from other individuals were encouraged and have been reflected in this report.

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on August 20, 2009. Attachment 2, Part 1, reference item #14 reads (see Figure 1):

- 14 CFR 25.853 (a): *“Data from testing one decorative laminate orientation substantiates a panel with the same decorative laminate That has a different orientation.”*
- 14 CFR 25.853 (d): *“See part 2 of this attachment.”*

Part 1, acceptable methods without additional data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
14	Decorative laminate orientation	Data from testing one decorative laminate orientation substantiates a panel with the same decorative laminate That has a different orientation.	See part 2 of this attachment.

Figure 1: Attachment 2, Part 1, Reference Item #14

Attachment 2, Part 2, reference item #14 reads (see Figure 2):

- 14 CFR 25.853 (a): *“See part 1 of this attachment.”*
- 14 CFR 25.853 (d): *“Data from testing one decorative laminate orientation substantiates a panel with the same decorative laminate with a different orientation.”*

Part 2, methods of compliance that require supporting data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
14	Decorative laminate orientation	See part 1 of this attachment.	Data from testing one decorative laminate orientation substantiates a panel with the same decorative laminate with a different orientation.

Figure 2: Attachment 2, Part 2, Reference Item #14

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of the terms ‘orientation’, ‘decorative laminate’ and ‘same’ should be provided so that confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

3.2.1 ORIENTATION

The industry team agrees that orientation used in the context of this item refers to the directional dependence or independence of flammability properties of a decorative laminate used in the interiors of transport category airplanes.

Directional dependence or independence of a material’s physical properties (e.g. mechanical properties) is a concept used in the field of material sciences. Physical properties of a material tend to display either homogeneous behavior across all directions (‘isotropy’) or directionally dependent behavior (‘anisotropy’) when measured along different axes. The word ‘isotropy’ derives from the Greek words ‘iso’, meaning ‘equal’ and ‘tropos’, meaning ‘direction’. The prefix ‘an-‘ is used to indicate the opposite meaning in ‘anisotropy’. The use of the term orientation is currently well established industry practice. Another word used sometimes within the industry for the term orientation is direction.

An anisotropic material will typically display its largest differences of directional behavior along distinct axes. These axes typically either coincide with a micro or macro structural orientation (e.g. crystalline orientation, grain or fiber direction) of the material itself or are the result of material processing (e.g. stresses and strains induced during the manufacturing process). The industry team agrees that if a decorative type should display any anisotropic flammability properties with an appreciable effect on the results of flammability testing, they should be best observable along a 0º and 90º orientation that corresponds to typical manufacturing orientations, such as ‘machine direction’ (MD) or ‘cross-machine direction’ (CMD).

The industry team therefore recommends that the term ‘orientation’ in the context of this item be defined as: “Machine and cross-machine direction (0º and 90º) of a decorative laminate used in the interiors of transport category airplanes”.

3.2.2 DECORATIVE LAMINATE

The industry team agrees that ‘decorative laminate’ is a polymer-based, single or multilayer, thin-gage, non self-supporting colored decorative sheet that may include additional non-polymer based reinforcing layers and typically contains at least one layer of a fluoropolymer-based film material.

Decorative Laminates are constructed of one or more layers [single or multilayer] of thin-gauge [thin gauge] plastic sheet [polymer-based] that may include additional layers of fiberglass or metallic sheet [additional non-polymer based reinforcing layers] and typically contain at least one layer of a fluoropolymer-based film material. Decorative laminates are always applied using an adhesive on top of an existing surface (substrate) and therefore never form ‘self-supporting’ parts [non-self-supporting]. They may be integrally pigmented or printed with water or solvent based inks to create a decorative color or pattern [colored]. Multi-layered sheets are bonded together during the manufacturing process using thin gauge adhesives or heat and pressure and may include embossing resins for accepting mechanically applied textures.

The use of decorative laminate as a decorative type in the interior of transport category airplanes is currently well established industry practice (state-of-the-art). Decorative laminates are typically being used on the following surfaces: sidewalls, lavatories, galleys, closets, linings, partitions, bin doors and ceilings. Other words used sometimes within the industry for the term decorative laminate are Tedlar, Decorative Tedlar Laminate (DTL), Declam, Airdec, Panlam, AerFilm, Flexdec, Decor, Decorative Film wallpaper or wall covering.

Decorative laminates as defined in the context of this item only refer to currently available, state-of-the-art decorative sheets that have been used in the interior of transport category airplanes over the past 20 years. Any decorative laminates that go beyond the scope of this item would be considered novel or unusual. It is neither the intent of this proposal to make any statements about the applicability of this MOC to such novel or unusual decorative laminates nor to lay out a qualification program by which such novel or unusual decorative laminates may be validated against this MOC.

Following other decorative types are specifically excluded from this item, as they are known to display anisotropic flammability properties depending on surface orientation:

- Decoratives with natural grains and woven products:
  - Wood (solid wood, wood veneers)
  - Fabrics (seat covers, carpets, curtains)

The industry team therefore recommends that the term ‘Decorative Laminate’ in the context of this item be defined as: “polymer-based, single or multilayer thin-gage, non self-supporting colored decorative sheet that may include additional non-polymer based reinforcing layers and typically contains at least one layer of a fluoropolymer-based film material”.

3.2.3 SAME

The industry team agrees that the term ‘same’ in the context of this item refers to a similar decorative type from:

- the same manufacturer, and
- the same product family, and
- the same product build-up.

So when the FAA draft policy memo refers to the “same decorative laminate with a different orientation”, the only change being allowed in the context of this item would be the <u>exclusive</u> change from one orientation to another, with all other product parameters staying the same.

The industry team therefore recommends that the term ‘same’ in the context of this item be defined as: “From the same manufacturer and same product family and same product build-up”.

4 VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

The use of this MOC has been grouped by the FAA into Part 1 for 14 CFR 25.853 (a) and Part 2 for 14 CFR 25.853 (d). This means that the FAA considers the use of this MOC as an acceptable method without the need of additional supporting data for Vertical Burn Testing but will require additional supporting data to accept this method for Heat Release and Smoke Density testing.

The industry team concurs with the FAA's position on 14 CFR 25.853 (a). The use of similarity of decorative laminate orientation (e.g. the substantiation of one orientation by using previous flammability test data from another orientation within the same decorative laminate) for aircraft interiors flammability testing according to 14 CFR 25.853 (a) is currently well established industry practice.

The industry team believes that sufficient data exists to substantiate the acceptance of this MOC for 14 CFR 25.853 (d) and move it to Part 1. The use of similarity of decorative laminate orientation (e.g. the substantiation of one orientation by using previous flammability test data from another orientation within the same decorative laminate) for aircraft interiors flammability testing according to 14 CFR 25.853 (d) is currently well established industry practice. The argument used for the similarity of decorative laminate orientation is that since decorative laminates do not display anisotropic flammability properties, changes exclusively in orientation within the same decorative laminate have no appreciable effect on the results of flammability testing (Heat Release and Smoke Density).

Historically, anisotropic flammability properties have not been observed on decorative laminates used in the interiors of transport category airplanes. In contrast to that, anisotropic flammability properties have been observed on a variety of other different non-plastic decorative types used in the interiors of transport category airplanes. Most woven fabrics and fibrous textile materials, such as carpet floor coverings, drapes, tapestries and seat covers display distinct anisotropic behavior in warp and fill directions. Other decorative types that have displayed distinct anisotropic flammability properties in the past include natural materials with a distinct fiber growth or grain direction, such as wood or wood veneers.

For such materials that are known to display anisotropic flammability properties, the FAA Aircraft Materials Fire Test Handbook [2] has introduced the requirement for *"materials that may have anisotropic properties"* to *"be tested in the orientation thought to give the highest results"* (Figure 3). Additionally, the handbook also requires materials with anisotropic properties to be tested *"perpendicular to the orientation used for the first set of specimens"* if certain Heat Release and Smoke Density thresholds are surpassed. As example of such materials, the Handbook specifically mentions MD and CMD for extrusions and warp and fill directions of woven fabrics.

5.4.4 Specimen Orientation

For materials that may have anisotropic properties (i.e., different properties in different directions, such as machine and cross-machine directions for extrusions, warp and fill directions of woven fabrics, etc.), the specimens will be tested in the orientation thought to give the highest results. If the average maximum heat release rate exceeds 58 kW/m^2 or the average total heat released during the first 2 minutes exceeds 58 kW min/m^2, a second set of specimens will be prepared and tested in the orientation that is perpendicular to the orientation used for the first set of specimens. The higher value for the average maximum heat release rate and the higher value for the average total heat released during the first 2 minutes will be reported.

6.4.4 Specimen Orientation

For materials that may have anisotropic flammability properties (i.e., different properties in different directions, such as machine and cross-machine directions for extrusions, warp and fill directions of a woven fabric, etc.), specimens will be tested in the orientation thought to give the highest result. If the average ${}^4D_m$ is greater than 180, a second set of specimens will be prepared and tested in the orientation that is perpendicular to the orientation used for the first set of specimens. The higher of the two average ${}^4D_m$ values will be reported.

Figure 3: Paragraph 5.4.4 & 6.4.4., FAA Aircraft Material Fire Test Handbook [2]

Although decorative laminates used in the interiors of transport category airplanes do differentiate between MD and CMD (0º and 90º) in their manufacturing process, they cannot be considered to be anisotropic materials when it comes to flammability properties. The differentiation in MD and CMD is simply a necessity of the manufacturing process that will require two distinct directions to be identified for indexing, printing and texturing purposes. However, the layer-by-layer chemical composition of the finished product does not change with orientation. Therefore, decorative laminate orientation has no appreciable effect on the results of flammability testing for decorative laminates.

4.2 PROPOSED STANDARD TO MEET

Move attachment 2, Part 2 reference item #14 for 14 CFR 25.853 (d) to attachment 2, Part 1 and delete reference item #14 from attachment 2, Part 2.

Modify attachment 2, Part 1, reference item #14 to read the following:

- 14 CFR 25.853 (a): *“Data from testing one decorative laminate orientation substantiates ~~a panel with~~ the same decorative laminate ~~That has~~ with a different orientation.”*
- 14 CFR 25.853 (d): *“Data from testing one decorative laminate orientation substantiates ~~a panel with~~ the same decorative laminate with a different orientation.”*

Additionally, the industry team agrees that since decorative laminates exhibit isotropic flammability properties, decorative laminate orientation falls under the existing guidance for orientation as per FAA Aircraft Materials Fire Test Handbook [2].

5 DATA / ANALYSIS

5.1 EXISTING TEST DATA

The industry has called upon its members to submit any type of existing flammability test data to support the similarity of decorative laminate orientation for 14 CFR 25.853 (d). Unfortunately, no such data could be obtained. The reason why such data could not be obtained is that the use of similarity of decorative laminate orientation has been a well established and widely accepted industry practice. No industry participant currently keeps track of decorative laminate orientation as a separate parameter of flammability testing. Unlike other decorative laminate parameters (such as part number, manufacturer or product family), the orientation of a decorative laminate will typically never be noted in the burn test specimen configuration of test coupons for Heat Release and Smoke Density testing.

The industry team agrees that no previously existing test data can be found to support the similarity of decorative laminate orientation.

5.2 PROPOSAL OF TESTS TO BE PERFORMED

As existing test data to support the similarity of decorative laminate orientation could not be obtained, the industry team has been called upon to devise a simple controlled flammability experiment to support that decorative laminate orientation has no appreciable effect on the results of flammability testing for 14 CFR 25.853 (d).

In order to provide substantiation to the industry group’s recommendation in paragraph 4.2, the industry group proposes a controlled experiment to isolate the influence of decorative laminate orientation on flammability testing according to 14 CFR 25.853 (d).

5.2.1 DECORATIVE LAMINATES

To provide substantiation to the industry group’s recommendation in paragraph 4.2, the 3 major decorative laminate manufacturers (Boeing, Isovolta, Schneller) will perform a series of flammability tests (14 CFR 25.853 (d), Heat Release & Smoke Density) on a variety of different decorative laminates with their adhesives of choice:

- Each manufacturer will select a minimum of 2 different decorative laminate product families:
  - Product families have been assigned randomly between different manufacturers as Product A and Product B. They therefore cannot be compared directly amongst different manufacturers.
- Within each product family, the following parameters will be the same:
  - Same adhesive system.
  - Same color.
  - Same texture.
  - Same product build-up.
  - Same gauge.
- Within each manufacturer, the following parameters will be the same:
  - Same flammability test facility.
  - Same flammability test chamber.
  - Same flammability test operator.

  - All Heat Release samples of one product family have to be completed on the same day.
  - All Smoke Density samples of one product family have to be completed on the same day.
  - No major equipment changes should be performed during the course of this test program:
    - No calibrations, transducer changes, etc.
- Across all 3 manufacturers, the following parameters will be the same:
  - Run all tests according to FAA Aircraft Material Fire Test Handbook [2].
  - Same isotropic substrate panel:
    - Aluminum sheet, 2024 T3, thickness 0.8 mm.
  - Same number of tests performed per product family:
    - 18 runs per product family.
    - 9 runs in MD, 9 runs in CMD
  - Same order of tests:
    - Alternate testing between MD and CMD, beginning with MD.
  - Same recorded data:
    - Date & time of each individual run performed.
    - Operator.
    - Test graph.
    - Gas Calibration Factor.

5.3 TEST RESULTS

The following figures represent a graphical overview of the test results from all 3 manufacturers. Each manufacturer has been assigned a random letter (A, B or C) to ensure anonymity. 3 separate figures are available for each individual manufacturer, displaying the results for Peak Heat Release, Total Heat Release and Smoke Density testing.

The blue columns indicate test results for product family A, the green columns indicate test results for product family B. To ensure anonymity, product families have been assigned randomly between different manufacturers as Product A and Product B. They therefore cannot be compared directly amongst different manufacturers.

Within each figure, the two leftmost columns display the averages of 9 runs each in MD for both product families. The two center columns display the averages of 18 runs each in MD & CMD for both product families. The two rightmost columns display the averages of 9 runs each in CMD for both product families. Direct comparisons should only be made within the same product family for the same manufacturer, i.e. likewise colors within one figure.

For a more detailed overview of the test data, please refer to Appendix A.

5.3.1 MANUFACTURER A

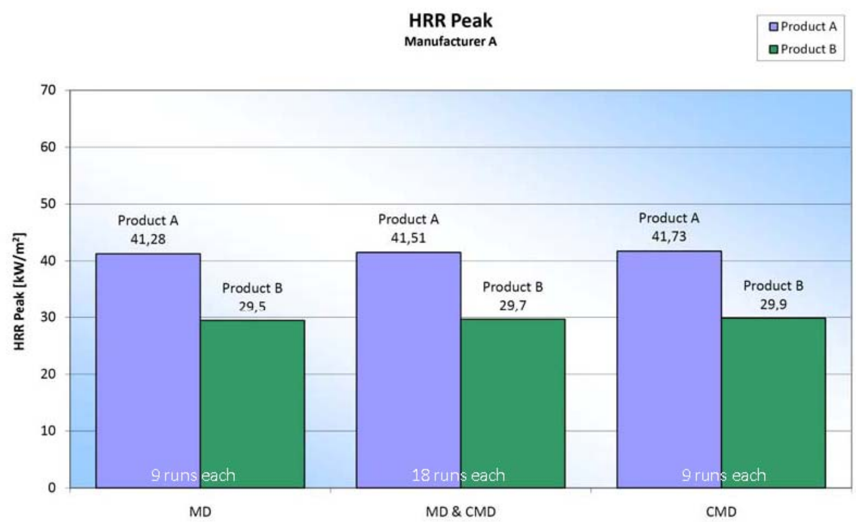

Figure 4: HRR Peak, Manufacturer A, Product A & B

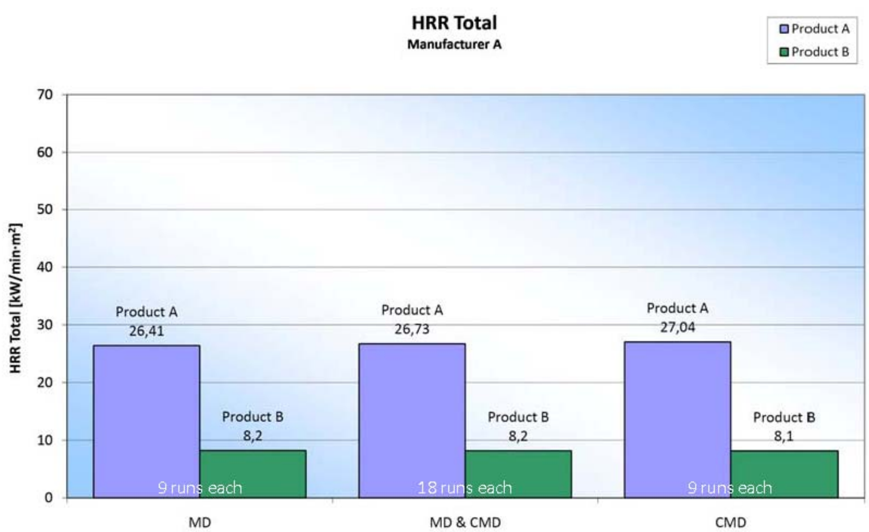

Figure 5: HRR Total, Manufacturer A, Product A & B

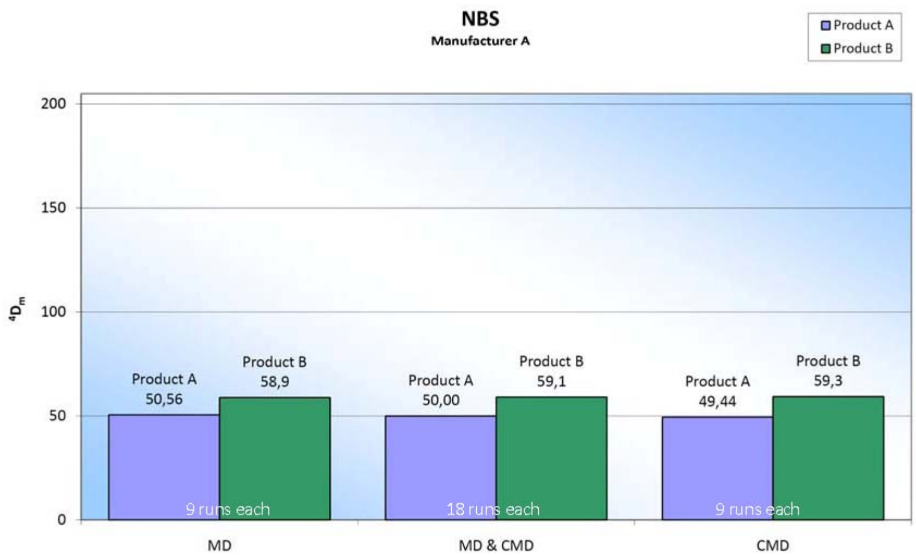

Figure 6: NBS, Manufacturer A, Product A & B

5.3.2 MANUFACTURER B

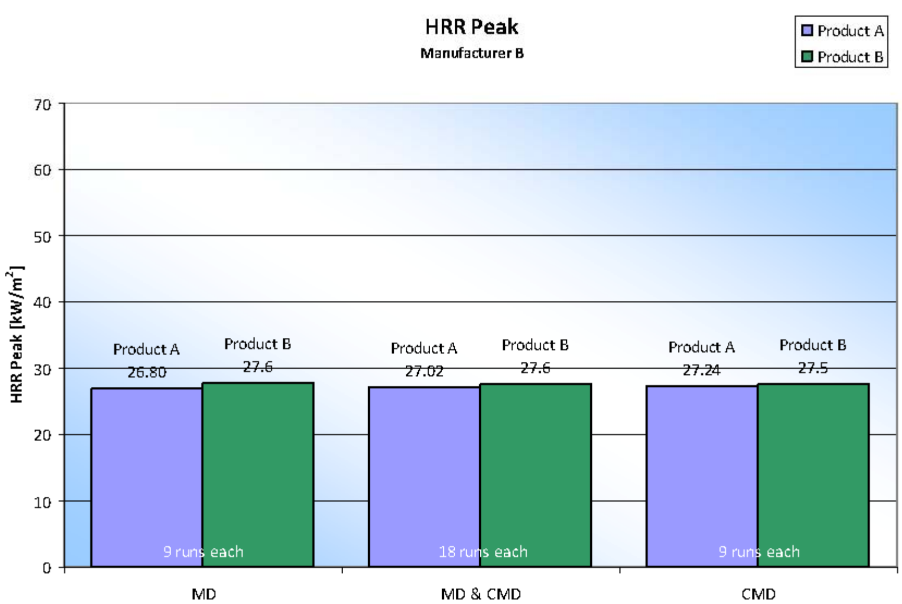

Figure 7: HRR Peak, Manufacturer B, Product A & B

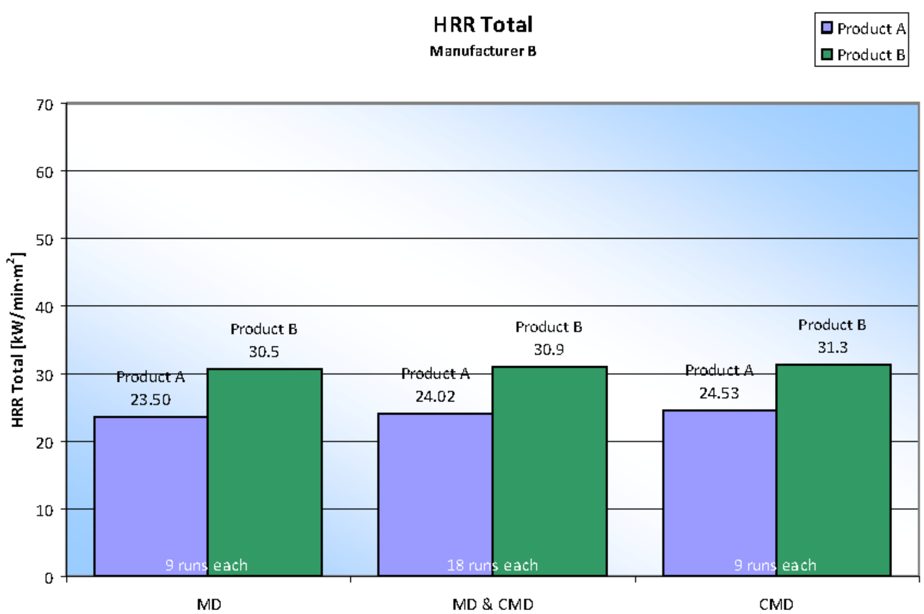

Figure 8: HRR Total, Manufacturer B, Product A & B

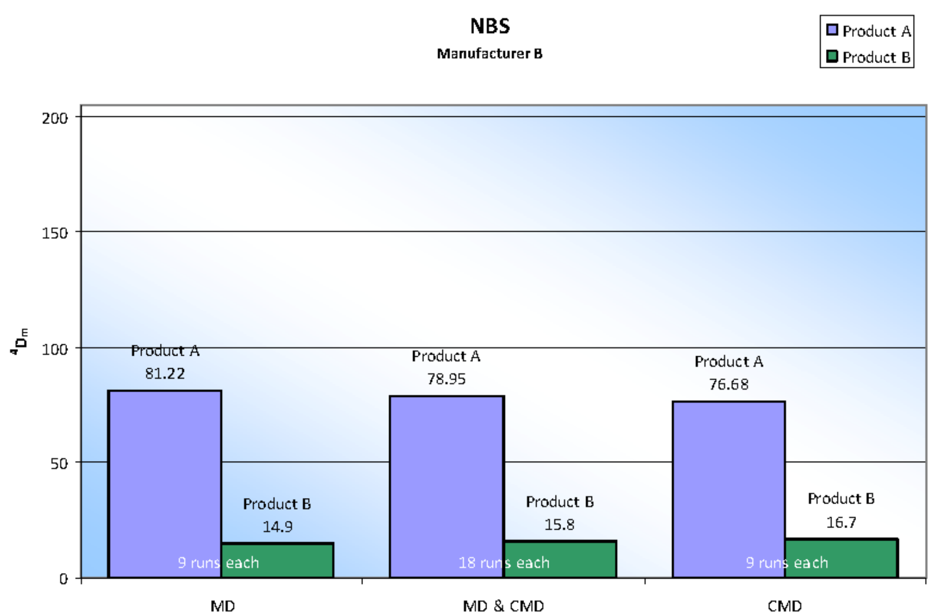

Figure 9: NBS, Manufacturer B, Product A & B

5.3.3 MANUFACTURER C

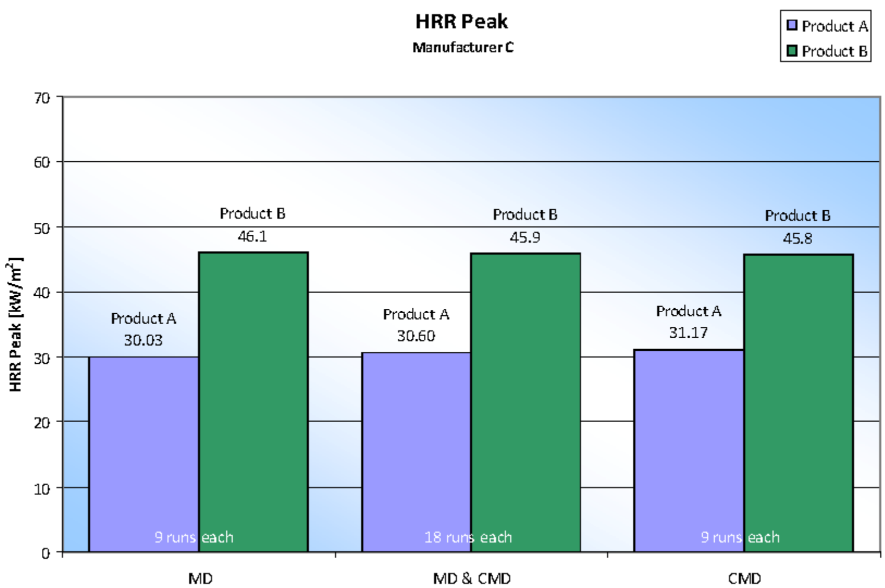

Figure 10: HRR Peak, Manufacturer C, Product A & B

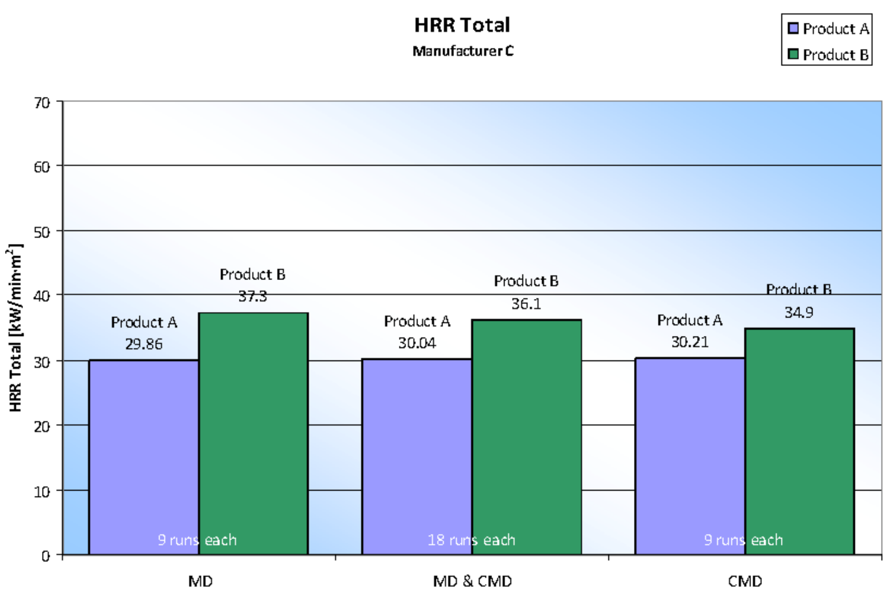

Figure 11: HRR Total, Manufacturer C, Product A & B

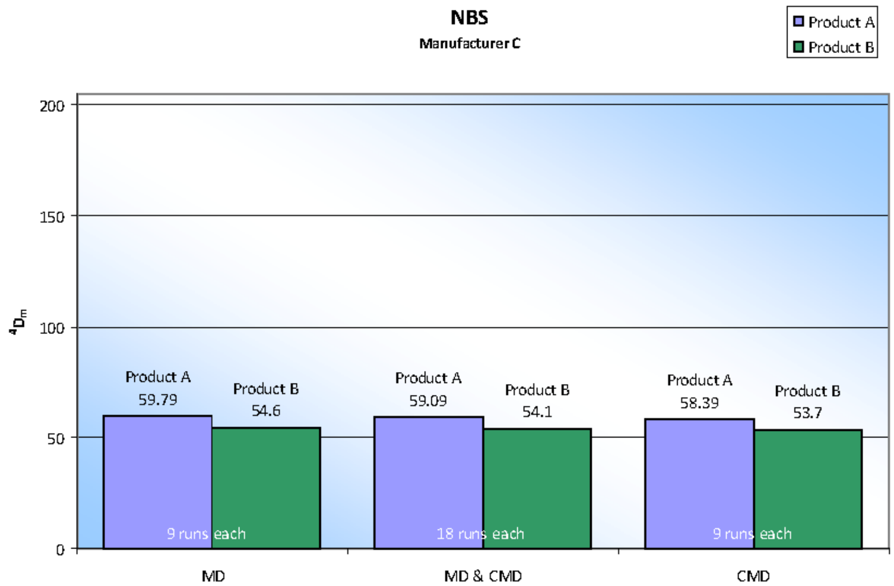

Figure 12: NBS, Manufacturer C, Product A & B

5.4 ANALYSIS OF TEST RESULTS

An apparent initial view of the test results provided in the graphical overview in section 5.3 yields no significant differences in the means of flammability test results within each individual product for MD and CMD. In order to further support these visual findings, additional statistical methods will be used with the goal to provide a meaningful comparison that shows whether decorative laminate orientation has an appreciable effect on the results of flammability testing.

A statistical analysis of test results from all 3 manufacturers was conducted with the General Linear Model (GLM), using a balanced 2-factor Analysis of Variance (ANOVA) to determine equivalence of means between two data sets. The two selected response variables were product family and orientation, with 2 factor levels each (Product A and Product B, MD and CMD). Minitab® 16 was used to analyze the data.

5.4.1 NORMALITY AND HOMOGENEITY

Normality and homogeneity of variance are assumptions of the ANOVA model. A visual comparison of the residual plots for HRR Peak, HRR Total and NBS Smoke Density shows that both preconditions are validated.

For a more detailed overview of normality and homogeneity of variance, please refer to the residual probability plots Appendix A, section 9, Figure 14 through Figure 25.

5.4.2 ANOVA TABLE

The ANOVA table displays two statistics that can help to evaluate whether pairs of means are different: p-values and R^2.

One statistic in the ANOVA table is the p-value (P) at 95% confidence. There is a p-value for each term in the model. The p-values provided with the individual hypothesis tests can be used to determine whether pairs of means are different:

- If the p-value for a comparison is ≤ the chosen α-level, the difference between the means is statistically significant.
- If the p-value is > the chosen α-level, the difference between means is not statistically significant.

All p-values for the factor orientation show a p-value larger than the chosen α-level ($\alpha = 0.05$) for the test data from all 3 manufacturers (see Figure 13). Therefore, the observed difference between the means of MD vs. CMD is not statistically significant.

R^2 is a measure of how well the model fits the data. These values can help to select the model with the best fit:

- R^2 describes the amount of variation in the observed response values that is explained by the predictor(s).
- R^2 can be used to estimate the influence of an individual response when compared to the sum of squares for all terms (incl. error) in the model.

The R^2 values show no appreciable contribution of orientation to the overall difference in means when compared to the sum of squares for all terms (incl. error) in the model (see Figure 13).

Summary of ANOVA Table	Seq. Sum of Squares			R^2			p-value (>0.05)		
	Total HRR	Peak HRR	^4D_m	Total HRR	Peak HRR	^4D_m	Total HRR	Peak HRR	^4D_m
Manufacturer A									
Orientation	0.7	1.7	1.0	**0.0%**	**0.1%**	**0.1%**	**0.681**	**0.658**	**0.847**
Product	3095.1	1261.4	747.1	95.9%	81.8%	46.7%	0.000	0.000	0.000
Orient.*Prod.	1.1	0.0	5.5	0.0%	0.0%	0.3%	0.600	0.987	0.653
Error	129.5	278.2	845.3	4.0%	18.1%	52.9%			
Total	3226.4	1541.4	1598.9	100.0%	100.0%	100.0%			
Manufacturer B									
Orientation	7.6	0.3	16.0	**1.2%**	**0.2%**	**0.0%**	**0.302**	**0.823**	**0.751**
Product	427.8	2.7	35891.0	65.3%	1.5%	87.5%	0.000	0.494	0.000
Orient.*Prod.	0.1	0.6	92.0	0.0%	0.4%	0.2%	0.895	0.737	0.449
Error	219.6	178.4	5041.0	33.5%	98.0%	12.3%			
Total	655.1	182.0	41040.0	100.0%	100.0%	100.0%			
Manufacturer C									
Orientation	9.6	1.6	11.1	**1.5%**	**0.1%**	**2.3%**	**0.319**	**0.632**	**0.250**
Product	327.2	2118.4	219.9	50.0%	90.7%	44.9%	0.000	0.000	0.000
Orient.*Prod.	17.1	4.6	0.8	2.6%	0.2%	0.2%	0.187	0.408	0.757
Error	300.9	211.6	258.5	45.9%	9.1%	52.7%			
Total	654.9	2336.2	490.3	100.0%	100.0%	100.0%			

Figure 13: Summary of ANOVA Table, Manufacturers A, B & C

5.4.3 GROUPING

Grouping was checked using the Tukey Method and 95% confidence. The grouping information generated by the Tukey method displays, in a summarized format, groups of factor level means that are not significantly different. If a level mean is not in a group, then its mean is significantly different from that group.

The Tukey table contains columns of letters that group the factor levels:

- Levels that share a letter are not significantly different.
- Conversely, if they do not share a letter, the level means are significantly different.

All grouping comparisons between the means of CMD with MD share the same letter in the Tukey table for the test data from all 3 manufacturers. Therefore, the observed difference between the means of MD vs. CMD is not statistically significant. If requested, detailed grouping data can be made available to the FAA for further analysis.

5.4.4 CONFIDENCE INTERVAL

Confidence intervals generated by the Tukey method at 95% confidence were used to determine whether two means are different:

- If an interval does not contain zero, there is a statistically significant difference between the corresponding means.

- If the interval does contain zero, the difference between the means is not statistically significant.

All pairwise comparisons among levels of orientation, with CMD subtracted from MD, yield results with an interval containing zero for the test data from all 3 manufacturers. Therefore, the observed difference between the means of MD vs. CMD is not statistically significant. If requested, detailed confidence interval data can be made available to the FAA for further analysis.

5.5 CONCLUSION

Both the apparent initial view of the test results in section 5.3 as well as the results of the statistical analysis of the test data in section 5.4 support that decorative laminate orientation has no appreciable effect on the results of flammability testing. Therefore, decorative laminates exhibit isotropic flammability properties.

5.5.1 STATISTICAL VERSUS PRACTICAL SIGNIFICANCE

The results of statistical methods should only be used as one of many indicators to evaluate the overall influence of a specific factor on the results of flammability testing. Statistical methods should not be regarded as the sole hard criterion to evaluate the overall influence of a specific factor on the results of flammability testing.

Even if individual factor level means are significantly different from a statistical standpoint, the difference may not be of any practical importance. Only knowledge of the subject area of aircraft materials flammability testing and not statistics alone can be used to answer the question of whether decorative laminate orientation shows an appreciable effect on the results of flammability testing.

6 CONCLUSION

The industry team concurs with the FAA's position on 14 CFR 25.853 (a) and believes that sufficient data has been presented to show that decorative laminates exhibit isotropic flammability properties and substantiate the acceptance of this MOC for 14 CFR 25.853 (d) and move it to Part 1.

Based on industry discussion and the results of the flammability testing performed and analyzed in paragraph 5 of this document, the industry team recommends revising the current proposal and providing further clarification of key terms as follows.

6.1 REVISED PROPOSAL

Move attachment 2, Part 2, reference item #14 for 14 CFR 25.853 (d) to attachment 2, Part1 and delete reference item #14 from attachment 2, Part 2.

Modify attachment 2, Part 1, reference item #14 to read the following:

- 14 CFR 25.853 (a): *"Data from testing one decorative laminate orientation substantiates ~~a panel with~~ the same decorative laminate ~~That has~~ with a different orientation."*
- 14 CFR 25.853 (d): *"Data from testing one decorative laminate orientation substantiates ~~a panel with~~ the same decorative laminate with a different orientation."*

Include the definition of all terms as listed in paragraph 3.2 ('orientation', 'decorative laminate' and 'same') in a commentary or list of significant key terms in the FAA draft policy memo and enforce their consistent use throughout the policy.

Additionally, the industry team agrees that since decorative laminates exhibit isotropic flammability properties, decorative laminate orientation falls under the existing guidance for orientation as per FAA Aircraft Materials Fire Test Handbook [2].

7 ABBREVIATIONS

ANOVA	=	Analysis of Variance
CFR	=	Code of Federal Regulations
CMD	=	Cross-Machine Direction
FAA	=	Federal Aviation Administration
FSTG	=	Flammability Standardization Task Group
GLM	=	General Linear Model
MD	=	Machine Direction
MOC	=	Methods of Compliance
NTF	=	Non-Textile Flooring

8 REFERENCES

[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

[2] FAA Handbook, FAA Technical Center, Report DOT/FAA/AR–00/42, *Aircraft Materials Fire Test Handbook*, April 2000.

9 APPENDIX A: DETAILED TEST DATA

9.1 MANUFACTURER A

Manufacturer A						
	Product A			Product B		
	Total HRR	Peak HRR	^4D_m	Total HRR	Peak HRR	^4D_m
Average	26,73	41,51	50,00	8,18	29,67	59,11
StDev	2,20	3,12	6,83	1,69	2,60	1,88
Min	23,60	36,50	35,00	5,40	25,00	56,00
Max	29,90	48,80	60,00	12,00	36,10	62,00
$\Delta_{Max-Min}$	6,30	12,30	25,00	6,60	11,10	6,00
Average MD	26,41	41,28	50,56	8,22	29,46	58,89
StDev MD	2,47	2,83	6,65	1,95	3,06	1,69
Min MD	23,60	38,60	36,00	5,40	25,00	57,00
Max MD	29,90	47,30	59,00	12,00	36,10	62,00
$\Delta_{Max-Min}$	6,30	8,70	23,00	6,60	11,10	5,00
Average CMD	27,04	41,73	49,44	8,14	29,88	59,33
StDev CMD	2,00	3,53	7,35	1,51	2,21	2,12
Min CMD	23,60	36,50	35,00	5,50	26,20	56,00
Max CMD	29,90	48,80	60,00	10,10	33,10	61,00
$\Delta_{Max-Min}$	6,30	12,30	25,00	4,60	6,90	5,00

Figure 14: Test Results, Manufacturer A, Product A & B

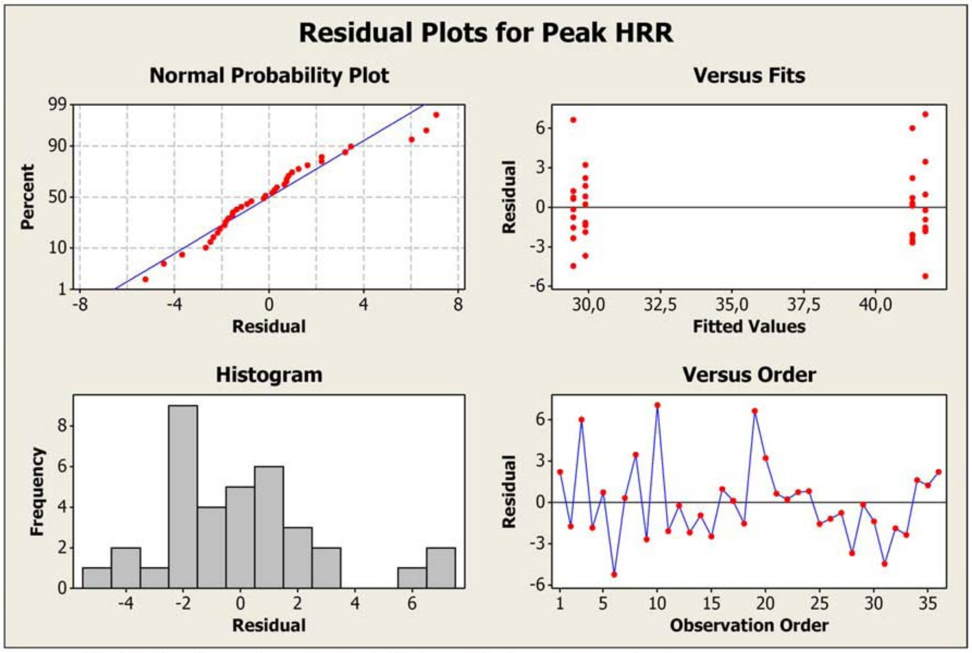

Figure 15: Minitab® Residual 4-in-1 Plot (HRR Peak), Manufacturer A

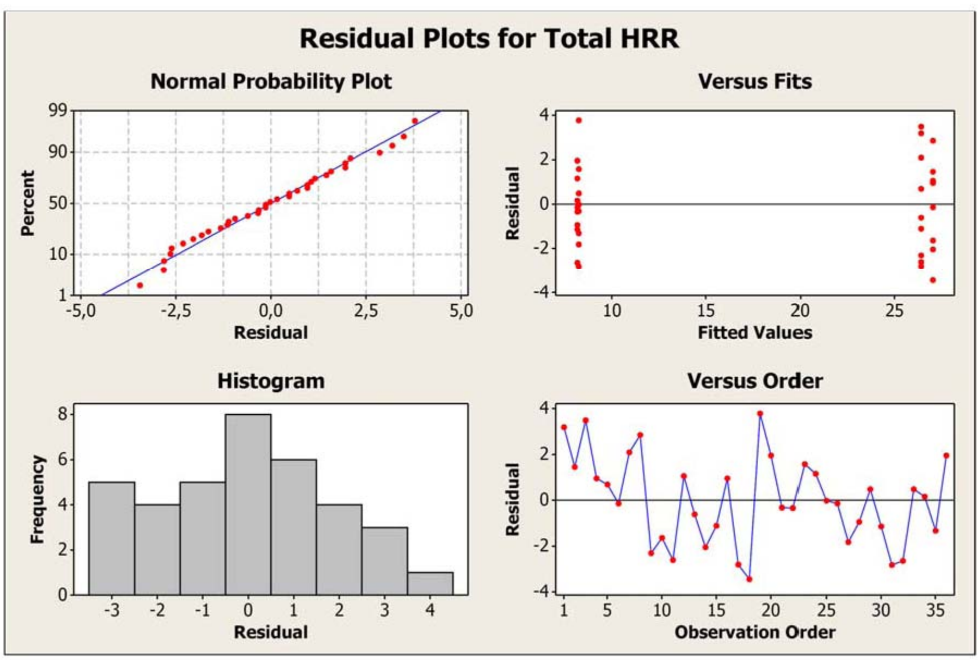

Figure 16: Minitab® Residual 4-in-1 Plot (HRR Total), Manufacturer A

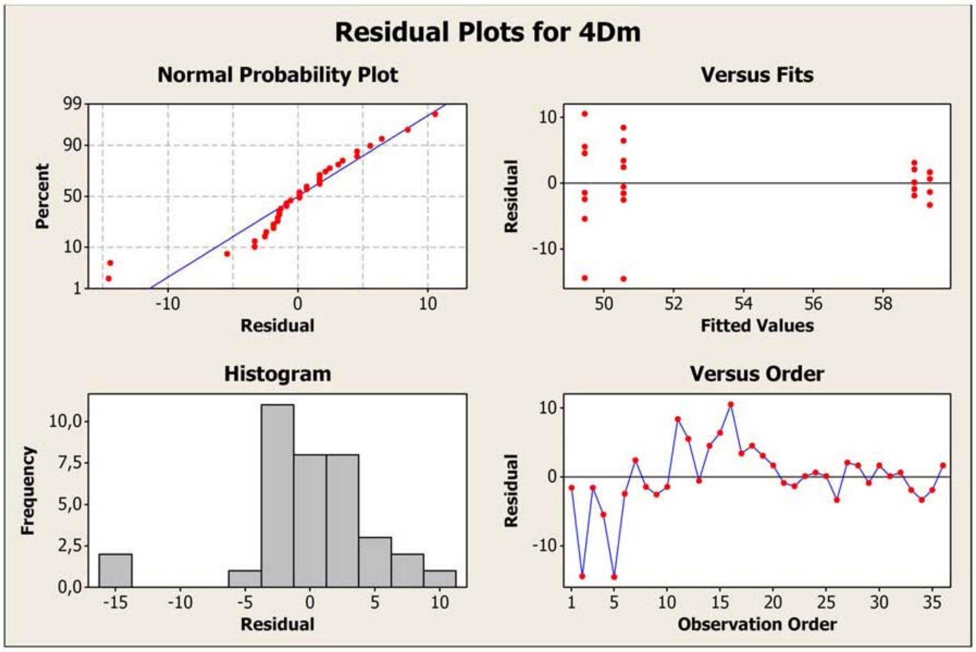

Figure 17: Minitab® Residual 4-in-1 Plot (NBS), Manufacturer A

9.2 MANUFACTURER B

Manufacturer B						
	Product A			Product B		
	Total HRR	Peak HRR	^4D_m	Total HRR	Peak HRR	^4D_m
Average	24.02	27.02	78.95	30.91	27.57	15.80
StDev	3.19	2.34	16.52	1.79	2.25	5.49
Min	15.10	20.20	54.10	27.40	23.80	9.10
Max	27.90	30.90	103.70	33.40	31.60	33.80
$\Delta_{Max-Min}$	12.80	10.70	49.60	6.00	7.80	24.70
Average MD	23.50	26.80	81.22	30.51	27.61	14.87
StDev MD	3.87	2.70	18.52	1.94	2.17	4.02
Min MD	15.10	20.20	56.00	27.40	24.50	9.10
Max MD	27.90	29.30	103.70	33.40	31.60	21.90
$\Delta_{Max-Min}$	12.80	9.10	47.70	6.00	7.10	12.80
Average CMD	24.53	27.24	76.68	31.31	27.52	16.73
StDev CMD	2.46	2.06	15.01	1.63	2.46	6.77
Min CMD	19.50	24.60	54.10	28.80	23.80	11.20
Max CMD	27.30	30.90	98.30	33.10	31.50	33.80
$\Delta_{Max-Min}$	7.80	6.30	44.20	4.30	7.70	22.60

Figure 18: Test Results, Manufacturer B, Product A & B

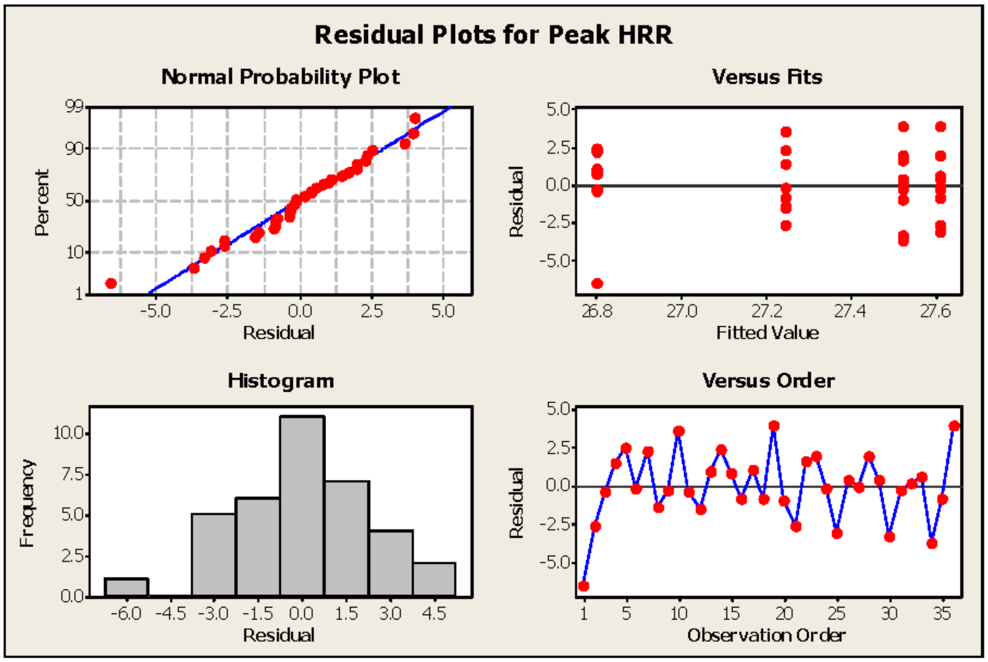

Figure 19: Minitab® Residual 4-in-1 Plot (HRR Peak), Manufacturer B

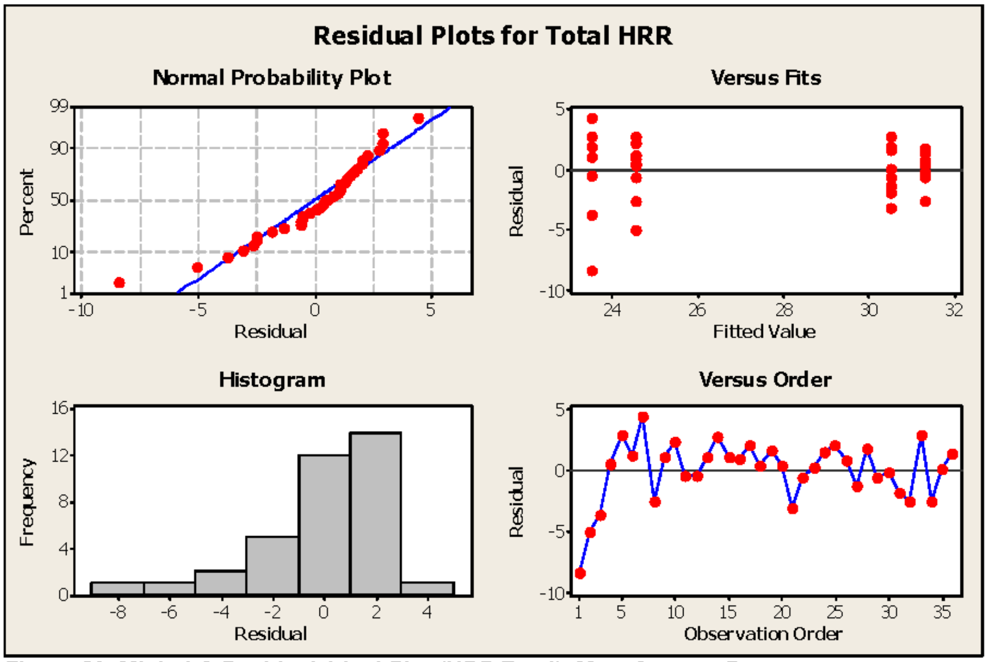

Figure 20: Minitab® Residual 4-in-1 Plot (HRR Total), Manufacturer B

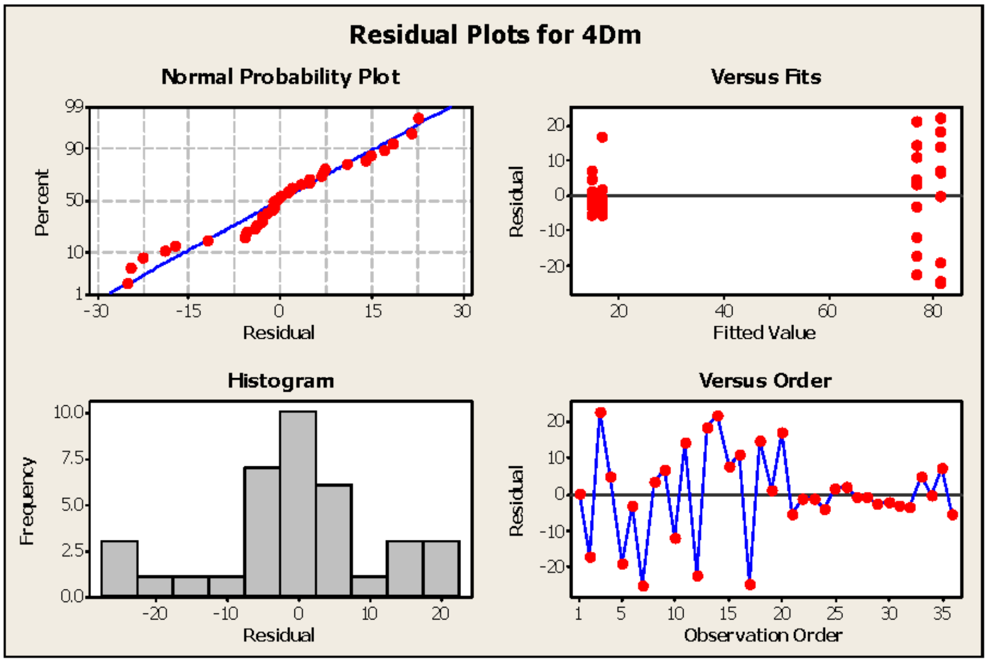

Figure 21: Minitab® Residual 4-in-1 Plot (NBS), Manufacturer B

9.3 MANUFACTURER C

Manufacturer C						
	Product A			Product B		
	Total HRR	Peak HRR	^4D_m	Total HRR	Peak HRR	^4D_m
Average	30.04	30.60	59.09	36.07	45.94	54.15
StDev	2.42	3.01	2.77	3.66	1.93	2.87
Min	25.01	25.39	54.21	30.16	42.47	49.11
Max	34.77	35.54	62.97	41.97	48.62	57.98
$\Delta_{Max-Min}$	9.76	10.15	8.76	11.81	6.15	8.87
Average MD	29.86	30.03	59.79	37.27	46.09	54.55
StDev MD	2.15	2.53	2.35	4.12	1.61	2.50
Min MD	26.79	25.72	56.59	30.16	44.10	49.99
Max MD	34.77	34.41	62.57	41.97	48.62	57.67
$\Delta_{Max-Min}$	7.98	8.69	5.98	11.81	4.52	7.68
Average CMD	30.21	31.17	58.39	34.86	45.79	53.74
StDev CMD	2.78	3.49	3.10	2.88	2.30	3.30
Min CMD	25.01	25.39	54.21	31.45	42.47	49.11
Max CMD	34.04	35.54	62.97	40.56	48.42	57.98
$\Delta_{Max-Min}$	9.03	10.15	8.76	9.11	5.95	8.87

Figure 22: Test Results, Manufacturer C, Product A & B

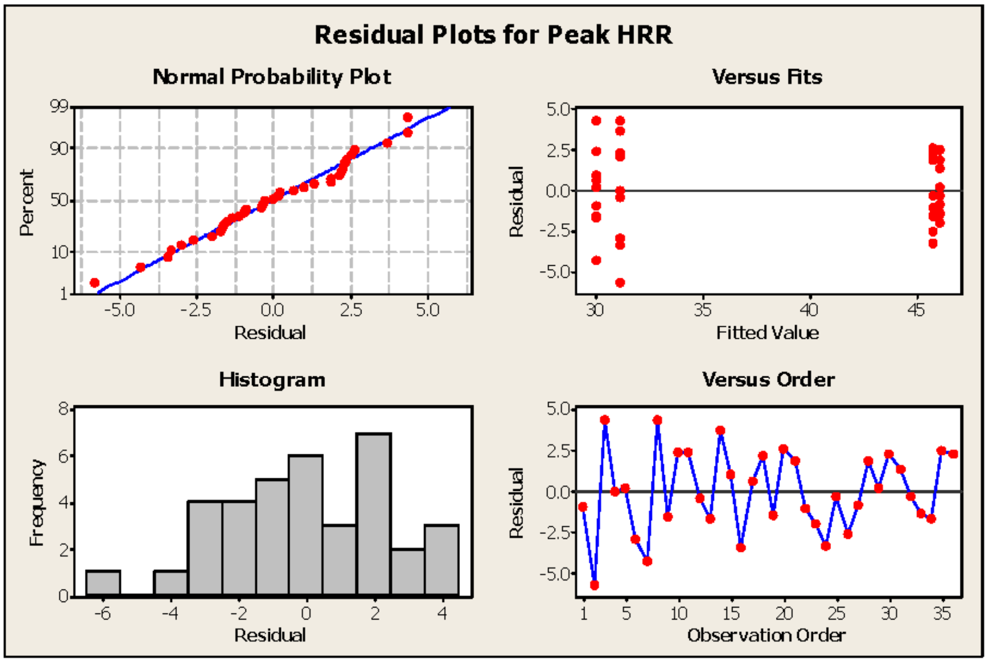

Figure 23: Minitab® Residual 4-in-1 Plot (HRR Peak), Manufacturer C

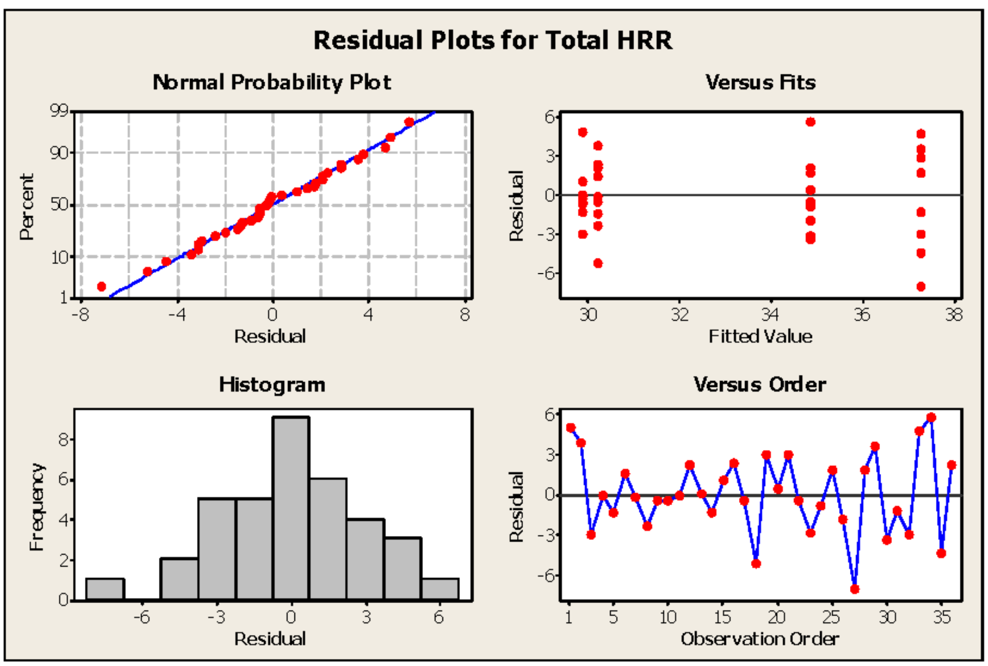

Figure 24: Minitab® Residual 4-in-1 Plot (HRR Total), Manufacturer C

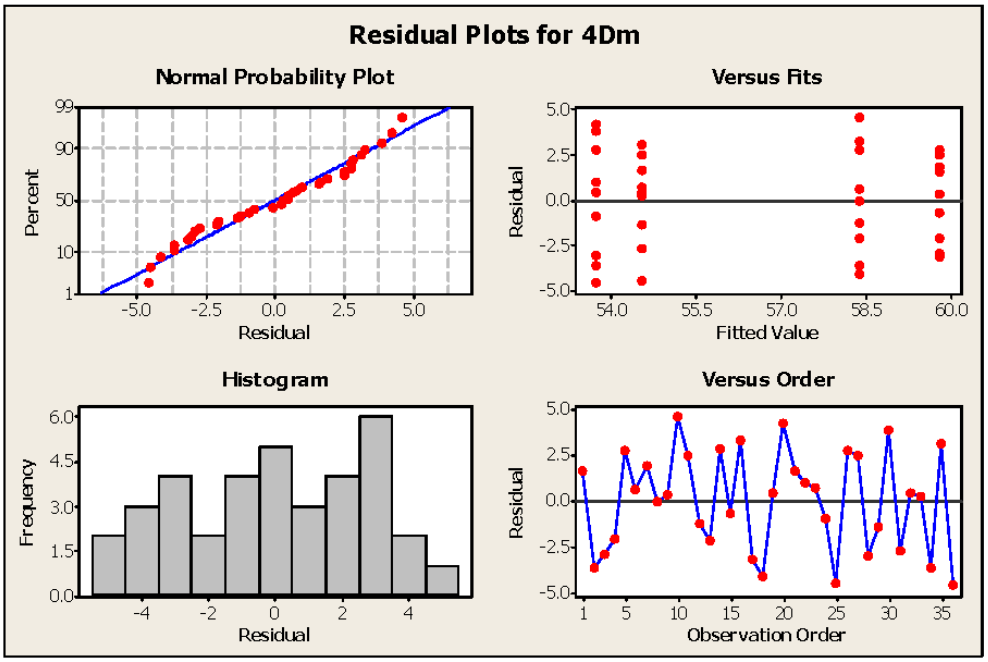

Figure 25: Minitab® Residual 4-in-1 Plot (NBS), Manufacturer C

APPENDIX O—ITEM 15: SYNTHETIC LEATHER-SUEDE

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM PROPOSAL

Part 2, Reference Item #15, “Synthetic Leather/Suede”

Revision – B, dated 2011-Nov-11

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				35	B				
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				37	B				
				38	B				
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				40	B				
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				42	B				
				43	B				

REVISION HISTORY

<table>
<tr><th>REV</th><th>DESCRIPTION</th><th>DATE</th><th>ISSUED BY</th></tr>
<tr><td>N/C</td><td>- Initial release</td><td>2010-Jun-09</td><td>Gilberto Niitsu</td></tr>
<tr><td>A</td><td>- Changed the wording on page 9:
From:
“The figure 4 below is presented to show that the test results (Burn Length and Self Extinguish Time)deviations occur between a range and this range is applicable for all tested materials (different colors). In other words, in a preliminary analysis we may assume that the color variation is not responsible for the test results deviations.”
To:
“The figure 4 below is presented to show that
• Within the same color, test results variation (avg. burn length and avg. self extinguish time) does exist;
• One color is no worse than any other;
• The large amounts of the results are between 2 and 4 inches(avg burn length), and between 0 and 2 seconds (avg self extinguish time)
These facts lead us to conclude that the differences in colors do not contribute for the test results variation”.
- Removed the 1σ plot data;
- Corrected the last sentence on page 12 from “burn length” to “self extinguish time”.
- Updated the item “6. Conclusions”:
From:
“Based on the synthetic leather test results (burn length and self extinguish time) we may conclude that the color variation does not have any influence on 12 seconds vertical test, once points exceeding the 1σ range are observed for different colors.”
To:
Based on the synthetic leather test results (burn length and self extinguish time) we may conclude that the color variation does not have any influence on 12 seconds vertical test, once within the same color, test results variation does exist and one color is no worse than any other”.
- Removed the item “7. Proposed Future Actions”;</td><td>2011-Jan-14</td><td>Gilberto Niitsu</td></tr>
<tr><td>B</td><td>- Cover page, changed from “Part 1” to “Part 2”;
- Added E-Leather data for similarity analysis;
- Extended the similarity substantiation for warp/lay directions and thickness variations;</td><td>2011-Nov-11</td><td>Gilberto Niitsu</td></tr>
</table>

B	- Item “4. Clarification of Terms”: - Updated “same material” definition - Added “synthetic leather/suede” definition	2011-Nov-10	Gilberto Niitsu

1. Introduction

Initially the aim of this report was to analyze the viability on accepting the substantiation of one color by using previous tested synthetic leather/suede of different color within the same material composition for flammability requirement 14CFR 25.853(a) – Vertical Test based on several test results. After all the data analysis it was verified that this substantiation may be extended for warp / lay directions and weight / thickness variations as discussed along the report.

For flammability requirements 14CFR 25.853(d) – Heat Release & Smoke Density, the FAA has already established that different colors of synthetic leather/suede may affect the test results. Therefore the testing of each color of synthetic leather/suede material is required.

2. Team Leader and Support Team

During a meeting in Huntington Beach/Ca on Sept 24, 2009, volunteers have been called to participate as Team Leader and Support Team for this reference item. However the Support Team listed below was contacted by the Embraer afterwards to this meeting and they have supported greatly.

2.1 TEAM LEADER

- Embraer

2.2 SUPPORT TEAM

- C&D Zodiac
- Tapis Corporation
- E-Leather Group

3. Project Definition

Currently, the ANM-115-09-XXX is available as an undated draft. The Attachment 2, Parts1 and 2 of this document for reference item # 15 read (figures 1 and 2 below):

Part 1, acceptable methods without additional data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
15	Synthetic leather/suede	See part 2 of this attachment.	Testing of each color synthetic leather/suede material is required.

Figure 1: ANM-115-09-xxx, Attachment 2, Part 1, reference item #15

Part 2, methods of compliance that require supporting data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
15	Synthetic leather/suede	Data from testing one synthetic leather/suede material sample will substantiate other colors of the same material.	See part 1 of this attachment.

Figure 2: ANM-115-09-xxx, Attachment 2, Part 2, reference item #15

Per figures 1 and 2 it is understood that for the synthetic leather/suede material, the color substantiation is not allowed for Heat Release and Smoke Density tests being each color testing required. For the Vertical test, data is required to support the acceptance of similarity.

Thus, Embraer has collected data from its laboratory and has received data from C&D, Tapis Corp. and E-Leather Group. All data presented here for synthetic leather/suede manufactured by Tapis Corporation and E-Leather Group were tested for 12 seconds Vertical Test. Additional data from other manufacturers or even from the manufacturers mentioned previously would be very much welcome.

The 12 seconds Vertical test data were treated in the following way:

- COLOR VARIATION ANALYSIS
- WARP / LAY DIRECTIONS ANALYSIS
- WEIGHT / THICKNESS VARIATION ANALYSIS

4. Clarification of Terms

"Same material" means same manufacturer, same material composition (except for the color composition) and same test specimen build-up. The change allowed in the context of synthetic leather/suede similarity would be color variation, warp/lay directions and weight/thickness variation, with all other parameters staying the same.

"Synthetic leather/suede" is a man made product that presents the natural leather/suede texture and visual appearance features. It may contain non-animal or processed animal products. "Processed animal product" may be understood when natural leather / suede fibres is extracted and then processed (woven) into product.

5. Evaluation of Test Data

5.1 COLOR VARIATION ANALYSIS

5.1.1 Tapis Synthetic leather – tested by itself (Embraer and C&D data)

The table 1 below presents the 12 seconds Vertical test data from Embraer and C&D Zodiac for the synthetic leather manufactured by Tapis Corp named Ultraleather tested by itself, i.e. no other material being considered. It is important to note that more than one test results for the same color material are presented.

Dripping time was unconsidered because no dripping was detected for all test data.

Table 1: 12 seconds Vertical Test data for Tapis Corp. Ultraleather material:

	Company name	Description	Color	12 seconds Vertical Test: Avg Burn Length (in)	12 seconds Vertical Test: Avg Self Extinguish Time (sec)
1	Embraer	ULFR 3720 SEASHELL		3,63	0,00
2	Embraer	ULFR 3720 SEASHELL		3,00	0,00
3	Embraer	ULFR 3720 SEASHELL		3,42	0,00
4	Embraer	ULFR 3720 SEASHELL		3,41	0,39
5	Embraer	ULFR 3609 BUFF		3,91	0,33
6	Embraer	ULFR 3609 BUFF		5,29	12,50
7	Embraer	ULFR 3609 BUFF		2,79	0,00
8	Embraer	ULFR 3609 BUFF		2,54	0,00
9	Embraer	ULFR 3609 BUFF		2,91	0,00
10	Embraer	ULFR 3609 BUFF		3,25	0,00
11	Embraer	ULFR 3609 BUFF		3,29	0,16
12	Embraer	ULFR 3609 BUFF		3,08	0,00
13	Embraer	ULFR 3700 IVORY		3,08	0,59
14	Embraer	ULFR 3700 IVORY		3,08	0,33
15	Embraer	ULFR 3455 MILKWEED		2,87	0,00
16	Embraer	ULFR 3455 MILKWEED		2,91	0,00
17	Embraer	ULFR 3455 MILKWEED		3,04	0,45
18	Embraer	ULFR 3455 MILKWEED		3,12	0,56
19	Embraer	ULFR 5815 POLAR		2,75	0,00
20	Embraer	ULFR 5815 POLAR	no photo	3,66	2,14
21	Embraer	ULFR 5815 POLAR		3,41	0,45
22	Embraer	ULFR 3470 SHELL		3,33	0,00
23	Embraer	ULFR 5222 CHABLIS		2,95	0,00
24	Embraer	ULFR 5222 CHABLIS		3,54	0,00
25	Embraer	ULFR 5222 CHABLIS		2,95	0,33
26	Embraer	ULFR 5222 CHABLIS		3,33	0,00
27	Embraer	ULFR 5653 CLOUD		2,75	0,00
28	Embraer	ULFR 5653 CLOUD		2,67	0,00
29	Embraer	ULFR 3810 OFF WHITE	no photo	3,25	0,00
30	Embraer	ULFR 3851 CHAMOIS		2,54	0,00
31	Embraer	ULFR 3851 CHAMOIS		3,33	0,00
32	Embraer	ULFR 3851 CHAMOIS		2,95	0,00
33	Embraer	ULFR 3851 CHAMOIS		4,24	8,66
34	Embraer	ULFR 3470 SHELL		3,70	0,00
35	Embraer	ULFR 3455 MILKWEED		2,75	0,33
36	Embraer	ULFR 3455 MILKWEED		3,49	0,00
37	Embraer	ULFR 3455 MILKWEED		2,87	0,00
38	Embraer	ULFR 3700 IVORY		3,41	0,00
39	Embraer	ULFR 3700 IVORY		4,16	8,66
40	Embraer	ULFR 5684 ARTIC		3,45	0,33
41	Embraer	ULFR 5684 ARTIC		3,00	0,00
42	Embraer	ULFR 5684 ARTIC		2,95	0,00
43	Embraer	ULFR 5684 ARTIC		3,24	0,33

Cont. Table 1:

				12 seconds Vertical Test	
	Company name	Description	Color	Avg Burn Length (in)	Avg Self Extinguish Time (sec)
44	Embraer	ULFR 2556 ADMIRAL		2,00	0,00
45	Embraer	ULFR 2556 ADMIRAL		2,00	0,00
46	Embraer	ULFR 2556 ADMIRAL		2,00	0,00
47	Embraer	ULFR 2556 ADMIRAL		2,41	0,00
48	Embraer	ULFR 2556 ADMIRAL		2,00	0,00
49	Embraer	ULFR 2556 ADMIRAL		2,00	0,00
50	Embraer	ULFR 2556 ADMIRAL		2,16	0,66
51	Embraer	ULFR 2556 ADMIRAL		1,08	0,00
52	Embraer	ULFR 2556 ADMIRAL		1,33	0,00
53	Embraer	ULFR 2556 ADMIRAL		2,50	0,00
54	Embraer	ULFR 2556 ADMIRAL		3,50	0,00
55	Embraer	ULFR 2556 ADMIRAL		2,66	0,00
56	Embraer	ULFR 2556 ADMIRAL		2,91	0,00
57	Embraer	ULFR 2556 ADMIRAL		3,00	0,00
58	Embraer	ULFR 2556 ADMIRAL		3,08	0,33
59	Embraer	ULFR 2556 ADMIRAL		3,16	0,00
60	Embraer	ULFR 3925		3,29	0,00
61	Embraer	ULFR 3925		2,87	0,00
62	Embraer	ULFR 3925		2,95	0,00
63	Embraer	ULFR 3925		3,45	1,06
64	Embraer	ULFR 3809 PORCELAIN		3,49	0,66
65	Embraer	ULFR 3809 PORCELAIN		2,95	0,00
66	Embraer	ULFR 3809 PORCELAIN		3,41	0,33
67	Embraer	ULFR 3809 PORCELAIN		2,87	0,00
68	Embraer	ULFR 3809 PORCELAIN		2,46	0,00
69	Embraer	ULFR 3809 PORCELAIN		2,87	0,00
70	Embraer	ULFR 3850		3,63	0,60
71	Embraer	ULFR 3850		3,75	1,23
72	Embraer	ULFR 3850		3,59	0,92
73	Embraer	ULFR 3599 ALMOND		3,12	0,33
74	Embraer	ULFR 3599 ALMOND		3,24	0,33
75	Embraer	ULTRALEATHER.HP-5666.DOVE.GREY		3,00	0,00
76	Embraer	ULTRALEATHER.HP-5666.DOVE.GREY		3,00	0,00
77	Embraer	ULTRALEATHER.HP-5666.DOVE.GREY		3,08	0,00
78	Embraer	ULTRALEATHER.HP-5666.DOVE.GREY		3,41	0,00
79	Embraer	ULTRALEATHER.HP-5666.DOVE.GREY		3,83	0,33
80	Embraer	ULTRALEATHER.HP-5666.DOVE.GREY		3,00	0,00
81	C&D Zodiac	ULFR 5708 GRANITE	no photo	3,00	0,25
82	C&D Zodiac	ULFR 9399 LILAC MIST	no photo	3,40	0,00
83	C&D Zodiac	ULFR 5666 DOVE GRAY	no photo	0,75	2,70
84	C&D Zodiac	ULFR 2551 BALTIC BLUE	no photo	0,65	2,45
85	C&D Zodiac	ULFR 5763 GRAY	no photo	2,10	2,70
86	C&D Zodiac	ULFR 2556 ADMIRAL	no photo	3,40	0,15
87	C&D Zodiac	ULFR 3817 SOFT TAUPE	no photo	2,40	0,00
88	C&D Zodiac	ULFR 5739 GRAPHITE	no photo	2,75	0,00
89	C&D Zodiac	ULFR 4261 JUNIPER	no photo	2,70	0,00
90	C&D Zodiac	ULFR 5758 SOFT GRAY	no photo	2,45	0,00
91	C&D Zodiac	ULFR 5681 SMOKE	no photo	2,45	0,00
92	C&D Zodiac	ULFR 2680 WINDSOR	no photo	1,00	0,00

From these data, a graphic “*Avg Burn Length (in) vs Ultraleather material*” and “*Avg Self Extinguish Time (sec) vs Ultraleather material*” were plotted per figure 3 below:

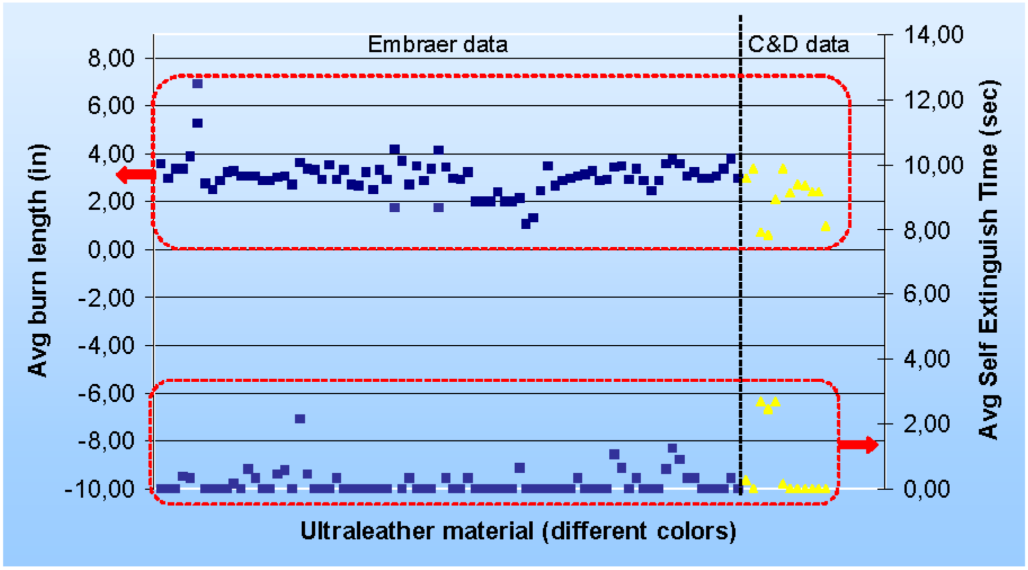

Figure 3: Graphic for Avg Burn Length (in) and Avg Self Extinguish Time (sec) *versus* Ultraleather material. Embraer (blue) and C&D (yellow) data.

Per graphic above (figure 3) we may verify that most of the burn length values are between 2 and 4 inches and the self extinguish time values are between 0 and 2 sec for the materials tested either at Embraer or at C&D labs what indicate that data are very confident once different laboratories are presenting similar results.

The figure 4 below is presented to show that:

- Within the same color, test results variation (avg. burn length and avg. self extinguish time) does exist;
- One color is no worse than any other;
- The large amounts of the results are between 2 and 4 inches (avg burn length), and between 0 and 2 seconds (avg self extinguish time).

These facts lead us to conclude that the differences in colors do not contribute for the test results variation.

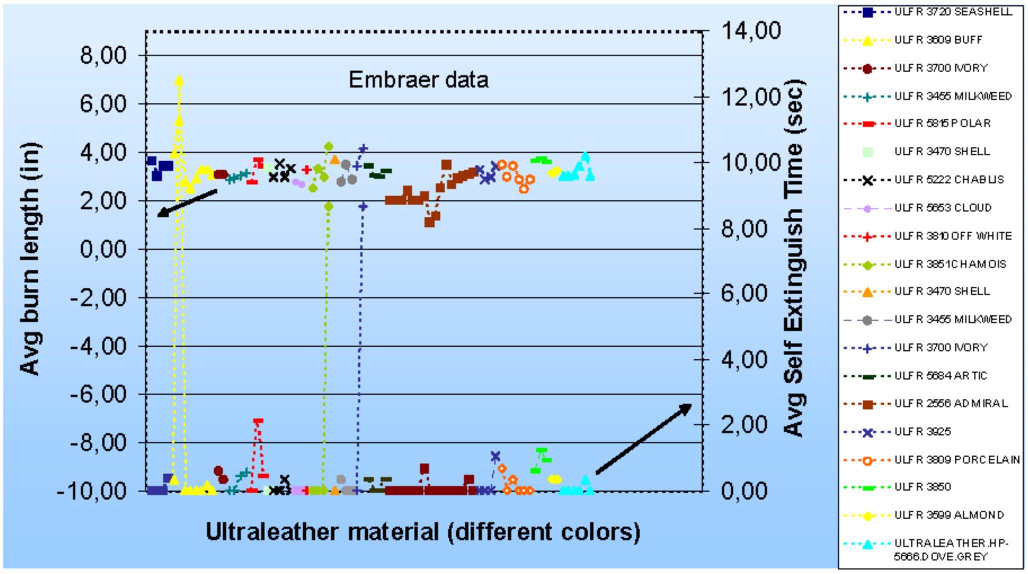

Figure 4: Graphic for Avg Burn Length (in) and Avg Self Extinguish Time (sec) *versus* Ultraleather material. Embraer data only.

The evaluation that the color of synthetic leather does not affect the test results may be better evidenced thru the basic statistical analysis demonstrated below.

5.1.1.1 Statistical analysis for Avg Burn Length

The average and the standard deviation for the 92 values of "Avg Burn Length" indicated in the table 1, are:

- Average → **2.95 inches**
- Std. Deviation → **0.71 inch**

Thus we may plot the data for 3σ, being:

- **3σ** = 3 Std. Deviation = 3 x 0.71 = **2.14 inches**

Just for remembering, for a normal distribution, about 68.3% of the values are within 1σ range and about 99.7% of the values are within 3σ range.

The figure 5 shows that the distribution is close to the average burn length of 2.95 inches with some points exceeding the 3σ range (only the highest data value (5.29 in) is above the range, and two points are below).

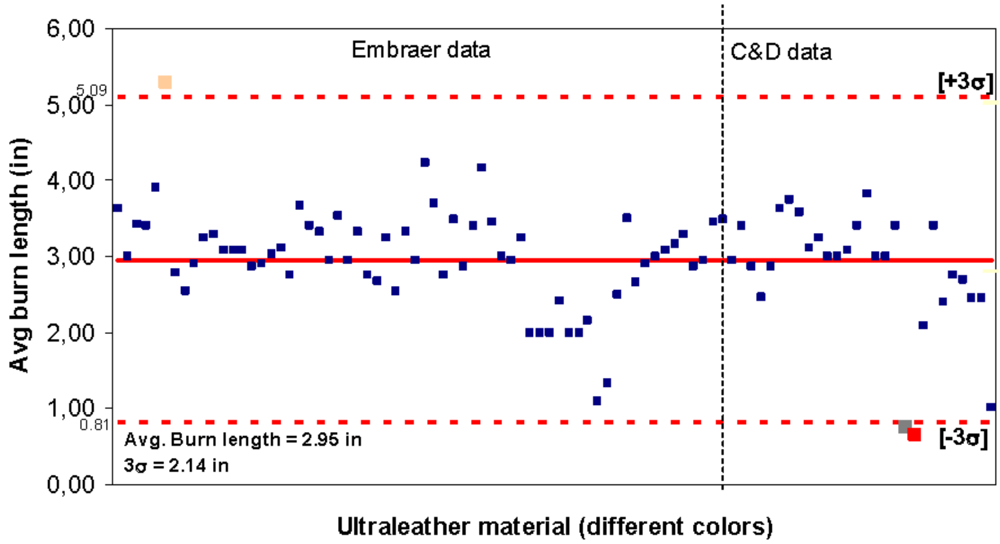

Figure 5: Graphic Avg Burn Length (in) *versus* Ultraleather material for 3σ range. Each color of the points exceeding 3σ range represents a different synthetic leather color.

By the histogram presented below (figure 6), an important information we can extract is that **98.9%** of the average burn length values for the tested materials are up to **5.09 inches** (the maximum value of average burn length identified in the table 1 is 5.29 inches). This value is well below the average burn length criteria of the requirement 14CFR 25.853(a) Part I (a) (1) (ii), which may not exceed 8 inches.

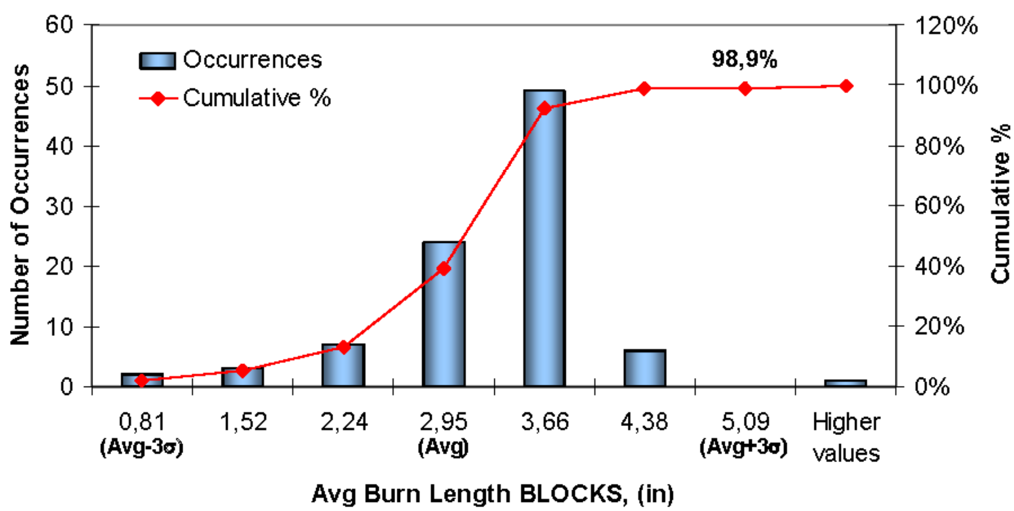

Figure 6: Average burn length histogram.

5.1.1.2 Statistical analysis for Avg Self Extinguish Time

Performing the same study for the Avg Self Extinguish Time, the average and the standard deviation for the 92 values of “Avg Self Extinguish Time” indicated in the table 1, are:

- Average → **0.56 sec**
- Std. Deviation → **1.84 sec**

Thus we may plot the data for 3σ, being:

- **3σ** = 3 Std. Deviation = 3 x 1.84 = **5.53 sec**

The figure 7 shows that the distribution is close to the average self extinguish time of 0.56 seconds with some points exceeding the +3σ range (-3σ range was not considered, since it would became negative time).

3 points are exceeding the 3σ range and each one is representing one different color.

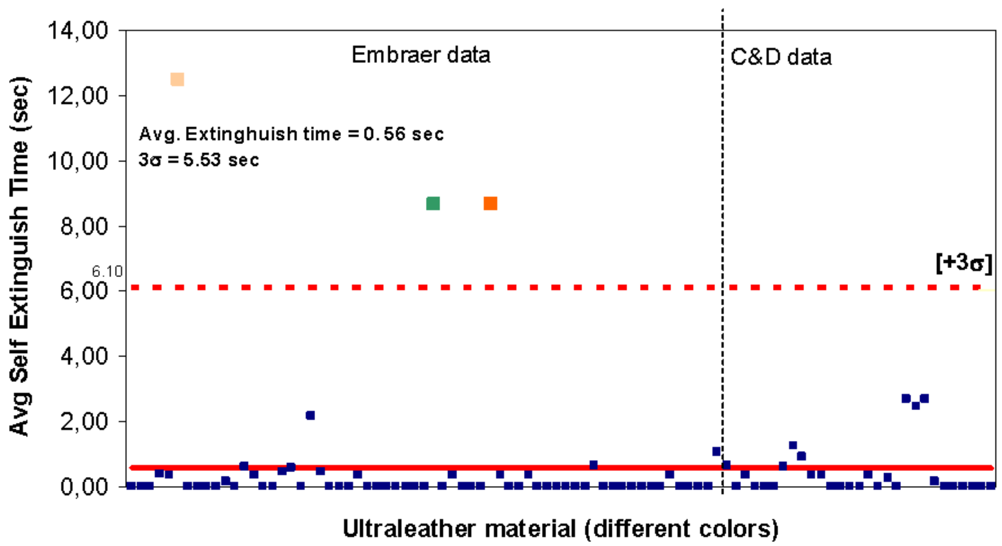

Figure 7: Graphic Avg Self Extinguish Time (sec) *versus* Ultraleather material for 3σ range. Each color of the points exceeding 3σ range represents a different synthetic leather color.

Also by the histogram presented below (figure 8), an important information we can extract is that **96.7%** of the average self extinguish values for the tested materials are up to **6.10 sec** (the maximum value of average self extinguish time identified in the table 1 is 12.5 sec). This value is below the average self extinguish time criteria of the requirement 14CFR 25.853(a) Part I (a) (1) (ii), which may not exceed 15 seconds.

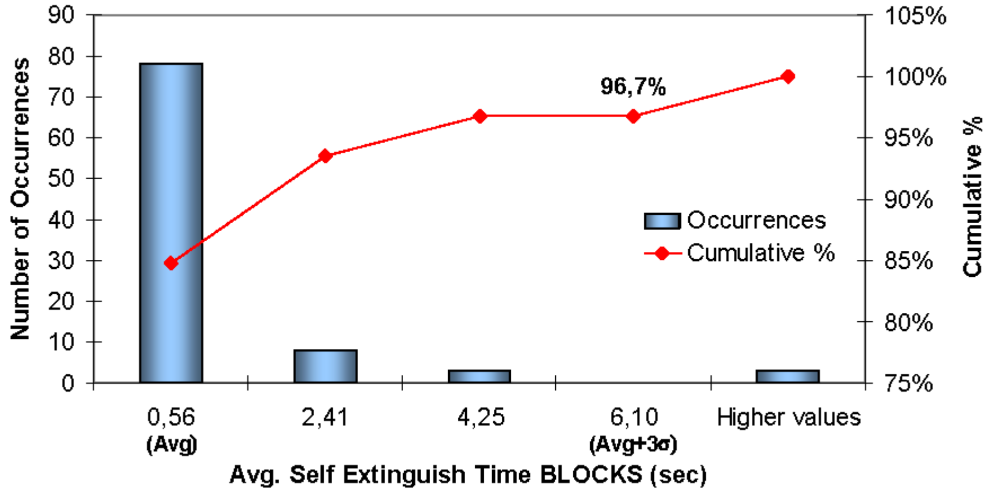

Figure 8: Average self extinguish time histogram.

5.1.2 Tapis Synthetic suede – tested by itself (Tapis Corp. data)

The table 2 below presents the 12 seconds Vertical test data from Tapis Corp. for the synthetic suede manufactured by Tapis Corp named Ultrasuede tested by itself, i.e. no other material being considered. It is important to mention that only one test result for each color is presented in this study.

Table 2: 12 seconds Vertical Test data for Tapis Corp. Ultrasuede material:

					12 seconds Vertical Test	
	Company name	Description	Color	Avg Burn Length (in)	Avg Self Extinguish (sec)	Avg Dripping Time (sec)
1	Tapis	USFRC 2679 Moonstone	2679 Moonstone	2,63	0,00	1,00
2	Tapis	9216 Purple Passion	9216 Purple Passion	3,27	0,00	1,00
3	Tapis	USFR 3344 Bone	3344 Bone	2,57	0,00	1,33
4	Tapis	2314 Aubergine	2314 Aubergine	3,33	1,33	0,67
5	Tapis	6496 Wine & Rose	6496 Wine & Roses	3,30	0,00	1,00
6	Tapis	5556 Celadon	5556 Celadon	3,33	1,00	0,67
7	Tapis	USFRC 5789 Graphite	5789 Graphite	3,47	0,00	0,67
8	Tapis	USFRC 3424 Chablis	3424 Chablis	2,60	0,00	0,00
9	Tapis	USFRC 3722 Seashell	3722 Seashell	2,77	0,00	0,33
10	Tapis	5171 Marigold	5171 Marigold	3,37	3,33	1,33
11	Tapis	HPC 2325 Glacie Blue	2325 Glacier Blue	3,07	0,00	1,00
12	Tapis	USFRC 3581 Doe	3581 Doe	3,10	0,00	0,67

Cont. Table 2:

	Company name	Description	Color	12 seconds Vertical Test: Avg Burn Length (in)	Avg Self Extinguish (sec)	Avg Dripping Time (sec)
13	Tapis	USFRC 2600 Windsor Grey		3,43	0,00	0,33
14	Tapis	USFRC 3583 Bisque		2,73	0,00	1,00
15	Tapis	USFRC 3280 Chamois		3,60	0,00	1,00
16	Tapis	USFRC 3694 Ivory		2,90	0,00	0,33
17	Tapis	9390 Wisteria		3,37	0,33	1,00
18	Tapis	4398 Lichen		2,93	0,00	1,33
19	Tapis	USFRC 3271 Taupe		3,03	0,00	0,33
20	Tapis	USFRC 3753 Koala		3,33	0,00	0,67
21	Tapis	USFRC 3582 Almond		2,73	0,00	0,33
22	Tapis	USFRC 5238 Topaz		2,80	0,00	0,67
23	Tapis	3699 Tobacco		3,23	0,00	0,00
24	Tapis	USFRC 5654 Arctic		2,50	0,00	0,33

From these data, the graphics "*Avg Burn Length (in) vs Ultrasuede material*", "*Avg Self Extinguish Time (sec) vs Ultraleather material*" and "Avg *Dripping Time (sec) vs Ultraleather material*" were plotted per figure 9, 10 and 11, respectively:

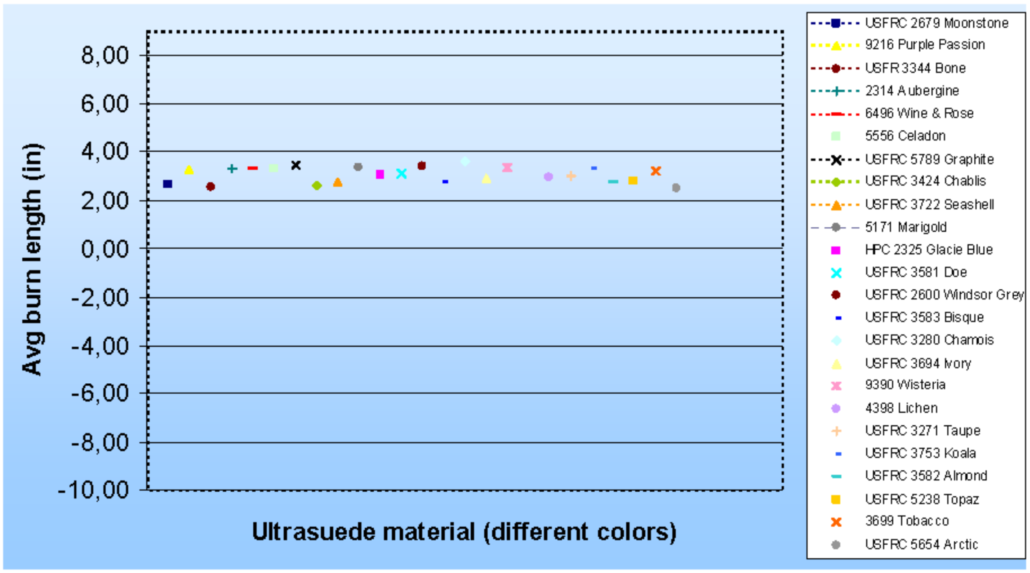

Figure 9: Graphic for Avg Burn Length (in) *versus* Ultrasuede material.

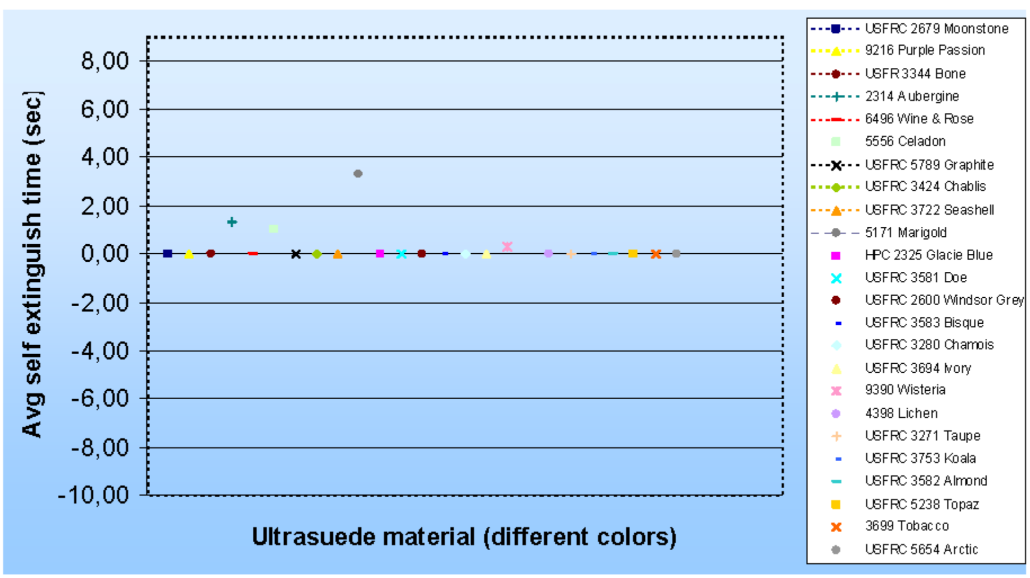

Figure 10: Graphic for Avg Self Extinguish Time (sec) *versus* Ultrasuede material.

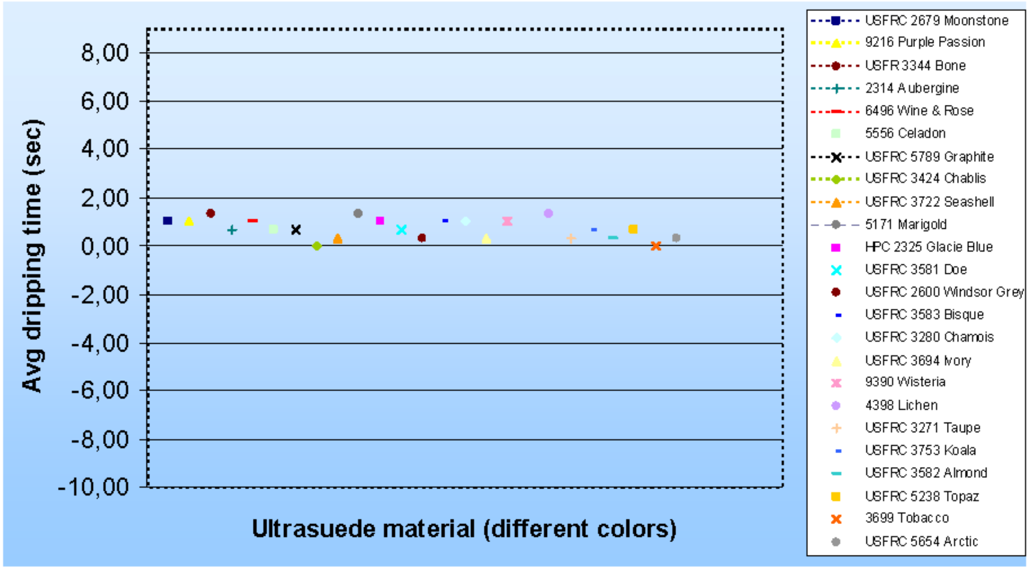

Figure 11: Graphic for Avg Dripping Time (sec) *versus* Ultrasuede material.

The figure 9 indicates that all the burn length values are between 2 and 4 inches no matter the color of the Ultrasuede material.

The figure 10 shows that most of the self extinguish time values are between 0 and 2 sec. The Ultrasuede 5171 Marigold presented the highest value of 3.33 sec.

And for the figure 11, similar to burn length values, all points are located in a narrow range between 0 and 2 sec of dripping time no matter the color.

Performing the statistical analysis for avg burn length, avg self extinguish time and avg dripping time, we have:

5.1.2.1 Statistical analysis for Avg Burn Length

The average and the standard deviation for the 24 values of "Avg Burn Length" indicated in the table 2 are:

- Average → **3.06 inches**
- Std. Deviation → **0.33 inch**

Thus we may plot the data for and 3σ, being:

- **3σ** = 3 Std. Deviation = 3 x 0.33 = **0.99 inch**

The figure 12 shows that the distribution is close to the average burn length of 3.06 inches with no data exceeding the 3σ range.

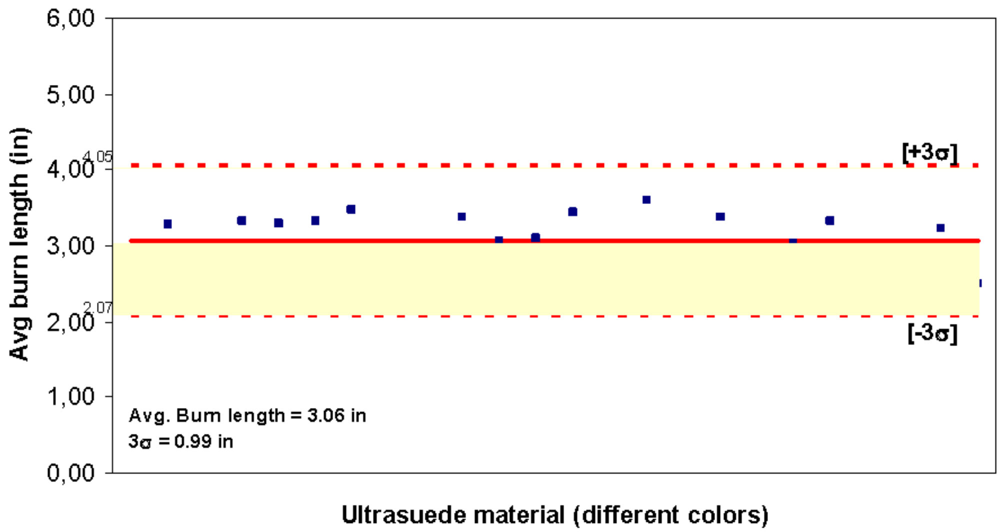

Figure 12: Graphic Avg Burn Length (in) *versus* Ultrasuede material for 3σ range. No points is exceeding the 3σ range.

The histogram presented below (figure 13) indicates that **100%** of the average burn length values for the tested materials are up to **4.05 inches**. This value is well below the average burn length criteria of the requirement 14CFR 25.853(a) Part I (a) (1) (ii), which may not exceed 8 inches.

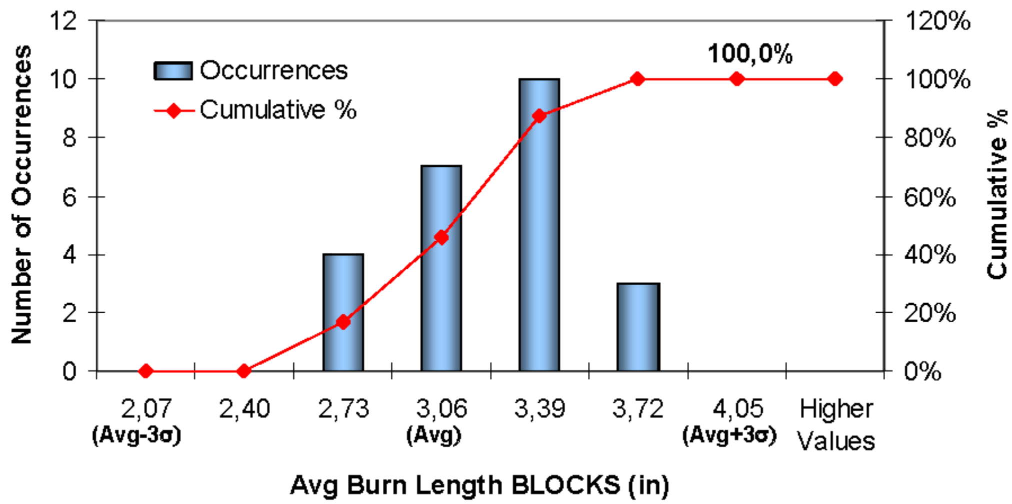

Figure 13: Average burn length histogram.

5.1.2.2 Statistical analysis for Avg Self Extinguish Time

Performing the same study for the Avg Self Extinguish Time, the average and the standard deviation for the <u>24 values</u> of "Avg Self Extinguish Time" indicated in the table 2, are:

- Average → **0.25 sec**
- Std. Deviation → **0.74 sec**

Thus we may plot the data for 3σ, being:

- **3σ** = 3 Std. Deviation = 3 x 0.74 = **2.21 sec**

The figure 14 shows that the distribution is close to the average self extinguish time of 0.25 seconds with 1 point is exceeding the 3σ range (-3σ range was not considered, since it would became negative time).

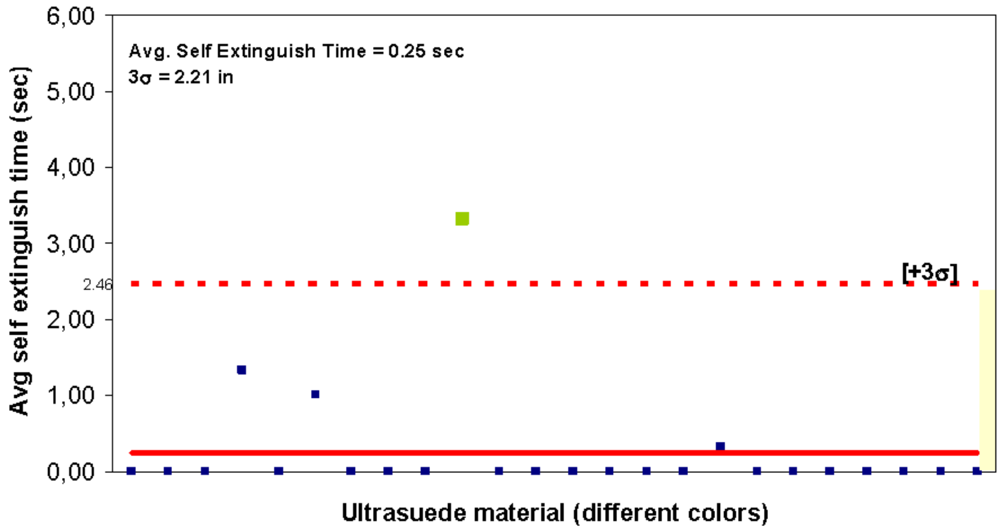

Figure 14: Graphic Avg Self Extinguish Time (sec) *versus* Ultrasuede material for 3σ range. One color is exceeding 3σ range.

Also by the histogram presented below (figure 15), is indicated that **95.8%** of the average self extinguish values for the tested materials are up to **2. 46 sec** (the maximum value of average self extinguish time identified in the table 3 is 3.33 sec). This value is below the average self extinguish time criteria of the requirement 14CFR 25.853(a) Part I (a) (1) (ii), which may not exceed 15 seconds.

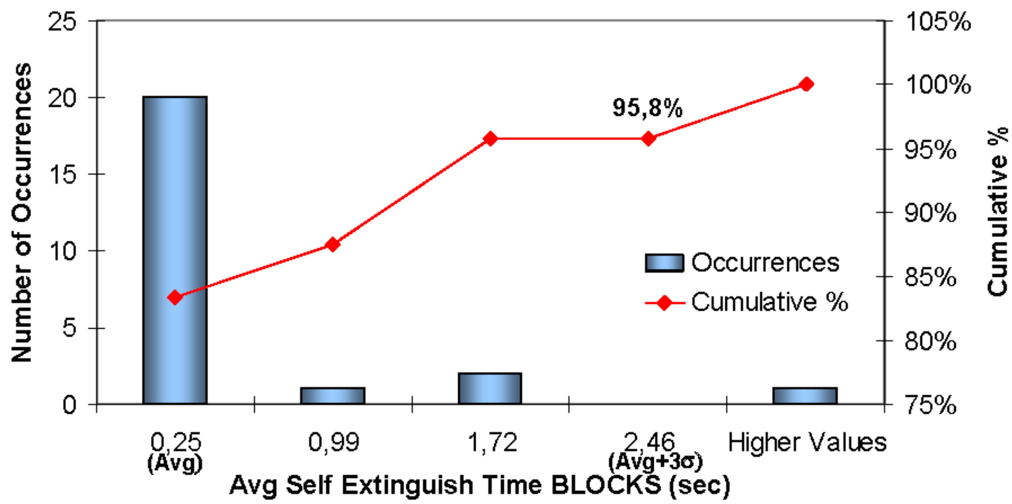

Figure 15: Average self extinguish time histogram.

5.1.2.3 Statistical analysis for Avg Dripping Time

Performing the same study for the Avg Dripping Time, the average and the standard deviation for the 24 values of "Avg Dripping Time" indicated in the table 2, are:

- Average → **0.71 sec**
- Std. Deviation → **0.40 sec**

Thus we may plot the data for 3σ, being:

- **3σ** = 3 Std. Deviation = 3 x 0.40 = **1.19 sec**

The figure 16 shows that the distribution is close to the average Dripping time of 0.71 seconds with no points is exceeding the +3σ range (-3σ range was not considered, since it would became negative time).

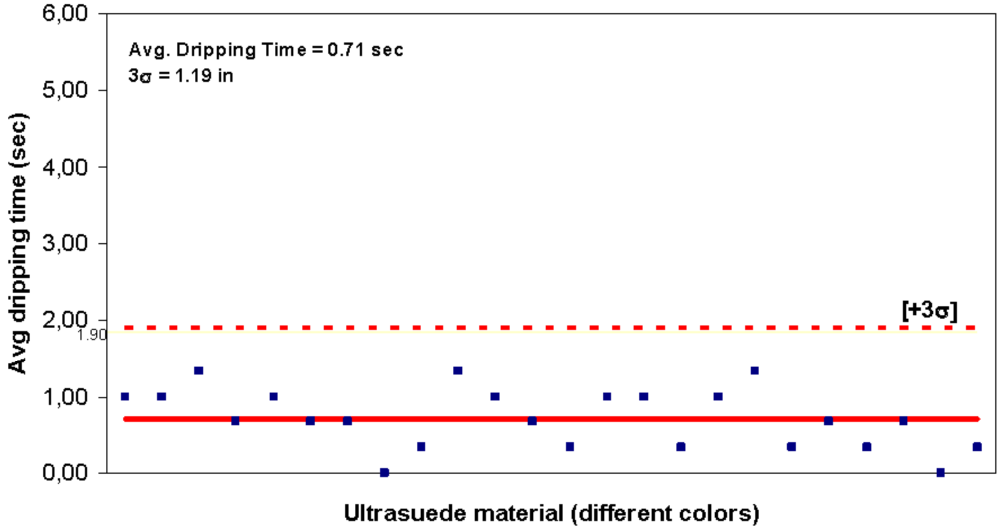

Figure 16: Graphic Avg Dripping Time (sec) *versus* Ultrasuede material for 3σ range. No color is exceeding 3σ range.

The histogram presented below (figure 17) indicates that **100%** of the average dripping time values for the tested materials are up to **1.90 sec**. This value is well below the average dripping time criteria of the requirement 14CFR 25.853(a) Part I (a) (1) (ii), which may not exceed 5 seconds.

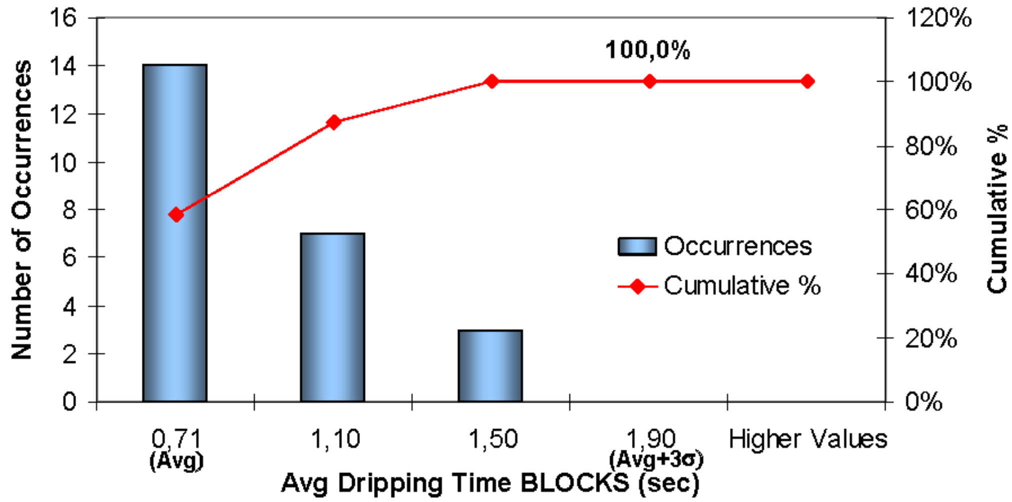

Figure 17: Average Dripping time histogram.

5.1.3 **E-Leather Synthetic leather – tested by itself (E-Leather data)**

The E-Leather data are segregated in 3 type products that present the same material composition with different grades which is all about weight and thickness:

- SL3UL: Ultralight
- SL3SL: Superlight
- SL3L: Light

5.1.3.1 SL3UL: Ultralight

The table 3 below presents the 12 seconds Vertical test data for the synthetic leather manufactured and supplied by E-Leather Group tested by itself, i.e. no other material being considered. It is important to note that more than one test results for the same color material are presented.

Dripping time was unconsidered because no dripping was detected for all test data.

Table 3: 12 seconds Vertical Test data for E-Leather SL3UL material:

	Company name	Description	Color	12 seconds Vertical Test (WARP) Avg Burn Length (in)	Avg Self Extinguish (sec)
1	E-Leather	SL3UL	Beige 1210	1,90	0,00
2	E-Leather	SL3UL	Black	1,90	0,00
3	E-Leather	SL3UL	Blue 08-856/2	2,30	0,00
4	E-Leather	SL3UL	Blue 08-856/2	1,30	0,00
5	E-Leather	SL3UL	Blue 08-917	3,10	0,00
6	E-Leather	SL3UL	Blue 09-0231	2,70	0,00
7	E-Leather	SL3UL	Blue 09-0231	2,00	0,00
8	E-Leather	SL3UL	Blue 09-1259	2,30	0,00
9	E-Leather	SL3UL	Blue 09-1259	1,80	0,00
10	E-Leather	SL3UL	Blue 09-1259	2,00	0,00
11	E-Leather	SL3UL	Blue 09-1260	1,60	0,00
12	E-Leather	SL3UL	Blue 09-1260	2,20	0,00
13	E-Leather	SL3UL	Blue 09-1260	2,00	0,00
14	E-Leather	SL3UL	Blue 09-1260	2,90	3,80
15	E-Leather	SL3UL	Blue 09-1260	2,30	0,40
16	E-Leather	SL3UL	Blue 09-1260	2,70	0,00
17	E-Leather	SL3UL	Blue 09-1260	2,40	0,00
18	E-Leather	SL3UL	Blue 09-1260	2,30	0,00
19	E-Leather	SL3UL	Blue 09-1260	2,30	0,00
20	E-Leather	SL3UL	Blue 09-1260	2,00	0,00
21	E-Leather	SL3UL	Blue 09-1260	1,90	0,00
22	E-Leather	SL3UL	Blue 09-1260	1,90	0,00
23	E-Leather	SL3UL	Blue 09-1260	2,60	0,00
24	E-Leather	SL3UL	Blue 09-1260	2,00	0,00
25	E-Leather	SL3UL	Blue 09-1260	1,90	0,00
26	E-Leather	SL3UL	Blue 09-1260	1,90	0,00
27	E-Leather	SL3UL	Blue 09-1260	2,00	0,00
28	E-Leather	SL3UL	Blue 1180	1,90	0,00
29	E-Leather	SL3UL	Blue 1328	1,90	0,00
30	E-Leather	SL3UL	Blue 1328	2,00	0,00
31	E-Leather	SL3UL	Blue 1328	1,90	0,00
32	E-Leather	SL3UL	Blue 1328	2,00	0,00
33	E-Leather	SL3UL	Blue 1328	2,10	0,00
34	E-Leather	SL3UL	Blue 1449	2,10	0,00
35	E-Leather	SL3UL	Blue 1449	1,90	0,00
36	E-Leather	SL3UL	Blue 1449	1,80	0,00
37	E-Leather	SL3UL	Blue 1449	1,80	0,20
38	E-Leather	SL3UL	Blue 1449	2,30	0,00
39	E-Leather	SL3UL	Blue 1767	1,30	0,00
40	E-Leather	SL3UL	Blue 353	1,10	0,00
41	E-Leather	SL3UL	Blue 353	2,20	0,00
42	E-Leather	SL3UL	Blue 353	2,10	0,00
43	E-Leather	SL3UL	Blue 353	1,80	0,00
44	E-Leather	SL3UL	Blue 353	2,00	0,00
45	E-Leather	SL3UL	Blue 353	2,00	0,00
46	E-Leather	SL3UL	Blue 353	1,90	0,00
47	E-Leather	SL3UL	Blue 390	2,50	0,00
48	E-Leather	SL3UL	Blue 390	5,00	0,40
49	E-Leather	SL3UL	Blue 684	1,60	0,00
50	E-Leather	SL3UL	Blue 906	1,00	0,00
51	E-Leather	SL3UL	Blue 907	1,40	0,00
52	E-Leather	SL3UL	Blue 970	2,00	0,00
53	E-Leather	SL3UL	Brown 08-856/1	2,30	0,00
54	E-Leather	SL3UL	Brown 08-856/1	1,10	0,00
55	E-Leather	SL3UL	Brown 1328	1,80	0,00
56	E-Leather	SL3UL	Brown 1361	2,10	0,00
57	E-Leather	SL3UL	Brown 1374	1,90	0,00
58	E-Leather	SL3UL	Brown 1374	2,00	0,00
59	E-Leather	SL3UL	Brown 1374	2,10	0,50
60	E-Leather	SL3UL	Brown 1374	1,90	0,20
61	E-Leather	SL3UL	Carmine	1,90	0,00
62	E-Leather	SL3UL	Chandratal	3,20	0,00
63	E-Leather	SL3UL	Chandratal	2,90	0,00
64	E-Leather	SL3UL	Chandratal	2,30	0,00
65	E-Leather	SL3UL	Chandratal	2,80	0,00
66	E-Leather	SL3UL	Chandratal	2,50	0,00

Cont. Table 3:

	Company name	Description	Color	12 seconds Vertical Test (WARP) Avg Burn Length (in)	Avg Self Extinguish (sec)
67	E-Leather	SL3UL	Chandratal	1,70	0,00
68	E-Leather	SL3UL	Chandratal	1,60	0,00
69	E-Leather	SL3UL	Chandratal	1,50	0,00
70	E-Leather	SL3UL	Chandratal	1,90	0,00
71	E-Leather	SL3UL	Chandratal	3,30	0,00
72	E-Leather	SL3UL	Chandratal	1,80	0,00
73	E-Leather	SL3UL	Chandratal	2,10	0,00
74	E-Leather	SL3UL	Chandratal	2,40	0,00
75	E-Leather	SL3UL	Chandratal	2,40	0,00
76	E-Leather	SL3UL	Chandratal	2,60	0,00
77	E-Leather	SL3UL	Chandratal	1,90	0,00
78	E-Leather	SL3UL	Chandratal	2,00	0,00
79	E-Leather	SL3UL	Chandratal	2,30	0,00
80	E-Leather	SL3UL	Chandratal	2,00	0,00
81	E-Leather	SL3UL	Chandratal	1,90	0,00
82	E-Leather	SL3UL	Chandratal	3,90	0,00
83	E-Leather	SL3UL	Chandratal	2,10	0,00
84	E-Leather	SL3UL	Chandratal	2,30	0,00
85	E-Leather	SL3UL	Chandratal	2,40	0,00
86	E-Leather	SL3UL	Chandratal	1,70	0,00
87	E-Leather	SL3UL	Chilka	3,10	0,00
88	E-Leather	SL3UL	Chilka	2,30	0,00
89	E-Leather	SL3UL	Chilka	2,50	0,00
90	E-Leather	SL3UL	Chilka	1,70	0,00
91	E-Leather	SL3UL	Chilka	2,40	0,00
92	E-Leather	SL3UL	Chilka	2,20	0,00
93	E-Leather	SL3UL	Chilka	1,80	0,00
94	E-Leather	SL3UL	Chilka	2,10	0,00
95	E-Leather	SL3UL	Chilka	2,30	0,00
96	E-Leather	SL3UL	Chilka	1,90	0,00
97	E-Leather	SL3UL	Confederate grey	2,90	0,00
98	E-Leather	SL3UL	Confederate grey	2,20	0,00
99	E-Leather	SL3UL	Confederate grey	1,90	0,00
100	E-Leather	SL3UL	Confederate grey	2,10	0,00
101	E-Leather	SL3UL	Dark blue	3,10	0,00
102	E-Leather	SL3UL	Dark blue 09-1260	2,00	0,00
103	E-Leather	SL3UL	Derwent	2,90	0,00
104	E-Leather	SL3UL	Derwent	2,00	0,00
105	E-Leather	SL3UL	Derwent	1,70	0,00
106	E-Leather	SL3UL	Derwent	1,80	0,00
107	E-Leather	SL3UL	Green 953	2,50	0,00
108	E-Leather	SL3UL	Green 953	1,90	0,00
109	E-Leather	SL3UL	Green 953	3,50	0,00
110	E-Leather	SL3UL	Green 953	3,50	0,00
111	E-Leather	SL3UL	Green 953	1,90	0,00
112	E-Leather	SL3UL	Green 953	1,90	0,00
113	E-Leather	SL3UL	Grey 1210	1,90	0,00
114	E-Leather	SL3UL	Grey 1210	1,90	0,00
115	E-Leather	SL3UL	Grey 1210	1,90	0,00
116	E-Leather	SL3UL	Grey 1523	1,90	0,00
117	E-Leather	SL3UL	Grey 1524	1,90	0,00
118	E-Leather	SL3UL	Grey 1767	1,90	0,00
119	E-Leather	SL3UL	Grey 860	2,10	0,00
120	E-Leather	SL3UL	Grey 860	2,00	0,00
121	E-Leather	SL3UL	Grey 861	2,20	0,00
122	E-Leather	SL3UL	Grey 861	1,80	0,00
123	E-Leather	SL3UL	Grey 861	2,00	0,00
124	E-Leather	SL3UL	Light blue	2,90	0,00
125	E-Leather	SL3UL	Ocean	1,70	0,00
126	E-Leather	SL3UL	Pewter	2,10	0,40
127	E-Leather	SL3UL	Purple 998A	1,30	0,00
128	E-Leather	SL3UL	Red 904	1,20	0,00
129	E-Leather	SL3UL	Red 905	1,40	0,00
130	E-Leather	SL3UL	Tidal	2,00	0,00
131	E-Leather	SL3UL	Windermere	1,90	0,00
132	E-Leather	SL3UL	Windermere	3,40	0,00

The figures 18 and 19 below are presented to show that:

- Within the same color, test results variation (avg. burn length and avg. self extinguish time) does exist;
- One color is no worse than any other;
- The large amounts of the results are between 1 and 4 inches (avg burn length), and between 0 and 1 seconds (avg self extinguish time).

These facts lead us to conclude that the differences in colors do not contribute for the test results variation.

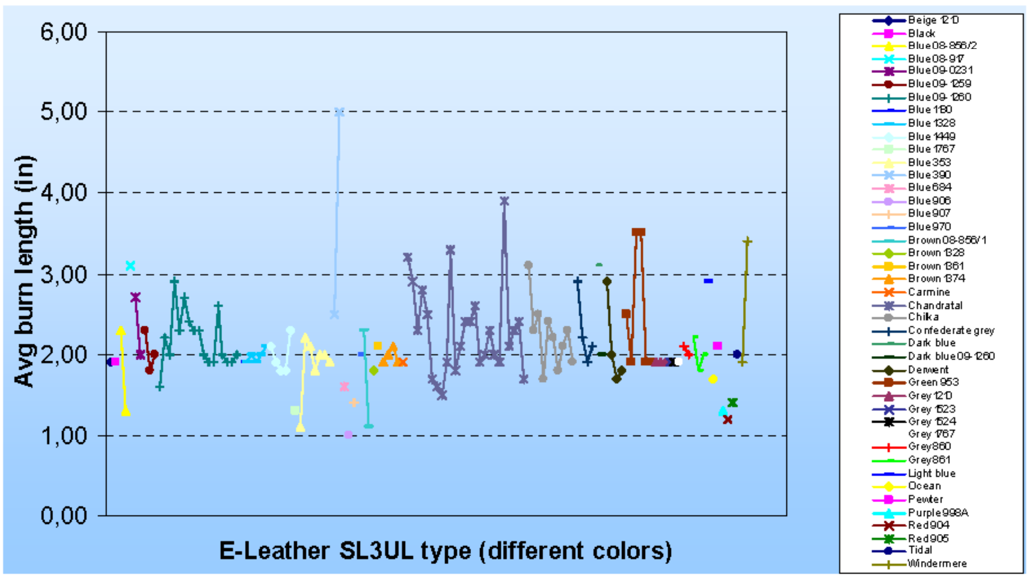

Figure 18: Graphic for Avg Burn Length (in) *versus* SL3UL material.

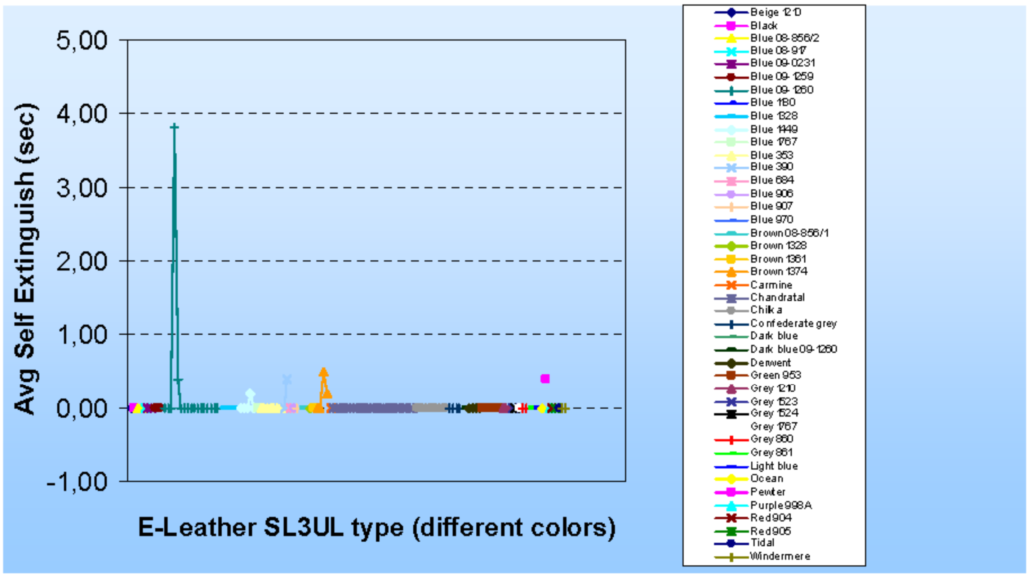

Figure 19: Graphic for Avg Self Extinguish Time (sec) *versus* SL3UL material.

The evaluation that the color of synthetic leather does not affect the test results may be better evidenced thru the basic statistical analysis demonstrated below.

5.1.3.1.1 Statistical analysis for Avg Burn Length

The average and the standard deviation for the 132 values of “Avg Burn Length” indicated in the table 3, are:

- Average → **2.14 inches**
- Std. Deviation → **0.55 inch**

Thus we may plot the data for 3σ, being:

- **3σ** = 3 Std. Deviation = 3 x 0.55 = **1.66 inches**

The figure 20 shows that the distribution is close to the average burn length of 2.14 inches with 2 points exceeding the 3σ range (highest data value of 5.00 in is above the 3σ range).

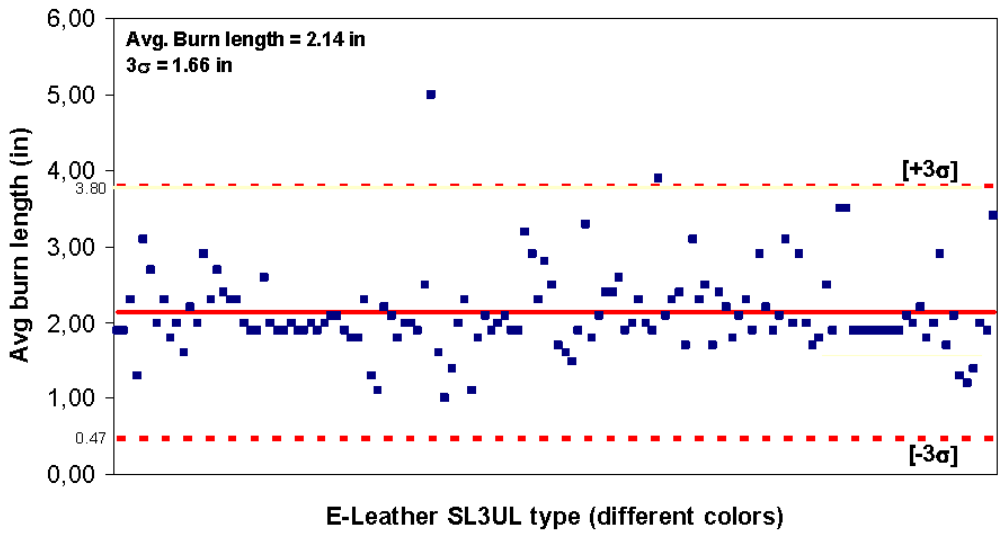

Figure 20: Graphic Avg Burn Length (in) *versus* E-Lethear SL3UL material for 3σ range. Each color of the points exceeding 3σ range represents a different synthetic leather color.

By the histogram presented below (figure 21), an important information we can extract is that **98.5%** of the average burn length values for the tested materials are up to **3.8 inches** (the maximum value of average burn length identified in the table 3 is 5 inches). This value is well below the average burn length criteria of the requirement 14CFR 25.853(a) Part I (a) (1) (ii), which may not exceed 8 inches.

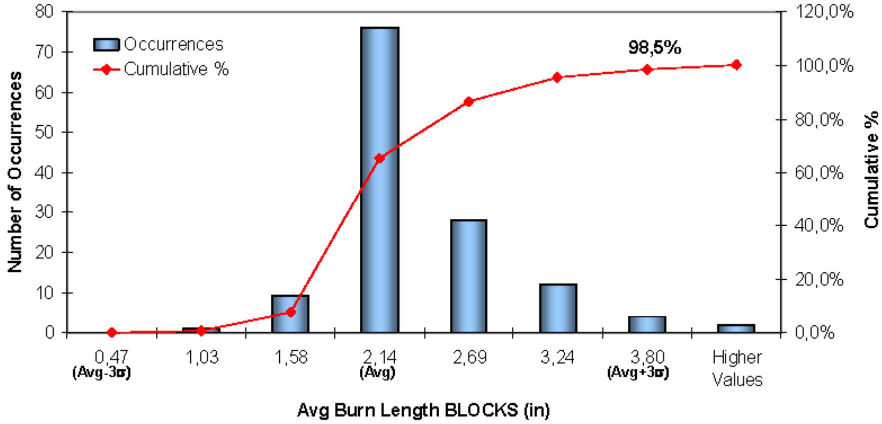

Figure 21: Average burn length histogram.

5.1.3.1.2 Statistical analysis for Avg Self Extinguish Time

Performing the same study for the Avg Self Extinguish Time, the average and the standard deviation for the <u>132 values</u> of "Avg Self Extinguish Time" indicated in the table 3, are:

- Average → **0.04 sec**

- Std. Deviation → **0.34 sec**

Thus we may plot the data for 3σ, being:

- **3σ** = 3 Std. Deviation = 3 x 0.34 = **1.01 sec**

The figure 22 shows that the distribution is close to the average self extinguish time of 0.04 seconds with one point exceeding the +3σ range (-3σ range was not considered, since it would became negative time).

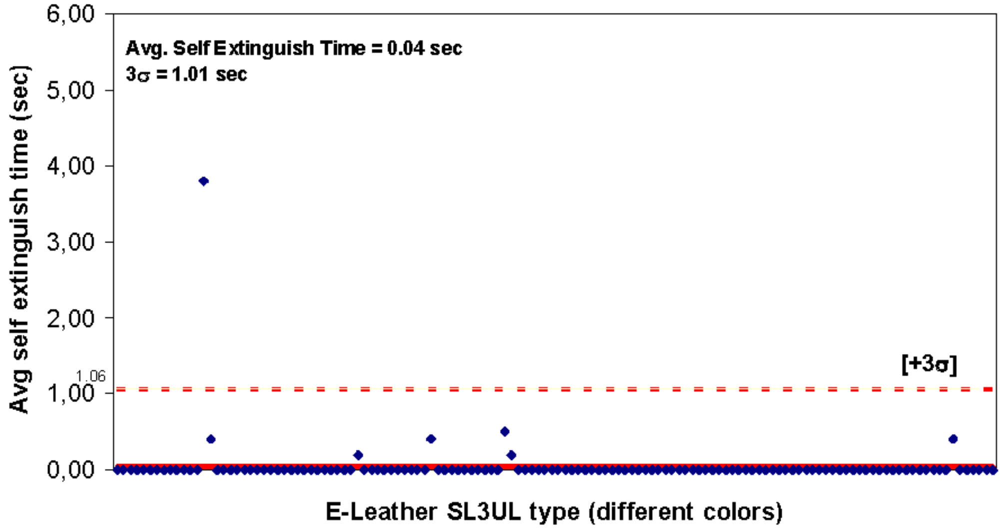

Figure 22: Graphic Avg Self Extinguish Time (sec) *versus* SL3UL material for 3σ range.

Also by the histogram presented below (figure 23), an important information we can extract is that **99.2%** of the average self extinguish values for the tested materials are up to **1.06 sec** (the maximum value of average self extinguish time identified in the table 3 is 3.8 sec). This value is below the average self extinguish time criteria of the requirement 14CFR 25.853(a) Part I (a) (1) (ii), which may not exceed 15 seconds.

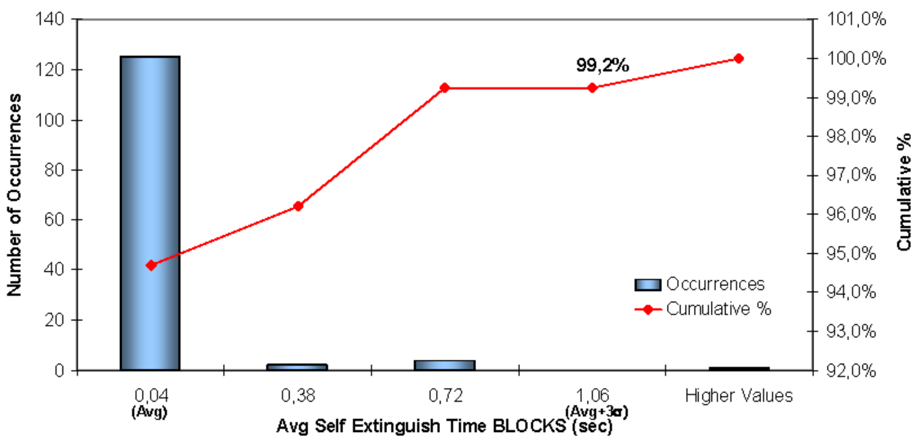

Figure 23: Average self extinguish time histogram.

5.1.3.2 SL3SL: Superlight

Performing the same study for SL3SL material the table 4 below presents the 12 seconds Vertical test data for the synthetic leather manufactured and supplied by E-Leather Group tested by itself. It is important to note that more than one test results for the same color material are presented.

Self extinguish and dripping time was unconsidered because no after flame and dripping was detected for all test data.

Table 4: 12 seconds Vertical Test data for E-Leather SL3SL material:

				12 seconds Vertical Test (WARP)
	Company name	Description	Color	Avg Burn Length (in)
1	E-Leather	SL3SL	Allatoona	3,10
2	E-Leather	SL3SL	Allatoona	2,50
3	E-Leather	SL3SL	Allatoona	2,40
4	E-Leather	SL3SL	Allatoona	2,30
5	E-Leather	SL3SL	Amage	2,20
6	E-Leather	SL3SL	Amage	2,10
7	E-Leather	SL3SL	Amage	1,00
8	E-Leather	SL3SL	Amage	2,30
9	E-Leather	SL3SL	Amage	2,40
10	E-Leather	SL3SL	Amage	1,90
11	E-Leather	SL3SL	Beige 09-0241	3,10
12	E-Leather	SL3SL	Beige 09-0241	3,40
13	E-Leather	SL3SL	Beige 09-0241	2,00
14	E-Leather	SL3SL	Beige 09-0241	3,80
15	E-Leather	SL3SL	Brown 09-0242	2,10
16	E-Leather	SL3SL	Brown 09-0242	3,80
17	E-Leather	SL3SL	Brown 09-0242	1,90
18	E-Leather	SL3SL	Brown 09-0242	2,70
19	E-Leather	SL3SL	Brown 09-0242	4,00
20	E-Leather	SL3SL	Brown 09-0243	1,90
21	E-Leather	SL3SL	Brown 09-0243	1,90
22	E-Leather	SL3SL	Columbian grey	3,70
23	E-Leather	SL3SL	Grey 1074	1,80
24	E-Leather	SL3SL	Leesville	3,20
25	E-Leather	SL3SL	Mist	1,80
26	E-Leather	SL3SL	Mist	1,20
27	E-Leather	SL3SL	Pearl	1,90
28	E-Leather	SL3SL	Royal	2,60
29	E-Leather	SL3SL	Sapphire	1,80
30	E-Leather	SL3SL	Sapphire	2,90
31	E-Leather	SL3SL	Sapphire	3,20
32	E-Leather	SL3SL	Sapphire	1,70
33	E-Leather	SL3SL	Tidal	2,30

The figure 24 below is presented to show that:

- Within the same color, test results variation (avg. burn length) does exist;
- One color is no worse than any other;
- The large amounts of the results are between 1 and 4 inches (avg burn length).

These facts lead us to conclude that the differences in colors do not contribute for the test results variation.

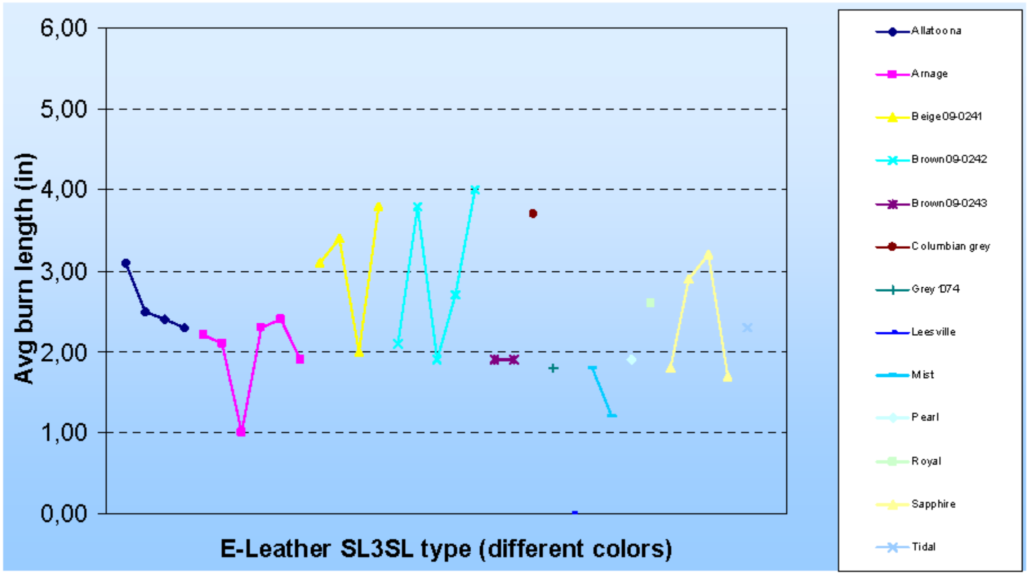

Figure 24: Graphic for Avg Burn Length (in) *versus* SL3SL material.

The evaluation that the color of synthetic leather does not affect the test results may be better evidenced thru the basic statistical analysis demonstrated below.

5.1.3.2.1 Statistical analysis for Avg Burn Length

The average and the standard deviation for the 33 values of “Avg Burn Length” indicated in the table X, are:

- Average → **2.45 inches**
- Std. Deviation → **0.76 inch**

Thus we may plot the data for 3σ, being:

- **3σ** = 3 Std. Deviation = 3 x 0.76 = **2.27 inches**

The figure 25 shows that the distribution is close to the average burn length of 2.45 inches with no points exceeding the 3σ range.

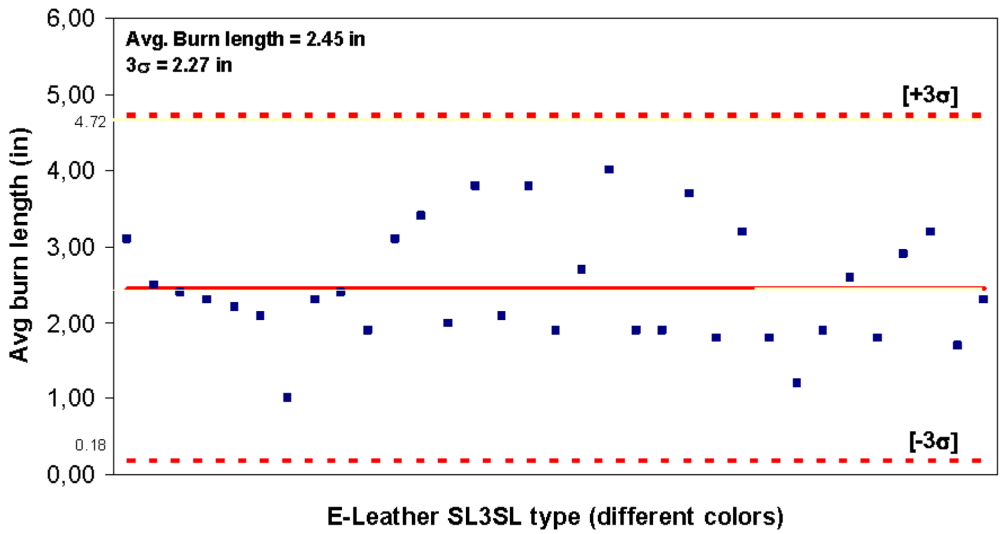

Figure 25: Graphic Avg Burn Length (in) *versus* E-Lethear SL3SL material for 3σ range.

By the histogram presented below (figure 26), an important information we can extract is that **100%** of the average burn length values for the tested materials are up to **4.72 inches** (the maximum value of average burn length identified in the table 4 is 4 inches). This value is well below the average burn length criteria of the requirement 14CFR 25.853(a) Part I (a) (1) (ii), which may not exceed 8 inches.

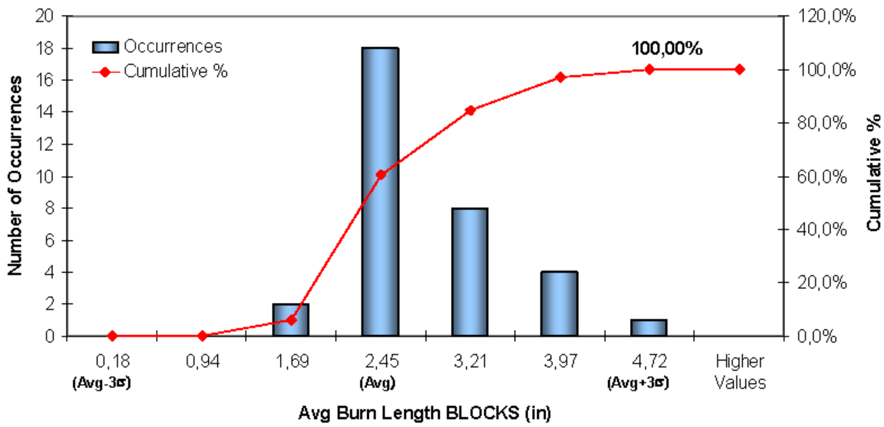

Figure 26: Average burn length histogram.

5.1.3.3 SL3L: Light

The table 5 below presents the 12 seconds Vertical test data for the synthetic leather manufactured and supplied by E-Leather Group tested by itself. It is important to note that more than one test results for the same color material are presented.

Dripping time was unconsidered because no dripping was detected for all test data.

Table 5: 12 seconds Vertical Test data for E-Leather SL3L material:

				12 seconds Vertical Test (WARP)	
	Company name	Description	Color	Avg Burn Length (in)	Avg Self Extinguish (sec)
1	E-Leather	SL3L	Grey 09-0416	2,10	0,00
2	E-Leather	SL3L	Grey 09-0416	1,80	0,00
3	E-Leather	SL3L	Grey 09-0416	1,90	0,00
4	E-Leather	SL3L	Grey 09-0416	1,60	0,00
5	E-Leather	SL3L	Grey 09-0416	2,40	0,00
6	E-Leather	SL3L	Grey 09-0416	2,10	0,00
7	E-Leather	SL3L	Grey 09-0416	2,60	0,00
8	E-Leather	SL3L	Grey 09-0416	2,30	0,00
9	E-Leather	SL3L	Grey 09-0416	1,80	0,00
10	E-Leather	SL3L	Grey 09-0416	2,70	0,00
11	E-Leather	SL3L	Grey 09-0416	2,40	0,00
12	E-Leather	SL3L	Grey 09-0416	2,20	0,00
13	E-Leather	SL3L	Grey 09-0416	2,00	0,00
14	E-Leather	SL3L	Carmine	2,00	0,00
15	E-Leather	SL3L	Carmine	1,40	0,00
16	E-Leather	SL3L	Carmine	2,70	0,00
17	E-Leather	SL3L	Carmine	1,70	0,00
18	E-Leather	SL3L	Carmine	2,00	0,00
19	E-Leather	SL3L	Carmine	2,10	0,00
20	E-Leather	SL3L	Carmine	1,90	0,00
21	E-Leather	SL3L	Carmine	2,00	0,00
22	E-Leather	SL3L	Carmine	3,30	0,60
23	E-Leather	SL3L	Carmine	1,80	0,00
24	E-Leather	SL3L	Carmine	1,90	0,00
25	E-Leather	SL3L	Rhodedendron	2,80	0,00
26	E-Leather	SL3L	Rhodedendron	2,30	0,00
27	E-Leather	SL3L	Rhodedendron	2,20	0,00
28	E-Leather	SL3L	Rhodedendron	2,30	0,00

The figures 26 and 27 below are presented to show that:

- Within the same color, test results variation (avg. burn length and avg. self extinguish time) does exist;
- One color is no worse than any other;
- The large amounts of the results are between 1 and 3 inches (avg burn length), and between 0 and 1 seconds (avg self extinguish time).

These facts lead us to conclude that the differences in colors do not contribute for the test results variation.

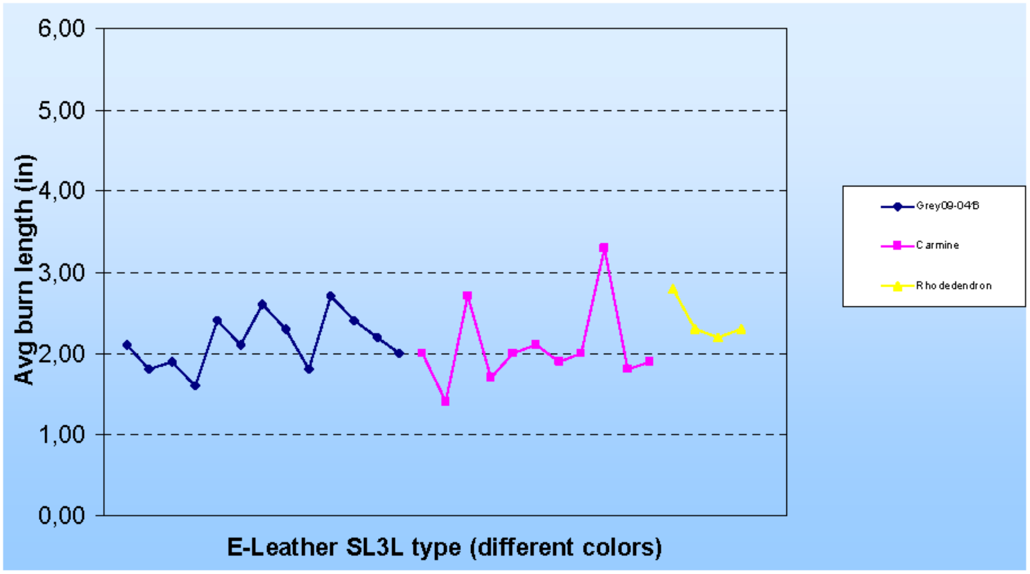

Figure 26: Graphic for Avg Burn Length (in) *versus* SL3L material.

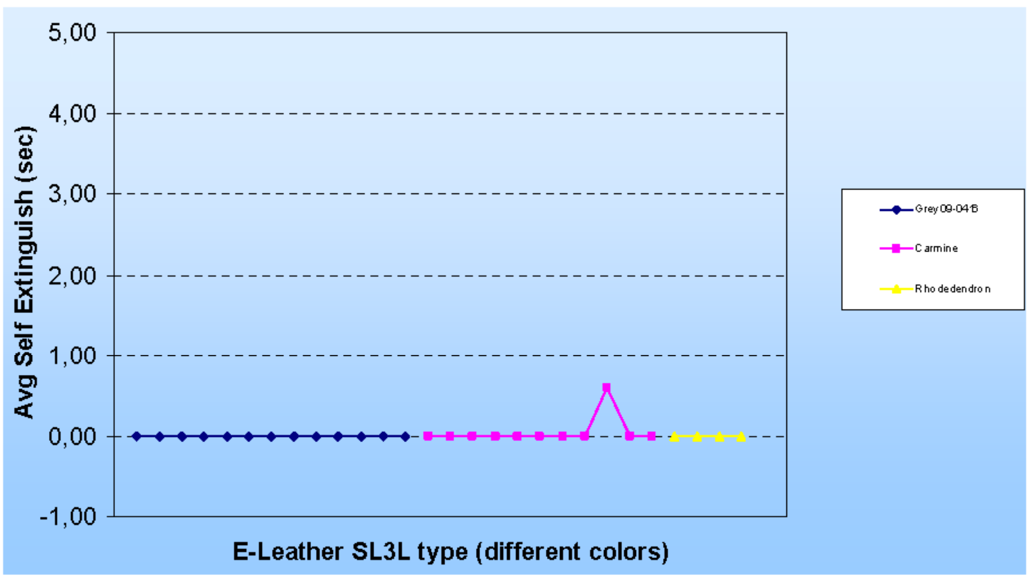

Figure 27: Graphic for Avg Self Extinguish Time (sec) *versus* SL3L material.

The evaluation that the color of synthetic leather does not affect the test results may be better evidenced thru the basic statistical analysis demonstrated below.

5.1.3.3.1 Statistical analysis for Avg Burn Length

The average and the standard deviation for the 28 values of “Avg Burn Length” indicated in the table 5, are:

- Average → **2.15 inches**
- Std. Deviation → **0.41 inch**

Thus we may plot the data for 3σ, being:

- **3σ** = 3 Std. Deviation = 3 x 0.41 = **1.22 inches**

The figure 28 shows that the distribution is close to the average burn length of 2.15 inches with no points exceeding the 3σ range.

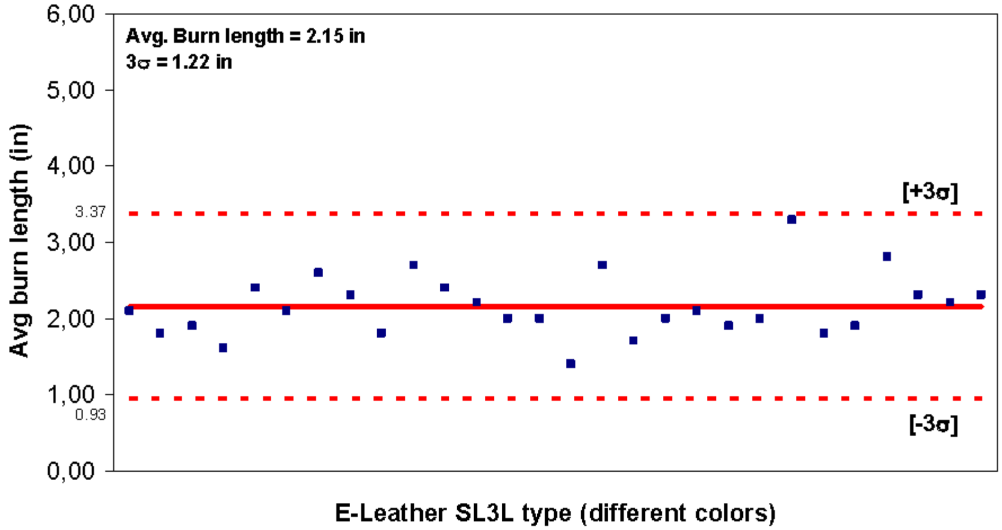

Figure 28: Graphic Avg Burn Length (in) *versus* E-Lethear SL3L material for 3σ range.

By the histogram presented below (figure 29), an important information we can extract is that **100%** of the average burn length values for the tested materials are up to **3.37 inches** (the maximum value of average burn length identified in the table 5 is 3.30 inches). This value is well below the average burn length criteria of the requirement 14CFR 25.853(a) Part I (a) (1) (ii), which may not exceed 8 inches.

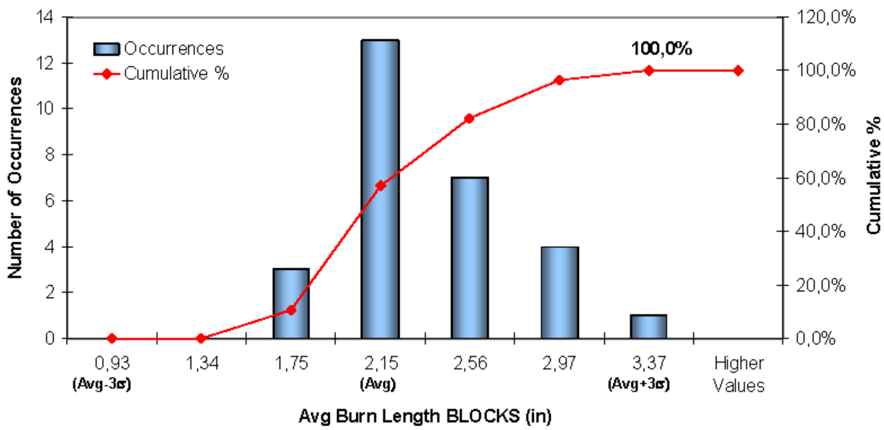

Figure 29: Average burn length histogram.

5.1.3.3.2 Statistical analysis for Avg Self Extinguish Time

Performing the same study for the Avg Self Extinguish Time, the average and the standard deviation for the 28 values of "Avg Self Extinguish Time" indicated in the table 5, are:

- Average → **0.02 sec**
- Std. Deviation → **0.11 sec**

Thus we may plot the data for 3σ, being:

- **3σ** = 3 Std. Deviation = 3 x 0.11 = **0.34 sec**

The figure 30 shows that the distribution is close to the average self extinguish time of 0.02 seconds with 1 point exceeding the +3σ range (-3σ range was not considered, since it would became negative time).

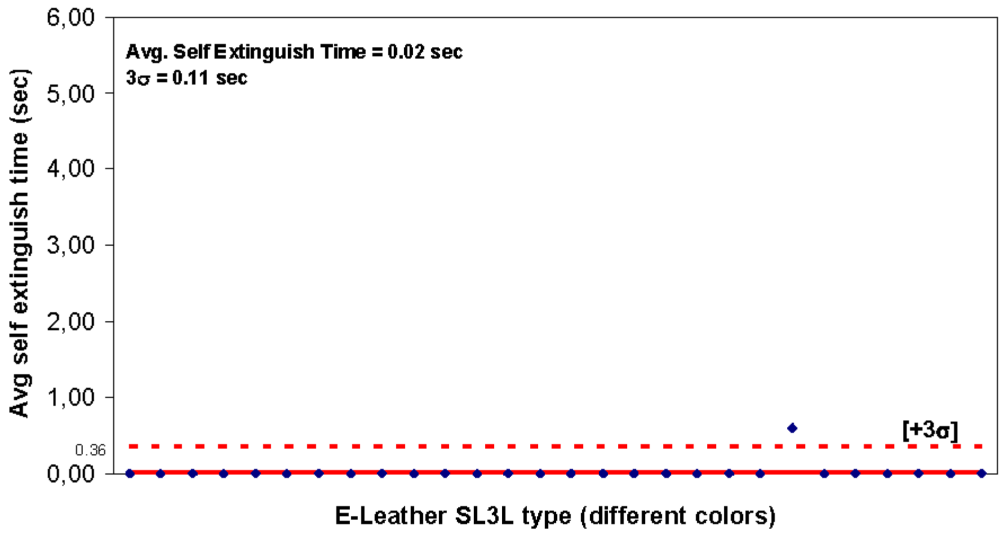

Figure 30: Graphic Avg Self Extinguish Time (sec) *versus* SL3L material for 3σ range.

Also by the histogram presented below (figure 31), an important information we can extract is that **96.4%** of the average self extinguish values for the tested materials are up to **0.36 sec** (the maximum value of average self extinguish time identified in the table 5 is 0.60 sec). This value is below the average self extinguish time criteria of the requirement 14CFR 25.853(a) Part I (a) (1) (ii), which may not exceed 15 seconds.

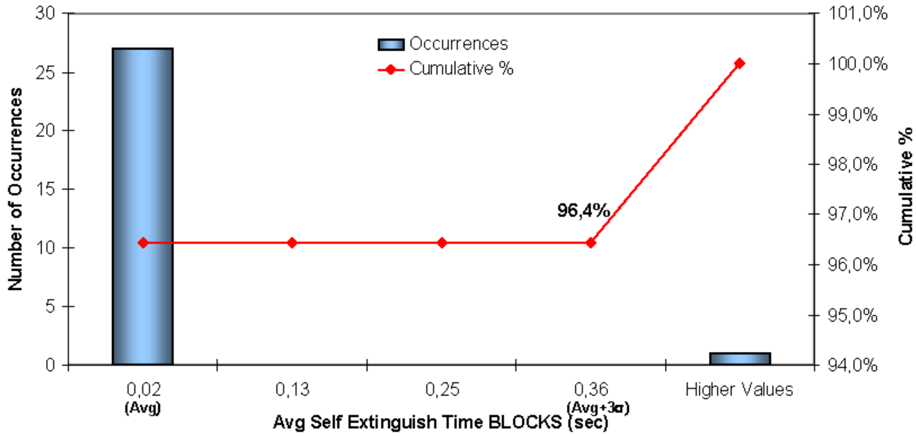

Figure 31: Average self extinguish time histogram.

5.2 WARP / LAY DIRECTIONS ANALYSIS

5.2.1 Tapis Synthetic leather – combined with others materials (C&D data)

The table 6 below presents the 12 seconds Vertical test data from C&D Zodiac for the synthetic leather manufactured by Tapis Corp named Ultraleather combined with others materials, which test specimen build-up may be verified thru the table 6. It is also presented the values for lay and warp directions.

In this study we will analyze the flammability test results on both synthetic leather directions (warp and lay) and if the synthetic leather combined with other materials may affect the flammability test results.

The table 6 shows different colors for each test specimen build-up, e.g. the "green block" in the table represents different colors of Ultraleather tested by itself. The "orange block" represents different colors of ultraleather tested according to the following construction: Ultraleather + Adhesive 1 + Ultraleather and so on.

Dripping time was unconsidered because no dripping was detected for all test data.

Table 6: 12 seconds Vertical Test data for Tapis Corp. Ultraleather material:

			12 seconds Vertical Test			
	Company name	Description	Avg Burn Length (in) LAY	Avg Burn Length (in) WARP	Avg Flame Time (sec) LAY	Avg Flame Time (sec) WARP
1	C&D Zodiac	Ultraleather HP, Baltic Blue 2551	1,00	1,10	2,40	0,00
2	C&D Zodiac	Ultraleather HP, Graphite 5739	1,20	1,30	0,00	0,00
3	C&D Zodiac	Ultraleather HP, Pewter 5796	2,00	2,20	0,00	0,00
4	C&D Zodiac	Ultraleather HP, Orchard 4262	2,10	2,30	0,00	0,00
5	C&D Zodiac	Ultraleather HP, Juniper 4261	2,20	2,50	0,00	0,00
6	C&D Zodiac	Ultraleather HP, Windsor 2680	2,50	2,70	0,00	0,00
7	C&D Zodiac	Ultraleather 3602 Adhesive 1 Ultraleather 3602	0,40	0,50	0,00	0,00
8	C&D Zodiac	Ultraleather HP, Admiral Blue 2556 Adhesive 1 Ultraleather HP, Admiral Blue 2556	2,00	1,60	0,00	0,00
9	C&D Zodiac	Ultraleather HP, Baltic Blue 2551 Adhesive 1 Ultraleather HP, Baltic Blue 2551	1,30	1,80	0,00	0,00
10	C&D Zodiac	Ultraleather HP, Graphite 5739 Adhesive 1 Ultraleather HP, Graphite 5739	1,10	1,20	0,00	0,00
11	C&D Zodiac	Ultraleather HP, Orchard 4262 Adhesive 1 Ultraleather HP, Orchard 4262	1,50	1,60	0,00	0,00
12	C&D Zodiac	Ultraleather HP, Juniper 4261 Adhesive 1 Ultraleather HP, Juniper 4261	2,00	2,00	7,90	0,00
13	C&D Zodiac	Ultraleather HP, Smoke 5681 Adhesive 1 Ultraleather HP, Smoke 5681	1,80	1,80	0,00	0,00
14	C&D Zodiac	Ultraleather HP, Windsor 2680 Adhesive 1 Ultraleather HP, Windsor 2680	1,50	1,50	0,00	0,00
15	C&D Zodiac	Ultraleather 3602 Adhesive 2 Termoplastic material	0,20	0,10	0,00	0,00
16	C&D Zodiac	Ultraleather 3602 Adhesive 3 Termoplastic material	2,20	2,50	0,00	0,00
17	C&D Zodiac	Ultraleather 5763 Adhesive 3 Termoplastic material	1,70	1,90	0,00	0,00
18	C&D Zodiac	Ultraleather HP, Admiral Blue 2556 Adhesive 4 Termoplastic material	1,20	1,60	0,00	0,00
19	C&D Zodiac	Ultraleather HP, Baltic Blue 2551 Adhesive 4 Termoplastic material	1,70	2,00	0,00	0,00
20	C&D Zodiac	Ultraleather HP, Graphite 5739 Adhesive 4 Termoplastic material	1,70	1,70	0,00	0,00
21	C&D Zodiac	Ultraleather HP, Pewter 5796 Adhesive 4 Termoplastic material	0,50	0,60	0,00	0,00
22	C&D Zodiac	Ultraleather HP, Orchard 4262 Adhesive 4 Termoplastic material	2,10	2,20	0,00	0,00
23	C&D Zodiac	Ultraleather HP, Juniper 4261 Adhesive 4 Termoplastic material	1,80	1,80	0,00	0,00
24	C&D Zodiac	Ultraleather HP, Smoke 5681 Adhesive 4 Termoplastic material	1,60	1,90	0,00	0,00
25	C&D Zodiac	Ultraleather HP, Windsor 2680 Adhesive 4 Termoplastic material	1,70	1,80	0,00	0,00

Cont. Table 6:

	Company name	Description	12 seconds Vertical Test: Avg Burn Length (in) LAY	Avg Burn Length (in) WARP	Avg Flame Time (sec) LAY	Avg Flame Time (sec) WARP
26	C&D Zodiac	Ultraleather 3602 Adhesive 2 Termoplastic material Adhesive 3 Metallic material	0,10	0,10	0,00	0,00
27	C&D Zodiac	Ultraleather 3602 Adhesive 3 Termoplastic material Adhesive 3 Metallic material	2,40	2,20	0,00	0,00
28	C&D Zodiac	Ultraleather HP, Admiral Blue 2556 Adhesive 4 Termoplastic material Adhesive 3 Metallic material	1,20	1,30	0,00	0,00
29	C&D Zodiac	Ultraleather HP, Baltic Blue 2551 Adhesive 4 Termoplastic material Adhesive 3 Metallic material	1,80	2,20	0,00	0,00
30	C&D Zodiac	Ultraleather HP, Graphite 5739 Adhesive 4 Termoplastic material Adhesive 3 Metallic material	1,90	1,80	0,00	0,00
31	C&D Zodiac	Ultraleather HP, Pewter 5796 Adhesive 4 Termoplastic material Adhesive 3 Metallic material	0,80	0,90	0,00	0,00
32	C&D Zodiac	Ultraleather HP, Orchard 4262 Adhesive 4 Termoplastic material Adhesive 3 Metallic material	2,40	2,20	0,00	0,00
33	C&D Zodiac	Ultraleather HP, Juniper 4261 Adhesive 4 Termoplastic material Adhesive 3 Metallic material	1,90	1,90	0,00	0,00
34	C&D Zodiac	Ultraleather HP, Smoke 5681 Adhesive 4 Termoplastic material Adhesive 3 Metallic material	1,50	1,60	0,00	0,00
35	C&D Zodiac	Ultraleather HP, Windsor 2680 Adhesive 4 Termoplastic material Adhesive 3 Metallic material	1,50	1,70	0,00	0,00

From these data, a graphic "*Avg Burn Length (in) vs Ultraleather material*" and "*Avg Self Extinguish Time (sec) vs Ultraleather material*" were plotted per figures 32 and 33, respectively:

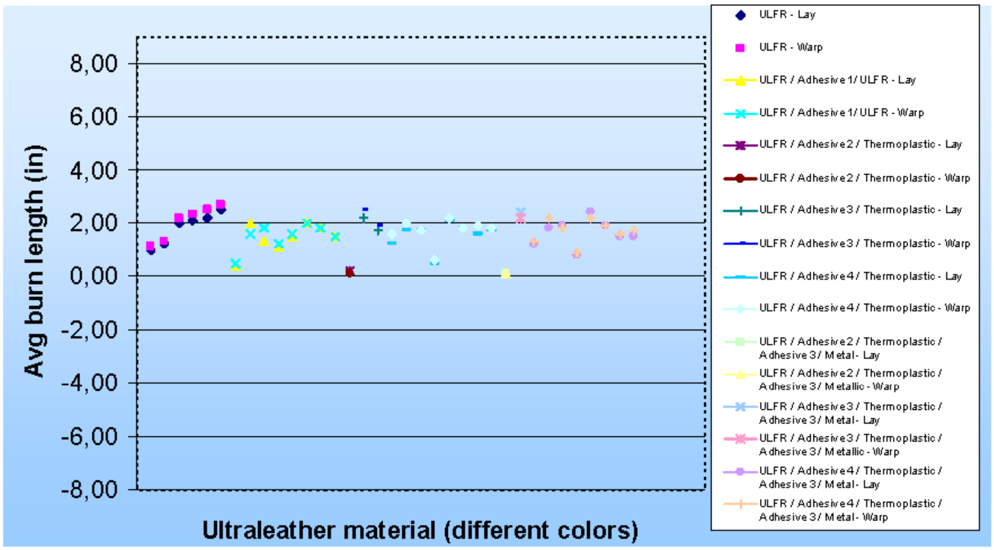

Figure 32: Graphic for Avg Burn Length (in) *versus* Ultraleather material.

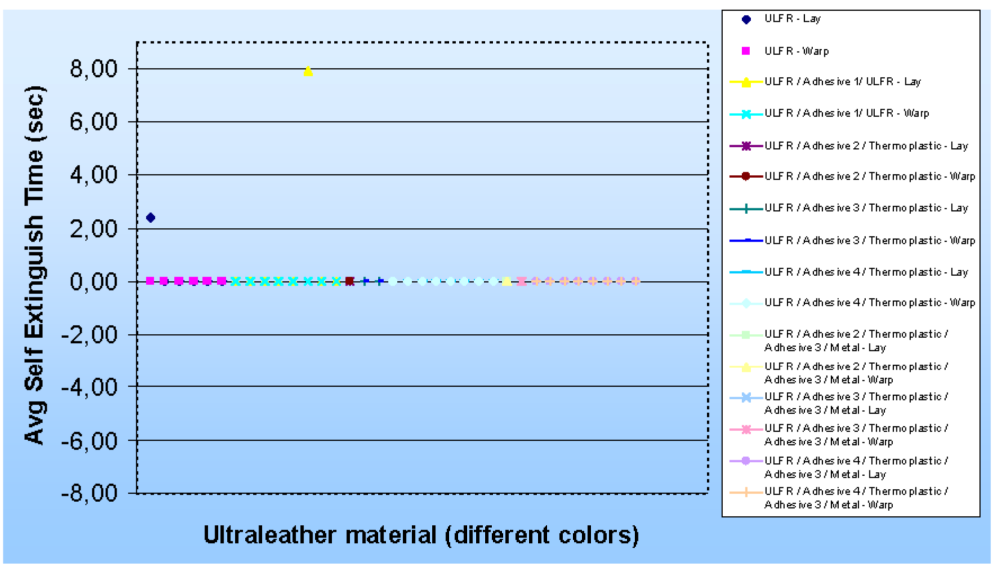

Figure 33: Graphic for Avg Self Extinguish Time (sec) *versus* Ultraleather material.

Per graphics above (figure 32 and 33) we may verify that most of the burn length values are between 1 and 3 inches and the self extinguish time values are zero seconds no matter the test specimen build-up. However it would not be correct to assume that any type of test specimen build-up using ultraleather material on the face may be substantiated by another one previously tested because you could approve by similarity a test specimen which the adhesive used presents a bad fire characteristic and the industry agrees that this may have negative effect on the self extinguish time.

We may verify thru the figures 32 and 33 above that the ultraleather lay and warp directions test results are very close for both burn length and self extinguish time. Herewith testing one direction would substantiate the other direction.

5.2.2 E-Leather Synthetic leather – tested by itself (E-Leather data)

For all the E-Leather type products (SL3UL, SL3SL and SL3L) we may verify thru the figures 34, 35 and 36 below that the lay and warp directions test results are very close for both burn length and self extinguish time. Herewith testing one direction would substantiate the other direction.

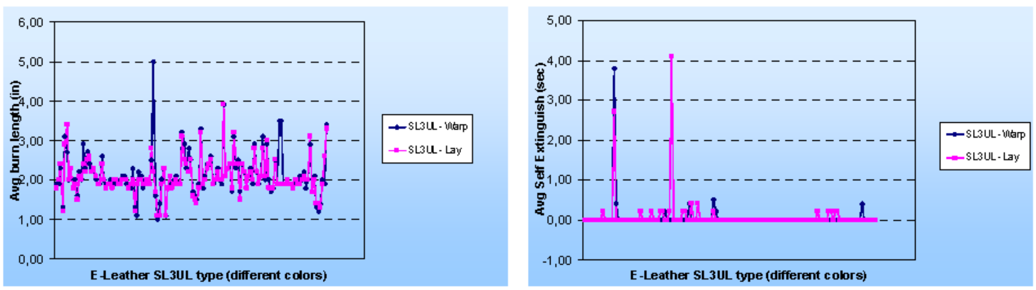

Figure 34: Graphic for Avg Burn Length (in) and Avg Self Extinguish Time (sec) *versus* SL3UL material.

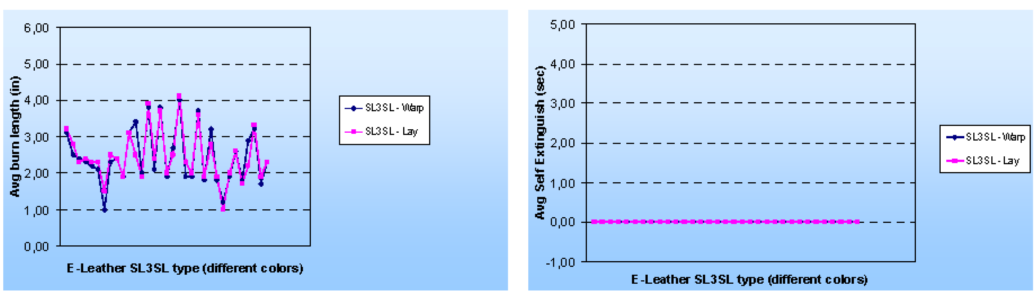

Figure 35: Graphic for Avg Burn Length (in) and Avg Self Extinguish Time (sec) *versus* SL3SL material.

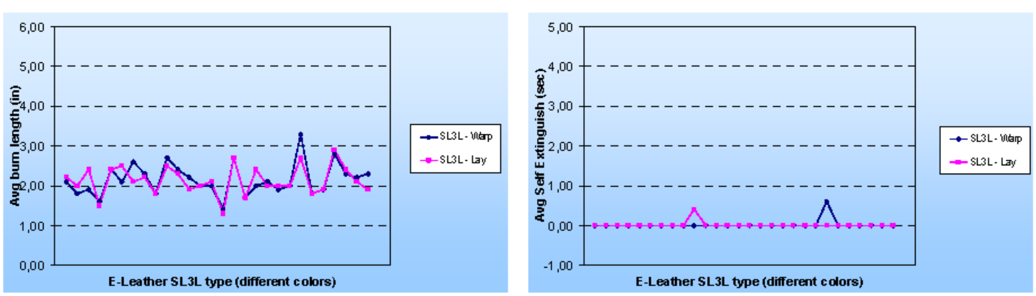

Figure 36: Graphic for Avg Burn Length (in) and Avg Self Extinguish Time (sec) *versus* SL3L material.

5.3 WEIGHT / THICKNESS VARIATION ANALYSIS

Another analysis done for E-Leather products SL3UL, SL3SL and SL3L was the weight / thickness variations on the flammability test results.

Per figures 37 and 38 below neither better nor worse behavior may be noted for burn length and self extinguish time for E-Leather products SL3UL, SL3SL and SL3L which present the same material composition with different grades of weight / thickness. In other words, most of the burn length values are between 1 and 4 inches and the self extinguish time values are zero to 1 second no matter the E-Leather type product.

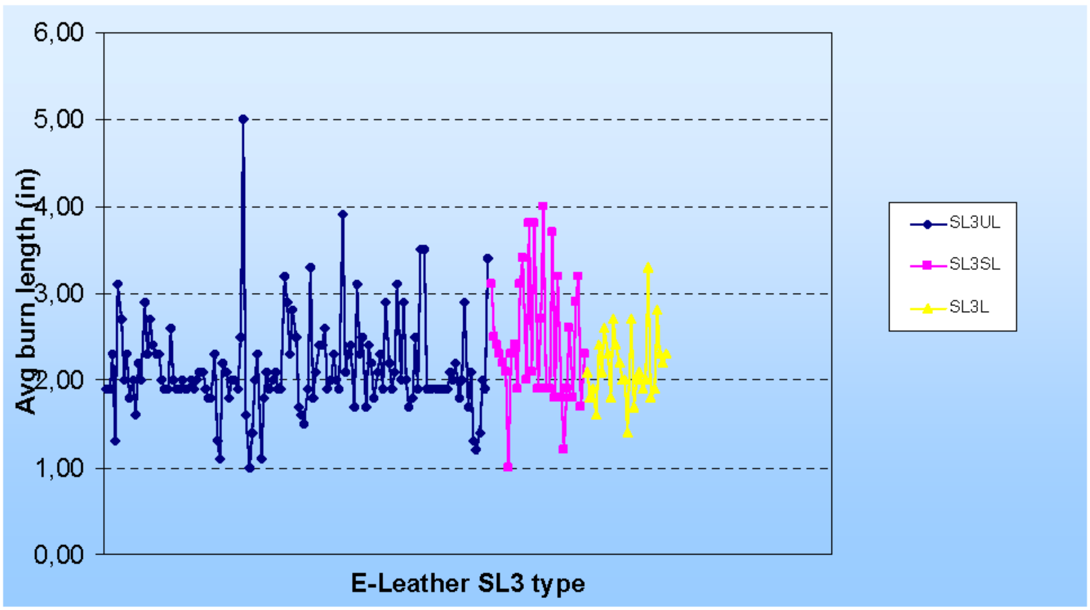

Figure 37: Graphic for Avg Burn Length (in) *versus* SL3 type material.

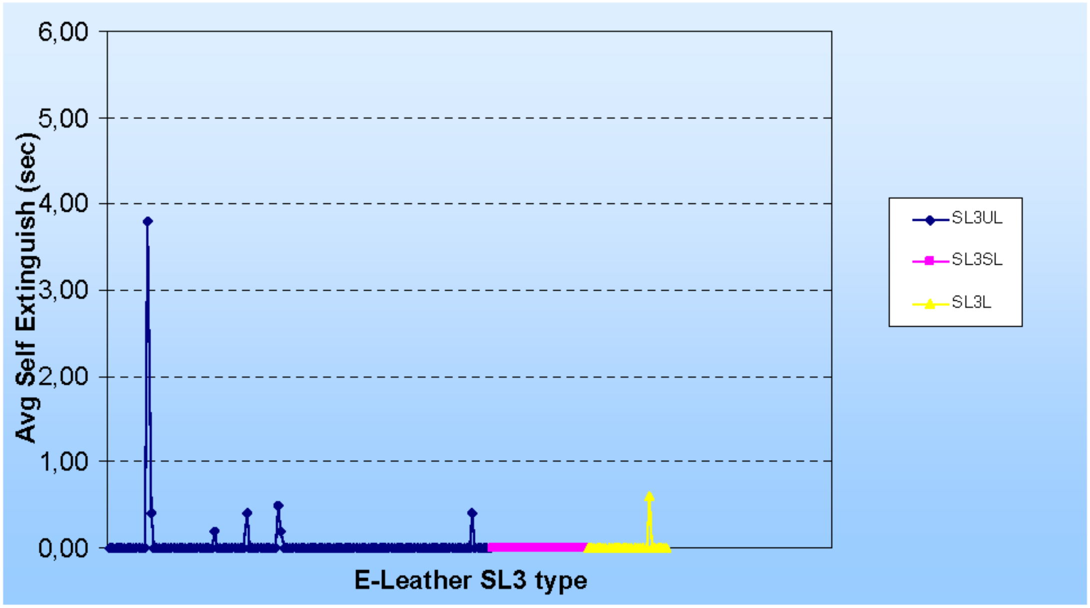

Figure 38: Graphic for Avg Self Extinguish Time (sec) *versus* SL3 type material.

6. Conclusions

Based on the synthetic leather / suede test results (burn length and self extinguish time) we may conclude that:

- Color variation;
- Warp / Lay directions and;
- Weight / thickness variation

do not have any influence on 12 seconds vertical test, once within these parameters, test results variation does exist and one color / direction / weight is no worse than any other color / direction / weight.

Thus the acceptance of the substantiation of one color / direction / weight by using previous tested synthetic leather / suede of different color / direction / weight within the same material type (same manufacturer, composition (except for the color composition) and same test specimen build-up) for flammability requirement 14CFR 25.853(a) – 12 seconds Vertical Test is reasonable.

Thru these findings we propose a new wording for Part 2, 25.853(a) reference item #15 which is “***Data from testing one color, direction or weight of synthetic leather/suede material sample will substantiate other color, direction or weight of the same material***”.

APPENDIX P—ITEM 16: ALUMINUM, STEEL, AND TITANIUM PARTS (EXCLUDING POWDER COATING)

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM PROPOSAL

Part 1, Reference Item #16, “Aluminum/steel/titanium parts (excluding powder coating)”

Revision C, 24 June, 2011

CONTENTS

REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
Original	Copy for Ballot	2010-July-28	Bruce Gwynne
A	Updated per FAA comments	2011-Feb-02	Bruce Gwynne
B	Updated Section 6.1	2011-Apr-13	Bruce Gwynne
C	Editorial Sections 4.1 & 6.1	2011-June-24	Bruce Gwynne

1 INTRODUCTION

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, "Policy Statement on Flammability Testing of Interior Materials" [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA's technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry.

Item 16 (Metals Items) test requirements and MOC's are straight forward and fall under the Part 1 category alone. Industry agrees with the general FAA approach but further definition was required to differentiate metals that did not conform to the written method, specifically magnesium alloys. A new description of these alloys has been proposed.

There was also the need to better define the term 'standard paint/finishes' used in the draft policy. The definition was modified to specify OEM qualification for specific aircraft or applications.

These definitions have been reviewed by the industry team and are submitted as the following consensus, justification and proposal.

2 INDUSTRY TEAM LEADER AND SUPPORT TEAM

At the FAA Materials Fire Test Working Group meeting on 21 October 2009 in Atlantic City, NJ, the following individuals formed the industry team for this reference item:

2.1 TEAM LEADER

- Gwynne, Bruce (Magnesium Elektron)

2.2 SUPPORT TEAM

- Phuong Ta (Goodrich)
- Michael Jensen (Boeing)
- Keith Couilliard (Boeing)
- Scott Campbell (C&D Zodiac)

This is a small group, principals being Bruce Gwynne and Phuong Ta. Others contributed as necessary.

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on 20 August, 2009. Attachment 2, Part 1, acceptable methods without additional data, reference item #16 reads:

Aluminum/steel/titanium parts (excluding powder coating)

- **14 CFR 25.853 (a):** *Bunsen Burner Test Requirement/Similarity*

  Unless they contain magnesium or magnesium alloys, unfinished metal parts do not require testing.
  Finished metal parts do not require testing provided:
  1) Standard paint/finishes are used and
  2) The parts do not contain magnesium or magnesium alloys.
  Standard paint/finishes are defined as inorganic finishes (e.g., anodize, alodine), epoxy primers and topcoats, urethane topcoats, and corrosion inhibiting dry films. See item 17, below, for powder coatings.

- **14 CFR 25.853 (d):** *Heat Release and Smoke Test Requirement/Similarity*

  The test requirement is decided based on size criteria.
  1) Test required if greater than 2 sq ft;
  2) No test if less than 1 sq ft; and
  3) Specific determination required between 1 and 2 sq ft.

3.2 DEFINITION OF TERMS

Standard paint/finishes are defined as aircraft OEM inorganic finishes (e.g., anodize, alodine), epoxy primers and topcoats, urethane topcoats, and corrosion inhibiting dry films. See item 17, below, for powder coatings.

Aircraft (Original Equipment Manufacturer) OEM qualified is defined as finishes and coatings that have been approved by the manufacturer (internally or through their supplier system) for use on that specific model aircraft for the specific application being certified.

Magnesium or magnesium alloys would now be described only as ‘magnesium containing alloys.’ This would include any metal base alloy system containing 20% or greater magnesium content. ‘Magnesium containing alloys’ would also include recognized ‘magnesium based alloys’ used in aircraft structures comprised of greater than 80% magnesium metal. Aluminum alloys containing less than 20% magnesium are not included in the definition of a magnesium containing alloy.

4 VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

The Part 1 Bunsen Burner test requirements have never been accepted by the FAA as an MOC for flammability certification of magnesium or magnesium alloy components for aircraft interiors materials. Alternative methods are under development for magnesium alloy approval. There is also the matter of defining what ‘magnesium or magnesium alloy’ actually is, as elemental magnesium metal is never used in aircraft but is often used as an alloying ingredient in commonly employed aluminum alloys that qualify for certification without testing under the current MOC. In both these regards, industry has been debating how to provide clarification to the way Ref 16 (also items #17 and #20) is written to exclude Magnesium. Ultimately it comes down to the question: is there a threshold percentage of magnesium content that can be established to determine which alloys conform to the MOC and don’t require testing? Some have suggested magnesium content of as little as 5% (as is common in some aluminum alloys) would disqualify the alloy from this MOC exemption.

Background

Magnesium alloys often contain aluminum as a strengthening agent and to improve ductility. Typical aluminum additions are (say) 5-10%. The reverse is true for aluminum alloys where additions of magnesium up to (say) 5+% may occur to produce desired properties, with typical Mg additions being 1-3%. The aluminum industry is the largest consumer of pure magnesium produced in the world. One half of the world magnesium smelting capacity goes into aluminum alloys used largely in beverage can applications. These magnesium containing aluminum alloys don’t burn any differently than non magnesium aluminum alloys.

In contrast to this, magnesium based alloys (alloys with >80% Mg), the subject of recent FAA flammability investigations has shown that increasing the Al content worsens the alloy’s flammability (ignition resistance) characteristics. Equally rare earth additions to magnesium based alloys often reduce the flammability aspects and in some cases render the magnesium alloy almost totally non flammable.

There are anomalies in magnesium alloys where the aluminum content is far greater. For instance there is a 50/50 magnesium/aluminum alloy defined by industry, but not for structural applications. It is for chemical and military pyrotechnic applications. This alloy is sometimes referred to as Magnalium and at the 50/50 ratio burns vigorously. It would never be used in an aircraft application; it has no mechanical properties of any use for an aircraft part.

No evaluation work has been performed, of which industry is aware, that has established at which point an alloy of any base metal (Al, Ti, Steel, Zn, etc.) becomes flammable due to increasing magnesium content. Therefore in order to satisfy the MOC by establishing a maximum magnesium threshold when there is no basis in fact is somewhat arbitrary. There are numerous research activities and programs in existence investigating innovative materials in any number of metal alloying combinations using magnesium additions that could exceed a (say) 20% proposed maximum that would be perfectly safe from a flammability standpoint. These would include but not limited to research in areas such as rapid solidification, powder metallurgy, metal matrix composites, semi solid forming and others that are all capable of producing unique alloy systems that may be quite different from traditionally developed molten state alloy systems. However to establish a 20% limit in magnesium content can arguably be a sensible approach considering no currently specified aluminum based alloy has a greater than 20% magnesium content and no currently specified magnesium based alloy has a magnesium content of less that 80% magnesium.

From the certification testing side, the FAA is currently engaged in a task group designed to develop a test (MOC) to allow magnesium based alloys to be used in aircraft seat structures. This is based on preliminary oil burner testing that was followed by full scale testing whose results demonstrated magnesium does not increase the hazard level in a post crash fire environment. The direction of the MOC test development is material dependant and probably not part specific. This is likely to be required of any magnesium containing alloy system, ie an alloy of any base metal with greater than 20% magnesium.

What we also know is that magnesium based alloys (greater than 80%) currently used in aircraft applications are identified and defined by a number of published metal specification authorities such as the ASTM, ASM, MIL Specs and MMPDS. These are by definition included in the description of magnesium containing alloys and would be subject to the same FAA magnesium flammability test requirements.

PROPOSED STANDARD TO MEET

Ref #16: Aluminum/steel/titanium parts (excluding powder coating)

- **14 CFR 25.853 (a):** Bunsen Burner Test Requirement/Similarity

Unfinished metal parts do not require testing providing they are not produced from magnesium containing alloys.

Finished metal parts do not require testing provided:

1) Standard paint/finishes are used and
2) The parts do not contain magnesium containing alloys.

Standard paint/finishes are defined as aircraft OEM inorganic finishes (e.g., anodize, chromate conversion coatings), epoxy primers and topcoats, urethane topcoats, and corrosion inhibiting coatings. See item 17, below, for powder coatings.

Aircraft (Original Equipment Manufacturer) OEM qualified is defined as finishes and coatings that have been approved by the manufacturer (internally or through their supplier system) for use on that specific model aircraft for the specific application being certified.

Magnesium containing alloys are defined as any metal alloy system comprised of greater than 20% magnesium metal. This definition includes Magnesium based alloys typically used in aircraft structure and are defined as magnesium alloys containing greater than 80% magnesium. Other methods of testing are required for certification of magnesium containing alloy parts.

- **14 CFR 25.853 (d):** Heat release and Smoke Test Requirement/Similarity

The test requirement is decided based on size criteria.

1) Test required if greater than 2 sq ft;
2) No test if less than 1 sq ft; and
3) Specific determination required between 1 and 2 sq ft.

5 DATA / ANALYSIS

5.1 EXISTING DATA

Magnesium based alloys are defined by and registered with the ASTM. It is not being suggested that the ASTM Standard be used as a criteria for definition and validation of what is a magnesium based alloy as there are proprietary alloy systems that are not registered. However the standard is offered as a reference to the general chemistry of magnesium alloys systems and constituents commonly employed as alloying ingredients.

[2] ASTM B275, Table X4.1 Magnesium-Alloy Registration Record is a good reference for commonly employed-in-aircraft magnesium alloys.

6 CONCLUSION

The concept the FAA want to convey in its draft policy memo is that a part constructed of magnesium containing alloys cannot be tested for compliance in this manner. The proposed draft policy original wording refers to 'magnesium and magnesium alloys.' There is no application for pure elemental magnesium in any aircraft part application. There are no studies determining at what level magnesium content of another base metal alloy increases its flammability, however it is felt that any base metal alloy containing greater than 20% magnesium would not qualify for exemption under the current MOC and must then be subject to methods developed subsequently specifically for magnesium containing alloy systems.

We should also be mindful that there are no magnesium based alloys that are currently used or would be considered in aviation structure that contains less than 80% magnesium. The [2] ASTM standard of registered cast and wrought magnesium alloys confirms this.

Therefore if an unfinished metallic component is an alloy that contains over 20% magnesium, by definition it is a magnesium containing or magnesium based alloy and cannot be approved using the Part 1 MOC testing. It would have to meet the requirements of some other MOC. If an unfinished metallic component is an alloy that contains less than 20% magnesium it does not require Part 1 testing under the MOC.

To satisfy the finishes component of the MOC, a refined definition of ‘standard finishes’ was also created. And with the magnesium definition established it follows that parts that are treated with standard finishes and are not made from a magnesium based alloy do not require testing other than defined in 14 CFR 25.853 (a).

The industry team does not disagree with the FAA’s position on item #16, 14 CFR 25.853 (a) and (d), but felt better definition of the terms ‘magnesium alloys’ and ‘standard paint/finishes’ was necessary. Industry also did not want to totally exclude consideration of magnesium containing and magnesium based alloys; hence a statement is included to reference other certification methods.

Due to the editorial nature and simple changes to this Item, it has been suggested that the document bypass peer review and proceed directly to ballot.

6.1 REVISED PROPOSAL

Ref #16: Aluminum/steel/titanium parts (excluding powder coating)

- **14 CFR 25.853 (a):** Bunsen Burner Test Requirement/Similarity

Unfinished metal parts do not require testing providing they are not produced from magnesium containing alloys.

Finished metal parts do not require testing provided:
1) Standard paint/finishes are used and
2) The parts do not contain magnesium containing alloys.

Standard paint/finishes are defined as aircraft OEM inorganic finishes (e.g., anodize, chromate conversion coatings), epoxy primers and topcoats, urethane topcoats, and corrosion inhibiting coatings. See item 17, below, for powder coatings.

Aircraft (Original Equipment Manufacturer) OEM qualified is defined as finishes and coatings that have been approved by the manufacturer (internally or through their supplier system) for use on that specific model aircraft for the specific application being certified.

Magnesium containing alloys are defined as any metal alloy system comprised of greater than 20% magnesium metal. This definition includes Magnesium based alloys typically used in aircraft structure and are defined as magnesium alloys containing greater than 80% magnesium. Other methods of testing are required for certification of magnesium containing alloys parts.

- **14 CFR 25.853 (d):** Heat release and Smoke Test Requirement/Similarity

The test requirement is decided based on size criteria.

1) Test required if greater than 2 sq ft;
2) No test if less than 1 sq ft; and
3) Specific determination required between 1 and 2 sq ft.

7 ABBREVIATIONS

FAA	=	Federal Aviation Administration
MOC	=	Methods of Compliance

8 REFERENCES

[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

[2] Annual Book of ASTM Standards, Section 2 – Nonferrous Metal Products, Volume 02.02 Aluminum and Magnesium Alloys, B275 Codification of Certain Nonferrous Metals and Alloys, Cast and Wrought, Table X4.1 Magnesium Alloy Registration Record.

APPENDIX Q—ITEM 20: EMBEDDED METAL DETAIL

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM REPORT

Part 1, Reference Item #20, “Embedded Metal Detail”

(Details Bonded to Base Panel Post-Cure of the Panel)

Revision – A, dated 2011-Nov-1

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REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
NC	Initial release	2011-Feb-14	Anthony Perugini
A	Harmonized thickness requirement in figure 8 (Page 11) with the requirements of Item 21 and 22, stating "the detail is at least 0.02" thick"	2011-Nov-1	Anthony Perugini

1 INTRODUCTION

The well established industry practice is to not perform aircraft interiors flammability testing according to 14 CFR 25.853 (a) and (d) for embedded metal details. The argument for not testing the embedded metal details is that the metal will not have an effect on the results of flammability testing.

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials” [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA’s technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Item 20 has been reviewed by the industry team and is submitting the following concurrence, justification and proposal.

2 INDUSTRY TEAM LEADER AND SUPPORT TEAM

2.1 TEAM LEADER

- Perez, Robert (AIM Aerospace)

2.2 SUPPORT TEAM

This proposal has been posted for peer review on the Flammability Standardization Task Group SharePoint Site where remarks, suggestions, corrections and contributions from the Flammability Standardization Task Group are encouraged.

- Anthony Perugini (AIM Aerospace)
- Dan Slaton (Boeing)
- Gilberto Niitsu (Embraer)
- Mary Pacher (Boeing)
- Michael Jensen (Boeing)

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on 20 August, 2009. Attachment 2, Part 1, reference item #20 reads (see Figure 1):

- 14 CFR 25.853 (a): *“Test the adhesive by itself or the detail and adhesive together per 12-second vertical. Limitation – Detail may not be constructed by magnesium or magnesium alloys”*.
- 14 CFR 25.853 (d): *“No test requirement”*

Part 1, acceptable methods without additional data

Item Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke test Requirement/Similarity
20	Embedded Metal Detail	Test the adhesive by itself or the detail and adhesive together per 12-second vertical. Limitation – Detail may not be constructed by magnesium or magnesium alloys.	No test requirement

Figure 1: Attachment 2, Part 1, Reference Item #20

No equivalent entry exists for reference item #20 in attachment 2, Part 2.

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of the term ‘Embedded Metal Detail’ should be provided so that confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and the industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

3.2.1 Embedded Metal Detail

An embedded metal detail is defined as a metal detail of various shapes that is bonded to a sandwich panel, post cure of the sandwich panel. Usually, part of the base (stock) sandwich panel is modified by removing core or face sheets before bonding the embedded metal detail to the base panel.

Examples of embedded metal details are conduits, fittings, edge supports, attachment fittings, hinges, latches, etc. Figures 2 through 6 show examples of embedded metal details. Reference item #22 for co-cured metal doublers. General cases of bonded metal details are shown in figure 7.

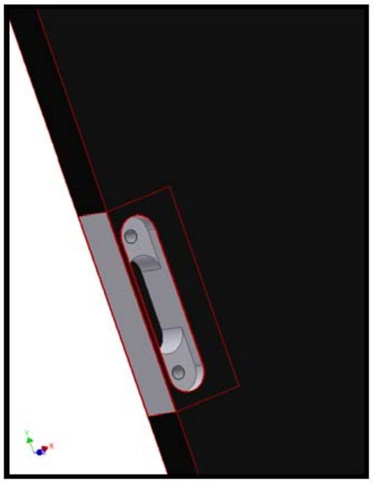

Figure 2: Hinge Block Bonded to Panel

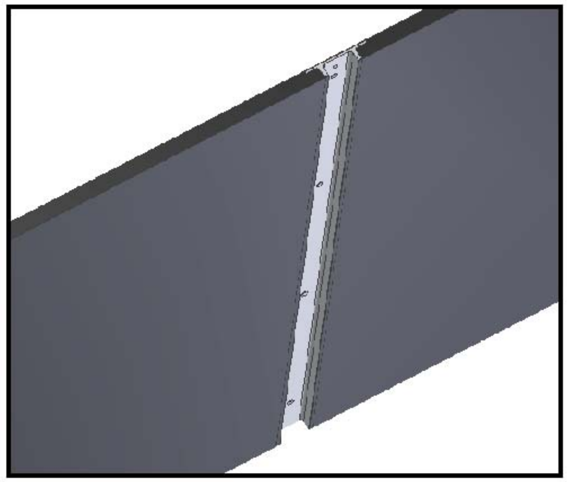

Figure 3: Bonded Extrusion (Cross-Section Shown in Figure 6)

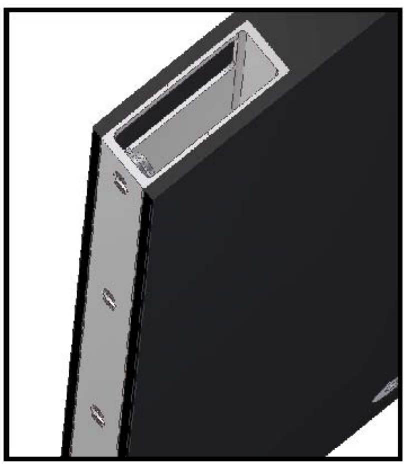

Figure 4: Bonded Extrusion

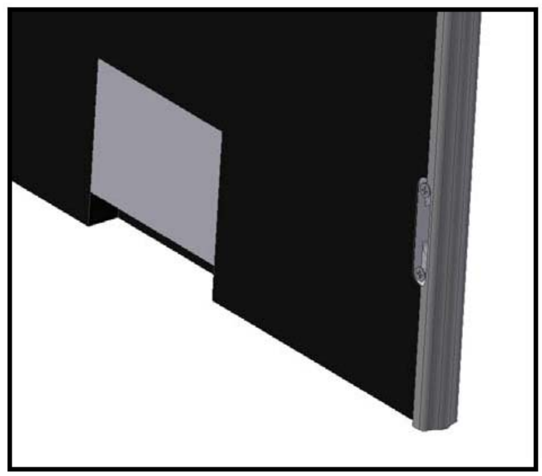

Figure 5: Bonded Metal Block

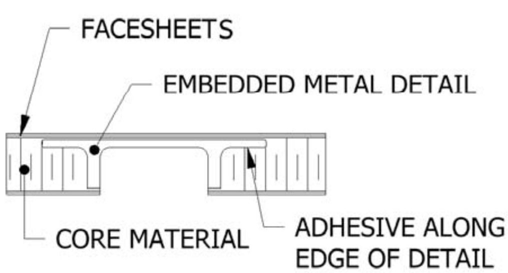

Figure 6: Typical Cross-Section of Embedded Metal Detail

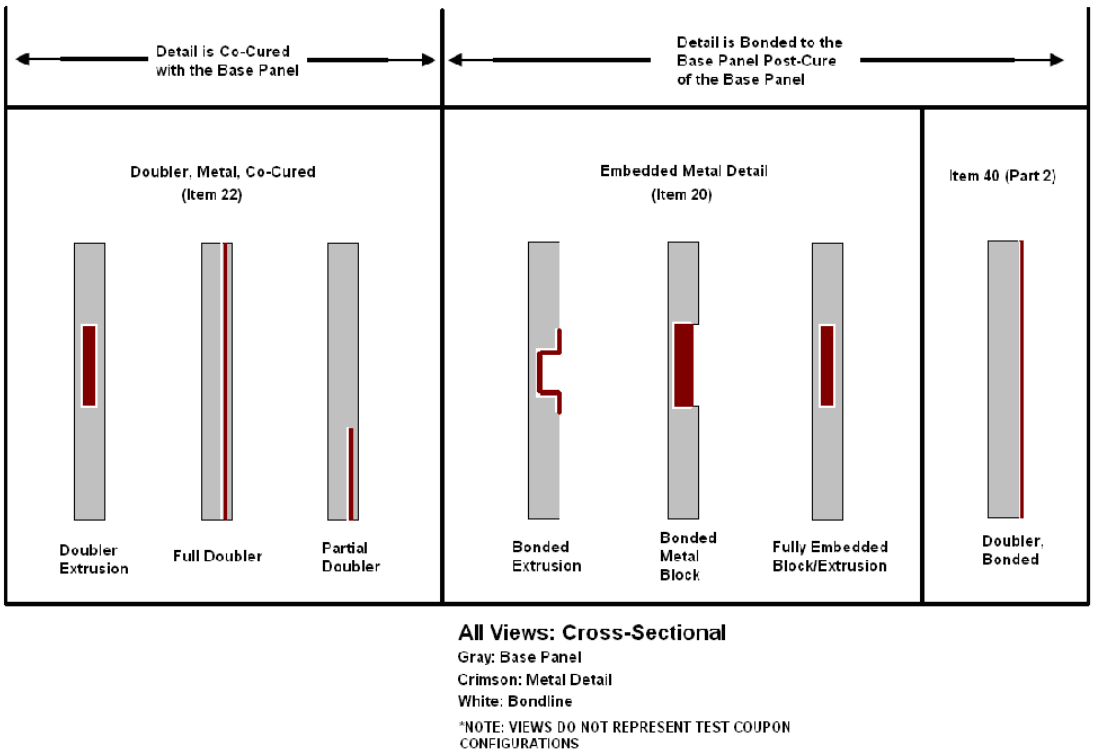

Figure 7: General cases of bonded metal details.

4 VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

The use of this MOC has been grouped by the FAA into Part 1 for both 14 CFR 25.853 (a) and (d). This means that the FAA has accepted this method for Vertical Burn, Heat Release and Smoke Density testing.

Based on industry discussion, the industry team determined that Item 20 titled “Embedded Metal Detail” has equivalent findings to those listed in Part 1, Item 22 (“Doubler, Metal, Co-cured”) which require no testing for 14 CFR 25.853 (a) and (d).

5 DATA/ANALYSIS

5.1 EXISTING TEST DATA

The industry has called upon its members to submit any existing flammability data to support 14 CFR 25.853 (a) and (d) for items 20, 22 and 40.

5.2 TEST RESULTS

Data supporting the harmonization of items 20, 22 and 40 has been compiled in appendix A.

5.3 ANALYSIS

Test data provided by Boeing and AIM Aerospace, Inc. validates the industry proposal to harmonize items 20, 22 and 40 which are considered to be metal details, bonded. Burn length and extinguishing times are significantly reduced for composite sandwich panels/substrates when tested with bonded metal details included in the construction. This data trend is present regardless of the type of adhesive used or the method of detail implementation (co-cured with the panel or secondarily bonded).

6 CONCLUSION

The industry team agrees with the FAA’s position on 14 CFR 25.853 (d).

The industry team further recommends that the 25.853 (a) Bunsen burner test requirement for item 20, Part 1 be harmonized with Items 21, 22, and 40.

Based on industry discussion, the industry team concludes that Embedded Metal Details do not diminish cabin safety nor contribute to fire propagation, therefore the industry team recommends that Item 20 be revised as follows:

Item Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke test Requirement/Similarity
20, 22, 40	Metal Detail, Bonded	No Test Requirement. Data from base panel substantiates (Provided that the detail is at least 0.02" thick). Limitation – Detail may not be constructed by magnesium or magnesium alloys.	No Test Requirement. Data from base panel substantiates.

Figure 8: Proposed change of Item 20

7 ABBREVIATIONS

FAA	=	Federal Aviation Administration
MOC	=	Methods of Compliance
CFR	=	Code of Federal Regulations

8 REFERENCES

[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

APPENDIX A

	Configuration	F1	F2	Construction (Boeing)	EXT Time (S)	Burn Length (IN)	Drip Ext Time
1	Bonded Metal		x	POLYCARBONATE 0.015 IN. 1 PLY **Pressure Sensitive Film Adhesive** Aluminum 0.030	0.0	0.2	nd (no drip)
	Bonded Construction (Substrate)		x	POLYCARBONATE 0.015 IN. **Pressure Sensitive Film Adhesive** FIBERGLASS REINFORCED POLYESTER 0.013 IN. 1 PLY	13.5	2.0	nd
2	Bonded Metal	x		POLYURETHANE FOAM 0.500 1 PLY **Pressure Sensitive Film Adhesive** Aluminum 0.030	0.0	2.9	nd
	Substrate Alone		x	POLYURETHANE 0.500 IN. 1 PLY	0.0	5.8	2
3	Bonded Metal		x	POLYISOCYANURATE 0.500 IN. 1 PLY **Epoxy Adhesive** Aluminum 0.030	1.0	3.3	nd
	Substrate Alone	x		POLYISOCYANURATE 0.500IN. 1 PLY	0.0	5.2	nd
4	Bonded Metal		x	ARAMID FIBER REINFORCED EPOXY 3 PLY **Epoxy Adhesive** Aluminum 0.030	0.0	0.1	nd
	Substrate Alone	x		ARAMID FIBER REINFORCED EPOXY 3 PLY	0.0	3.5	nd
5	Bonded Metal	x		POLYCARBONATE/POLYVINYLFLUORIDE 0.080 IN. 1 PLY **Urethane Adhesive** Aluminum 0.030	0.0	1.5	nd
	Bonded Construction (Substrate)	x		POLYCARBONATE/POLYVINYLFLUORIDE .080 IN. 1 PLY Paint Primer 1 PLY Urethane Paint	0.0	2.7	nd
	Substrate Alone		x	POLYCARBONATE/POLYVINYLFLUORIDE 0.080 IN. 1 PLY	2.0	0.7	nd

		F1	F2	Construction (Boeing)	EXT Time (S)	Burn Length (IN)	Drip Ext Time
6	Bonded Metal		x	NYLON 6/6 0.051 PLY **Epoxy Adhesive** Aluminum 0.030	0.0	0.1	nd
	Substrate Alone		x	NYLON 6/6 0.02 IN. 1 PLY	0.0	0.2	nd
	Substrate Alone	x		NYLON 6/6 0.060 1 PLY	3.3	1.9	1.8
7	Bonded Metal	x		ALUMINUM 0.060IN. **Epoxy ADHESIVE** ALUMINUM 0.030 IN. **Structural Film Adhesive** POLYURETHANE Foam 0.500 IN. 1 PLY **Structural Film Adhesive** ALUMINUM 0.030 IN. **Epoxy Adhesive** ALUMINUM 0.060	0.0	0.1	nd
	Substrate Alone	x		POLYURETHANE FOAM 0.500 IN. 1 PLY	0.0	5.4	nd
8	Bonded Metal	x		Decorative Laminate **Pressure Sensitive Film Adhesive** FIBERGLASS REINFORCED PHENOLIC 2 PLY ALUMINUM 0.080 IN. **Epoxy ADHESIVE** POLYURETHANE Foam 0.500 IN. 1 PLY FIBERGLASS REINFORCED PHENOLIC 2 PLY **Epoxy Adhesive** ALUMINUM 0.100 IN.	0.0	0.3	nd
	Bonded Construction (Substrate)	x		DURADEC WALLPAPER 1 PLY **Pressure Sensitive Film Adhesive** FIBERGLASS REINFORCED PHENOLIC 2 PLY POLYURETHANE Foam 0.500 IN. 1 PLY FIBERGLASS REINFORCED PHENOLIC2 PLY	0.8	2.5	nd
	Bonded Construction (Substrate)	x		DURADEC WALLPAPER **Pressure Sensitive Film Adhesive** FIBERGLASS REINFORCED PHENOLIC 2 PLY POLYURETHANE Foam 0.500 IN. 1 PLY FIBERGLASS REINFORCED PHENOLIC 2 PLY INTEGRALLY COLORED TEDLAR	3.1	3.3	nd

		F1	F2	Construction (Boeing)	EXT Time (S)	Burn Length (IN)	Drip Ext Time
9	Bonded Metal	x		ALUMINUM 0.050 IN. **Epoxy Adhesive** FIBERGLASS REINFORCED PHENOLIC 2 PLY Honeycomb Core 0.750 IN. 1 PLY FIBERGLASS REINFORCED PHENOLIC 2 PLY	0.0	0.1	nd
	Bonded Construction (Substrate)	x		FIBERGLASS REINFORCED PHENOLIC 2 PLY ARAMID Honeycomb Core 0.750 IN. 1 PLY FIBERGLASS REINFORCED PHENOLIC 2 PLY	0.0	1.2	nd
	Bonded Construction (Substrate)	x		REINFORCED TEDLAR LAMINATE 1 PLY FIBERGLASS REINFORCED PHENOLIC 2 PLY ARAMID Honeycomb Core 0.750 IN. 1 PLY FIBERGLASS REINFORCED PHENOLIC 2 PLY REINFORCED TEDLAR LAMINATE 1 Ply	0.9	1.8	nd
10	Bonded Metal		x	Extruded thermoplastic polyurethane 0.080 IN. 1 PLY **Epoxy Adhesive** ALUMINUM 0.080 IN.	0.0	0.3	nd
	Substrate	x	x	Extruded thermoplastic 0.072" polyurethane	0.8	1.3	nd

		F1	F2	Construction (AIM Aerospace, Inc) Note: Test face is listed first and construction description continues inward	EXT Time (S)	Burn Length (IN)	Drip Ext Time
1	Bonded Metal	x		PHENOLIC/FIBERGLASS PREPREG 1 PLY 0.02" Thick Aluminum doubler co-cured (FILM ADHESIVE) ARAMID HONEYCOMB CORE 1 PLY .170 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY	0	0.1	nd
	Bonded Construction (Substrate)	x		PHENOLIC/FIBERGLASS PREPREG 1 PLY ARAMID HONEYCOMB CORE 1 PLY .340 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY	3.3	0.77	nd
2	Bonded Metal	x		ENAMEL PAINT BEIGE PHENOLIC/FIBERGLASS PREPREG 1 PLY ARAMID HONEYCOMB CORE 1 PLY .460 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY (FASTBOND CONTACT ADHESIVE) 0.010 IN THK ALUMINUM ALLOY DECORATIVE MATERIAL	0	0.97	nd
	Bonded Construction (Substrate)	x		ENAMEL PAINT BEIGE PHENOLIC/FIBERGLASS PREPREG 1 PLY ARAMID HONEYCOMB CORE 1 PLY .460 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY	3.67	1	nd
3	Bonded Metal	x		ENAMEL PAINT BEIGE PHENOLIC/FIBERGLASS PREPREG 1 PLY ARAMID HONEYCOMB CORE 1 PLY .460 IN (FASTBOND CONTACT ADHESIVE) 0.010 IN THK ALUMINUM ALLOY DECORATIVE MATERIAL	0	2.6	nd
	Bonded Construction (Substrate)	x		ENAMEL PAINT BEIGE PHENOLIC/FIBERGLASS PREPREG 1 PLY ARAMID HONEYCOMB CORE 1 PLY .460 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY ENAMEL PAINT BEIGE	0	2.7	nd

		F1	F2	**Construction (AIM Aerospace, Inc)** Note: Test face is listed first and construction description continues inward	EXT Time	Burn Length	Drip Ext Time
4	Bonded Metal	x		DECORATIVE MATERIAL PHENOLIC/FIBERGLASS PREPREG 1 PLY ARAMID HONEYCOMB CORE 1 PLY .450 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY (FASTBOND CONTACT ADHESIVE) 0.01 IN ALUMINUM ALLOY DECORATIVE MATERIAL	0	2.2	nd
	Bonded Construction (Substrate)	x		DECORATIVE MATERIAL PHENOLIC/FIBERGLASS PREPREG 1 PLY ARAMID HONEYCOMB CORE 1 PLY .460 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY ENAMEL PAINT BEIGE	0	3.9	nd
5	Bonded Metal	x		PHENOLIC/FIBERGLASS PREPREG 1 PLY 0.02" Thick Aluminum doubler co-cured (FILM ADHESIVE) ARAMID HONEYCOMB CORE 1 PLY .170 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY	0	0	nd
	Bonded Construction (Substrate)	x		PHENOLIC/FIBERGLASS PREPREG 1 PLY ARAMID HONEYCOMB CORE 1 PLY .340 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY	3.3	0.77	nd

APPENDIX R—ITEM 21: EDGE TRIM, METAL

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM PROPOSAL

Part 1, Reference Item #21, “Edge Trim, Metal”

Revision – NC, dated 2010-July-10

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REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
NC	Official Release	2010-July-10	Eva Ronnqvist

1 INTRODUCTION

The well established industry practice is to not perform aircraft interiors flammability testing according to 14 CFR 25.853 (a) and (d) for metal edge trims. The argument for not testing the metal edge trims is that the metal will not have an effect on the results of flammability testing.

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials” [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA’s technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Item 21 has been reviewed by the industry team and is submitting the following concurrence, justification and proposal.

2 INDUSTRY TEAM LEADER AND SUPPORT TEAM

During an industry meeting on 3 March 2010 in Renton, WA, the following individual has volunteered to be an industry team focal for this reference item:

2.1 TEAM LEADER

- Ronnqvist, Eva (AIM Aerospace)

2.2 SUPPORT TEAM

This proposal has been posted for peer review on the Flammability Standardization Task Group SharePoint Site where remarks, suggestions, corrections and contributions from the Flammability Standardization Task Group were encouraged. The current revision incorporates feedback received from the industry team peer review.

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on 20 August, 2009. Attachment 2, Part 2, reference item #21 reads (see Figure 1):

- 14 CFR 25.853 (a): *“No test required provided edge trim is at least 0.02” thick.*
- 14 CFR 25.853 (d): *“No test required.”*

Part 1, acceptable methods without additional data

Item Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke test Requirement/Similarity
21	Edge Trim, metal	No test required provided edge trim is at least 0.02" thick.	No test requirement

Figure 1: Attachment 2, Part 2, Reference Item #21

No equivalent entry exists for reference item #21 in attachment 2, Part 2.

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of the term ‘Edge Trim’ should be provided so that confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

3.2.1 Edge Trim, Metal

Edge trims, Metal, are defined as metal trim attached mechanically, by hook and loop fasteners, by double back tape or by adhesive to the edge of a sandwich panel. The metal edge trims can be formed metal, metal extrusions, machined or casted metal. Trims used as joints shall also be considered edge trim, metal. Examples of edge trims are shown in Figures 2 - 6.

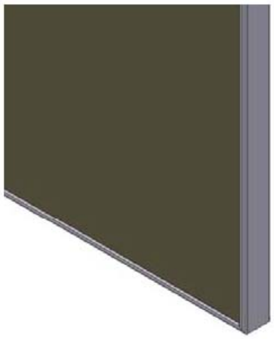

Figure 2: Metal Edge Trim

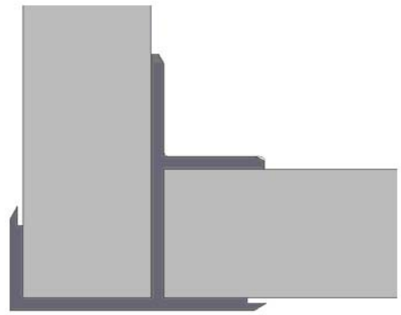

Figure 3: Joint

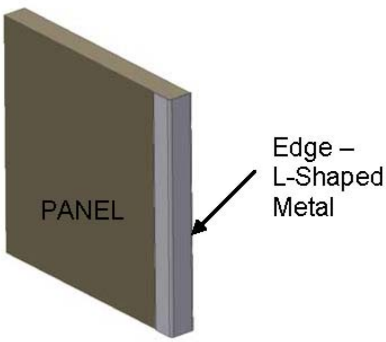

Figure 4: L-Shaped Metal Edge Trim

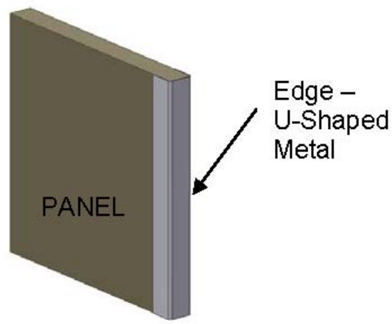

Figure 5: U-Shaped Metal Edge Trim

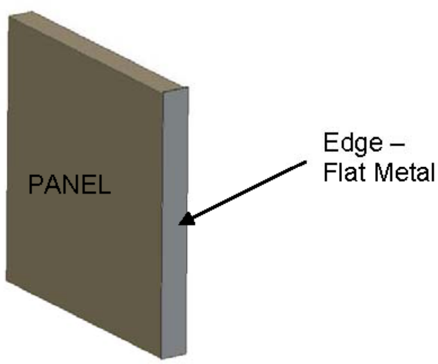

Figure 6: Flat Metal Edge Trim

4 CONCLUSION

The industry team agrees with the FAA's position on 14 CFR 25.853 (a) and (d).

Based on industry discussion, the industry team concurs with the current proposal and recommends including the definition of the term "Edge Trim, Metal" listed in Section 3.2.1 in a commentary or list of significant key terms in the FAA draft policy memo and enforce their consistent use throughout the final policy.

5 ABBREVIATIONS

FAA	=	Federal Aviation Administration
MOC	=	Methods of Compliance
CFR	=	Code of Federal Regulations

6 REFERENCES

[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

APPENDIX S—ITEM 22: DOUBLER, METAL, AND COCURED

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM REPORT

Part 1, Reference Item #22, “Doubler, Metal, Co-Cured”

(Details Co-cured with Base Panel)

Revision – A, dated 2011-Nov-1

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REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
NC	Initial Release	2011-Feb-14	Anthony Perugini
A	Harmonized thickness requirement in figure 5 (Page 10) with the requirements of Item 20 and 21, stating "the detail is at least 0.02" thick"	2011-Nov-1	Anthony Perugini

1 INTRODUCTION

The well established industry practice is to not perform aircraft interiors flammability testing according to 14 CFR 25.853 (a) and (d) for co-cured metal doublers. The argument for not testing the co-cured metal doublers is that the metal will not have an effect on the results of flammability testing.

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials” [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA’s technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Item 22 has been reviewed by the industry team and is submitting the following concurrence, justification and proposal.

2 INDUSTRY TEAM LEADER AND SUPPORT TEAM

2.1 TEAM LEADER

- Perez, Robert (AIM Aerospace)

2.2 SUPPORT TEAM

This proposal has been posted for peer review on the Flammability Standardization Task Group SharePoint Site where remarks, suggestions, corrections and contributions from the Flammability Standardization Task Group are encouraged.

- Perugini, Anthony (AIM Aerospace)
- Slaton, Dan (Boeing)
- Niitsu, Gilberto (Embraer)
- Mary Pacher (Boeing)
- Michael Jensen (Boeing)

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on 20 August, 2009. Attachment 2, Part 1, reference item #22 reads (see Figure 1):

- 14 CFR 25.853 (a): *"No test requirement. Data from base panel substantiates."*
- 14 CFR 25.853 (d): *"No test required. Data from base panel substantiates."*

Part 1, acceptable methods without additional data

Item Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke test Requirement/Similarity
22	Doubler, Metal, Co-Cured	No test requirement. Data from base panel substantiates.	No test requirement. Data from base panel substantiates.

Figure 1: Attachment 2, Part 1, Reference Item #22

No equivalent entry exists for reference item #22 in attachment 2, Part 2.

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of the term 'Co-cured Metal Doubler" should be provided so that confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and the industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

3.2.1 Doubler, Metal, Co-Cured

A co-cured metal doubler (sheet, block or extrusion) is defined as a detail, co-cured with the composite skin materials. Additional adhesive (usually film adhesive) is typically added to the sandwich panel construction to adhere the doubler to honeycomb and prepreg. Refer to Figure 2 for a typical cross-section of co-cured sheet metal doubler. Refer to Figure 3 for a typical cross section of a co-cured metal block or extrusion. General cases of bonded metal details are shown in figure 4.

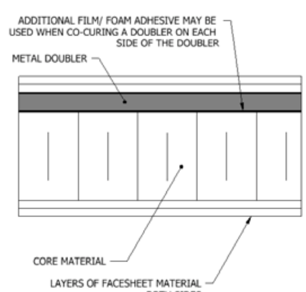

Figure 2: Co-Cured Metal Doubler Cross-Section

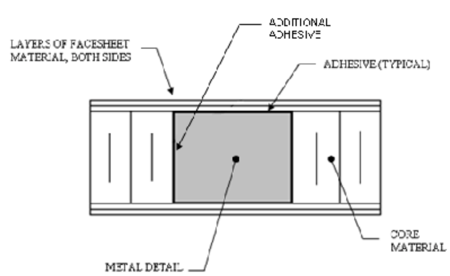

Figure 3: Co-Cured Metal Doubler Extrusion Cross-Section

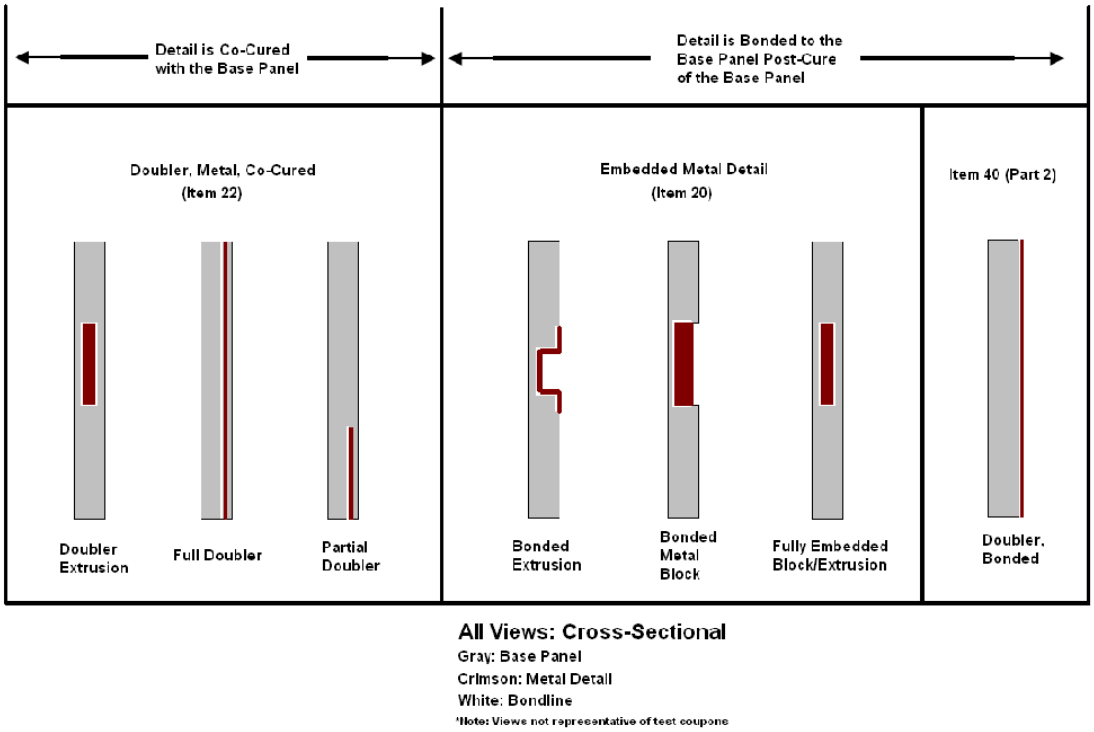

Figure 4: General cases of bonded metal details.

4 DATA/ANALYSIS

4.1 Existing Test Data

The industry has called upon its members to submit any existing flammability data to support 14 CFR 25.853 (a) and (d) for items 20, 22 and 40.

4.2 Test Results

Data supporting the harmonization of items 20, 22 and 40 has been compiled in appendix A.

4.3 Analysis

Test data provided by Boeing and AIM Aerospace, Inc. validates the industry proposal to harmonize items 20, 22 and 40 which are considered to be metal details, bonded. Burn length and extinguishing times are significantly reduced for composite sandwich panels/substrates when tested with bonded metal details included in the construction. This data trend is present regardless of the type of adhesive used or the method of detail implementation (co-cured with the panel or secondarily bonded).

5 CONCLUSION

The industry team agrees with the FAA’s position on 14 CFR 25.853 (a) and (d).

The industry team further recommends that the 25.853 (a) Bunsen burner test requirement for item 22, Part 1, be harmonized with items 20, and 40.

Based on industry discussion, the industry team concludes that Metal Doublers, Co-Cured, do not diminish cabin safety nor contribute to fire propagation, therefore the industry team recommends that Item 22 to be revised as follows:

Item Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke test Requirement/Similarity
20, 22, 40	Metal Detail, Bonded	No Test Requirement. Data from base panel substantiates (Provided that the detail is at least 0.02" thick). Limitation – Detail may not be constructed by magnesium or magnesium alloys.	No Test Requirement. Data from base panel substantiates.

Figure 5: Proposed change of Item 22

6 ABBREVIATIONS

FAA	=	Federal Aviation Administration
MOC	=	Methods of Compliance
CFR	=	Code of Federal Regulations

7 REFERENCES

[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

APPENDIX A

	Configuration	F1	F2	Construction (Boeing)	EXT Time (S)	Burn Length (IN)	Drip Ext Time
1	Bonded Metal		x	POLYCARBONATE 0.015 IN. 1 PLY **Pressure Sensitive Film Adhesive** Aluminum 0.030	0.0	0.2	nd (no drip)
	Bonded Construction (Substrate)		x	POLYCARBONATE 0.015 IN. **Pressure Sensitive Film Adhesive** FIBERGLASS REINFORCED POLYESTER 0.013 IN. 1 PLY	13.5	2.0	nd
2	Bonded Metal	x		POLYURETHANE FOAM 0.500 1 PLY **Pressure Sensitive Film Adhesive** Aluminum 0.030	0.0	2.9	nd
	Substrate Alone		x	POLYURETHANE 0.500 IN. 1 PLY	0.0	5.8	2
3	Bonded Metal		x	POLYISOCYANURATE 0.500 IN. 1 PLY **Epoxy Adhesive** Aluminum 0.030	1.0	3.3	nd
	Substrate Alone	x		POLYISOCYANURATE 0.500IN. 1 PLY	0.0	5.2	nd
4	Bonded Metal		x	ARAMID FIBER REINFORCED EPOXY 3 PLY **Epoxy Adhesive** Aluminum 0.030	0.0	0.1	nd
	Substrate Alone	x		ARAMID FIBER REINFORCED EPOXY 3 PLY	0.0	3.5	nd
5	Bonded Metal	x		POLYCARBONATE/POLYVINYLFLUORIDE 0.080 IN. 1 PLY **Urethane Adhesive** Aluminum 0.030	0.0	1.5	nd
	Bonded Construction (Substrate)	x		POLYCARBONATE/POLYVINYLFLUORIDE .080 IN. 1 PLY Paint Primer 1 PLY Urethane Paint	0.0	2.7	nd
	Substrate Alone		x	POLYCARBONATE/POLYVINYLFLUORIDE 0.080 IN. 1 PLY	2.0	0.7	nd

		F1	F2	Construction (Boeing)	EXT Time (S)	Burn Length (IN)	Drip Ext Time
6	Bonded Metal		x	NYLON 6/6 0.051 PLY **Epoxy Adhesive** Aluminum 0.030	0.0	0.1	nd
	Substrate Alone		x	NYLON 6/6 0.02 IN. 1 PLY	0.0	0.2	nd
	Substrate Alone	x		NYLON 6/6 0.060 1 PLY	3.3	1.9	1.8
7	Bonded Metal	x		ALUMINUM 0.060IN. **Epoxy ADHESIVE** ALUMINUM 0.030 IN. **Structural Film Adhesive** POLYURETHANE Foam 0.500 IN. 1 PLY **Structural Film Adhesive** ALUMINUM 0.030 IN. **Epoxy Adhesive** ALUMINUM 0.060	0.0	0.1	nd
	Substrate Alone	x		POLYURETHANE FOAM 0.500 IN. 1 PLY	0.0	5.4	nd
8	Bonded Metal	x		Decorative Laminate **Pressure Sensitive Film Adhesive** FIBERGLASS REINFORCED PHENOLIC 2 PLY ALUMINUM 0.080 IN. **Epoxy ADHESIVE** POLYURETHANE Foam 0.500 IN. 1 PLY FIBERGLASS REINFORCED PHENOLIC 2 PLY **Epoxy Adhesive** ALUMINUM 0.100 IN.	0.0	0.3	nd
	Bonded Construction (Substrate)	x		DURADEC WALLPAPER 1 PLY **Pressure Sensitive Film Adhesive** FIBERGLASS REINFORCED PHENOLIC 2 PLY POLYURETHANE Foam 0.500 IN. 1 PLY FIBERGLASS REINFORCED PHENOLIC2 PLY	0.8	2.5	nd
	Bonded Construction (Substrate)	x		DURADEC WALLPAPER **Pressure Sensitive Film Adhesive** FIBERGLASS REINFORCED PHENOLIC 2 PLY POLYURETHANE Foam 0.500 IN. 1 PLY FIBERGLASS REINFORCED PHENOLIC 2 PLY INTEGRALLY COLORED TEDLAR	3.1	3.3	nd

		F1	F2	Construction (Boeing)	EXT Time (S)	Burn Length (IN)	Drip Ext Time
9	Bonded Metal	x		ALUMINUM 0.050 IN. **Epoxy Adhesive** FIBERGLASS REINFORCED PHENOLIC 2 PLY Honeycomb Core 0.750 IN. 1 PLY FIBERGLASS REINFORCED PHENOLIC 2 PLY	0.0	0.1	nd
	Bonded Construction (Substrate)	x		FIBERGLASS REINFORCED PHENOLIC 2 PLY ARAMID Honeycomb Core 0.750 IN. 1 PLY FIBERGLASS REINFORCED PHENOLIC 2 PLY	0.0	1.2	nd
	Bonded Construction (Substrate)	x		REINFORCED TEDLAR LAMINATE 1 PLY FIBERGLASS REINFORCED PHENOLIC 2 PLY ARAMID Honeycomb Core 0.750 IN. 1 PLY FIBERGLASS REINFORCED PHENOLIC 2 PLY REINFORCED TEDLAR LAMINATE 1 Ply	0.9	1.8	nd
10	Bonded Metal		x	Extruded thermoplastic polyurethane 0.080 IN. 1 PLY **Epoxy Adhesive** ALUMINUM 0.080 IN.	0.0	0.3	nd
	Substrate	x	x	Extruded thermoplastic 0.072" polyurethane	0.8	1.3	nd

FAA Memorandum
ANM-115-09-XXX, "Policy Statement on Flammability Testing of Interior Materials"
Part 1, Reference Item #22, "**Doubler, Metal, Co-Cured**"

		F1	F2	**Construction (AIM Aerospace, Inc)** Note: Test face is listed first and construction description continues inward	EXT Time (S)	Burn Length (IN)	Drip Ext Time
1	Bonded Metal	x		PHENOLIC/FIBERGLASS PREPREG 1 PLY 0.02" Thick Aluminum doubler co-cured (FILM ADHESIVE) ARAMID HONEYCOMB CORE 1 PLY .170 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY	0	0.1	nd
	Bonded Construction (Substrate)	x		PHENOLIC/FIBERGLASS PREPREG 1 PLY ARAMID HONEYCOMB CORE 1 PLY .340 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY	3.3	0.77	nd
2	Bonded Metal	x		ENAMEL PAINT BEIGE PHENOLIC/FIBERGLASS PREPREG 1 PLY ARAMID HONEYCOMB CORE 1 PLY .460 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY (FASTBOND CONTACT ADHESIVE) 0.010 IN THK ALUMINUM ALLOY DECORATIVE MATERIAL	0	0.97	nd
	Bonded Construction (Substrate)	x		ENAMEL PAINT BEIGE PHENOLIC/FIBERGLASS PREPREG 1 PLY ARAMID HONEYCOMB CORE 1 PLY .460 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY	3.67	1	nd
3	Bonded Metal	x		ENAMEL PAINT BEIGE PHENOLIC/FIBERGLASS PREPREG 1 PLY ARAMID HONEYCOMB CORE 1 PLY .460 IN (FASTBOND CONTACT ADHESIVE) 0.010 IN THK ALUMINUM ALLOY DECORATIVE MATERIAL	0	2.6	nd
	Bonded Construction (Substrate)	x		ENAMEL PAINT BEIGE PHENOLIC/FIBERGLASS PREPREG 1 PLY ARAMID HONEYCOMB CORE 1 PLY .460 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY ENAMEL PAINT BEIGE	0	2.7	nd

		F1	F2	**Construction (AIM Aerospace, Inc)** Note: Test face is listed first and construction description continues inward	EXT Time	Burn Length	Drip Ext Time
4	Bonded Metal	x		DECORATIVE MATERIAL PHENOLIC/FIBERGLASS PREPREG 1 PLY ARAMID HONEYCOMB CORE 1 PLY .450 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY (FASTBOND CONTACT ADHESIVE) 0.01 IN ALUMINUM ALLOY DECORATIVE MATERIAL	0	2.2	nd
	Bonded Construction (Substrate)	x		DECORATIVE MATERIAL PHENOLIC/FIBERGLASS PREPREG 1 PLY ARAMID HONEYCOMB CORE 1 PLY .460 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY ENAMEL PAINT BEIGE	0	3.9	nd
5	Bonded Metal	x		PHENOLIC/FIBERGLASS PREPREG 1 PLY 0.02" Thick Aluminum doubler co-cured (FILM ADHESIVE) ARAMID HONEYCOMB CORE 1 PLY .170 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY	0	0	nd
	Bonded Construction (Substrate)	x		PHENOLIC/FIBERGLASS PREPREG 1 PLY ARAMID HONEYCOMB CORE 1 PLY .340 IN PHENOLIC/FIBERGLASS PREPREG 1 PLY	3.3	0.77	nd

APPENDIX T—ITEM 23: COLOR OF THERMOPLASTICS, ELASTOMERS, AND FLOOR PANELS

INDUSTRY FLAMMABILITY
STANDARDIZATION TASK GROUP

ANM-115-09-XXX, "Policy Statement on
Flammability Testing of Interior Materials"

INDUSTRY TEAM REPORT

Part 1, Reference Item #23, "Color of Thermoplastics. Elastomers and Floor Coverings"

Final Report

28-November-2011

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REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
New	Initial Release	June 15, 2010	M. Jensen
A	Test Report – Data and analysis added	September 29, 2011	M. Jensen and Team
B	Added data on floor coverings	November 28, 2011	M. Jensen

1 INTRODUCTION

Thermoplastic color similarity (e.g. the substantiation of one thermoplastic color by using previous flammability test data from another thermoplastic color within the same thermoplastic type) for aircraft interiors flammability testing according to 14 CFR 25.853 (a) is a well established industry practice. The use of color similarity for 14 CFR 25.853 (d) is not as well documented. The argument for thermoplastic color similarity is that changes exclusively in color within the same thermoplastic type have no appreciable effect on the results of flammability testing (vertical burn, heat release and smoke emission).

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials” [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA’s technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

This proposal will address the color of thermoplastics, elastomers and decorative non-textile floor coverings. This item has been reviewed by the industry team and is submitted for FAA concurrence.

2 INDUSTRY TEAM LEADER AND SUPPORT TEAM

During industry meetings started on 24 September 2009 in Huntington Beach, CA, and continued at the FAA Materials Fire Test Working Group meetings and other face to face meetings of the Flammability Standardization Task Group, the following individuals have volunteered to form the industry team for this reference item:

2.1 TEAM LEADER

- Michael Jensen. (Boeing)

2.2 SUPPORT TEAM

- Miler, Michael C (Schneller LLC)
- Rathbun, Jason (Schneller LLC)
- Story, Charles W. C. (Magee Plastics Co.)
- Zimmerman, Patrick (3M)
- Jym Kauffman (Kydex)
- Ralph R. Buoniconti (SABIC Innovative Plastics)
- Serge Le Neve DGA Aeronautical Systems

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on 20 August, 2009. Attachment 2, Part 2, reference item #23 reads (see Figure 1):

Part 2, methods of compliance that require supporting data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
23	Color of thermoplastics, elastomers and floor panels	Data from testing an integrally colored material substantiates the same material type and thickness for a different color.	For integrally colored thermoplastics, conduct engineering tests on a variety of colors to determine the most critical color. Conduct a certification test on the color that produces the most critical values. The resulting data can be used to substantiate other colors of the same materials by similarity/critical case analysis.

Figure 1 Attachment 2, Part 2, Reference Item #23

No equivalent entry exists for reference item #23 in attachment 2, Part 1.

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of the terms 'color', "decorative non-textile floor covering", 'thermoplastic' and 'same' are provided so that confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

3.2.1 COLOR - The complete visual appearance of a decorative sheet used in the interiors of transport category airplanes, including base color, prints, images, text or design.

3.2.2 Decorative Non-Textile Floor Covering – A decorative polymer based (typically an elastomer such as vinyl) mat used on aircraft floors that does not incorporate fibers on the exposed surface. These mats are typically used in entry ways, galleys and lavatories where fluid resistance and ease of cleaning are a concern.

3.2.3 THERMOPLASTIC - A polymer-based, homogenous heavy-gage, self-supporting sheet capable of being formed using heat multiple times.

3.2.4 SAME - The term "the same" in the context of this item refers to a thermoplastic from:

The same manufacturer or specification[1],
The same product family (same chemistry other than color pigmentation), and
The same nominal thickness (within industry standard tolerances).

1 – The specification must control the flammability properties and general chemistry (i.e., polycarbonate or Nylon) for materials to be the same from different manufacturers but qualified to the same specification, including types, classes, etc. that control chemical properties.

4 VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

The use of this MOC has been grouped by the FAA into Part 2 for both 14 CFR 25.853 (a) and (d). This means that the FAA requires additional supporting data to accept this method for Vertical Burn, Heat Release and Smoke Density testing.

Section 5 provides the test plan the FAA reviewed that will be used to substantiate Item 23a as written. In addition to what has been proposed by the FAA in the draft policy memo, the Industry team further proposed to show that color can be substantiated by similarity for heat release and smoke testing 14 CFR 25.853(d) using the data developed by the proposed testing, or using existing data.

4.2 PROPOSED STANDARD TO MEET

Split attachment 2, Part 2, reference item #23 into 3 separate items and change the title of the original item to:

- #23a: *“Thermoplastic Color”*

Modify attachment 2, Part 2, reference item #23 to read the following:
- 14 CFR 25.853 (a): “Data from testing one color of thermoplastic, decorative non-textile floor covering or elastomer (including elastomeric foams) can be used to substantiate another color of the same thermoplastic, decorative non-textile floor covering or elastomer at the same thickness.”
- 14 CFR 25.853 (d): “Data from testing one color of thermoplastic can be used to substantiate another color of the same thermoplastic at the same thickness.”

If the data analysis shows that color does make a difference for 14 CFR 25.853 (d), the same data will be analyzed to show that the original FAA proposal (stated below) can be utilized. The report will document what process an applicant should follow to use this MOC.

> For integrally colored thermoplastics, conduct engineering tests on a variety of colors to determine the most critical color. Conduct a certification test on the color that produces the most critical values. The resulting data can be used to substantiate other colors of the same materials by similarity/critical case analysis.

5 DATA / ANALYSIS

5.1 PROPOSAL TO SUBSTANTIATE THERMOPLASTIC COLOR BY SIMILARITY

The following data was collected to substantiate the use of color similarity for thermoplastics for both 14 CFR 25.853(a) and (d) and elastomers and decorative non-textile floor coverings to 14CFR 25.853(a). To show that color similarity is applicable across the range of thermoplastics used in the aviation industry, data for a minimum of six different types of plastics was to be collected for 14 CFR 25.853(a) [12 or 60 second vertical burn] and a minimum of four different plastics for 25.853(d). Seven different types of plastic data were collected for vertical burn. For elastomers, 6 different colors of one type were tested to the horizontal 2.5 inch/minute Bunsen burner requirement. For decorative non-textile floor coverings, 7 different types of coverings totaling 27 different colors were tested.

Originally, a minimum of 5 sets (one set is three specimens) of data per color family and a minimum of 5 color families were to be tested for each plastic at a single thickness (between 0.059 and 0.100). A color family is a general grouping of colors encompassing a similar base color and pigments. Data was to be gathered on the following color families for each plastic as a minimum:

White, black/gray, beige, and two primary or secondary colors (such as red, blue, yellow or green) as available.

However, due to the nature of the aviation industry were muted colors are preferred (grays, whites, tans and blues), not all of the colors were available and sometimes not enough sets of data could be found, while others had far more than 5 sets. The charts show what colors were tested and how many data sets were used.

Also, data for a silicone elastomer is presented to show the lack of effect of color on elastomers. Additional data on elastomers is provided in Report #44 for elastomeric fillet seals in section 5.2.3.

Data and analysis for decorative non-textile floor coverings is presented in Appendix B.

5.1.1 TEST CHAMBER/LAB VARIABILITY

It is widely known that there can be a great deal of variability between test sites for OSU heat release and smoke testing as well as operator measurements for burn length for vertical burn. To minimize the effects of lab variability, the goal was to have all testing for a single type of thermoplastic conducted in a single lab. Extensive quality assurance data conducted by the manufacturers of the thermoplastic was used to fulfill the data required in Section 5.1. With the large amount of historical data, it was not always possible to confirm that data was all from the same lab, thus this variable remained as a potential source of variation in the final data.

5.2 TEST RESULTS

Test results are provided in graphic form. Vendor-supplied data is presented for 7 manufacturers (A through G) and 11 different thermoplastics (1 through 11) of thermoplastics. Due to the proprietary nature of the data, the manufacturers and plastics are listed by a letter or number only. The key to the letters and numbers versus manufacturer and plastic is available to the FAA upon request as well as any of the data that was used to construct the charts. The charts are divided into three sections:

5.2.1 Vertical Burn Data Thermoplastics
5.2.2 OSU Heat Release and Smoke Data.Thermoplastics
5.2.3 Elastomer Data

Table 1 – List of Thermoplastic Manufacturers and Plastics

Manufacturer	Plastic	# of colors	Generic Type	12 Sec Vertical	60 Sec Vertical	OSU/Smoke
A	1	8[2]	CPVC		X	X
B	2	40	Engineered			X[1]
	3	29	Engineered			X[1]
	4	20	Polycarbonate		X	
	8	3	Polycarbonate		X	
C	5	47	Acrylic PVC		X	X
	6	41	Acrylic PVC		X	X
D	9	4	Polycarbonate	X	X	
E	7	4	PVC		X	
F	10	4	Engineered		X	X
G	11	3	PVC Acrylic		X	

1 – No Smoke data available
2 – Color Families

5.2.1 Vertical Burn Results

The data provided from manufacturer A is grouped into color families, meaning the data for each color bar is a group of slightly different colors in the same family (i.e., blue) with the data averaged together. The values at the bottom of the columns are the total number of data sets (a test set of three specimens) averaged together. For example, the color grey has 56 data sets averaged together. After flame times for this product were reported as zero.

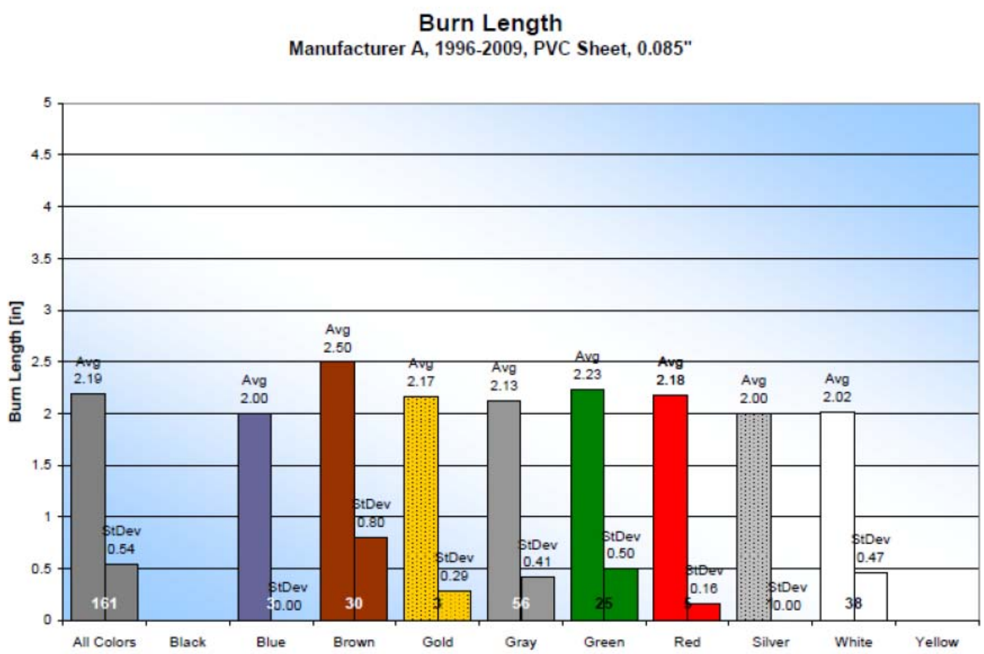


Figure 2 Manufacture A, Plastic 1 - 60 Sec Vertical Burn Length 0.085" Thick Sheet
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg burn length.

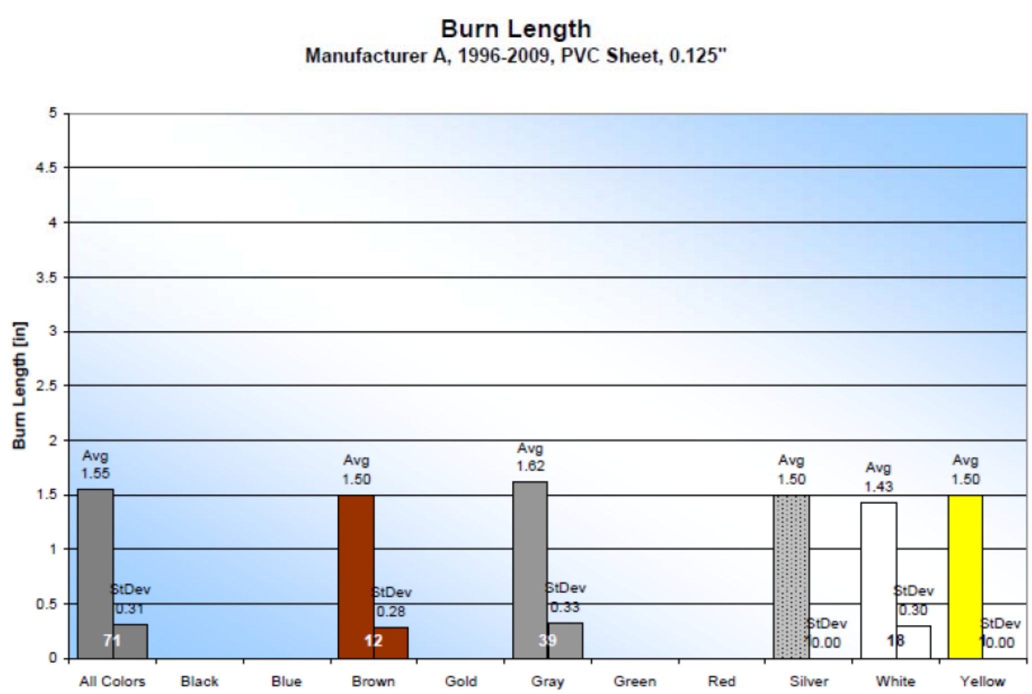


Figure 3 Manufacturer A, Plastic 1 – 60 Sec Vertical Burn Length 0.125" Thick Sheet
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg burn length.

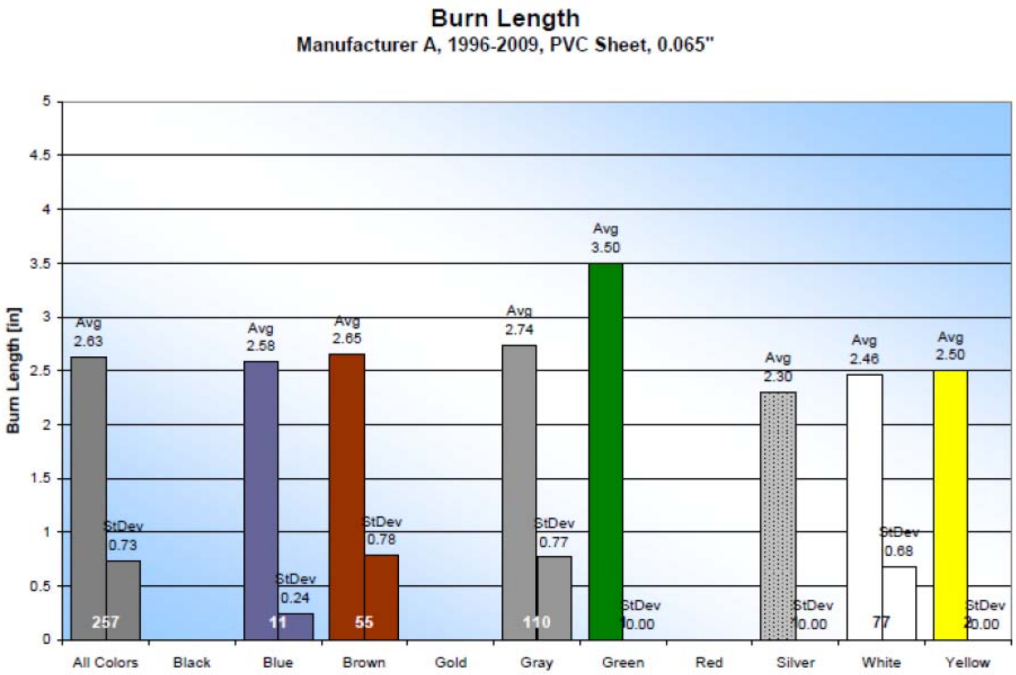


Figure 4 Manufacturer A, Plastic 1 – 60 Sec Vertical Burn Length 0.065" Thick Sheet
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg burn length.

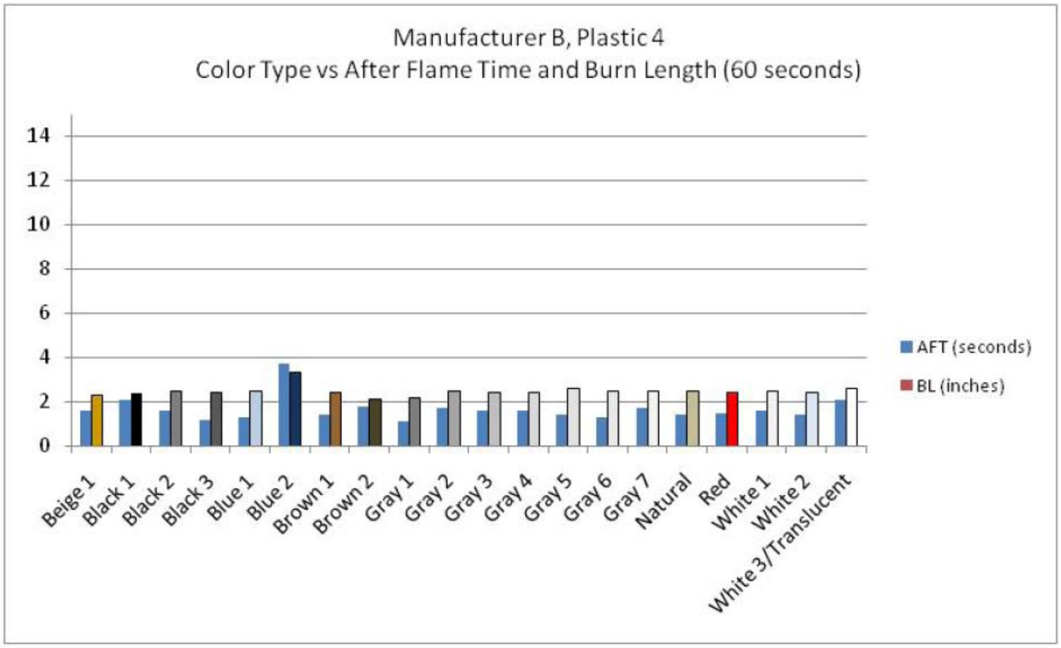


Figure 5 Manufacture B, Plastic 4 Color Type Vs After Flame Time and Burn Length (60 seconds)
Note that the color of the burn length columns approximates the name of the color and not the color noted on the graph legend.

Table 2 – Total Number of data sets per color for Figure 5 and Standard Deviations

Color	Count	AFT StdDev	BL StdDev
Beige 1	61	0.98	0.73
Black 1	36	1.42	0.76
Black 2	156	1.27	0.67
Black 3	48	0.64	0.66
Blue 1	17	1.01	0.89
Blue 2	6	2.24	0.49
Brown 1	26	1.01	0.73
Brown 2	8	0.71	0.87
Gray 1	16	0.64	0.54
Gray 2	21	1.51	0.61
Gray 3	17	1.07	0.71
Gray 4	28	1.03	0.47
Gray 5	20	0.72	0.61
Gray 6	102	0.97	0.65
Gray 7	48	1.62	0.81
Natural	13	0.78	0.47
Red	30	0.95	0.79
White 1	132	1.51	0.69
White 2	27	1.48	0.76
White 3/Translucent	86	1.69	0.82

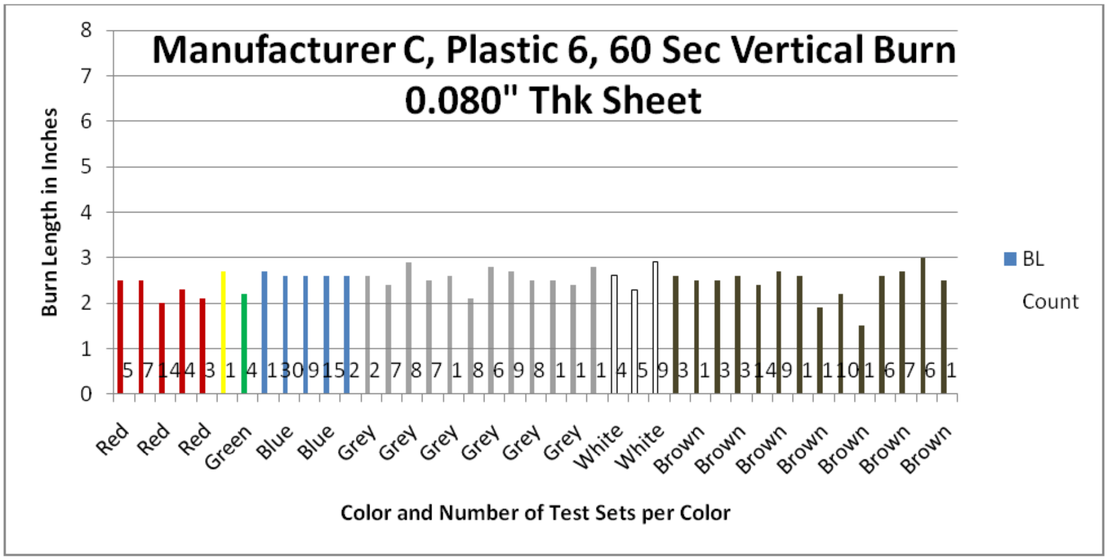


Figure 6 Manufacturer C, Plastic 6, 60 Second Vertical Burn Length at 0.080" Thick
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg burn length.

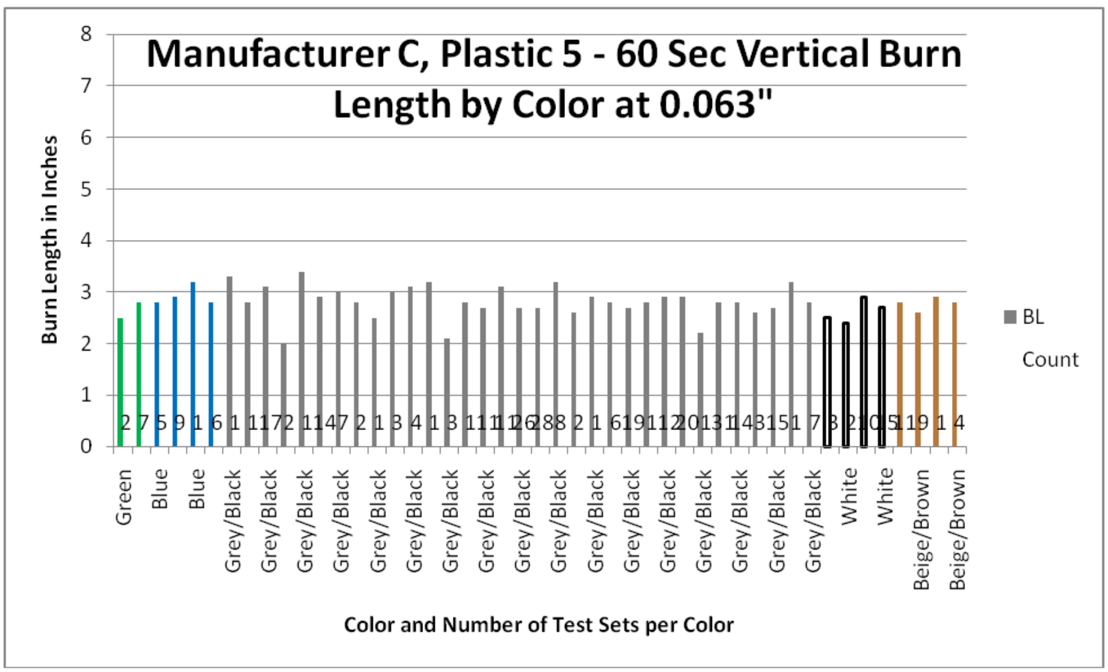


Figure 7 Manufacturer C, Plastic 5, Burn Length by Color at 0.063" Thick
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg burn length.

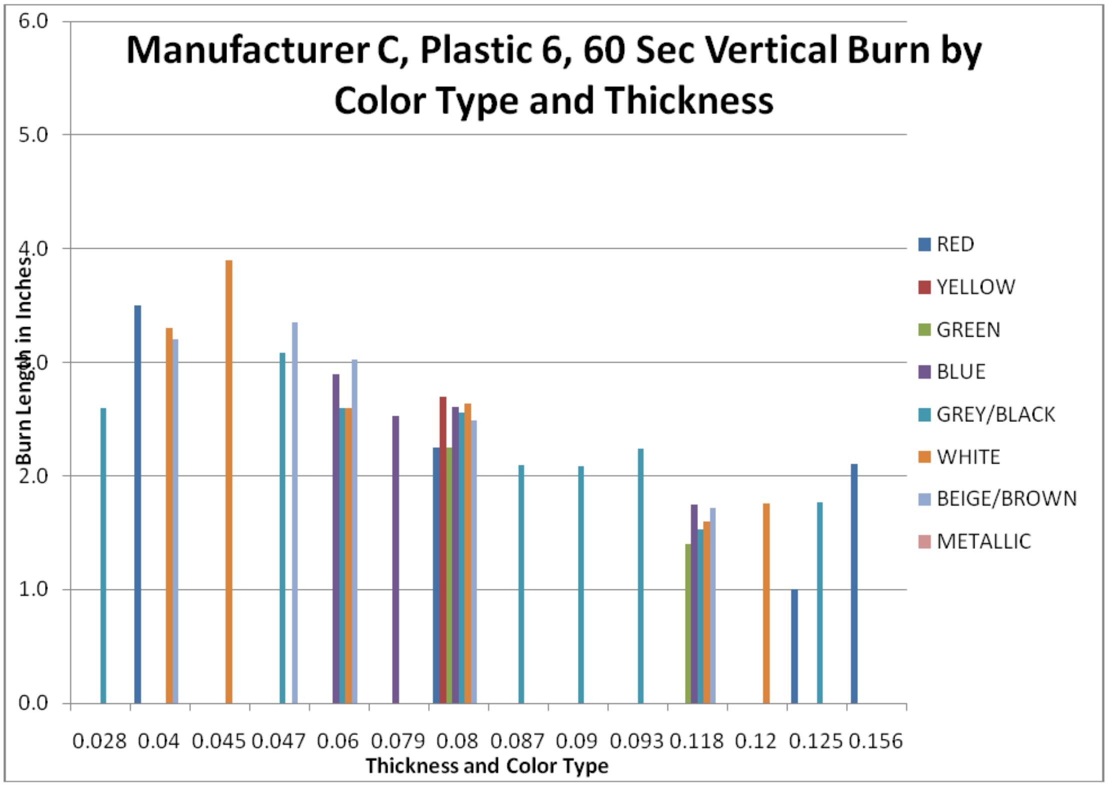


Figure 8 Manufacturer C, Plastic 6, 60 Second Vertical Burn Length by Color Family and Thickness

Figure 8 groups individual colors into color families and compares burn length of these color families by plastic thickness. The largest data sets are at thicknesses of 0.060", 0.080" 0.093" and 0.118". Graph shows the trend that burn length decreases with thickness and burn lengths at a given thickness are similar for all color families. Outliers have very low number of test sets.

Table 3 – Total count of tests sets for each thickness in Figure 8

Thick	**0.028**	**0.040**	**0.045**	**0.047**	**0.060**	**0.079**	**0.080**	**0.087**	**0.090**
Count	1	11	1	15	30	3	236	19	4
Thick	**0.093**	**0.118**	**0.120**	**0.125**	**0.156**				
Count	30	35	5	16	2				

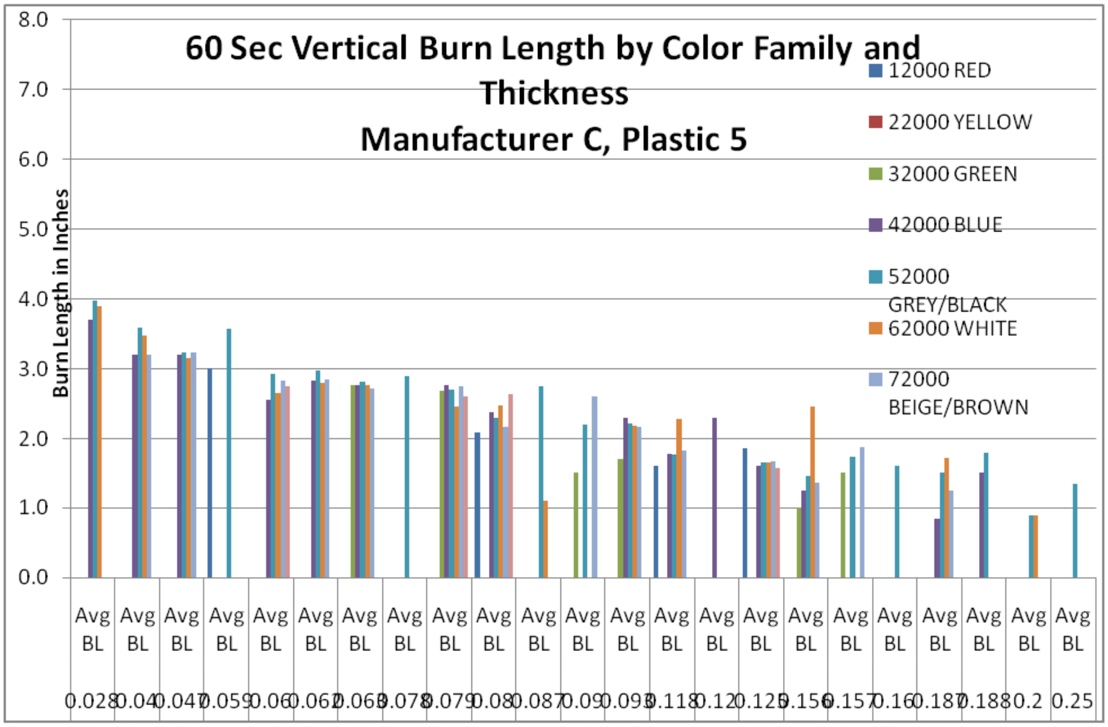


Figure 9 - Manufacturer C, Plastic 5 - 60 Second Vertical Burn Length by Color Family and Thickness

Figure 9 groups individual colors into color families and compares burn length of these color families by plastic thickness. The largest data sets are at thicknesses of 0.047, 0.060", 0.063", 0.080", 0.090", 0.093", 0.118" 0.125'and 0.188". Graph shows the trend that burn length decreases with thickness and burn lengths at a given thickness are similar for all color families. Outliers have very low number of test sets.

Table 4 – Total count of tests sets for each thickness in Figure 9

Thick	**0.028**	**0.040**	**0.047**	**0.059**	**0.060**	**0.062**	**0.063**	**0.078**	**0.079**
Count	21	57	96	4	164	24	361	11	38
Thick	**0.080**	**0.087**	**0.090**	**0.093**	**0.118**	**0.120**	**0.125**	**0.156**	**0.157**
Count	268	3	205	841	101	1	551	30	24
Thick	**0.160**	**0.187**	**0.188**	**0.188**	**0.2**	**0.25**			
Count	2	38	205	12	2	2			

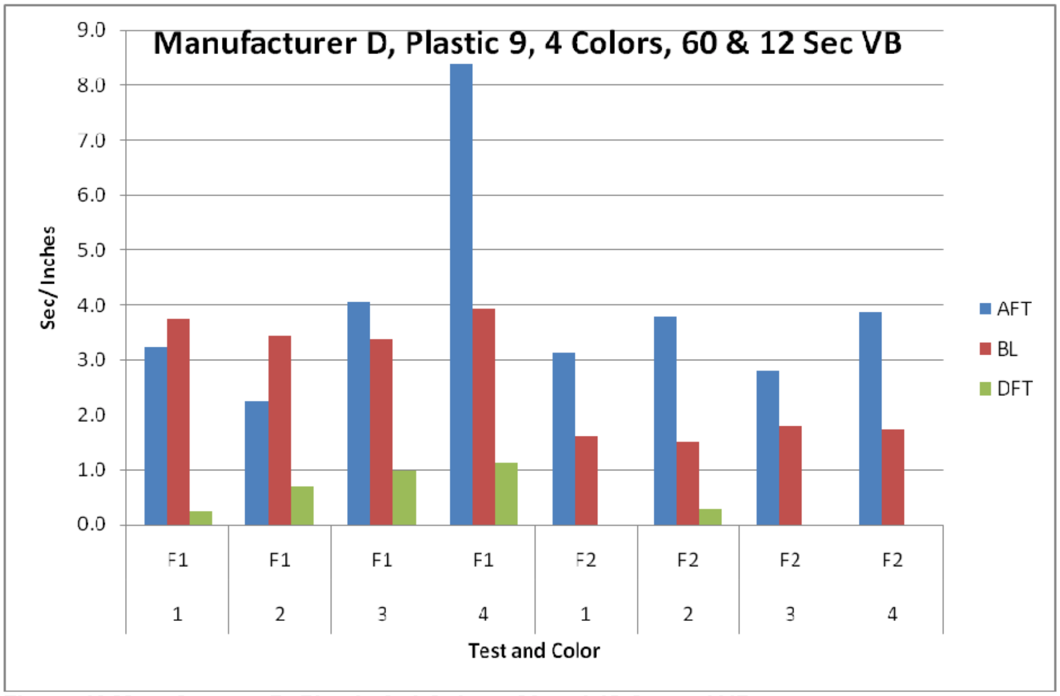


Figure 10 Manufacturer D, Plastic 9, 4 Colors, 60 and 12 Second VB
Test sets per color: 1 – 18, 2 – 8, 3 – 20, 4 - 16
See further discussion of this data in Appendix A.

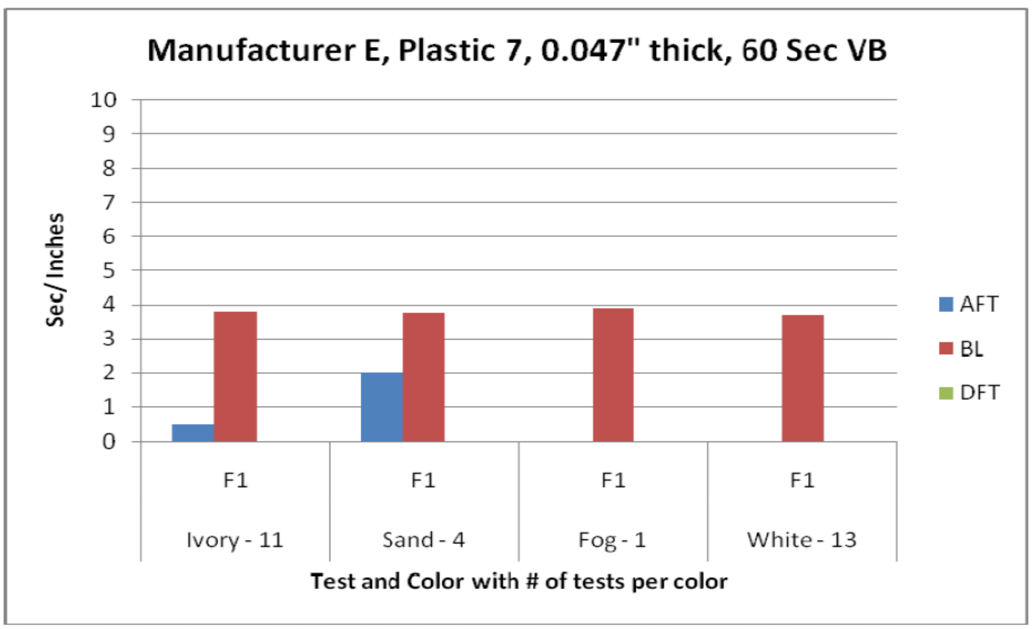


Figure 11 Manufacturer E, Plastic 7, 4 colors at 0.047" Thickness, 60 Sec Vertical Burn
Number of test data sets is noted by the color in the graph.
Note that the AFT were due to a single data point within one test set.

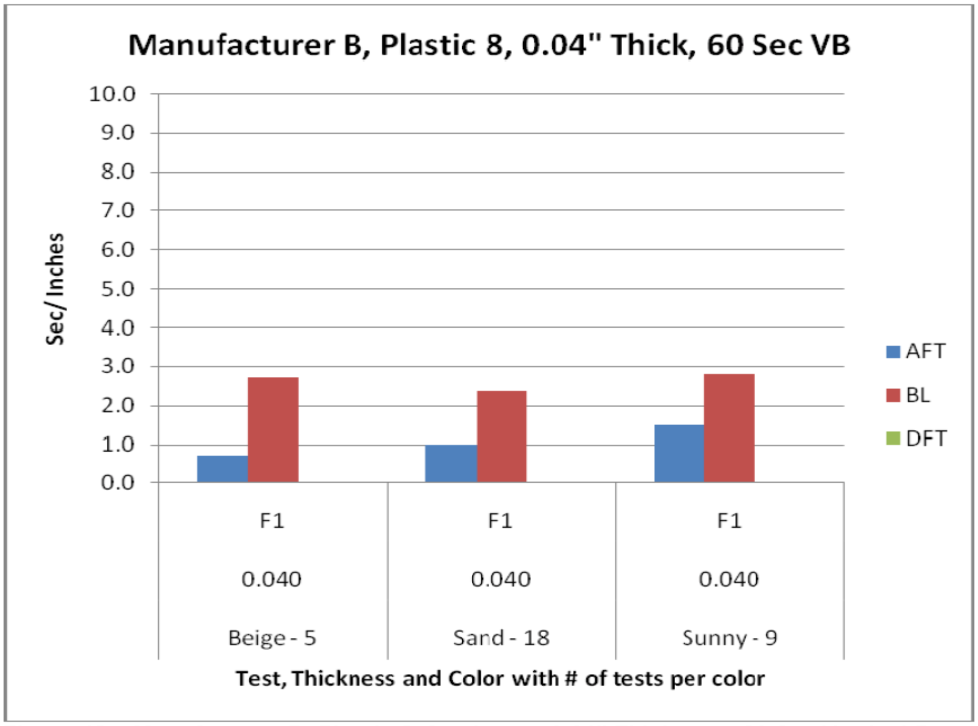


Figure 12 – Manufacturer B, Plastic 8, 3 colors at 0.04" Thickness, 60 Sec Vertical Burn
Number of test data sets is noted by the color in the graph.

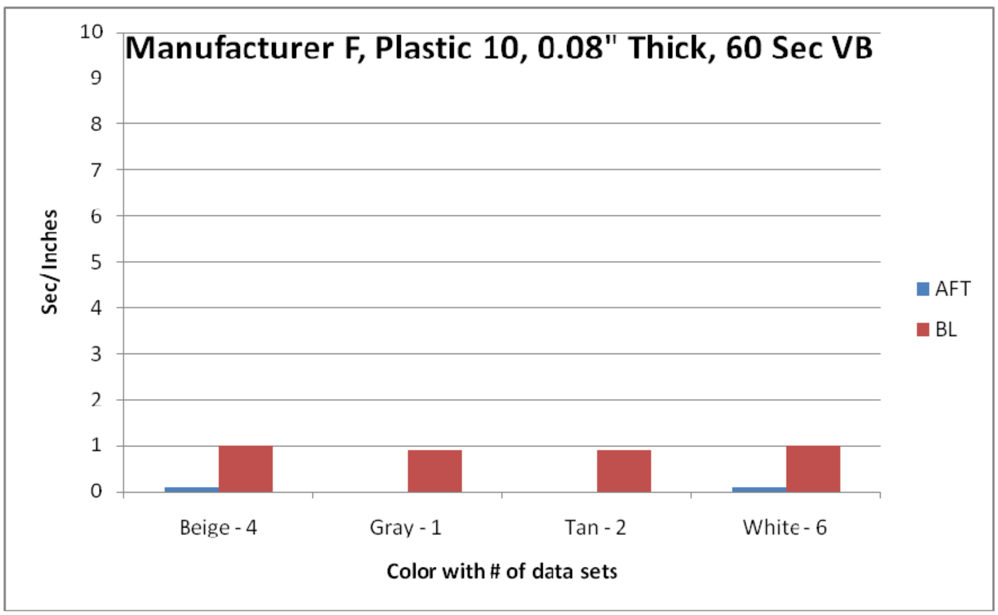


Figure 13– Manufacturer F, Plastic 10, 4 colors at 0.080" Thickness, 60 Sec Vertical Burn
Number of test data sets is noted by the color in the graph.

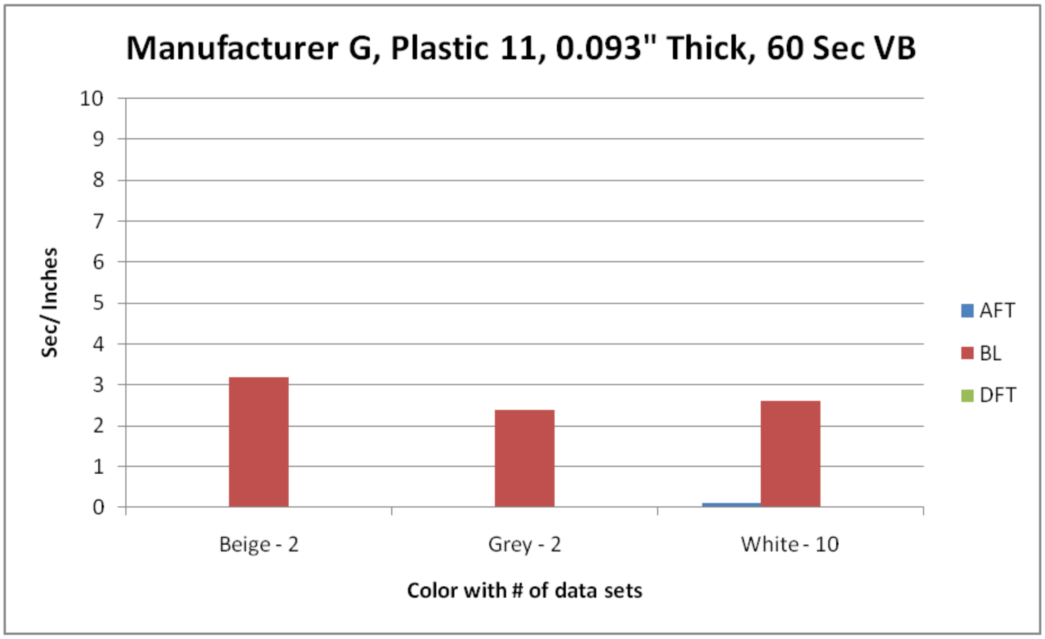


Figure 14 – Manufacturer G, Plastic 11, 3 colors at 0.093” Thickness, 60 Sec Vertical Burn
Number of test data sets is noted by the color in the graph.

5.2.2 – Heat Release Results

5.2.2.1 Manufacturer A

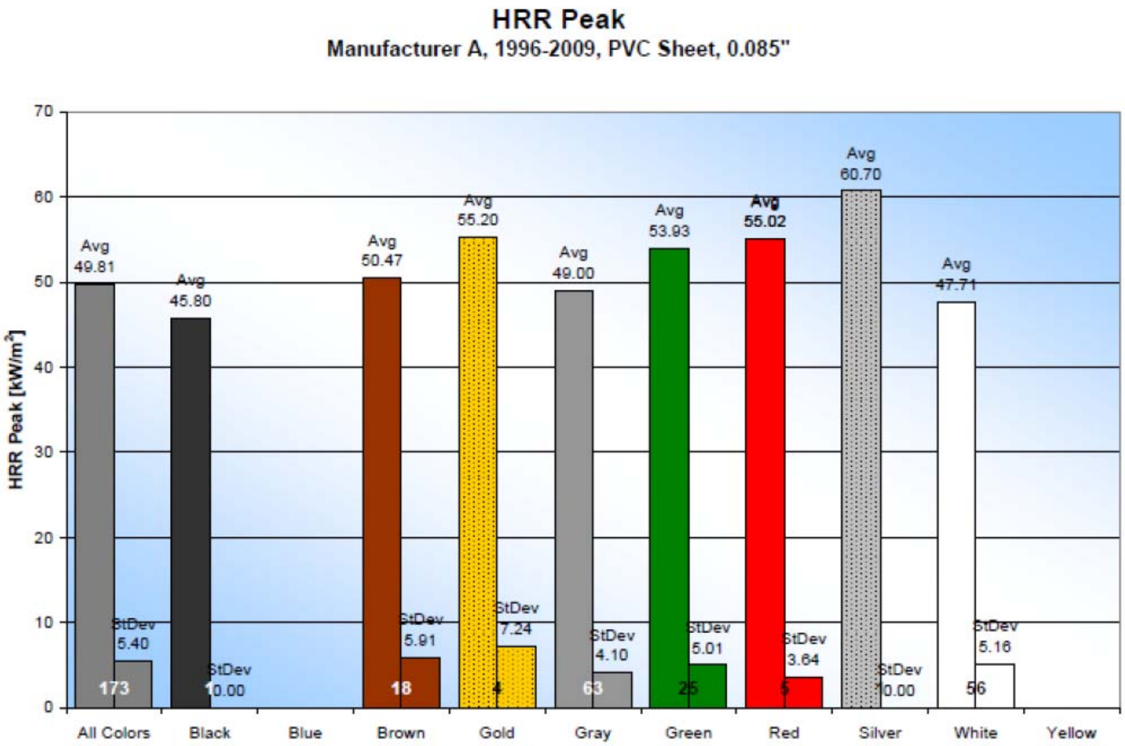


Figure 15 Manufacturer A Heat Release Peak 0.085” Thick Sheet
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg peak HRR.

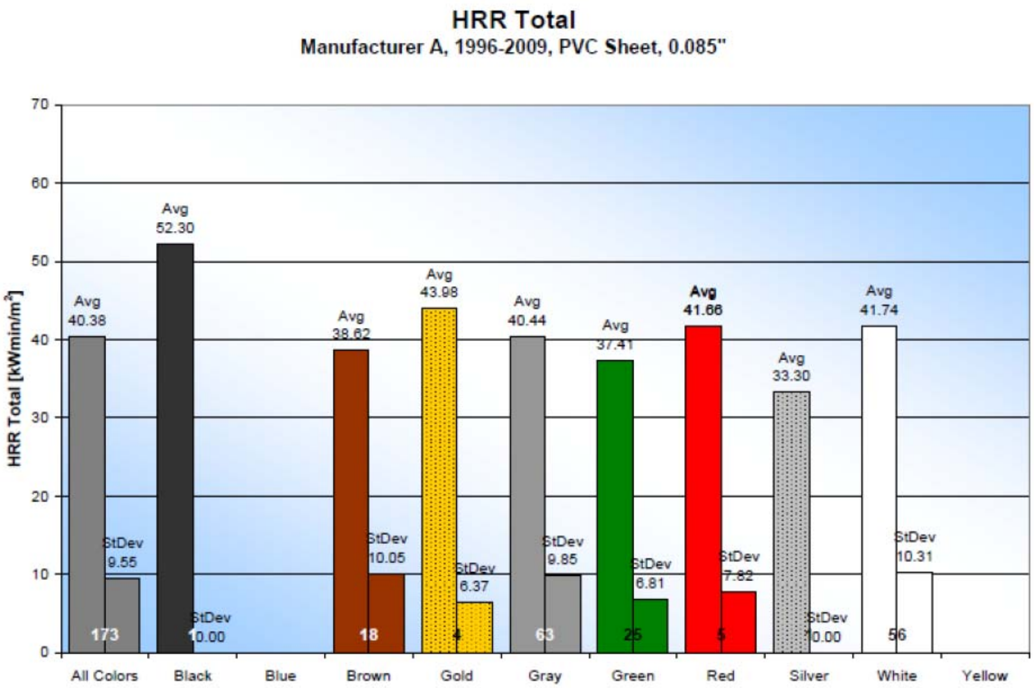


Figure 16 Manufacturer A Heat Release Rate 0.085" Thick Sheet
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg Total HRR.

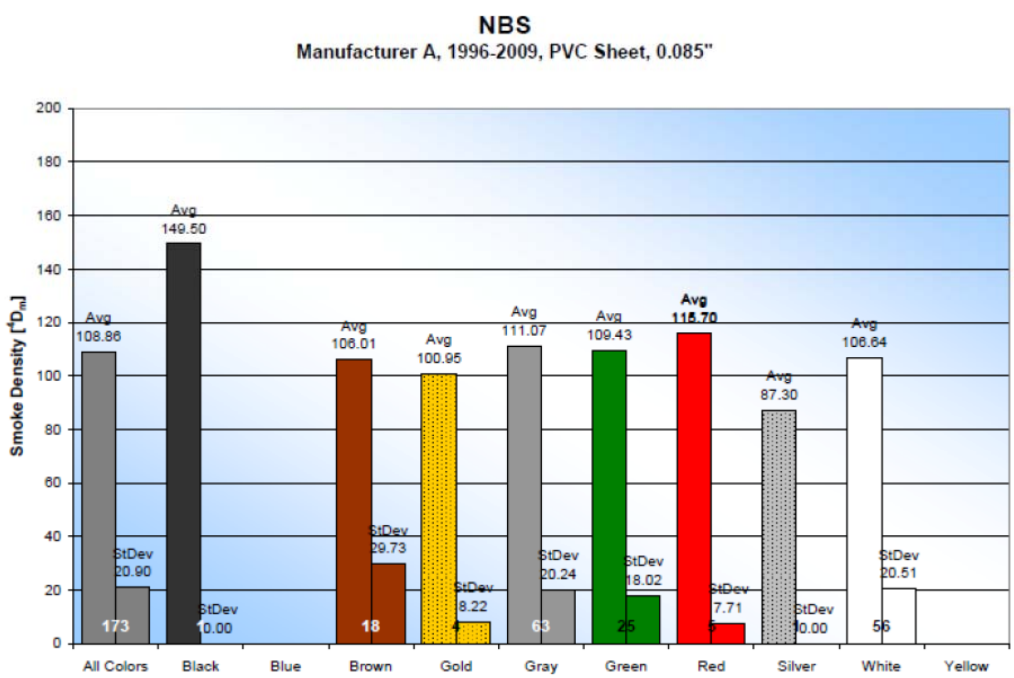


Figure 17 Manufacturer A NBS Smoke Data 0.085" Thick Sheet
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg Ds.

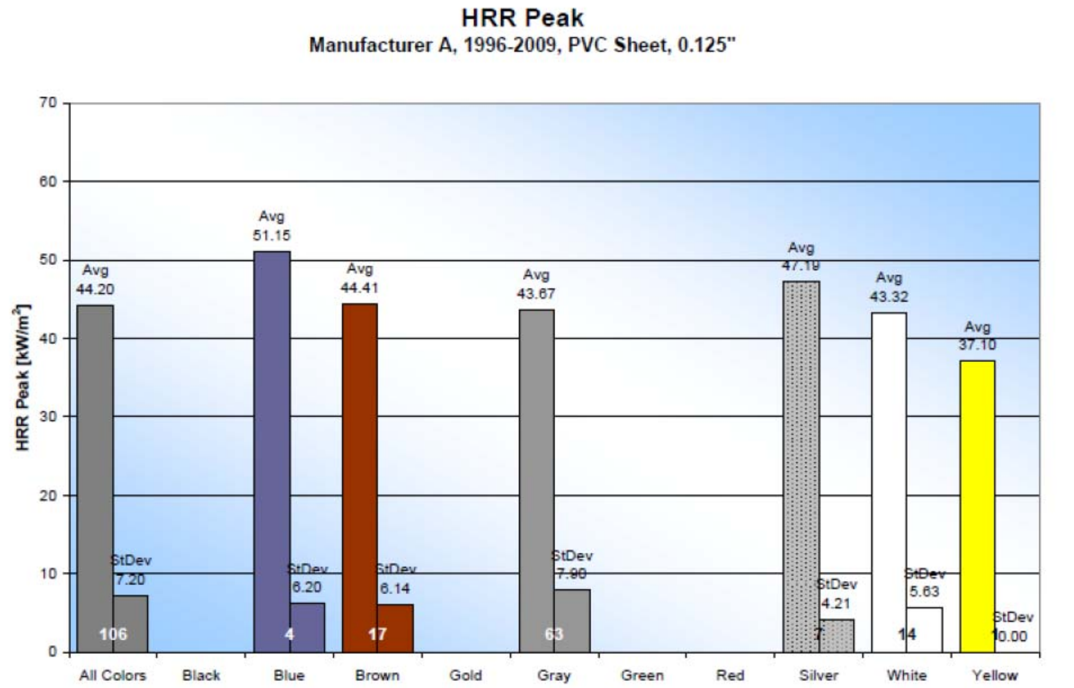


Figure 18 Manufacturer A Heat Release Peak 0.125" Thick Sheet
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg Peak HRR.

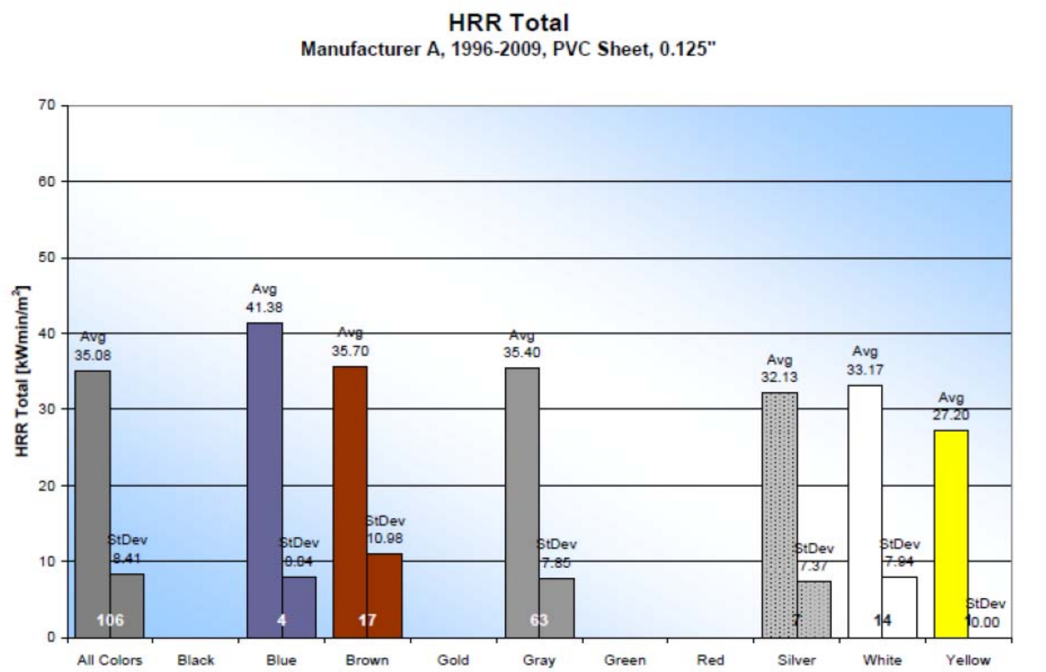


Figure 19 Manufacturer A Heat Release Rate 0.125" Thick Sheet
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg Total HRR.

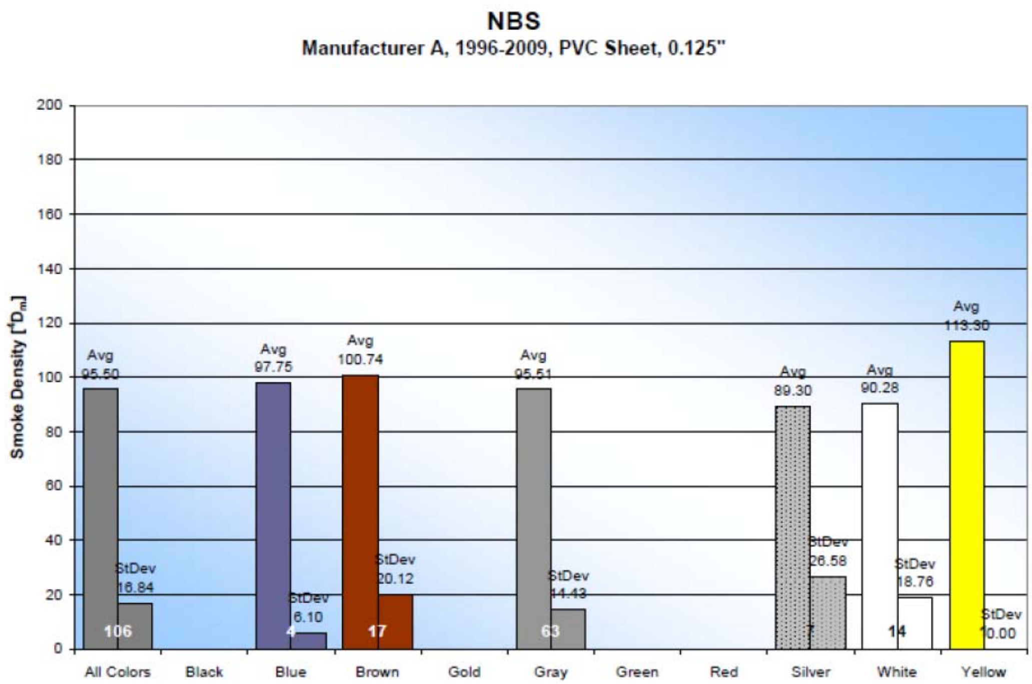


Figure 20 Manufacturer A NBS Smoke Data 0.125" Thick Sheet
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg Ds.

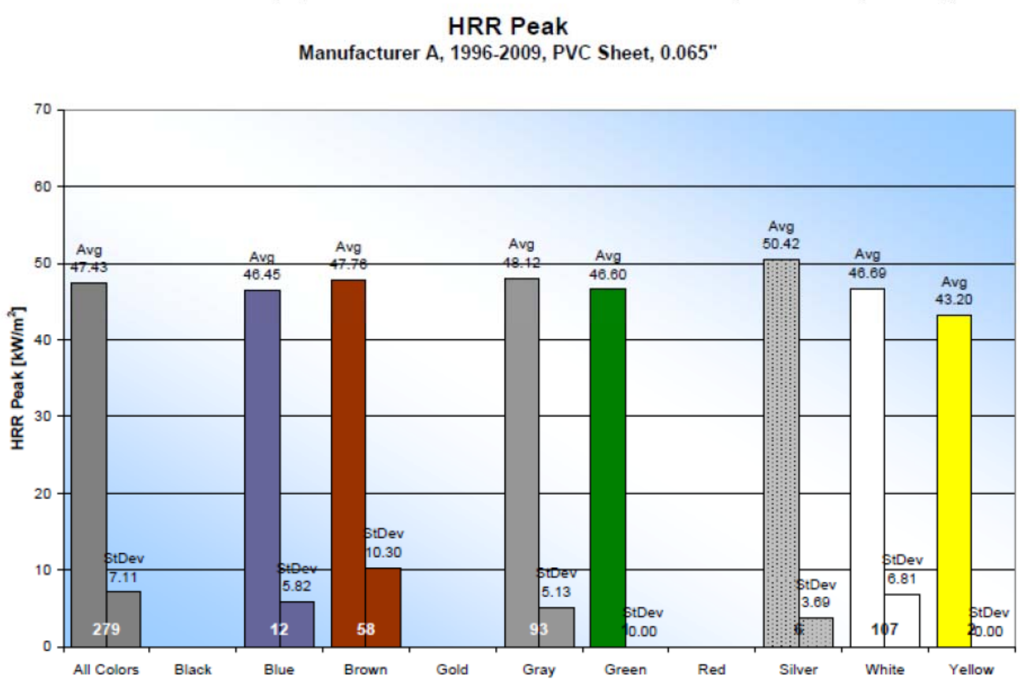


Figure 21 Manufacturer A Heat Release Peak 0.065" Thick Sheet
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg burn length.

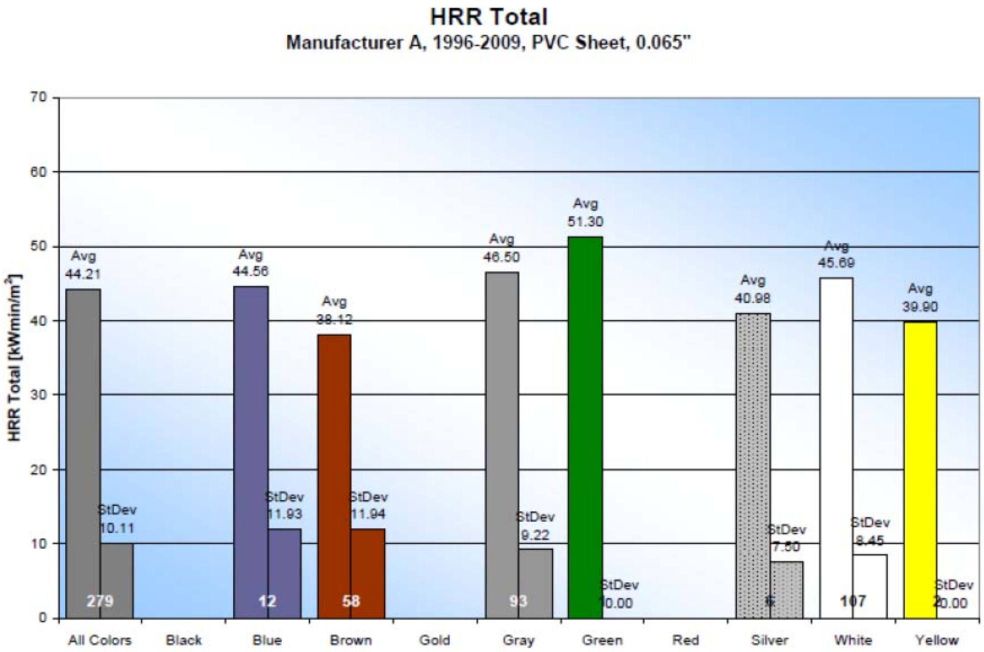


Figure 22 Manufacturer A Heat Release Rate 0.065" Thick Sheet
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg Total HRR.

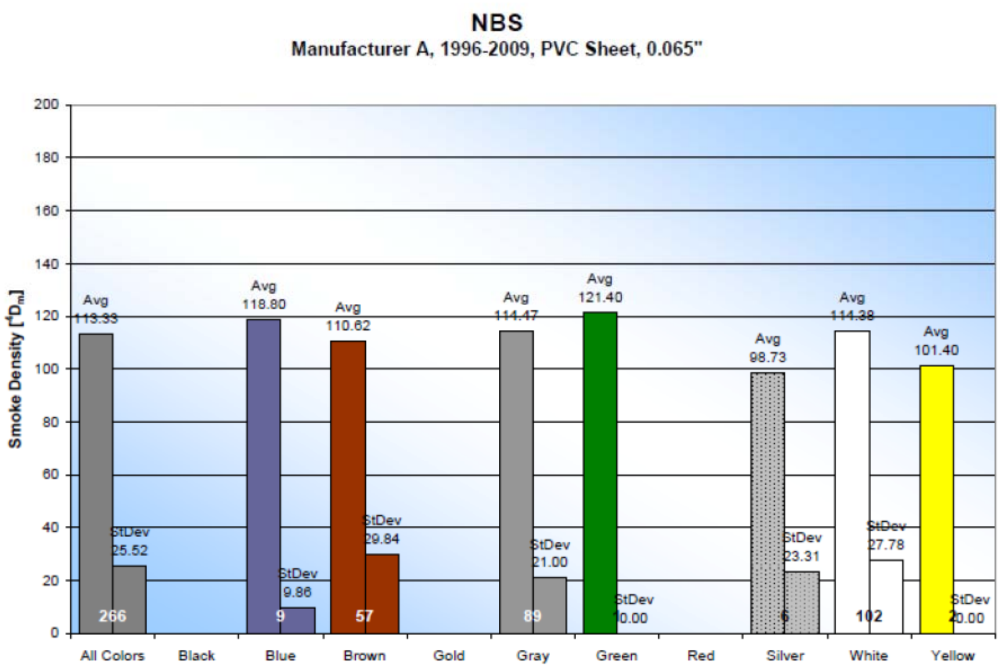


Figure 23 Manufacturer A NBS Smoke Data 0.065" Thick Sheet
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg Ds.

5.2.2.2 Manufacturer B (Plastic 2 and 3)

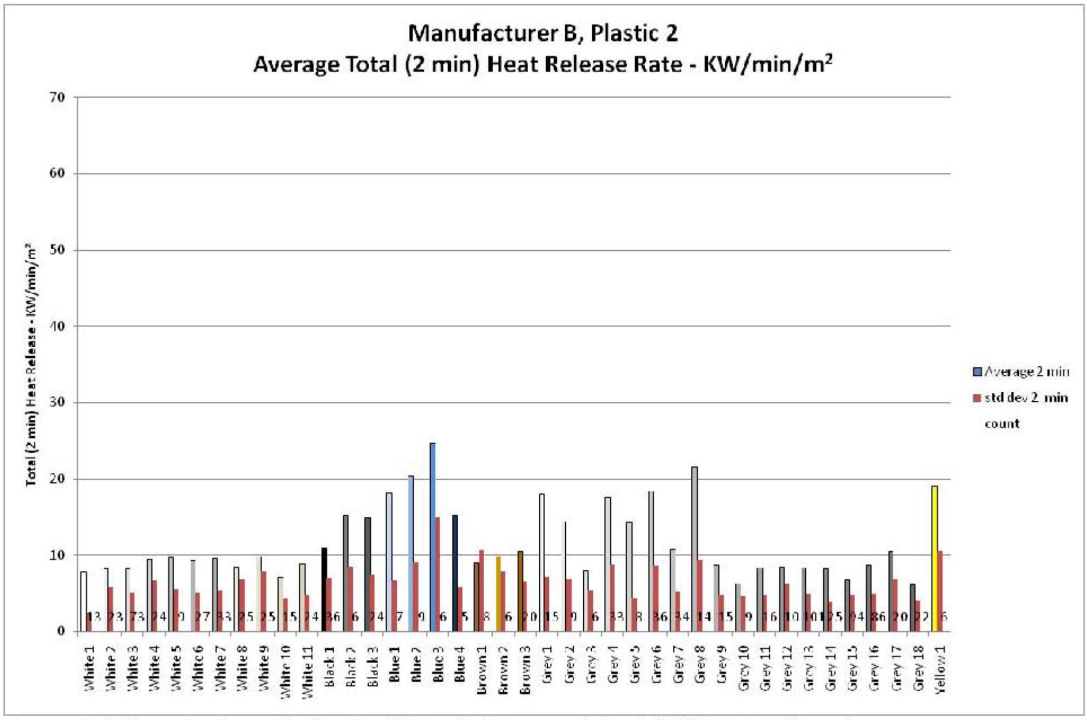


Figure 24 Manufacturer B Plastic 2 Heat Release Rate 0.080" Thick Sheet
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg Total HRR.

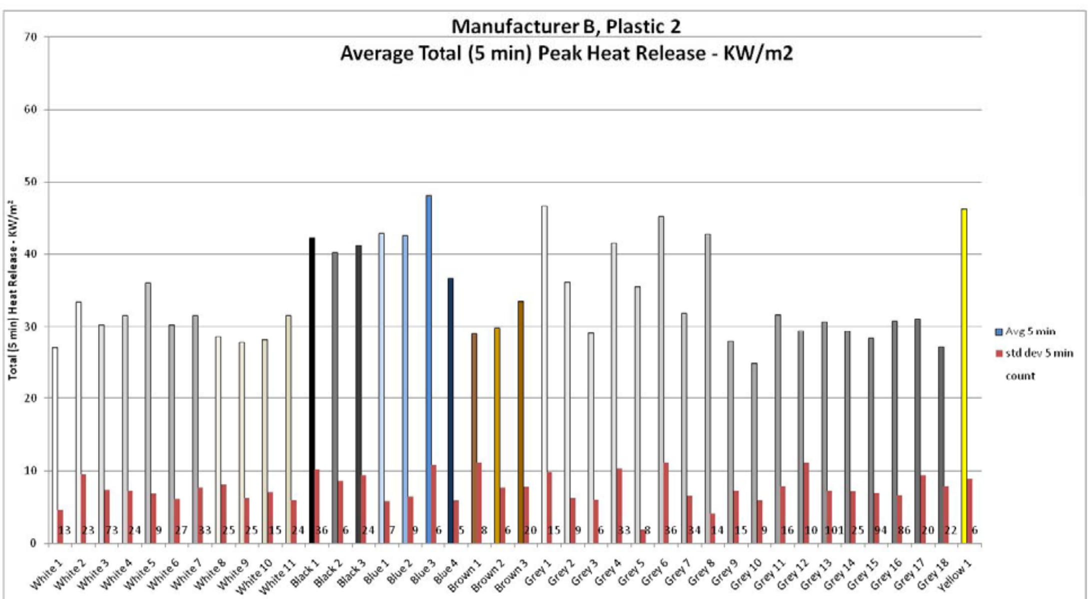


Figure 25 Manufacturer B Plastic 2 Heat Release Peak 0.080" Thick Sheet
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg Peak HRR.

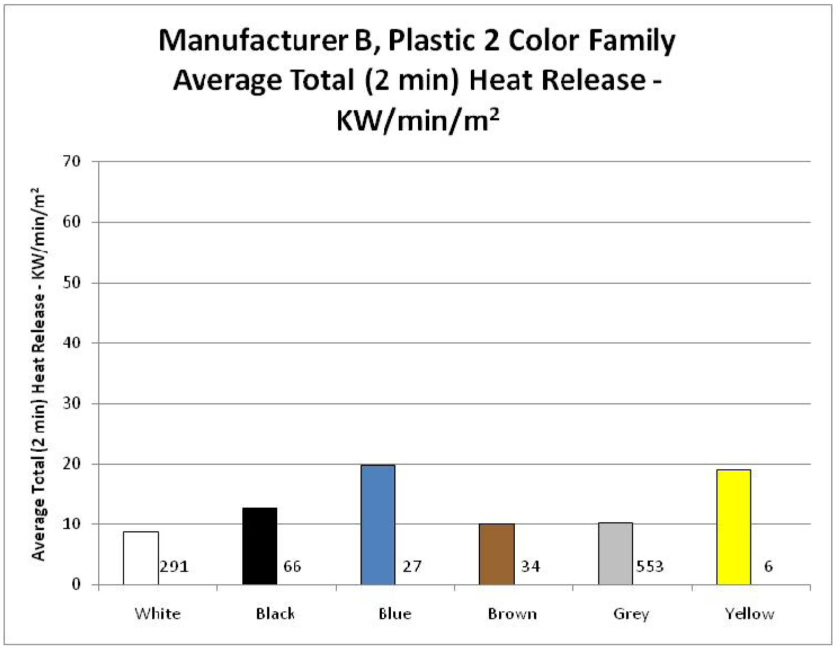


Figure 26 Manufacturer B Plastic 2 Color Families Heat Release Rate 0.080" Thick Sheet
This is a summary of Figure 24 by color families.

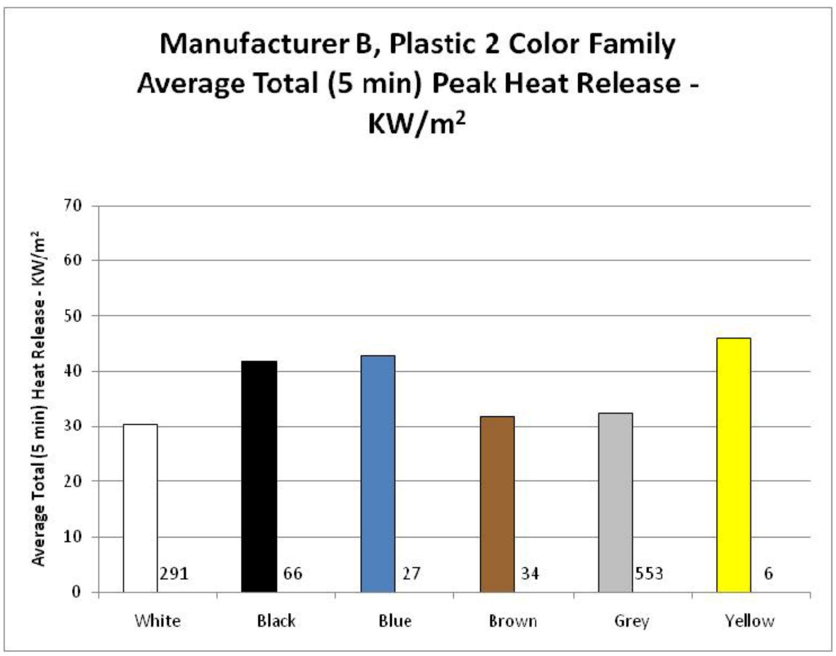


Figure 27 Manufacturer B Plastic 2 Color Families Heat Release Peak 0.080" Thick Sheet
This is a summary of Figure 25 by color families.

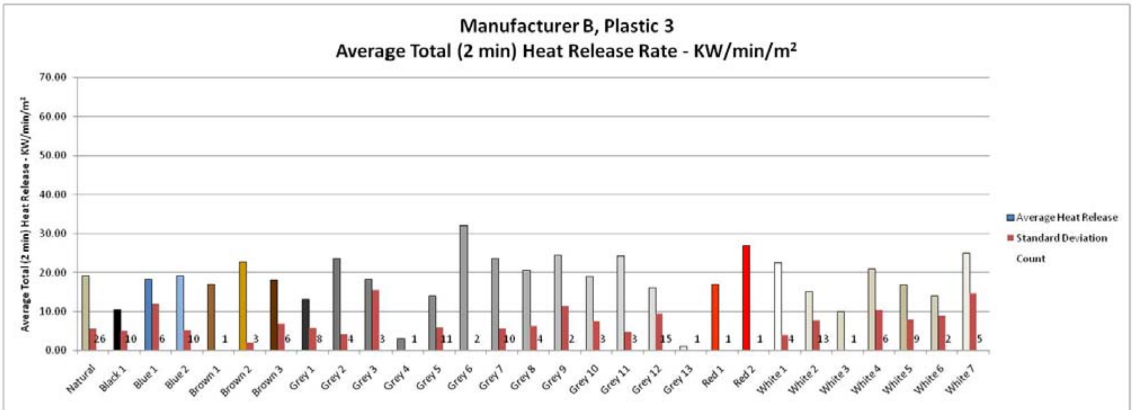


Figure 28 Manufacturer B Plastic 3 Heat Release Rate 0.080” Thick Sheet
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg Total HRR

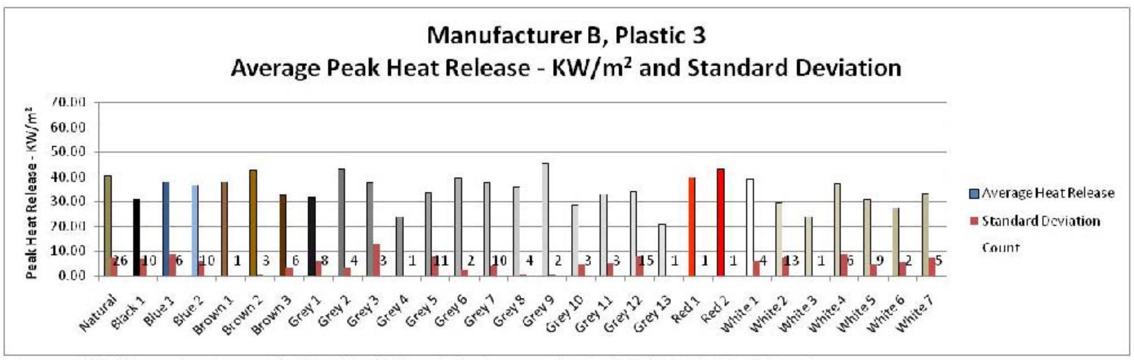


Figure 29 Manufacturer B Plastic 3 Heat Release Peak 0.080” Thick Sheet
Numbers at the bottom of graphs are the total count of data sets averaged. Bar height is avg Peak HRR

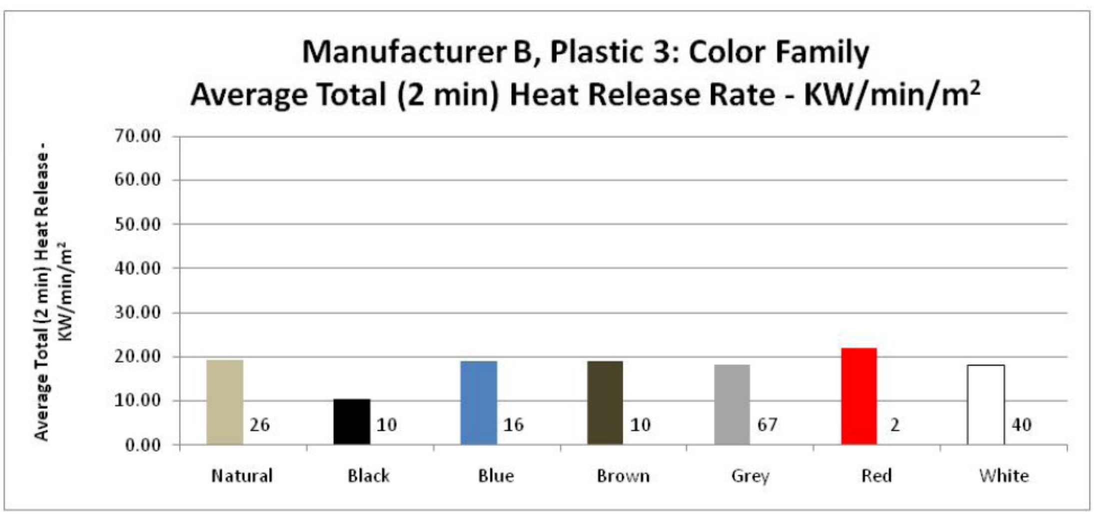


Figure 30 Manufacturer B Color Families Plastic 3 Heat Release Rate 0.080” Thick Sheet
This is a summary of Figure 28 by color families.

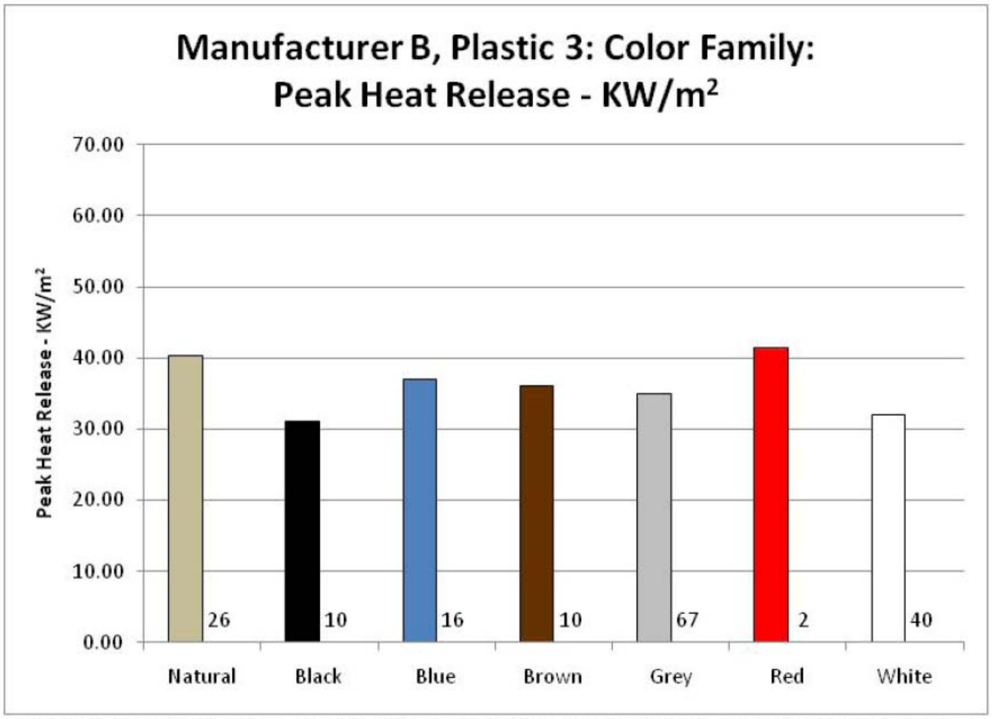


Figure 31 Manufacturer B Plastic 3 Color Families Heat Release Peak 0.080" Thick Sheet
This is a summary of Figure 29 by color families.

5.2.2.3 Manufacturer C (Plastic 5) – Thickness is noted on charts

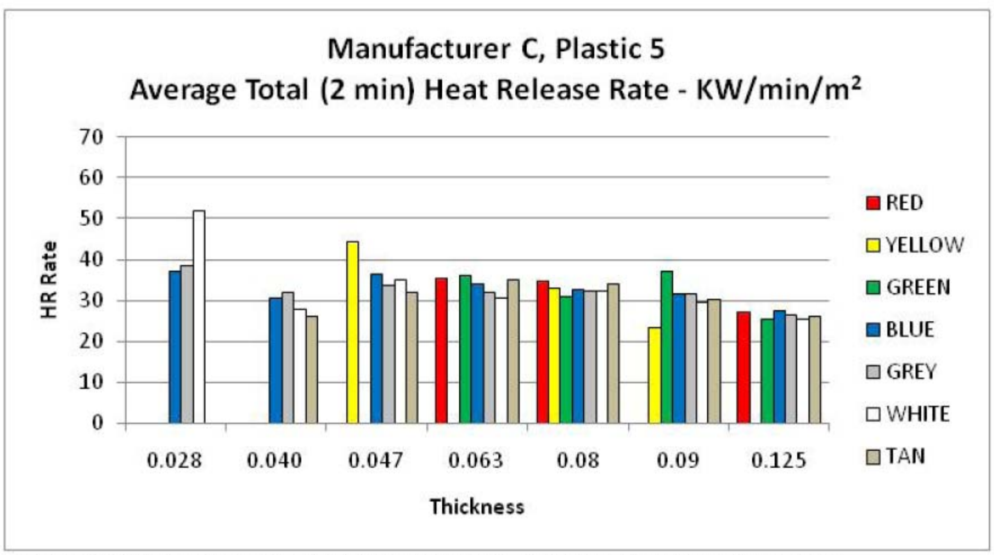


Figure 32 Manufacturer C Plastic 5 Heat Release Rate Various Thicknesses
Individual colors grouped into color families.

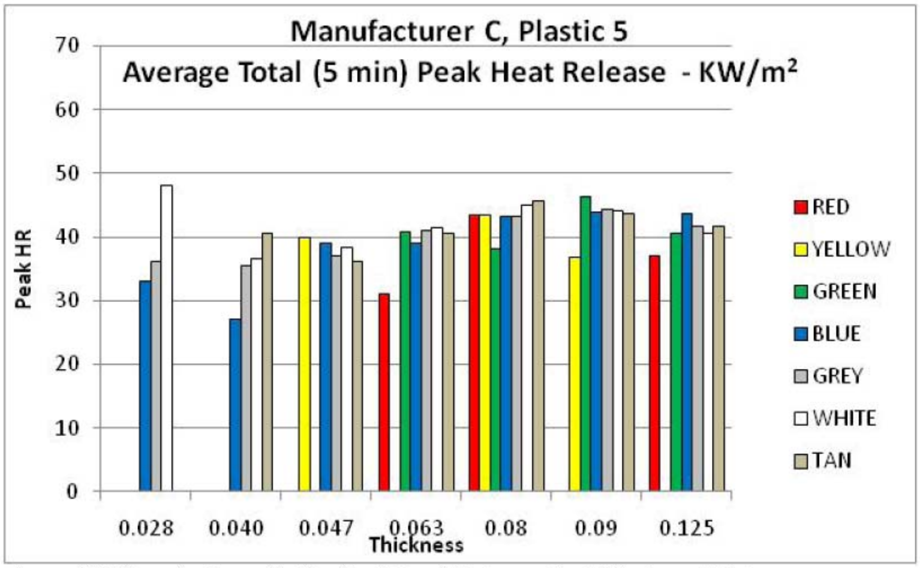


Figure 33 Manufacturer C Plastic 5 Heat Release Peak Various Thicknesses
Individual colors grouped into color families.

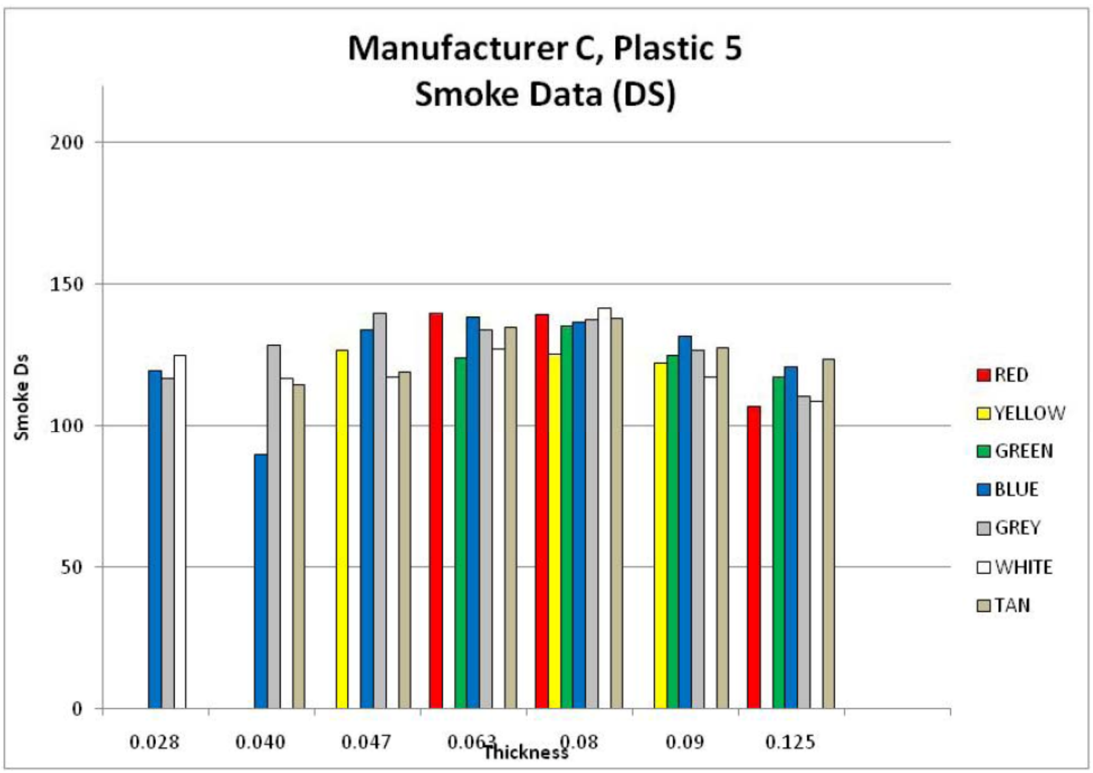


Figure 34 Manufacturer C Plastic 5 NBS Smoke Data Various Thicknesses
Individual colors grouped into color families.

Table 5 – Number of Test Sets per Color and Thickness for Plastic 5

Color \ Thickness	0.028	0.040	0.047	0.060/ 0.063	0.079/ 0.080	0.090/ 0.093	0.118/ 0.125
Red				2	9		6
Yellow			1		1	1	
Green				15	8	4	2
Blue	8	3	8	64	73	29	102
Grey	13	35	185	434	171	1009	479
White	1	14	46	88	27	164	95
Tan		2	12	78	55	111	78
Metallic					4		

Table 6 –Data for a Single Color and Thickness of Plastic 5

Color	Thickness	Total HHR	Peak HHR	Smoke	Test Date
Blue	0.125	28.00	39.00	105.00	27-Aug-08
Blue	0.125	13.00	32.00	104.00	06-Jan-09
Blue	0.125	47.00	45.00	84.00	24-Apr-09
Blue	0.125	8.00	24.00	131.00	02-Jun-09
Blue	0.125	25.00	36.00	101.00	17-Jun-09
Blue	0.125	19.00	24.00	70.00	01-Jul-09
Blue	0.125	20.00	34.00	79.00	13-Jul-09
Blue	0.125	23.00	40.00	107.00	27-Jul-09
Blue	0.125	16.00	42.00	104.00	15-Oct-09
Blue	0.125	31.00	40.00	94.00	10-Nov-09
Blue	0.125	22.00	52.00	126.00	07-Dec-09
Blue	0.125	38.24	50.77	137.20	21-Dec-09
Blue	0.125	38.24	50.77	137.20	21-Dec-09
Blue	0.125	12.00	32.00	123.00	25-Jan-10
Blue	0.125	29.00	39.00	114.00	02-Mar-10
Blue	0.125	29.00	45.00	102.00	25-Mar-10
Blue	0.125	31.00	43.00	97.00	29-Apr-10
Blue	0.125	43.00	44.00	69.00	03-Jun-10
Blue	0.125	37.00	37.00	133.00	06-Aug-10
Blue	0.125	13.94	34.76	150.12	31-Aug-10
	STD DEV	10.6	7.6	22.4	

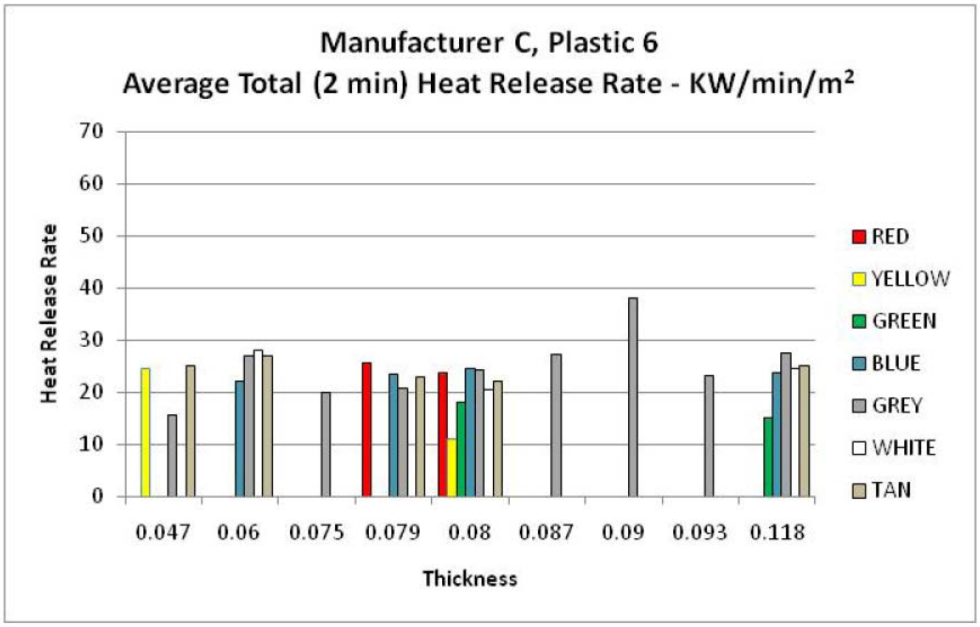


Figure 35 Manufacturer C Plastic 6 Heat Release Rate Various Thicknesses
Individual colors grouped into color families.

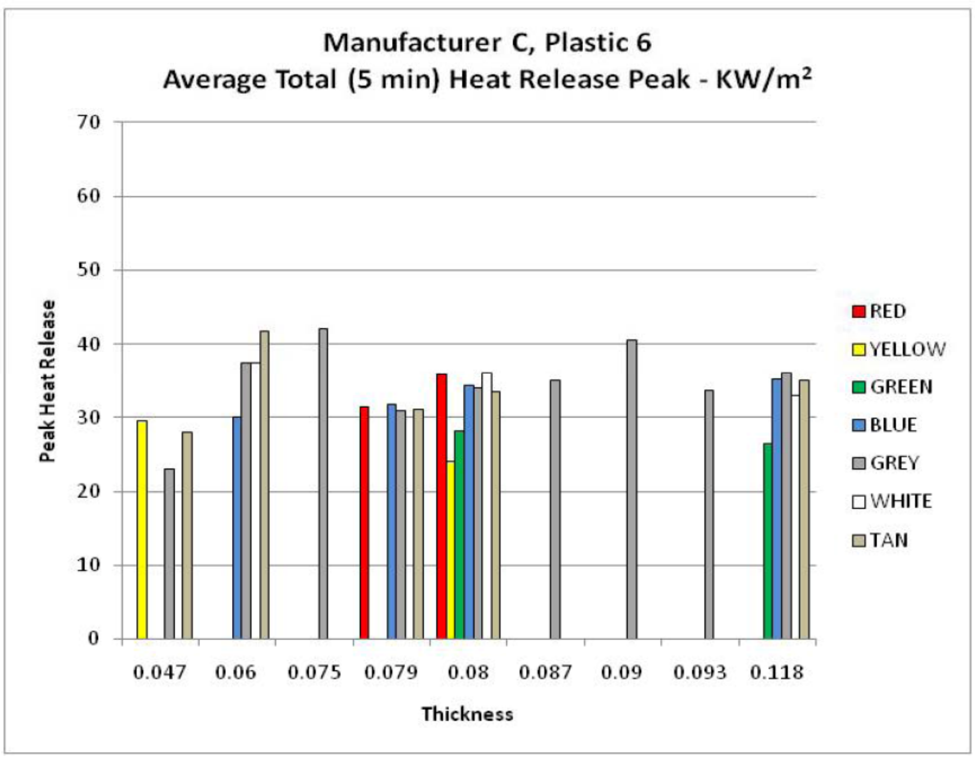


Figure 36 Manufacturer C Plastic 6 Heat Release Peak at Various Thicknesses
Individual colors grouped into color families.

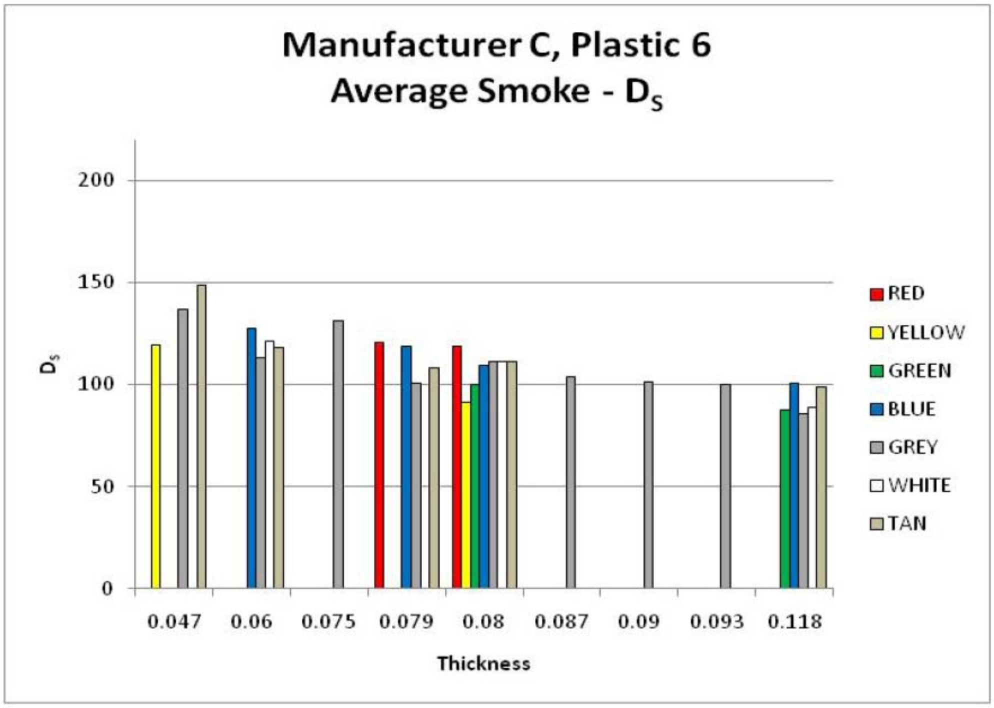


Figure 37 Manufacturer C Plastic 6 NBS Smoke Data Various Thicknesses
Individual colors grouped into color families.

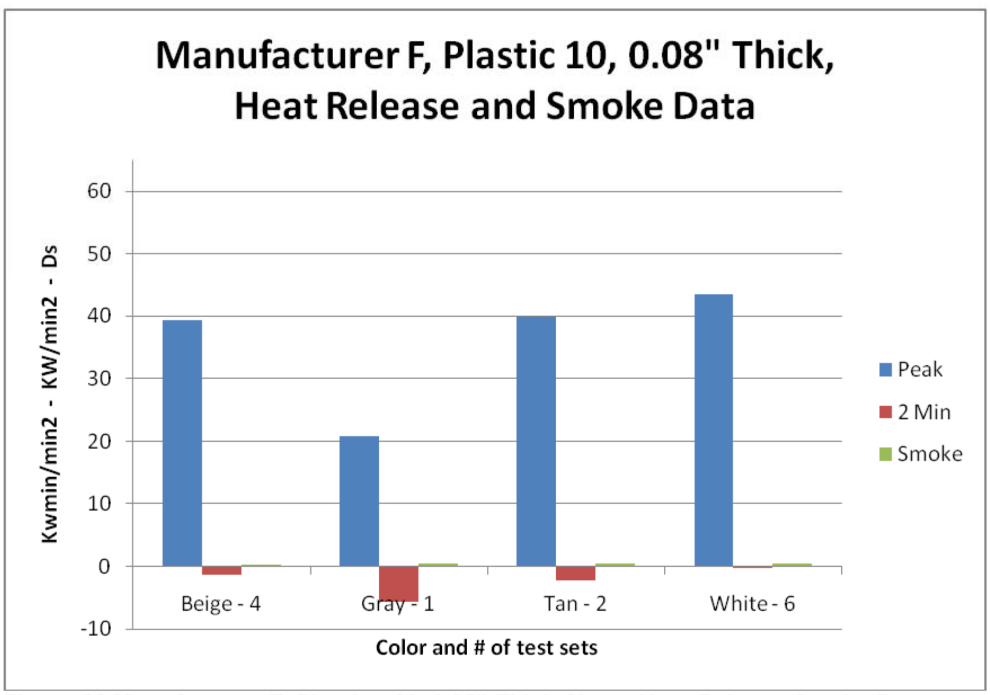


Figure 38 Manufacturer F, Plastics 10, 0.08" Thick Sheet, Heat Release Smoke Data

5.2.3 Elastomer Data

The independence of flammability results on color are demonstrated using a silicone rubber material AS172U by Momentive Performance Materials. On March 10, 2011 the colors listed below were tested and all received a burn rate of zero (the flame did not travel far enough to measure a burn rate) in the horizontal Bunsen burner.

Color	Color Name	Burn Rate (in /min)
BAC70950	GRAY 1	0
BAC70913	WHITE 1	0
BAC7426	WHITE 2	0
BAC70960	GRAY 2	0
BAC70961	GRAY 3	0
BAC870	BEIGE	0

5.3 ANALYSIS OF TEST RESULTS

5.3.1 Vertical Burn

Figures 2 through 14 show the compilation of test results of 12 and 60-second vertical burn tests for 9 different plastics. These plastics represent a wide use of plastics on aircraft, including CPVC, PVC, polycarbonate, ABS and engineered plastics (due to the proprietary nature of these materials, providing the generic description would reveal the manufacturer). The results for burn length tend to be very consistent across the board. After flame time tends to have more variation within a given color. The reason for this is that a flame can flicker for quite a long time, causing great variability in the after flame time, but having almost no effect on the burn length; therefore, the analysis of this data tends to look only at the burn length. There are other sources of error within the test data that is impossible to completely remove including test location, test operator, test set-up, and slight variation in the basic polymer across different batches. As all these sources of error are included within the data analysis, the significance of the variation specifically caused by one attribute like color has inherent uncertainly. This uncertainty must be kept in context with the general tread of results when developing final conclusions. Each plastic is discussed in detail in the following paragraphs.

The manufacturer A, plastic 1 data (as shown in Figures 2 – 4) is very consistent for burn length (after flame time is not given as it is 0 for this plastic). From the bar charts, there are two data points that show a bigger difference than the majority of data (0.085” brown and the 0.065” green). As there is only a single test set representing the green 0.065” data, this can be considered an outlier as there is insufficient data to establish a clear trend. When looking at the data for both the brown and green in the other thicknesses, the results show they fall in line with the other colors, providing some justification to that the single data points are outliers due to other sources of variation.

Manufacturer A, Plastic 1 is unique because the material is a thermoplastic base material with a decorative laminate cap (thin laminate film similar in construction to decorative in item 5b) which creates the color. The thermoplastic base material may have no relation to the color of the decorative cap. All of the other plastics in this report are homogeneous plastic material.

Manufacturer B, plastic 4 data for vertical burn testing (as shown in figure 5) shows very consistent results for all colors. For the blue samples, 2 of the individual sets of the 6 reported provided values higher than the others which resulted in a higher average of the blue data compared to the other colors. Other colors also displayed similar high results in some lots, but there was more data that moved the overall average lower. Since the range of data for this blue is similar to that of the other colors, it is assumed that given more data, the results would line up with the rest of the colors taking into account the normal test variation.

Manufacture C, Plastic 6, shows consistent results as shown in Figure 6 - 9. Figure 8 provides a comparison of the effect of thickness, and provides clear evidence for the "thin for thick" criteria. The results show no significant effect from color.

Manufacturer D, Plastic 9, shows very consistent burn lengths across the 4 different colors as shown in Figure 10 &11. This data contains one color that shows a potential outlier in after flame time. To further evaluate this variation, the detailed data set results are shown in Appendix A. Graphs for each of the data points making up the individual colors are displayed and shows the high variability from lot to lot of after flame time within a given color. Knowing that after flame time has a higher potential to provide variation within a few seconds, these results are difficult to assign color as a primary factor. With the other known sources of variation, these results do not indicate a significant concern and taken in total the data supports no significant effect just due to color.

Results from manufacturer F & G in figures 13 & 14 add additional data showing that color has no significant effect.

Overall, the Bunsen burner data supports the method of compliance for 14CFR 25.853(a) requirements for color similarity, allowing data for one color to substantiate another color of the same plastic.

5.3.2 OSU Heat Release and Smoke Similarity

Each manufactures data from the OSU Heat Release and Smoke testing is analyzed and described below.

The data for Manufacturer A, Plastic 1, shows very consistent results for all colors (Figures 15 to 38). Plastic 1 has a decorative laminate cap over a thicker base thermoplastic sheet and this construction can be viewed as similar to item 5b, a decorative laminate on a panel, where in this case, the panel is a thermoplastic sheet. In item 5b, a significant amount of data has been submitted showing that different decorative laminate colors can be certified by similarity. As shown by the consistent data for this material and data in 5b in general, a thermoplastic material with a decorative cap can be considered the same as a decorative laminate cap on a panel. Therefore, a material of this construction can be covered by item 5b. The range of data presented in this report is consistent with the variation seen for other types of decorative laminates provided in 5B.

Manufacturer B, Plastic 2 show a trend with color as shown in Figures 24 through 27. Certain grays and blues appear to have higher heat release values dependent on color. Blue and yellow have about 10 point higher total and peak values than the other colors when the colors are grouped together in families (Figures 26 and 27) Plastic 3 shows almost no effect due to color as shown in Figures 28 through 31. It should be noted that these two plastics have very similar chemistry and that for plastic 3; the blacks are lower in both peak and total heat release than the other colors, opposite of plastic 2. Smoke data is unavailable for plastics 2 and 3 as the manufacturer does not test it typically for quality assurance because the numbers are so low based on the material chemistry as compared to the FAA requirement.

Manufacturer C, plastics 5 and 6, show very consistent results across all color families as shown in Figures 32 through 37. The majority of the data for plastic 5 is at 0.063, 0.080 and 0.090 thicknesses. In these ranges, the graphs are very similar. Only red and yellow tend to vary slightly, but that is because these colors have the least amount of test sets as shown in Table 5. There are only two sets of data for red at 0.063” and no yellow. Even if one color family is slightly high for one thickness, it is not the highest at a different thickness. The peaks of each chart are random, supporting the theory that color does not affect the results. Where there is a bar that is significantly higher or lower, it is always due to the results being from only one or two data points.

Table 6 is the data for a single color blue at one thickness for plastic 5 and shows the large variability typical in all the test data for these plastics (plastics 1 through 5). For this color blue, the Total HRR ranges from 8 to 47 (standard deviation of 10.6), the Peak HRR ranges from 24 to 50.8 (standard deviation of 7.6) and the Smoke Ds ranges from 69 to 150.1 (standard deviation of 22.4). This wide range of data for a single color shows the difficulty in comparing results for one color versus another.

Manufacturer F, Plastic 10, has the least amount of data, but where there is more than a single test set (grey has only one set) the peak and total heat release is nearly the same for all colors.

5.3.3 Elastomer Data

As is typical with elastomeric materials, when tested to the horizontal burn requirements, the flame never reaches the timing zone, but instead self extinguishes. Of all the colors tested, none reached the timing zone. Because elastomers typically don’t reach the timing zone when tested, no difference can be discerned between colors.

6 CONCLUSION

Plastic 1 from manufacturer A does not truly meet the provided definition of thermoplastic for the proposed item 23 MOC. A construction with a decorative laminate cap on a thermoplastic base falls within the category of item 5b, (similarity of decorative laminate colors). The data presented here and in the report for 5b for this type of construction shows that color similarity can be applied for both 14 CFR 25.853(a) and (d).

Based on results of the Bunsen burner flammability testing presented in section 4 and analyzed in section 5 of this document, the industry team believes that data from testing one color of thermoplastic can be used to substantiate another color of the same thermoplastic at the same thickness for 14 CFR 25.853(a).

For elastomers, although there is limited data, the case for allowing color similarity is strong. Most elastomers never reach the timing zone for determining burn rate, making it difficult to determine any effect of color, but also of no importance given the high margin for passing the test.

The data for OSU heat release and smoke optical density provides a good view of the known and expected variation of these test methods. For the different sets of data from each manufacturer, there is no one color that could easily be stated as the “worst case” to be used as a standard for similarity as suggested in the draft policy memo. Industry believes that color similarity for OSU Heat Release and Smoke can be allowed based on the following points:

- The degree of variation within a given color of a single material is large, making it difficult to assign any given difference (lot to lot variations, OSU calibration, operator, color difference, etc.) as a discriminating factor in data differences.
- The margins by which these plastics meet the FAA requirements are fairly large.

As such, the industry team recommends that color similarity be allowed for thermoplastics for 14 CFR 25.853(a) and (d) and be presented as follows.

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
23	Color of thermoplastics, decorative non-textile floor covering and elastomers	Data from testing an integrally colored thermoplastic, decorative non-textile floor covering or elastomer substantiates the same thickness thermoplastic, decorative non-textile floor covering or elastomer of a different color.	Data from testing an integrally colored thermoplastic substantiates the same thickness thermoplastic of a different color.

FAA Memorandum **ANM-115-09-XXX**, "Policy Statement on Flammability Testing of Interior Materials"
Part 2, Reference Item #23, "**Color of Thermoplastics**"

If the FAA is unable to accept the recommendation above for 14 CFR 25.853(d), as an added means of ensuring a different color will be compliant, the industry team recommends the following modification of the above proposal be considered.

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
23	Color of thermoplastics, decorative non-textile floor covering and elastomers	Data from testing an integrally colored thermoplastic, decorative non-textile floor covering or elastomer substantiates the same thickness thermoplastic, decorative non-textile floor covering or elastomer of a different color.	Data from testing an integrally colored thermoplastic substantiates the same thickness thermoplastic of a different color given the data used is less than or equal to: 55 KW/min/m2 for 2 min Total, 55 KW/min2 for Peak, and 180 Ds.

7 ABBREVIATIONS

FAA	=	Federal Aviation Administration
MOC	=	Method of Compliance
CFR	=	Code of Federal Regulations

8 REFERENCES

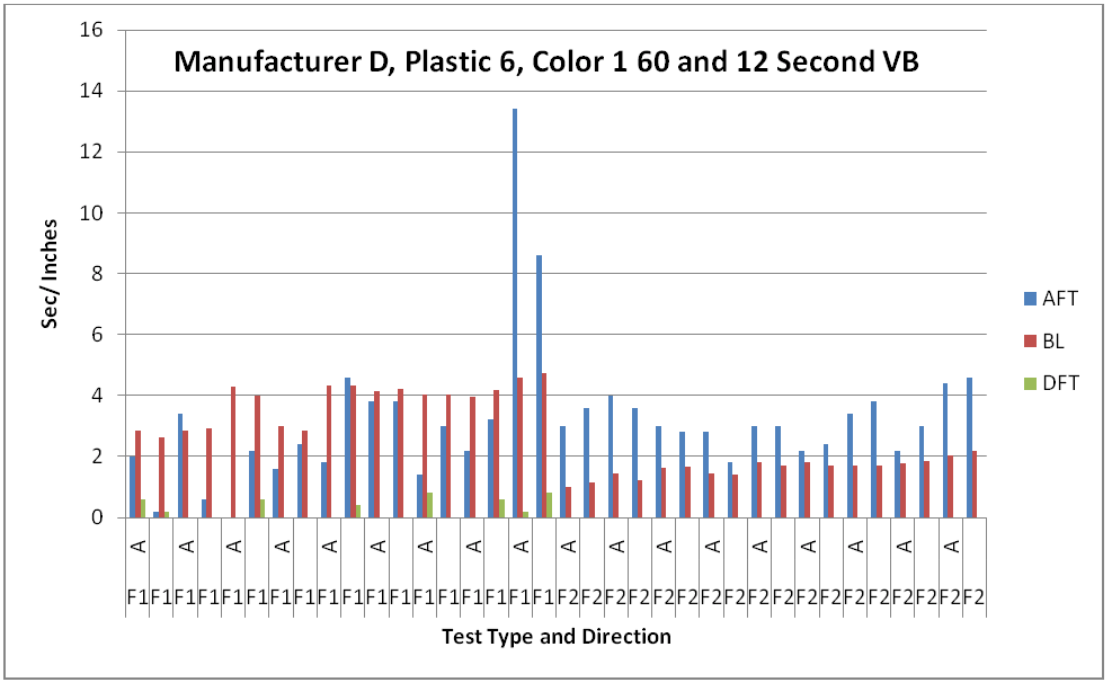
[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

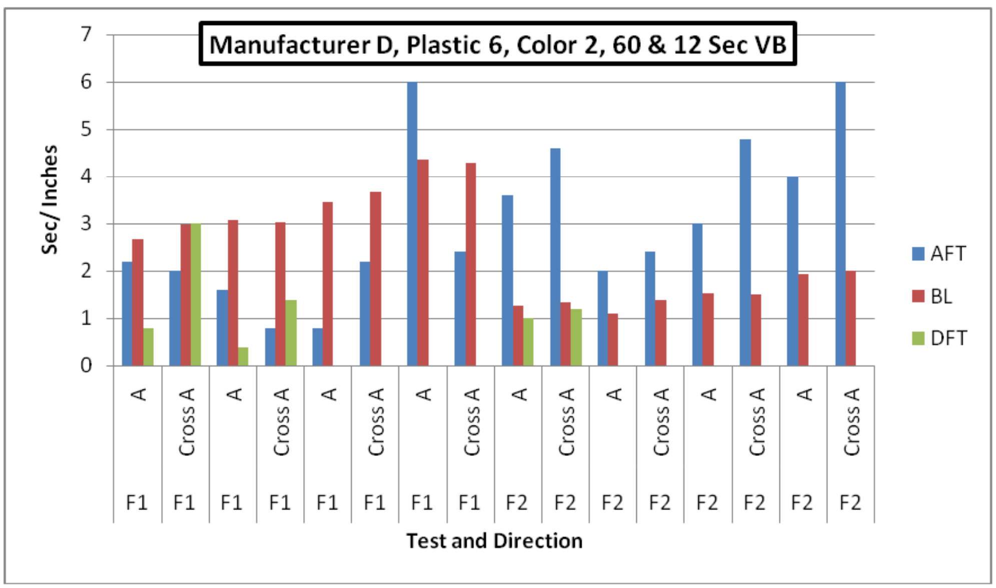
[2] n.n., *14 CFR Part 25, [Docket No. 24594; Amendment No. 25-61], Improved Flammability Standards for Materials Used in the Interiors of Transport Category Airplane Cabins,* Department of Transportation, Federal Aviation Administration, July 1986.

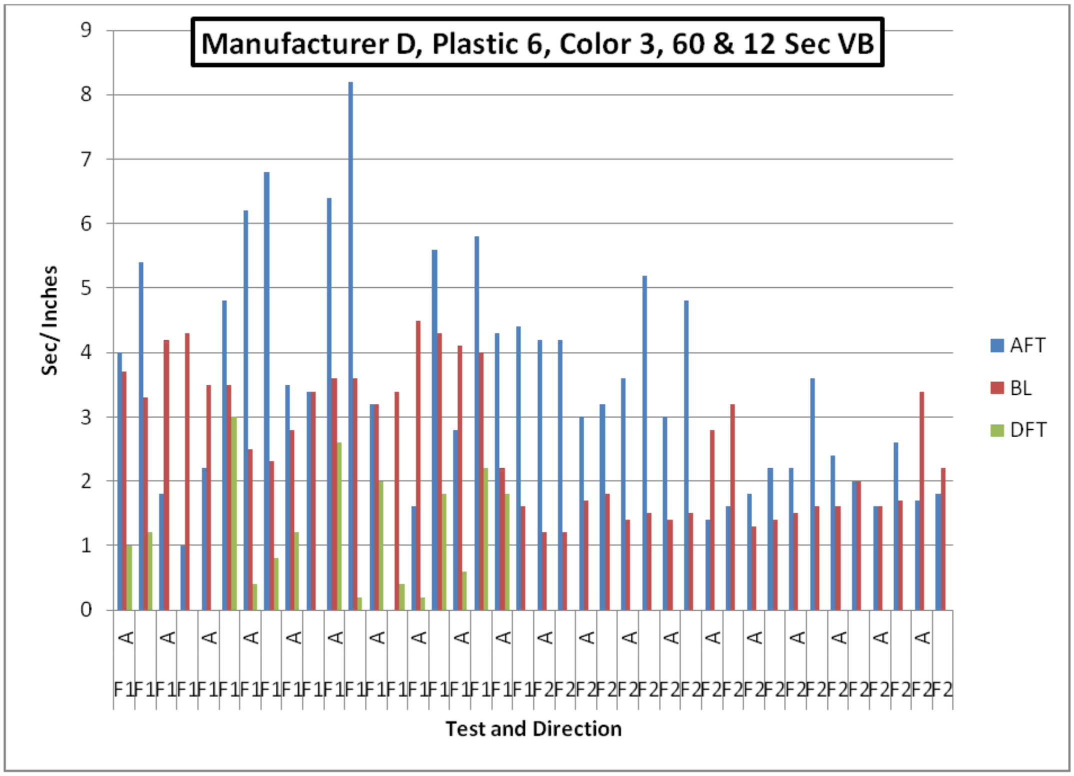
[3] n.n., *14 CFR Part 25, [Docket No. 24594; Amendment No. 25-66], Improved Flammability Standards for Materials Used in the Interiors of Transport Category Airplane Cabins*, Department of Transportation, Federal Aviation Administration, August 1988.

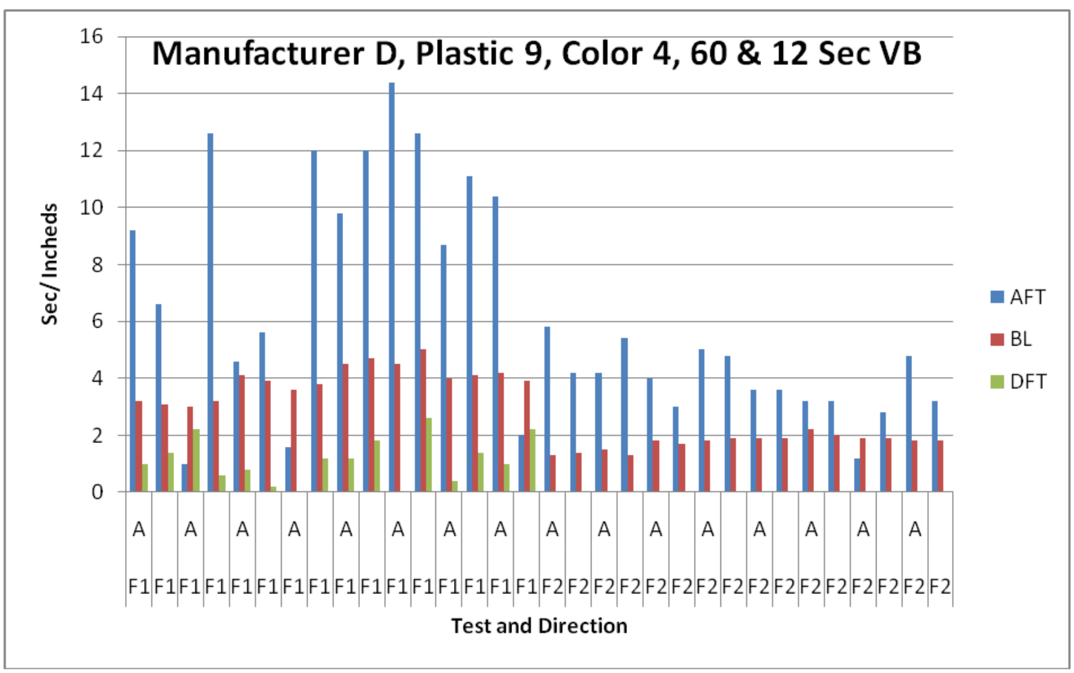
9 Appendix A

The following graphs show multiple lots of a single color for Manufacturer D, Plastic 6. The graphs show the large variability in after flame time, but relative consistency in burn length. Test F1 is 60 second vertical burn and F2 is 12 second.






Manufacturer D, Plastic 6, Color 3, 60 & 12 Sec VB
Sec/ Inches
Test and Direction
AFT
BL
DFT


Manufacturer D, Plastic 9, Color 4, 60 & 12 Sec VB
Sec/ Incheds
Test and Direction
AFT
BL
DFT

10 Appendix B

Test Data and Analysis for Decorative Non-Textile Floor Coverings

APPENDIX U—ITEM 25: CLEAR PLASTIC WINDOWS AND SIGNS

Rev A
November 15, 2010

Part 1, Item 25:

Clear Signs and Windows

Ke-winn Chan

1. PREAMBLE

Cabin interior components have historically been tested for flammability compliance by separate entities, each with their own interpretation of aviation flammability regulations. FAA draft policy memo, ANM-115-09-xxx is part of a joint effort between the FAA and the cabin interiors industry to standardize the means of compliance to aviation flammability requirements.

A draft of ANM-115-09-xxx was released by the FAA in the 3rd quarter of 2009, with 2 main categories of cabin interior materials. The first category has methods of compliance that are acceptable to the FAA, without any need for supporting test data. The second category has methods of compliance that need further study, in order for a common means of compliance to be established.

Clear signs and windows belong to the first category. The purpose of this document is thus to standardize the methods of compliance for materials installed as "Clear Signs and Windows".

2. TEAM LEADER AND SUPPORT TEAM

During a meeting on Sept 24, 2009, in Huntington Beach/Ca., the following volunteer joined the "Clear Signs and Windows" team:

- Ke-winn Chan (Airbus, Mobile AL), team leader

In addition, this document has been produced with support from Ingo Weichert, Airbus Germany, David Julin, B/E Aerospace and Jeff Smith, Gulfstream.

3. DEFINITION OF TERMS

Presently, ANM-115-09-xxx is available as an undated draft. The current version was received on August 20, 2009. Part 1, reference no. 25, reads:

Part 1, acceptable methods without additional data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
25	Clear plastic windows and signs	Test per appendix F, part I, (a)(1)(iv).	No test requirement.

The following terms are defined:

1. Clear plastic windows
    a. Clear plastic materials used functionally as windows, e.g. interior window pane, partition window, etc.

2. Clear plastic signs
    a. Clear plastic materials used functionally as signs e.g. safety information placards, exit signs, light covers etc.

Examples of clear materials include PMMA (Plexiglas), polycarbonates, PEI (polyetherimide), acrylic etc. Note that mineral glass is not considered in this document as it is not a plastic material, even though it can be clear.

4. DEFINITION OF PROJECT

The following are proposed to be the main components of the final report:

a. Definition of terms:
See Chapter 3 of this document for details.

b. Current means of compliance:
Materials that meet the definition of ‘clear plastic windows and signs’ need to meet the requirements of Appendix F, part I, (a)(1)(iv), which uses the horizontal 15-second test as the means of compliance.

c. Exceptions:
Any application of clear plastic materials, other than windows and signs, will require different means of compliance, depending on material usage, for example:

1. <u>Large, decorative coverings of sidewall panels with clear plastic material –</u>
These would need to fulfill 60 second vertical, smoke density and heat release requirements.

2. <u>Clear front panels of stowages, or bar units –</u>
These belong to the category of cabin furnishing items requiring a 12 second vertical test per Appendix F, part I, (a)(1)(ii).

d. Concurrence from FAA:
This would be anticipated to be in the form of a written statement.

4.1 SUMMARY OF TESTS TO BE PERFORMED

The primary means of compliance for materials used as clear plastic windows and signs, will be the 15-second horizontal test.

Installations meeting the criteria for 60 (or 12) second vertical, heat release and smoke density testing, as outlined in Chapter 4(c) – Exceptions, will use the appropriate tests to show compliance to flammability regulations.

There is one exemption available: Windows and transparent panels inserted in cabin partitions that are necessary to provide flight attendants with an unobstructed view of the passenger cabin.

APPENDIX V—ITEM 26: PRINTED WIRING BOARDS

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM PROPOSAL

Part 1, Reference Item #26, “Printed wiring boards (PWB)”

Revision – A, dated 26 April 2012

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13	A								

2 REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
NC	Initial release.	1 April 2011	Jeff Smith
A	Updated sections 8.4, 8.5, 9 and 9.1.	26 April 2012	Scott Campbell

3 INTRODUCTION

Introduction: As part of the industry activities to provide validation of the Part 2 items from the referenced FAA draft policy, the industry teams are reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Item 26 has been reviewed by the industry team and is submitted the following proposals and justification.

4 INDUSTRY TEAM LEADER AND SUPPORT TEAM

During the FAA Materials Fire Test Working Group meeting on 21 October 2009 in Atlantic City, NJ, the following individuals have volunteered to form the industry team for this reference item:

4.1 TEAM LEADER

- Smith, S. Jeffrey (Gulfstream Aerospace Corporation)

4.2 SUPPORT TEAM

- Couilliard, Keith (Boeing)
- Niitsu, Gilberto (Embraer)
- Glamoclija, Petar (Bombardier Aerospace)
- Jensen, Michael (Boeing)
- David Lucas (Cessna)

This list is by no means final, but represents a snapshot of the currently active industry participants. Additional remarks, suggestions, corrections and contributions from other individuals are very much encouraged.

5 PROJECT DEFINITION

5.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX dated “Proposed” is available as draft. The current version has been uploaded to the FAA website on 20 August, 2009. Attachment 2, Part 1, reference item #26 reads (see Figure 1):

“The test coupons must replicate the PWB laminate; however, the copper tracing may be excluded from the coupon configuration. The test must include the PWB material with solder mask and conformal coating, if a conformal coating is used. Testing of the laminate in the thinnest cross section will substantiate other PWBs made of the same laminate with thicker constructions. “

5.2 PWB Clarification which was added to issue paper by Boeing:

Printed Wiring Boards: The Method of Compliance for printed wiring boards as defined in Part 1, Reference Number 26, will be interpreted to allow certification test data generated by testing boards with or without copper tracing patterns to be used to certify boards with any copper tracing pattern, provided the conformal coating, laminate, and solder mask are the same. This guidance was provided by Jeff Gardlin during the 8/20/09 Industry Standardization meeting.

26	Printed wiring boards (PWB)	The test coupons must replicate the PWB laminate; however, the copper tracing may be excluded from the coupon configuration. The test must include the PWB material with solder mask and conformal coating, if a conformal coating is used. Testing of the laminate in the thinnest cross section will substantiate other PWBs made of the same laminate with thicker constructions.	No test requirement.

Figure 1: Attachment 2, Part 1, Reference Item #26

No equivalent entry exists for reference item #26 in attachment 2, Part 2.

5.3 Expanded PROPOSAL

The Team proposes to expand on this issue to include:

5.3.1 Definition of specific test required for PWBs;

5.3.2 The FAA's acceptance of UL 94 V-0 Qualification as acceptable means to show compliance to 14 CFR § 25.853(a).

5.3.3 Provide guidelines for determining similarity to previously tested circuit boards.

5.4 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of the terms 'Printed wiring boards (PWBs)', 'copper tracing', 'conformal coating', and 'same' should be provided so that confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

5.5 Printed wiring boards (PWBs)

The industry team agrees that a printed wiring board, or PWB, is used to mechanically support and electrically connect electronic components using conductive pathways, tracks or traces etched from copper sheets laminated onto a non-conductive substrate. It is also referred to as printed circuit board (PCB) or etched wiring board. A PCB populated with electronic components is a printed circuit assembly (PCA), also known as a printed circuit board assembly (PCBA).

5.6 Copper Tracing

The industry team agrees that the vast majority of printed wiring boards are made by bonding a layer of copper over the entire bare substrate, sometimes on both sides, (creating a "blank PWB") then removing unwanted copper after applying a temporary mask (e.g. by etching), leaving only the desired copper traces. A few PWBs are made by adding traces to the bare substrate (or a substrate with a very thin layer of copper) usually by a complex process of multiple electroplating steps.

5.7 Conformal Coating (CC)

Conformal coatings are materials applied to electronic circuitry to act as protection against moisture, dust, chemicals, and temperature extremes that if uncoated (non-protected) could result in a complete failure of the electronic system.

5.8 Solder mask

Solder mask or solder resist is a lacquer like layer of polymer that provides a permanent protective coating for the copper traces of a printed circuit board (PCB) and prevents solder from bridging between conductors, thereby preventing short circuits. The solder mask is most often applied with a green tint but is available in a wide variety of colors and finishes. It also provides some protection from the environment.

5.9 Same

The industry team agrees that “same” means from the same manufacturer and same product family (same material / chemical composition) and same product build-up. So when the FAA draft policy memo refers to the “same type”, the only change being allowed in the context of PWBs similarity would be the exclusive change from one thickness to another, provided it falls within the thickness range qualified and all other product parameters as listed above staying the same. Additionally different copper traces and bare substrate textures are allowed for similarity purposes.

6 VALIDATION OF INDUSTRY PRACTICE

6.1 INDUSTRY PROPOSAL DISCUSSION

The use of this MOC has been inserted by the FAA into Part 1 for both 14 CFR 25.853 (a) and (d). This means that the method is acceptable and can be used as shown. The industry team is proposing to provide additional guidance and recognizes that the FAA will require additional supporting data to accept these additional methods for Vertical Burn.

7 PROPOSED STANDARDS TO MEET

7.1 Definition of specific test required for PWBs; Flammability Testing accomplished per the 12 Second/Vertical Test for Electrical Conduit and/or Thermoformed parts, Electrical Conduit/Thermoformed parts are the closest matches to PWBs in 14 CFR Part 25 Appendix F Part I. Also, as accepted in Part 1, the test sample may or may not include the copper trace or be populated but must include any solder mask and conformal coating to be utilized in the final assembly. This is an accepted industry practice and should require no additional substantiation for FAA acceptance.

7.2 The FAA’s acceptance of UL 94 V-0 Classification as acceptable means to show compliance to 14 CFR § 25.853(a); Most printed wiring (PWB) or circuit boards utilized in aircraft electronic components are produced from base prepreg and laminate materials manufactured to an industry standards such as IPC-4101 – “Specification for Base Materials for Rigid and Multilayer Printed Boards” (IPC-Association Connecting Electronics Industries). Prior to using IPC-4101, printed wire boards were specified through MIL-S-13949- “Sheet, Printed Wiring Board, General Specification For”, which was canceled without replacement in 1998. Conformal coatings (CC) typically applied to PWB assemblies for environmental protection were specified to requirements of MIL-I-46058- “Insulating Compound, Electrical (For Coating Printed Circuit Assemblies)”, which is currently inactive for new design and will be canceled. The industry replacement for this military specification is the IPC-CC-830- “Qualification and Performance of Electrical Insulating Compound for Printed Wiring Assemblies”. The IPC-4101and the IPC-CC-830 standards require flammability testing to be performed to industry standard UL94 “Test for Flammability of Plastic Materials for Parts in Devices and Appliance”. The industry team acknowledges that generally the UL 94 test method is not directly equivalent to the 14 CFR Part 25, Appendix F test method and is not to be used for compliance to § 25.853(a). It is important to note that there is a fundamental difference between FAA Part 25 App F Part I(a)(1)(ii) 12 second Vertical Test and the UL 94 20 mm Vertical Burning Test, where the FAA test has specific test criteria and pass/fail criteria for that test, UL uses a single test method then depending on how sample performs rates it as V-0, V-1 or V-2 with V-0 being the most stringent (reference table 2). This proposal intends to support use of industry specifications that require a specific UL 94 flammability test classification, V-0, as the method to verify self-extinguishing properties of the PWB and CC materials to support an equivalent level of safety determination for PWB and PWB/CC only. It should be noted that not every IPC-4101 Slash Number requires flammability testing, therefore this proposal addresses only those specific individual Slash Numbers that specifically require flammability testing to be conducted. The proposed standard would only be applicable to those PWB and CC materials that have UL 94 V-0 self-extinguishing flammability classifications, and any materials that do not have these classifications would require the flammability testing to 14 CFR 25.853/Appendix F Part I (a)(ii). The applicant is to document that the base material (based on an industry specification) used in the construction of the printed boards being installed in the electrical components will comply with UL94, V-0 Vertical Flammability Testing Requirements. It can be seen by the comparison table of the UL94 V-0 vs. the Appendix F Vertical Test Requirements that the UL94 V-0 is a controlled and repeatable test method that can be relied upon to determine materials flammability and self-extinguishing properties of materials.

7.3 Table 1 Comparison of Test Methods

Criteria	UL 94 50W (20 mm) Vertical Burning Test	14 CFR 25.853(a) Appendix F (a)(1)(ii) (12 sec Vertical)
Conditioning	23 ± 2 C (73.4 ± 3 F) 50 ± 5 % humidity 48 hours	75 ± 5 F 50 ± 5 % humidity Moisture equilibrium + 24 hours
# of Specimens	Min. 2 sets of 5	Min 1 set of 3
Size of specimen	Qualification: 0.032 and 0.063 inch-thick; QC conformance: > 0.020 inch-thick (Ref. IPC-4101B)	2" W (exposed area) x 12" H x minimum thickness of part to be qualified
Type of burner	Methane Gas w/.37" ID tube Per ASTM D 5025	Bunsen or Tirrill burner w/.37" ID tube
Gas Supply	37 ±1 MJ/m^3 (minimum):	
Flame requirement	50 W (20 mm), 700 C (1292 °F) per ASTM D 3801, ASTM D 5207; measured at center of flame; Gas flow rate of 105ml/min with back pressure< 10 mm of water	Min 1550 F (843 C) flame temperature; measured at center of flame.
Flame height	.78" (20 mm) blue flame	1.5"
Height of specimen above top edge of burner	.39" (10 ±1mm)	.75"
Time of flame exposure	t_1: 10 ±0.5 sec, remove, record afterflame time; t_2: 10 ±0.5 sec remove, applied immediately upon ceasing of t_1 afterflame	12 secs
Pass/Fail Criteria	See Table 2 below	Ave burn length not to exceed 8" Ave flame time not to exceed 15 sec Ave flame time of drippings not to exceed 5 sec. from falling

Table 2 UL 94 V-0, V-1 Rating Criteria

Criteria Conditions	V-0	V-1
Afterflame time for each individual specimen t_1 or t_2	≤ 10 s	≤ 30 s
Total afterflame time for any condition set (t_1 plus t_2 for the 5 specimens)	≤ 50 s	≤ 250 s
Afterflame plus afterglow time for each individual specimen after the second flame application ($t_2 + t_3$)	≤ 30 s	≤ 60 s
Afterflame or afterglow of any specimen up to the holding clamp	No	No
Cotton indicator ignited by flaming particles or drops	No	No

As the industry standards, historically, MIL-S-13949 (PWB) and MIL-I-46058 (CC) materials performance criteria were met by flammability testing to UL-94, and with the transition by industry to the IPC-4101 and IPC-CC-830, respectively, the same materials performance criteria is being met by industry. There is no enhanced level of safety that is gained by testing to § 25.853/Appendix F for these baseline materials that were designed, tested, and manufactured under the original military specifications or are now currently designed, tested, and manufactured to the IPC industry specifications. The UL94, V-0-flammability requirements demonstrate that the PWB and CC materials have self-extinguishing properties and will not propagate fire and therefore will provide a level of safety for the internals of the electronic components acceptable for electronic components installed in the passenger cabin.

As the base material is the significant flammable material internal to the electronic component, other small electronic parts (ie. resistors, diodes, etc.) will not be accounted for in the flammability requirements.

7.4 Conformal Coatings and Solder Masks

Conformal Coatings and Solder Mask compounds can be qualified for general use by testing on a worst case derived from the test data in section 8. Testing of a compound applied to the poorest performing pcb composition will qualify it for use on any pcb provided the pcb itself meets the minimum criteria established in this proposal.

8 DATA / ANALYSIS

8.1 EXISTING TEST DATA

The industry has called upon its members to submit any type of existing flammability test data to support 4.2.2 for 14 CFR 25.853(a).

8.2 PROPOSAL OF TESTS TO BE PERFORMED

8.2.1 To support the proposal defined in 4.2.2 testing shall be accomplished on PWBs manufactured to specifications that include both UL 94 V-0 and the V-1 Ratings using the FAA Part 25 App F Part I(a)(1)(ii) 12 second Vertical Test. It is expected that the PWBs with the UL 94 V-0 Classification will consistently pass the FAA Test where the PWBs with the UL 94 V-1 Classification may not to show a correlation between the UL test method and the FAA test method. Testing shall consist of 20 specimen sets selected from IPC 4101 specifications, 10 sets that require UL 94 V-0 certification and 10 sets that require UL 94 V-1 certification. All specimens shall be the thinnest available. Table 3 outlines the proposed samples but is subject to change based on availability.

Table 3 UL 94 V-0 PCB Test Specimens

IPC-4101 Slash #	PWB Material/Fire Retardant	Ratings
IPC-4101/10	Woven E-glass/Epoxy/Bromine/Antimony oxide	UL94 V-0, CEM-1
IPC-4101/12	Woven E-glass/Epoxy/Bromine	UL94 V-0, CEM-3
IPC-4101/14	Woven E-glass/Epoxy/Phosphorus	UL94 V-0, CEM-3
IPC-4101/21	Woven E-glass/Difunctional Epoxy/Bromine	UL94 V-0, FR-4
IPC-4101/24	Woven E-glass/Epoxy/Bromine	UL94 V-0, FR-4
IPC-4101/26	Woven E-glass/Epoxy/Bromine	UL94 V-0, FR-4
IPC-4101/58	Nonwoven Aramid Paper/Epoxy/Non-epoxy/Phosphorus	UL94 V-0
IPC-4101/80	Woven E-glass/Epoxy/Phenolic/Bromine/Antimony oxide	UL94 V-0, CEM-1
IPC-4101/81	Woven E-glass/ Epoxy/Bromine	UL94 V-0, CEM-3
IPC-4101/97	Woven E-glass/ Difunctional Epoxy/Bromine	UL94 V-0, FR-4
IPC-4101/98	Woven E-glass/Epoxy/Bromine	UL94 V-0, FR-4
IPC-4101/99	Woven E-glass/Epoxy/Bromine	UL94 V-0, FR-4
IPC-4101/101	Woven E-glass/ Difunctional Epoxy/Bromine	UL94 V-0, FR-4
IPC-4101/121	Woven E-glass/ Difunctional Epoxy/Bromine	UL94 V-0, FR-4
IPC-4101/124	Woven E-glass/Epoxy/Bromine	UL94 V-0, FR-4
IPC-4101/126	Woven E-glass/Epoxy/Bromine	UL94 V-0, FR-4
IPC-4101/129	Woven E-glass/Epoxy/Bromine	UL94 V-0, FR-4

Table 4 UL 94 V-1 PCB Test Specimens

IPC-4101 Slash #	PWB Material/Fire Retardant	Ratings
IPC-4101/2	Cellulose Paper/Phenolic/Bromine/Chlorine	UL 94 V-1, FR-1
IPC-4101/3	Cellulose Paper/Phenolic/Bromine/Chlorine	UL 94 V-1, FR-2
IPC-4101/4	Cellulose Paper/Epoxy/Bromine/Chlorine/Antimony oxide	UL 94 V-1, FR-3
IPC-4101/5	Cellulose Paper/Phenolic/Phosphorus	UL 94 V-1, FR-2
IPC-4101/11	Woven E-glass/Polyester/Vinyl Ester/Bromine	UL 94 V-1
IPC-4101/13	Woven E-glass/Polyester/Vinyl Ester/Bromine	UL 94 V-1
IPC-4101/23	Woven E-glass/Epoxy/Bromine	UL94 V-1, FR-5
IPC-4101/25	Woven E-glass/Epoxy/Bromine	UL94 V-1
IPC-4101/27	E-glass/Epoxy/Bromine	UL94 V-1
IPC-4101/28	Woven E-glass/Epoxy/Bromine	UL94 V-1
IPC-4101/29	Woven E-glass/Cyanate ester/Epoxy/Bromine	UL94 V-1
IPC-4101/54	Aramid Fiber/Cyanate ester/Bromine	UL94 V-1
IPC-4101/55	Aramid Fiber/Epoxy/Bromine	UL94 V-1
IPC-4101/70	S-2 glass/Cyanate ester/Bromine	UL94 V-1
IPC-4101/71	Woven E-glass /Cyanate ester/Bromine	UL94 V-1
IPC-4101/82	Woven E-glass/Epoxy/Bromine	UL94 V-1, FR-4
IPC-4101/83	Woven E-glass/Epoxy/Bromine	UL94 V-1, FR-4
IPC-4101/90	Woven E-glass/Polyhenylene ether/Bromine/Antimony oxide	UL 94 V-1
IPC-4101/91	Woven E-glass/Polyhenylene ether/Bromine	UL 94 V-1
IPC-4101/92	Woven E-glass/Epoxy/Phosphorus	UL94 V-1
IPC-4101/93	Woven E-glass/Epoxy/Aluminum hydroxide	UL94 V-1, FR-4
IPC-4101/94	Woven E-glass/Epoxy/Phosphorus	UL94 V-1, FR-4
IPC-4101/95	Woven E-glass/Epoxy/Aluminum hydroxide	UL94 V-1, FR-4
IPC-4101/96	Woven E-glass/Polyhenylene ether/Phosphorus	UL 94 V-1

8.3 Testing to validate for Conformal Coatings shall Testing to validate for Conformal Coatings shall consist of 20 specimen sets selected from IPC 4101 specifications, 10 sets that require UL 94 V-0 certification and 10 sets that require UL 94 V-1 certification. Table 4 outlines the proposed samples but is subject to change based on availability.

8.4 TEST RESULTS

Several PWB suppliers were contacted, but test samples could not be obtained.

8.5 ANALYSIS

This report gives a detailed comparative analysis showing how the UL94 (with V-0 rating) gives an equivalent level of safety as the FAA 12-second vertical Bunsen burner test. Additionally, the FAA has been supportive of discussions in ARAC to allow in future rulemaking tests like UL94 to be used for smaller components, like PWBs, as equivalent.

9 CONCLUSION

PWBs that carry a UL94 V-0 rating can be acceptable for finding compliance with the FAA 12-second vertical burn test (14CFR 25.853(a)).

9.1 REVISED PROPOSAL

PWBs that carry a UL94 V-0 rating can be acceptable for finding compliance with the FAA 12-second vertical burn test (14CFR 25.853(a)). Conformal coatings (CC) added to a UL94 V-0 PWB can be qualified by testing applied on a UL94 V-0 compliant board to the UL94 vertical test to obtain a V-0 rating or a meet a FAA 12-second vertical Bunsen burner test in combination. Then the coating would be qualified for use on any other UL94 V-0 compliant boards.

10 ABBREVIATIONS

FAA	=	Federal Aviation Administration
MOC	=	Methods of Compliance
CFR	=	Code of Federal Regulations

11 REFERENCES

[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

[2] n.n., *14 CFR Part 25, [Docket No. 24594; Amendment No. 25-66], Improved Flammability Standards for Materials Used in the Interiors of Transport Category*

Airplane Cabins, Department of Transportation, Federal Aviation Administration, August 1988.

[3] *UL 94 Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, Fifth Edition, Dated October 29, 1996 with revisions through and including June 4, 2009.*

APPENDIX W—ITEM 27: MATERIAL VERSUS INSTALLATION

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM PROPOSAL

Part 1, Reference Item #27, “Material versus Installation”

Revision – NC, dated 2010-June-18

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REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
NC	Official Release	2010-June-18	Keith Couilliard

1 INTRODUCTION

As part of the industry activities to provide validation of the Part 1 items from the referenced FAA draft policy, the industry teams are reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Item 27 has been reviewed by the industry team and is submitting the following proposals and justification.

The methodology for Bunsen burner testing per the requirements of an installation versus testing per the requirements of the individual material components of an installation (e.g. carpet is substantiated using the 12-second Bunsen burner test unless the carpet is installed on the sidewall, in which case it is then tested as part of the sidewall using the 60-second Bunsen burner test) in aircraft interiors flammability testing according to 14 CFR 25.853 (a) is currently well established industry practice.

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials” [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA’s technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Item 27 has been reviewed by the industry team and is submitting the following concurrence, justification and proposal.

2 INDUSTRY TEAM LEADER AND SUPPORT TEAM

During an industry meeting on 24 September 2009 in Huntington Beach, CA, and the FAA Materials Fire Test Working Group meeting on 21 October 2009 in Atlantic City, NJ, the following individuals have volunteered to form the industry team for this reference item:

2.1 TEAM LEADER

- Keith Couilliard (Boeing)

2.2 SUPPORT TEAM

- Weichert, Ingo (Airbus)
- Landroni, Francisco (Embraer)
- Alcorta, Hector (Bombardier)
- Slaton, Dan (Boeing)
- Lulham, Ian (Bombardier)
- Smith, Jeff (Gulfstream)
- Le Neve, Serge (CEAT)
- Scott Campbell (C&D Zodiac)

This list is by no means final, but represents a snapshot of the currently active industry participants. Additional remarks, suggestions, corrections and contributions from other individuals are very much encouraged.

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on 20 August, 2009. Attachment 2, Part 1, reference item #27 reads (see Figure 1):

- 14 CFR 25.853 (a): *"The part installation overrides the test method applicable to the material. For instance, carpet is substantiated using the 12-second Bunsen burner test unless the carpet is installed on the sidewall. Then it is tested as part of the sidewall using the 60-second Bunsen burner test."*
- 14 CFR 25.853 (d): *"Not applicable."*

Part 1, acceptable methods without additional data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
27	Material versus installation	The part installation overrides the test method applicable to the material. For instance, carpet is substantiated using the 12-second Bunsen burner test unless the carpet is installed on the sidewall. Then it is tested as part of the sidewall using the 60-second Bunsen burner test.	Not applicable.

Figure 1: Attachment 2, Part 1, Reference Item #27

No equivalent entry exists for reference item #27 in attachment 2, Part 2.

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of the terms 'material' and 'installation' should be provided so that confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo, and used consistently throughout the document.

3.2.1 MATERIAL

The industry team agrees that a definition of the term 'material' is necessary as it is used in the method of compliance discussion related to item #27.

The industry team therefore recommends that the term ‘material’ in the context of this item be defined as substances or raw matter with certain physical properties that are used as inputs to production, manufacturing or finishing processes.

3.2.2 INSTALLATION

The industry team agrees that a definition of the term ‘installation’ is necessary as it is used in the method of compliance discussion related to item #27.

The industry team therefore recommends that the term ‘installation’ in the context of this item be defined as finished materials or finished products installed in position or connected for use on parts through a process of bonding, or co-curing (not mechanically fastened or taped).

4 VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

In 14 CFR Part 25.853(a), materials such as floor coverings, textiles, decorative and non-decorative coated fabrics, leathers, thermoplastics, etc, when applied to components identified in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(i), are considered “finishes or decorative surfaces” of those components.

Therefore, materials and/or parts called out in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(ii), installed on parts called out in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(i), shall be tested to the requirements of 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(i).

For example, formed thermoplastic parts would typically be substantiated by testing per the 12-second vertical test of (a)(1)(ii). But if a sidewall panel is made from a thermoplastic material, it would have to be tested to the 60-second vertical flammability test of (a)(1)(i). Another example would be carpet, which is substantiated by testing per the 12-second vertical test of (a)(1)(ii) unless it is installed on the sidewall. Then it is tested as part of the sidewall using the 60-second vertical test of (a)(1)(i).

Materials and/or parts called out in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(ii), <u>not</u> installed on parts called out in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(i), shall be tested to the requirements of 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(ii).

For example, a relatively small cover or door consisting of materials defined in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(ii), attached mechanically to a component identified in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(i) would be substantiated by testing per the 12-second vertical test of (a)(1)(ii).

For any installed details or materials covered as separate items with their own MOCs in the FAA Policy Memo ANM-115-09-XXX, those MOCs shall take precedence over the MOC in this item.

5 DATA / ANALYSIS

N/A

6 CONCLUSION

The Part 1, Item 27 team believes that the current proposed MOC applicable to 25.853(a) is justified and acceptable but should be improved for clarity by pointing to any exceptions to the general criteria, by providing specific examples (other than for carpet) in AC 25-17A or in the applicable supplements of the Aircraft Materials Fire Test Handbook, and by referencing 25.853(d) definitions and descriptions as supporting information to clarify the terms in Appendix F Part 1 sub part (a)(1)(i).

6.1 REVISED PROPOSAL

With the clarifications listed below, the part installation overrides the test method applicable to the material.

For example, formed thermoplastic parts would typically be substantiated by testing per the 12-second vertical test of (a)(1)(ii). But if a sidewall panel is made from a thermoplastic material, it would have to be tested to the 60-second vertical flammability test of (a)(1)(i). Another example would be carpet, which is substantiated by testing per the 12-second vertical test of (a)(1)(ii) unless it is installed on the sidewall. Then it is tested as part of the sidewall using the 60-second vertical test of (a)(1)(i). Lastly, a relatively small cover or door consisting of materials defined in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(ii), attached mechanically to a component identified in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(i) would be substantiated by testing per the 12-second vertical test of (a)(1)(ii).

Materials and/or parts called out in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(ii), installed on parts called out in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(i), shall be tested to the requirements of 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(i). Materials and/or parts called out in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(ii), <u>not</u> installed on parts called out in 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(i), shall be tested to the requirements of 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(ii).

<u>Clarifications</u>

1. The general panel construction (including decorative finishes) for parts defined by CFR Part 25 Appendix F Part 1 sub part (a)(1)(i) must be constructed of materials that meet the test requirements of (a)(1)(i). See additional clarification below.[1]

2. Parts defined by 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(ii) made of materials specified in sub part (a)(1)(iv) may be tested per the requirements of (a)(1)(iv).

3. Installed panel details or materials defined as separate items per FAA Policy Memo ANM-115-09-XXX shall be substantiated per those applicable MOCs (e.g. Part 2, Item 28).

4. Carpet and Floor Coverings installed on structural flooring shall be tested per the requirements of 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(ii).

[1]*Due to different interpretations of the current terms in Appendix F Part 1 sub part (a)(1)(i), refer to 14 CFR Part 25.853(d) definitions and descriptions when additional clarification is needed:*

(1) Interior ceiling and wall panels, other than lighting lenses and windows;
(2) Partitions, other than transparent panels needed to enhance cabin safety;
(3) Galley structure, including exposed surfaces of stowed carts and standard containers and the cavity walls that are exposed when a full complement of such carts or containers is not carried; and
(4) Large cabinets and cabin stowage compartments, other than under seat stowage compartments for stowing small items such as magazines and maps.

The preceding items shall be tested to the requirements of 14 CFR Part 25 Appendix F Part 1 sub part (a)(1)(i).

A logic flow for this approach is provided in Figure 2 below:

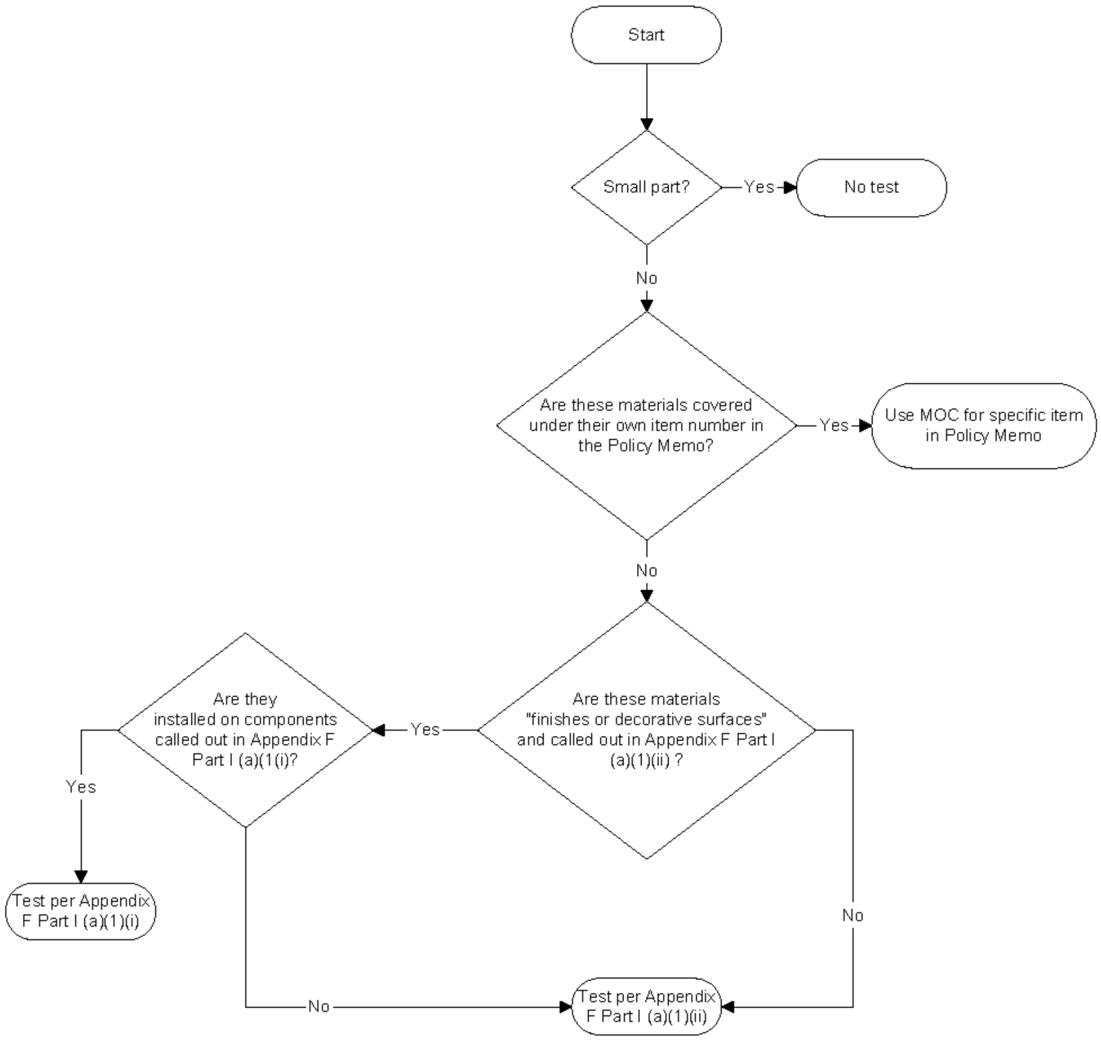

Figure 2 – Logic Flow for Item 27 – Material vs. Installation

ABBREVIATIONS

FAA	=	Federal Aviation Administration
MOC	=	Methods of Compliance
CFR	=	Code of Federal Regulations

7 REFERENCES

[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

[2] n.n., *14 CFR Part 25, [Docket No. FAA-2004-19412; Amendment No. 25-116], Miscellaneous Cabin Safety Changes,* Department of Transportation, Federal Aviation Administration, November 2004.

APPENDIX X—ITEMS 28-32, 34-37, AND 39-41: BONDED DETAILS

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM FINAL REPORT

Part 1, Reference Items #28-32, 34-37, 39-41 “Bonded Details per 14 CFR 25.853(a)”

Revision D: Final Report -

Dated: May 15, 2012

TABLE OF CONTENTS

RECORD OF REVISIONS

Revision	Date	Description	Issued by
NC	8/03/10	Original Release	Lisa Gras
NC Rev A	1/10/2011	Update from October Huntington Beach Team Meeting, and additional MoC criteria to address currently used/certified adhesives.	Dan Slaton/Scott Campbell
NC Rev B	3/30/2011	Updated from February 28th industry team meetings. Updated MoC proposals.	Dan Slaton
Rev C	10/7/2011	Final Report - Completed conclusions and modified MoC options as developed in team meetings since March 2011.	Dan Slaton
Rev D	5/15/2012	Final Report – Corrected Option 3 liner thickness reference: (is: 0.02", was: 0.20)	Dan Slaton

1. INTRODUCTION

In August 2009 an industry team formed to begin work on a policy statement to the FAA to address flammability testing of interior materials. The Bonded Details Team has been created to formulate an approach demonstrating that adhesives do not significantly change the flammability characteristics of the materials listed in Reference Items 28-32, 34-37, 39-41 of Part 2 of the FAA Memorandum ANM-115-09-xxx. In general, industry believes testing the detail not bonded to the substrate has no appreciable effect on the results of flammability testing (60 second vertical Bunsen burner, 12 second vertical Bunsen burner, 15 second horizontal Bunsen burner).

FAA Memorandum ANM-115-09-XXX, Part 2, Reference Items 28-32, 34-37, 39-41 requires additional supporting data prior to acceptance that testing the detail without adhesive to the appropriate requirement in Appendix F, Part I (a)(1)(i), (a)(1)(ii) or (a)(1)(iv) substantiates the bonded configuration.

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, "Policy Statement on Flammability Testing of Interior Materials". In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA's technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. Items 28-32, 34-37, 39-41 have been reviewed by the industry team and are submitting the following concurrence, justification and proposal.

After two years of work by the industry team and regulators, final MoC options are being provided to the FAA for final approval and inclusion into the final policy.

2. INDUSTRY TEAM

During an industry meeting on 24 September 2009 in Huntington Beach, CA, and the FAA Materials Fire Test Working Group meeting on 21 October 2009 in Atlantic City, NJ, the following individuals have volunteered to form the industry team for the Bonded Details per 14 CFR 25.853(a) reference item:

TEAM LEAD

Gras, Lisa.	(Jamco America)

SUPPORT TEAM

Imamura, Gilberto	(Jamco/JADE)
Gustafon, Kim	(3M)
Beardsley, Jim	(3M)
Jansen, Kurt	(Falcon Jet)
Leach, David	(Henkel)
Lucas, David	(Cessna)
Moylan, John	(Delsen)
Prummer, Michael	(Bostik)
Quillen, Bryan	(Sogerma/EADS)
Waldrop, Mike	(Falcon Jet)
Weber, Jennifer	(Boeing)
Zimmerman, Patrick	(3M)
Slaton, Dan	(Boeing)
Chris Christopher Kessler	(Anolis Interiors GmbH)
Eva Ronnqvist	(AIM)
Kevin Ruonavaara	(B/E Aerospace/Flight Structures)
Dinda Padmasana	(B/E Aerospace/Flight Structures)

3.0 PROJECT DEFINITION

3.1 CURRENT FAA PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on 20 August, 2009. Attachment 2, Part 1 and 2, reference item #28 reads as follows (see Figure 1):

Part 1, methods of compliance that do not require supporting data			
Reference Number	**Feature / Construction**	**25.853(a) Bunsen Burner Test Requirement/Similarity**	**25.853(d) Heat Release and Smoke Test Requirement/Similarity**
28	Bonded details	See part 2 of this attachment.	The test requirement is decided based on size criteria. ▪ Test required if greater than 2 sq ft ▪ No test if less than 1 sq ft ▪ Further consideration required between 1 and 2 sq ft

Part 2, methods of compliance that require supporting data			
Reference Number	**Feature / Construction**	**25.853(a) Bunsen Burner Test Requirement/Similarity**	**25.853(d) Heat Release and Smoke Test Requirement/Similarity**
28	Bonded details	Unless it can be concluded that the part is small and does not contribute to the propagation of a fire in accordance with Appendix F, Part I (a)(1)(v), testing of the detail, without adhesive, to the appropriate requirement in Appendix F, Part I (a)(1)(ii) or (a)(1)(iv) substantiates the bonded configuration.	See Part 1, item 28, of this attachment.
29	Rub strips/trim (chafing and decorative, includes bullnose trim)	See part 2, item 28, of this attachment.	See Part 1, item 28, of this attachment.
30	Edge trim, nonmetallic (includes bullnose edge trim)	See part 2, item 28, of this attachment.	See Part 1, item 28, of this attachment.
31	Hook and Loop	See part 2, item 28, of this attachment.	See Part 1, item 28, of this attachment.

Part 2, methods of compliance that require supporting data			
Reference Number	**Feature / Construction**	**25.853(a) Bunsen Burner Test Requirement/Similarity**	**25.853(d) Heat Release and Smoke Test Requirement/Similarity**
32	Placards	See part 2, item 28, of this attachment.	See Part 1, item 28, of this attachment.
34	Brackets and Clips, metallic or non-metallic	See part 2, item 28, of this attachment.	See Part 1, item 28, of this attachment.
35	Wire raceways (bonded to panel vs. conduit bonded within panel)	See part 2, item 28, of this attachment.	See Part 1, item 28, of this attachment.
36	Kickstrips	See part 2, item 28, of this attachment.	See Part 1, item 28, of this attachment.
37	Felt	See part 2, item 28, of this attachment.	See Part 1, item 28, of this attachment.
39	Doublers, pre-cured	See part 2, item 28, of this attachment.	See Part 1, item 28, of this attachment.
40	Doublers, metal (bonded)	See part 2, item 28, of this attachment.	See Part 1, item 28, of this attachment.
41	Mirrors, plastic	See part 2, item 28, of this attachment. **Note:** If the mirror is large enough to be considered part of the wall construction, then the mirror should be tested to appendix F, part I, (a)(1)(i).	See Part 1, item 28, of this attachment.

Figure 1

3.2 Proposed MOC - 25.853(a) Bunsen Burner Test Requirement

Based on industry practice and to provide standardization, a modified proposal has been developed. This will provide standardized means for showing compliance of bonded detail constructions.

The industry team recommends that the MoC be revised to accommodate optional methods for showing compliance of details bonded to large exposed panels. The current draft policy is unclear what test requirement to use when testing the detail by itself and clarifications are proposed. In addition, standardized adhesive and bonded configurations are defined. Clarification that testing the as installed configuration is always an acceptable means along with size criteria is proposed to enable consistent application of the requirements. Criterion is defined to allow current adhesives being used in compliant configurations to be allowed for continued use in similar bonded configurations without further compliance testing. Any one of the options is available to show compliance of the bonded constructions by the testing described in the MoC.

The four MoCs that are being proposed are identified below with a full description of the MoC defined in the Table that follows.

OPTION #1: Test the adhesive, detail, and substrate separately.
OPTION #2: Test a non-metallic bonded construction using a specific adhesive, and test detail and substrate separately.
OPTION #3: Test the bonded detail using a specific adhesive on a worst case substrate.
OPTION #4: Test the as-Installed configuration.

#	Description	Industry Team Proposal
28	Bonded Details	Unless it can be concluded that the part is small and does not contribute to the propagation of a fire in accordance with Appendix F, Part I (a)(1)(v), the following methods of compliance are available to substantiate the bonded construction. **OPTION #1: Adhesive, Detail, and Substrate tested separately:** Test the adhesive by itself to 12-sec VBB and separately test the detail and substrate, without adhesive, to the applicable requirements in Appendix F, Part I (a)(1)(i), (a)(1)(ii) or (a)(1)(iv). NOTE: This MoC is not applicable to hook/loop, placards, or other thin polymer films; use other MoCs options for compliance of these bonded features. NOTE: This MoC is also valid when adhesive is not used and the bonded construction is created from cocuring with a composite panel (e.g. no adhesive). **OPTION #2: Non-metallic Bonded Construction of specific adhesive:** Separately test the detail and substrate, without adhesive, to the applicable requirements in Appendix F, Part I (a)(1)(i), (a)(1)(ii) or (a)(1)(iv), and show compliance of the specific adhesive using data bonding two non-metallic materials together.. Note: This option is not applicable to hook and loop, placards or thin films. These bonded details will need to be substantiated using option 3 or 4.

		OPTION #3: Specific Detail Bonded to a Worst Case Substrate: Test the specific detail bonded to a thin laminate such at a thickness of 0.02" or less (considered worst case) in accordance with Appendix F, Part I (a)(1)(ii). Once qualified in this manner, the detail/adhesive combination may be bonded to other substrates without further test. Data substantiates the bonded detail/adhesive combination on any substrate. Test data on the minimum thickness on a detail substantiates any thicker detail of the same material. **OPTION #4: As Installed Configuration** Test the "as installed" configuration to the applicable requirements in Appendix F, Part I (a)(1)(i), (a)(1)(ii) or (a)(1)(iv) based on the detail being bonded. If the bonded area of the detail is greater than 2 square feet, test the bonded construction to 60sec VBB. Note: If the base panel is over 0.25 inches, the back side would be either tested to the same test requirement, or by using item # 9 (FASE) to the base panel testing.
29	Rub Strips	See Item 28 above for applicable General MoC.
30	Non-Metallic Edge Trim	See Item 28 above for applicable General MoC.
31	Hook and Loop	See Item 28 above for applicable General MoC.
32	Placards	See Item 28 above for applicable General MoC.
34	Non-Metallic Brackets/Clips	See Item 28 above for applicable general MoC.
35	Bonded Wire Raceways	See Item 28 above for applicable general MoC.
36	Kickstrips	See Item 28 above for applicable general MoC.
37	Felt	See Item 28 above for applicable general MoC.
38	Grommets	No test requirement per appendix F, part I, (a)(1)(v) (Small Part).
39	Pre-Cured Doublers	See Item 28 above for applicable general MoC.
40	Bonded Metal Doublers	See Item 28 above for applicable general MoC.
41	Plastic Mirrors	See Item 28 above for applicable general MoC.

The overall goal of the MoC options will enable the industry to address compliance in multiple valid ways. Multiple options are based on data and technical rationale that ensures confidence in the compliance approach that maintains the current level of safety. Since the cross-section configuration required for Bunsen burner testing does not always match the installed configuration, these optional MoCs provide ways to show compliance that provide acceptable validation of flammability performance. Shown below are specific details on the goals of each optional MoC.

Goal of MoC Option #1: This MoC provides a basic material test on the adhesive. The 12secVBB is a baseline adhesive test being used across the various adhesive related features. Testing the adhesive by itself is known to be a robust evaluation of the material. With the knowledge and data showing that bonded constructions are more flame resistant than the detail tested by itself, this provides support for this standardized MoC.

Goal of MoC Option #2: This MoC provides a means to show compliance using data from a non-metallic bonded construction using the same adhesive along with test results on the detail and substrate by themselves. The knowledge and data showing that bonded constructions are more flame resistant than the detail tested by itself supports the use of this MoC. This MoC allows an efficient way to show compliance for adhesives currently in use for which compliance data has already been generated.

Goal of MoC Option #3: This MoC provides a basic bonded material/adhesive configuration test on a worst case construction. This MoC allows an efficient way to test a specific detail in a worst case configuration and allow similarity of the detail and adhesive bonded to other panels. This minimizes the compliance data required to be generated for a specific detail/adhesive combination.

Goal of MoC Option #4: This MoC simply describes the acceptable practice of testing the actual installed configuration, which provides a means to confirm acceptable flammability properties. This also defines a size criterion where the 60sec VBB test would be required on the bonded construction as the bonded area becomes large. This size criterion will standardize the criteria across industry and aligns with the heat release size criteria.

4.0 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of the terms 'Bonded Detail', 'Edge Trim, non-metallic' , 'Kickstrips', 'Felt' , "Grommets", and "Wire Raceways" should be provided so confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry.

4.1 Bonded Detail

The industry team agrees that a bonded detail is a metallic or non-metallic additive element that is secured by non-mechanical means to a panel surface. The bonding materials include adhesives such as epoxy, urethane, etc. The application methods are not critical to this definition but are usually applied manually or sprayed onto one or both surfaces. In some cases bonded details may be co-cured with the composite panel during the cure cycle. Pressure sensitive adhesive (PSA), inclusive of double sided tapes, is another common type of non-mechanical means that is covered under this proposal. Bonding of the hook side or loop side individually to a panel is covered under this proposal, but the attachment of the hook to the loop is not considered as it is a mechanical attachment method. Typical Bonded Details include, but are not limited to, rub strips, edge trims, hook & loop fasteners, placards, brackets & clips, external wire raceways, kickstrips, felt, pre-cured doublers, and plastic mirrors, yet this should not be considered all inclusive. Application of this MoC is applicable to the bonded area of any bonded detail and not part of the detail surface area that is not bonded. This does not apply to thin films bonded to panels.

The industry team therefore recommends that the term 'Bonded Detail' in the context of this item be defined as inclusive of all features described in attachment 2, Part 2 items 29-32, 34-37, & 39-41. In addition, it is acknowledged that other types of Bonded Details may come up and can use the criteria of this proposal.

4.2 Edge Trim – Non-Metallic

Edge trim, non-metallic is defined as a molded, extruded, formed, or flat piece of non-metallic material that is bonded to the edge of a panel or a panel joint. The trim may wrap around the edge of the panel(s) or be applied to the cut edge of the panel. The industry team agrees that hardwood trim, commonly used as a bullnose, should be included in the definition of non-metallic materials in the context of this item. Edge trim does not exceed more than 2" from the edge of the panel.

4.3 Kickstrip

The industry team agrees that a kickstrip is a material or combination of materials applied at floor level of a vertical surface as a means of protection of the base materials from damage & wear and not as the primary decorative covering of the panel.

4.4 Felt

The industry team agrees that felt, in the context of this item, refers to a non-woven cloth that is produced by matting, condensing and pressing non-metallic fiber material used as a thermal insulation, sound dampening, or moisture barrier and not used as the primary decorative covering of the panel.

4.5 Grommet

A grommet is a rigid or flexible type of edge trim that is applied around the inside edge of a hole through a panel. Grommets may be designed for a specific size hole or they may be an flexible trim piece that is cut to length and applied to unique hole contours. Grommets are used to reinforce a hole, to shield something from the sharp edges of the hole, or both.

4.6 Wire Raceway

Wire raceways are a type of conduit to provide for placement of wires and cables. It can be installed internal to a panel or externally applied with various adhesives.

4.7 Rub Strip

A rub strip is defined as a molded, extruded, formed, or flat piece of non-metallic material that is bonded to the surface of a panel for the purpose of protecting the panel from damage.

5.0 COMMON INDUSTRY PRACTICE

Common industry practice can differ slightly depending upon company and local regulatory guidance. A common industry practice is to test the detail part without adhesive as data exists supporting this practice as "most critical." Current FAA regulations require testing the relevant cross section as installed in the aircraft which is also used within industry. There is no indication that this lack of standardization has caused significant safety issues. To provide a more standardized approach, the Bonded Details Team will work towards providing technical rationale and data sufficient to support the MoCs being proposed.

During the industry team activities, the final MoCs were modified to provide options which all assess the flammability properties of the adhesive in different ways.

6.0 DATA COLLECTION AND ANALYSIS

The Bonded Details Team determined there is currently considerable data available without having to do any further testing supporting the final proposed MoC options. Supporting industry data is summarrized representing bonded configurations with a variety of different adhesives, details and substrates. Data will include detail and substrates tested by themselves without adhesive along with data on representative bonded constructions of the same adhesives.

7.0 EXISTING TEST DATA

During early discussions, the Industry Team considered collecting and summarizing existing data. After review by several industry members, it became clear that finding a complete set of comparison data on details, substrates, adhesives and bonded constructions would be difficult. It also became clear that the cost and schedule to perform a new test program to evaluate a broad range of adhesives and details was not possible in the time allowed. After much discussion and development of the conservative MoCs defined in this final report, the industry team members also concurred that it was not required to generate additional data as the MoCs require data on the adhesives for substantiating bonded constructions.

Boeing provided a large summary of data that compares flammability performance data on details, substrates, and their bonded constructions. This data illustrates the general trend that bonded constructions are more fire resistant than the details or adhesive tested alone. A summary of the Boeing data is included in Appendix A and is available to the FAA as proprietary data. The data includes over 300 different bonded configurations and details using 16 different types of adhesives. This substantial database provides justification of the MoCs defined in this final report.

8.0 ANALYSIS OF TEST RESULTS

The collective knowledge of the Industry Team was used to review available data and evaluate materials flammability behavior. Technical discussions resulted in developing common MoCs applicable to all types of bonded details and adhesives. Certain types of bonded details were constrained to specific MoCs due to the known flammability behavior in certain constructions (e.g. placards, hook-and-loop, thin films). These technical discussions resulted in standardized MoCs that provide a positive validation of the adhesive material behavior and are supported by industry. The robust optional means of compliance are aligned with the other draft policy item MoCs involving adhesives. These MoCs are supported by data trends of existing data and technical knowledge of how adhesives are used on interior aerospace designs.

9.0 CONCLUSION

The Industry Team is recommending MoC options that positively provide validation of the adhesives used in bonded constructions while leveraging the use of existing data on adhesives where possible. In contrast to the original draft policy which proposed testing only the detail by itself, all MoC options defined in this final report rely on having data that includes the adhesive. These means of compliance have been thoroughly reviewed and validated to define robust MoCs for standardized application across industry. The Industry Team is confident that the MoCs being proposed provide the means to appropriately generate and apply compliance data for adhesive bonded constructions that maintain necessary levels of interior fire safety.

10.0 REFERENCES

1. Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.
2. n.n., *14 CFR Part 25, [Docket No. 24594; Amendment No. 25-61], Improved Flammability Standards for Materials Used in the Interiors of Transport Category Airplane Cabins,* Department of Transportation, Federal Aviation Administration, July 1986.

3. n.n., *14 CFR Part 25, [Docket No. 24594; Amendment No. 25-66], Improved Flammability Standards for Materials Used in the Interiors of Transport Category Airplane Cabins*, Department of Transportation, Federal Aviation Administration, August 1988.

11.0 ACRONYMS

ACO - AIRCRAFT CERTIFICATION OFFICE

CFR - CODE OF FEDERAL REGULATIONS

FAA - FEDERAL AVIATION ADMINISTRATION

MOC - METHOD OF COMPLIANCE

MS - MICROSOFT

OSU - OHIO STATE UNIVERSITY

PSA - PRESSURE SENSITIVE ADHESIVE

TBD - TO BE DETERMINED

APPENDIX A

Summary of Boeing data supporting Industry Standardization Team #28, Bonded Details, 14CFR25.853(a)

Overview:

Boeing has generated flammability data that support a common Method of Compliance for bonded details. This data summary is being submitted to the Industry Team #28 to support the proposal for testing the bonded detail by itself to show compliance for the bonded construction. A complete report of all the data will be provided to the FAA as Boeing proprietary data.

Test Data Summary:

Below is a summary of Bunsen burner data that is compiled for supporting the draft policy MoC. Data from over 300 bonded configurations using 16 different adhesive types were evaluated. When comparing the bonded construction test data with data on the detail and substrate by themselves, the bonded construction data is no worse than the detail by itself, and often better. Since bonded details involve a very thin bondline between the detail and the substrate, there is very little impact that the adhesive has on the results. The trend that better Bunsen burner performance is observed in bonded constructions is also due to the increased mass of the construction being tested, which provides a larger heat sink and less likely the configuration will ignite and propagate flame. Typical variation observed in Bunsen burner is seen in the data comparison (burn lengths within 2") and is not considered statistically significant.

Adhesive Type	Bonded Configurations
Acrylic, Pressure Sensitive Adhesive (PSA)	28
Synthetic Rubber Cement	8
Epoxy-polyamide, 2-part, RT Cure	13
Buna-N Rubber	10
Neoprene Rubber	15
Silicone RTV, 1-part, High Strength	26
Silicone RTV, 2-part	7
Epoxy, 2-part, RT Cure, Flexible, Flame Retardant	32
Epoxy, 2-part, RT Cure, Fast Cure	18
Polyester, 2-part	19

Silicone, 2-part, High Strength	12
Silicone, 1-part	12
Urethane, 2-part, RT Cure, Flame Retardant	35
Urethane, 2-part, RT Cure, Non-Flame Retardant	49
Urethane, 2-part, RT Cure, Sprayable, Flame Retardant	17
Epoxy, 2-part, RT Cure, Flexible, Flame Retardant, High Strength	19

Conclusions:

Data has been provided demonstrating that bonded constructions provide better flammability performance in Bunsen burner than the detail tested alone. This flammability performance is expected since the adhesive bondlines are not exposed and the bonded construction has higher mass. These test results support the proposed MoC that test data on the detail alone could be used to show compliance of the bonded configuration. Generate data on the adhesives would provide a more conservative means of compliance.

APPENDIX Y—ITEMS 28-32, 34-37, AND 39-41: BONDED DETAILS

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM PROPOSAL

Part 1, Reference Item #28, 25.853(d). “Bonded Details” Also includes #29-32, 34-41

Revision – Rev C, dated 29 August, 2011

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REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
NC	Initial Release	2010-Aug-31	Cheryl Hurst
A	Revised proposal based on FAA comments and teams recommendations	2010-Nov-18	Cheryl Hurst
B	Added cumulative detail definition and corrected minor formatting errors.	2011-Mar-01	Cheryl Hurst
C	Revised definition of Panel Surface	2011-Aug-29	Cheryl Hurst

1.0 INTRODUCTION

The use of size, quantity, & installation/proximity criteria as a basis of determining requirements of Bonded Details for aircraft interiors flammability testing according to 14 CFR 25.853 (d) is currently a well established industry practice. As defined in the regulation preamble, the requirement criteria is that when features are installed such that they do not constitute a “large visible outer surface area” during TT&L they do not contribute significantly to the flashover event nor deter from the post crash survivability.

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials” [1] (FAA draft policy memo). In this document, the FAA has summarized acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA’s technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

The industry team has reviewed Part 1 Item 28, inclusive of items 29-32, 34-41 only listed in Part 2, and is submitting the following proposal related to meeting 25.853(d) requirements.

2.0 INDUSTRY TEAM LEADER AND SUPPORT TEAM

During industry meetings held 24 September 2009 in Huntington Beach, CA, and the FAA Materials Fire Test Working Group meeting on 21 October 2009 in Atlantic City, NJ, the following individuals volunteered to form the industry team for the referenced items:

TEAM LEADERS

- Gras, Lisa (Jamco America)
- Hurst, Cheryl (American Airlines)

SUPPORT TEAM

- Imamura, Gilberto (Jamco/JADE)
- Gustafon, Kim (3M)
- Beardsley, Jim (3M)
- Jansen, Kurt (Falcon Jet)
- Leach, David (Henkel)
- Lucas, David (Cessna)
- Moylan, John (Delsen)
- Prummer, Michael (Bostik)
- Quillen, Bryan (Sogerma/EADS)
- Waldrop, Mike (Falcon Jet)
- Weber, Jennifer (Boeing)
- Zimmerman, Patrick (3M)
- Slaton, Dan (Boeing)
- Lulham, Ian (Bombardier)
- Smith, Jeff (Gulfstream)

This list is by no means final, but represents a snapshot of the currently active industry participants. Additional remarks, suggestions, corrections and contributions from other individuals are very much encouraged.

3.0 PROJECT DEFINITION

3.1. CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version was uploaded to the FAA website on 20 August, 2009. Attachment 2, Part 1, reference item #28 reads:

- 14 CFR 25.853 (d): *“The test requirement is decided based on size criteria.*
  1) Test required if greater than 2 sq ft;
  2) No test if less than 1 sq ft; and
  3) Further considerations required between 1 and 2 sq ft.”

Attachment 2 Part 2 Items #29-32, 34-41 refer back to Part 1 Item #28

Part 1, acceptable methods without additional data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
28	Bonded details	See part 2 of this attachment.	The test requirement is decided based on size criteria. 1) Test required if greater than 2 sq ft; 2) No test if less than 1 sq ft; and 3) Further considerations required between 1 and 2 sq ft.

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of the terms ‘Bonded Detail’, ‘Edge Trim, non-metallic’ , ‘Kickstrips’, ‘Felt’ , “Grommets”, “Wire Raceways”, “Panel Surface Area”, “Bonded Construction”, “Bond Area” , and “Lineally Applied” should be provided so that confusion between different parties over their meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

3.2.1 BONDED DETAIL

The industry team agrees that a bonded detail is an additive element that is secured by non-mechanical means to a panel surface. The bonding materials include adhesives such as epoxy, urethane, etc… The application methods are usually applied manually or sprayed onto one or both surfaces. In some cases, bonded details may be co-cured with the composite panel during the cure cycle. Pressure sensitive adhesive (PSA), inclusive of double sided tapes, is another common type of non-mechanical means that is covered under this proposal. Bonding of the hook side or loop side individually to a panel is covered under this proposal, but the attachment of the hook to the loop is not considered as it is a mechanical attachment method. Typical bonded details include, but are not limited to, rub strips, edge trims, hook & loop fasteners, placards, brackets & clips, external wire raceways, kick strips, felt, pre-cured doublers, and plastic mirrors.

The industry team therefore recommends that the term ‘bonded detail’ in the context of this item be defined as inclusive of all items described in attachment 2, Part 2 items 29-32 & 34-41.

3.2.2 EDGE TRIM – NON-METALLIC

Edge trim, non-metallic is defined as a molded, extruded, formed, or flat piece of non-metallic material that is bonded to the edge of a panel or a panel joint. The trim may wrap around the edge of the panel(s) or be applied to the cut edge of the panel. The industry team agrees that hardwood trim, commonly used as a bullnose, should be included in the definition of non-metallic materials in the context of this item. Edge trim does not exceed more than 2” from the edge of the panel.

3.2.3 KICKSTRIPS

The industry team agrees that a kickstrip is a material or combination of materials applied at floor level of a vertical surface as a means of protection of the base materials from damage & wear and not as the primary decorative covering of the panel.

3.2.4 FELT

The industry team agrees that felt, in the context of this item, refers to a non-woven cloth that is produced by matting, condensing and pressing non-metallic fiber material used as a thermal insulation, sound dampening, or moisture barrier and not used as the primary decorative covering of the panel.

3.2.5 GROMMET

A grommet is a rigid or flexible type of edge trim that is applied around the inside edge of a hole through a panel. Grommets may be designed for a specific size hole or they may be an flexible trim piece that is cut to length and applied to unique hole contours. Grommets are used to reinforce a hole, to shield something from the sharp edges of the hole, or both.

3.2.6 WIRE RACEWAYS

Wire raceways are a type of conduit to provide for placement of wires and cables. It can be installed internal to a panel or externally applied with various adhesives.

3.2. 7 RUB STRIP

A rub strip is defined as a molded, extruded, formed, or flat piece of non-metallic material that is bonded to the surface of a panel for the purpose of protecting the panel from damage.

3.2.8 PANEL SURFACE AREA

A surface is a single panel or multiple individual panels that butt together with minimal or no gap to provide a continuous surface. Panels in different planes that join together and are not contiguous are considered to be separate surfaces. Examples: 2 panels meeting at a 90 degree joint are not considered to be contiguous so are separate surfaces. A curved bag bin door is a contiguous pael surface. The work face of a galley with multiple individual panels/doors all in the same plane is considered to be a contiguous surface.

3.2.9 BONDED CONSTRUCTION
A bonded construction is the build-up of a panel inclusive of all materials and details at a specific cross section that are attached by means of adhesive bond.

3.2.10 BOND AREA
The bond area is the effective surface area where adhesive is applied between the panel surface area and the attached adherent.

3.2.11 LINEALLY APPLIED
A bonded detail is considered to be lineally applied when it is a long thin part typically with a width of 2.0” or less and the surface area is spread out in a long, narrow band. Examples of Bonded Details that commonly meet this definition include, but are not limited to, Rub Strips/Trims (#29), Edge Trim/non-metallic (#30), Exterior Wire Raceways (#35), Felt (#37), Kickstrips (#36), Metal & Plastic Bracket (#34), Hook & Loop Fastener (#31), and Grommets (#38).

3.2.12 CUMMULATIVE DETAIL
Groupings of small items of same construction, each of which individually falls below the 1 to 2 sq ft rule but as a collective group on a single **Panel Surface Area** may exceed that criteria. Examples of Bonded Details that commonly meet this definition include, but are not limited to, Placards (#32), Metal & Plastic Bracket (#34), Hook & Loop Fastener (#31), Felt (#37), and Grommets (#38).

4.0 VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

While the proposed size criteria is generally accepted & used by the industry for determination of when a panel surface area reaches a size where it can be considered a “large panel surface area”, use of these generic panel criteria require further clarifications to define instances where Bonded Details do not need to be considered as part of the bonded construction for compliance to 25.853(d). Ref. Figure 1 for example of each of the following scenarios.

a. Bonded Details with bond lines less than 1” wide should be excluded from consideration due to their lineally applied nature and small area contribution.

b. Bonded Details located fully within 2” of panel edge should be excluded from consideration due to their lineally applied nature and will not constitute a large surface area.

c. Bonded Details located fully within 4” of floor should be excluded from consideration given their close proximity to the cabin floor which was found during full scale testing to have very little involvement until after flashover had occurred.

d. Rubstrips, raceways, and other bonded details that are lineally applied and less than 2sq ft on a single panel surface should be excluded from consideration. These types of

Bonded Details are applied on discrete monuments and by their nature will not constitute a large surface in a concentrated area.

In all of the above mentioned considerations, the requirements of 14 CFR 25.853(d) must still be met for the panel surface onto which the Bonded Detail is adhered as well as the detail itself meeting the applicable requirements of 25.853(a). In addition, for bonded details of the same material construction on the same panel surface area, the determination of size is based on the cumulative total of those details.

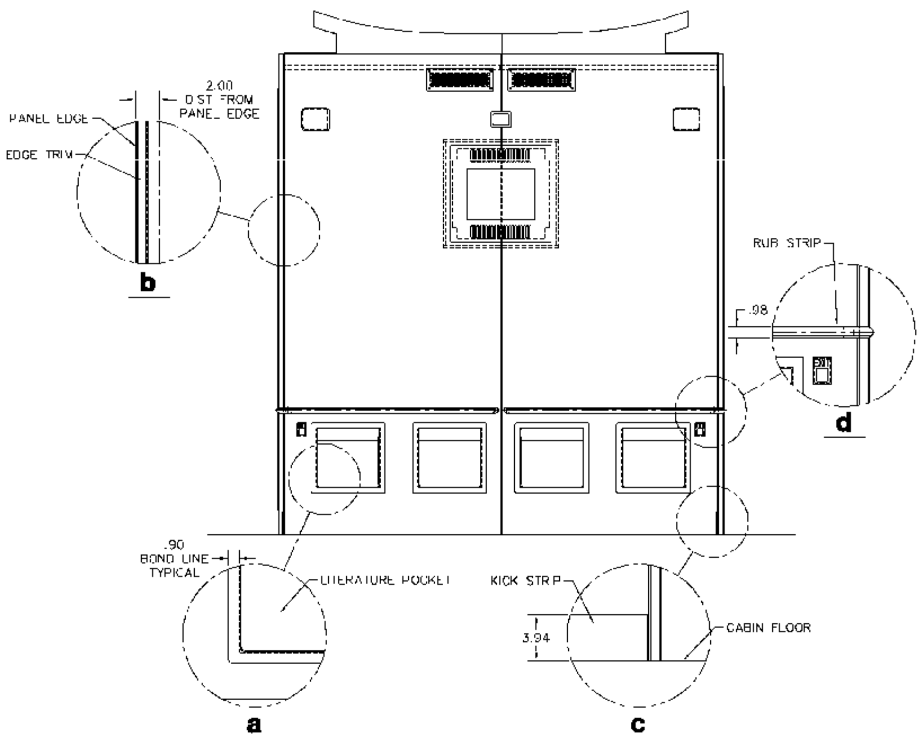

FIGURE 1

4.2 PROPOSED STANDARD TO MEET

The Industry Team proposes the following clarifications and criteria be made to Part 1 Item #28 to better define how the size criteria is applied in determination of testing requirements.

Revise Item #28

- 14 CFR 25.853 (d): *"The test requirement for bonded details is decided based on size and installation/proximity criteria defined below.*

  1) Test required if cumulative total greater than 2 sq ft;
  2)No test if cumulative total less than 1 sq ft; and
  3)Further considerations required between 1 and 2 sq ft
  4)A Bonded Detail can be excluded from testing if
    a) It is a bond line less than 1.0" wide on an individual item
    b) It is located fully within 2.0" of panel edge
    c) It is located fully within 4.0" of cabin floor
    d) Lineally applied and less than 2 sq ft in total surface area on a panel surface

5.0 DATA / ANALYSIS

5.1 EXISTING TEST DATA

The industry has called upon its members to submit any type of existing flammability test data to support size & installation/proximity criteria as a basis of determining requirements of Bonded Details to 14 CFR 25.853 (d) requirements. However, since it has been common practice not to test such installations, no existing test data was available. It is also considered to be impractical to attempt HR/SD sample testing of representative materials of these specific details as most would not fit the test fixtures in their as built condition and raw material samples requested specifically to fit this purpose would be cost prohibitive. The industry team therefore proposes to substantiate its technical position through the review and analysis of existing MOC justifications and the historical FAA testing supporting original development of the heat release regulation. This review will compare the contribution of the Bonded Details applied per their respective proposed exemption criteria relative to the overall cabin environment.

5.2 MOC JUSTIFICATIONS & HISTORICAL TESTING ANALYSIS

The current industry practices outlined in section 4.0 have been authorized by the FAA on numerous MOC's, the justification for which was based on comments and guidance found in the preambles to Amendments 25-61, 25-66, & 25-83. The initial rule stated "The primary purpose of the new flammability standard is to ensure that interior materials with larger outer surface areas will not become involved rapidly and contribute to a fire when exposed to flames". Further clarifications allowed exemptions for smaller items citing "Because of their relatively small volume and surface area, small parts (door & window moldings, seat trays, arm rest, etc…) need not meet the new standard". This same reasoning has been applied in the creation of the proposed exemptions discussed in Section 4.1 in determining when an additional item falls into the "etc…" category of the "small volume and surface area" criteria.

The industry team has developed the criteria, presented in Sections 4.1 and 4.2 of this report, which will help standardize evaluation of the specifically listed bonded details while maintaining appropriate size criteria in the determination of whether heat release testing is required per 25.853(d) as intended by the initial rule making.

6.0 CONCLUSION

The recommended exemptions from the FAA’s proposed size criteria will not reduce the flammability safety standards of 25.853(d) for materials used in the interior of transport category airplane cabins intended to improve the aircraft cabin occupant survivability of a post crash fire.

For all other installations categorized as Bonded Details, the Industry concurs with the use of the FAA’s proposed size criteria as the basis for determining compliance requirements to 25.853(d).

The final policy is recommended to read as follows:

Item #	Feature/Construction	25.853(d) Heat Release & Smoke Test Requirement/Similarity
28	Bonded Details	• *“The test requirement for a bonded detail is decided based on size and installation/proximity criteria defined below.* *1) Test required if cumulative total greater than 2 sq ft;* *2)No test if cumulative total less than 1 sq ft; and* *3)Further considerations required between 1 and 2 sq ft* *4)A Bonded Detail can be excluded from testing if* *a) It is a bond line less than 1.0” wide on an individual item* *b) It is located fully within 2.0” of panel edge* *c) It is located fully within 4.0” of cabin floor* *d) It is lineally applied and less than 2 sq ft in total surface area on a panel surface*

It is also recommended that the exclusions for Bonded Details identified in 4) above be extended to the evaluation criteria for these same type details when mechanically fastened to a panel and are considered individually.

7.0 ABBREVIATIONS

FAA	=	Federal Aviation Administration
MOC	=	Methods of Compliance
CFR	=	Code of Federal Regulations
HRR/SD	=	Heat Release & Smoke Density

8.0 REFERENCES

[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

[2] n.n., *14 CFR Part 25, [Docket No. 24594; Amendment No. 25-61], Improved Flammability Standards for Materials Used in the Interiors of Transport Category Airplane Cabins,* Department of Transportation, Federal Aviation Administration, July 1986.

[3] n.n., *14 CFR Part 25, [Docket No. 24594; Amendment No. 25-66], Improved Flammability Standards for Materials Used in the Interiors of Transport Category Airplane Cabins*, Department of Transportation, Federal Aviation Administration, August 1988.

[4] n.n., *14 CFR Part 25, [Docket No. 26192; Amendment No. 25-83], Improved Flammability Standards for Materials Used in the Interiors of Transport Category Airplane Cabins*, Department of Transportation, Federal Aviation Administration, February 1995.

APPENDIX Z—ITEM 33: EDGE POTTING AND/OR EDGE FOAM

Industrial Flammability Standardization Task Group

ANM-115-09-XXX "Policy Statement on Flammability Testing of Interior Materials"

Industry Team Proposal

Parts 1 and 2, Reference Item No. 33, "Edge Fill Materials"

Revision D

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REVISION HISTORY

Rev	Description	Date	Issued By
NC	Initial release	12-14-2010	PGZ
Rev A	Initial Release with FAA feedback addressed	1-22-2011	PGZ
Rev B	Incorporation of Test Plan in Appendix A	4-12-2011	DB, PGZ
Rev C	Remove Test plan from Appendix A, submit relating test report to the share point; Incorporated minor changes	7-19-2011	DB
Rev D	Final Report with Test Data	8-18-11	DB, PGZ

1 INTRODUCTION

Edge Fill materials are applied to reinforce the edges of honeycomb panels which are used in production of aircraft floor panels and interior monuments like wall, ceiling, bulkheads, galley and lavatories The quantities of materials used relative to the size of panel are dependent on the size of the panel, but generally small. (Less than 10%)

Due to a lack of standardization across the industry flammability practices, the FAA has decided to publish a draft version of the FAA Memorandum ANM-115-09-XXX, "Policy Statement on Flammability Testing of Interior Materials" [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials used therein, based on the FAA's technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in order:

1. Acceptable methods without additional data (Attachment 2, Part 1)
2. Methods of compliance that require supporting data (Attachment 2, Part 2)

As part of the industry activates to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry team is also reviewing the Part 1 items to provide definitions, descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. The industry team has reviewed Item 33 and is submitting the following concurrence, justification and proposal.

2 INDUSTRY TEAM LEADERS & SUPPORT TEAM

2.1 TEAM LEADERS

Klaus Boesser (SELL-Zodiac)
Dr. Patrick G. Zimmerman (3M)

2.2 SUPPORT TEAM

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- Bill Marter (Magnolia)

3 PROJECT DEFINITION

3.1 Current Proposal

Currently, ANM-115-09-XXX is available as an undated draft. The current version is available from the FAA website as of 20 August 2009. Part 1, reference item #33 reads as shown below in Figure 1:

Figure 1
Part 1, Acceptable Method without Additional Data

Reference Number	Feature/Construction	25.853(a) Bunsen Burner Test Requirements/Similarity	25.853(d) Heat Release Requirements/Similarity
33	Edge potting and/or edge foam	Test a fabricated section of the panel containing the edge potting compound or foam to 60-second vertical burn.	Test Criteria is decided based on the size criteria 1. Test required if greater than 2 sq ft. 2. No test if less than 1 sq ft and 3. Further considerations required between 1 &2 sq ft. (per item 28)

Figure 2
Part 2, Methods of Compliance that Require Supporting Data

Reference Number	Feature/Construction	25.853(a) Bunsen Burner Test Requirements/Similarity	25.853(d) Heat Release Requirements/Similarity
33	Edge potting and/or edge foam	Test a block of foam or potting compound by itself per appendix F - part I, (a)(1)(ii).(12 sec)	See Part 1 of this attachment.

3.2 Definition of Terms

In the Interest of the overall stated goal of standardization of industry flammability practices, clear definitions of terms are stated here;

A. Sandwich Panel

A rigid panel fabricated using face sheets (either fiber reinforced resins or metal) on either side of a core material (a rigid foam or a honeycomb structure made of aluminum or phenolic resin and aramid paper or fiberglass).

B. Standard Panel:

A panel with one or two ply non-metallic skins, nominally 6.35 to 13 mm (0..25" - .51") thick non-metallic honeycomb core, which meets 14 CRF 25.853(a), Appendix F, Part 1(a)(1)(i)

C. Core Back:

The process of removing the core (e.g. honeycomb), from the edge of a panel back a determined dimension, while maintaining the upper and lower skins.

D. Edge Fill Material:
The material used to fill the edge of a panel. Usually to improve the compression strength (in the z direction) of the panel edge, provide moisture resistance to avoid ingress of water or other fluids, and to provide a flat and/or smooth surface for the attachment of other materials, e.g. paints, trim, decorative laminates. Compositions vary by manufacturer but are usually made of either resin/fillers, resin/fillers/blowing agents, or foams which are incorporated into the panel manufacturing process.

E. Monuments
A monument is a functional interiors component within the passenger cabin of the airplane. Examples are, but not limited to, Lavatories, Galleys, Class dividers and Closets.

F. Plaques or Bricks:
A solid construct made up of exclusively Edge Fill Material which is ¼” x 3” x 12” nominal size.

3.3 Test Specimen Orientation

Test Specimen would be these two configurations

a. Brick samples of resin would be tested per the Fire Test Handbook [B] Chapter 1. See Figure III below.
b. Standard samples are to be tested according to Figure IV below, not as prescribed in the Fire Test Handbook [B] Chapter 1.

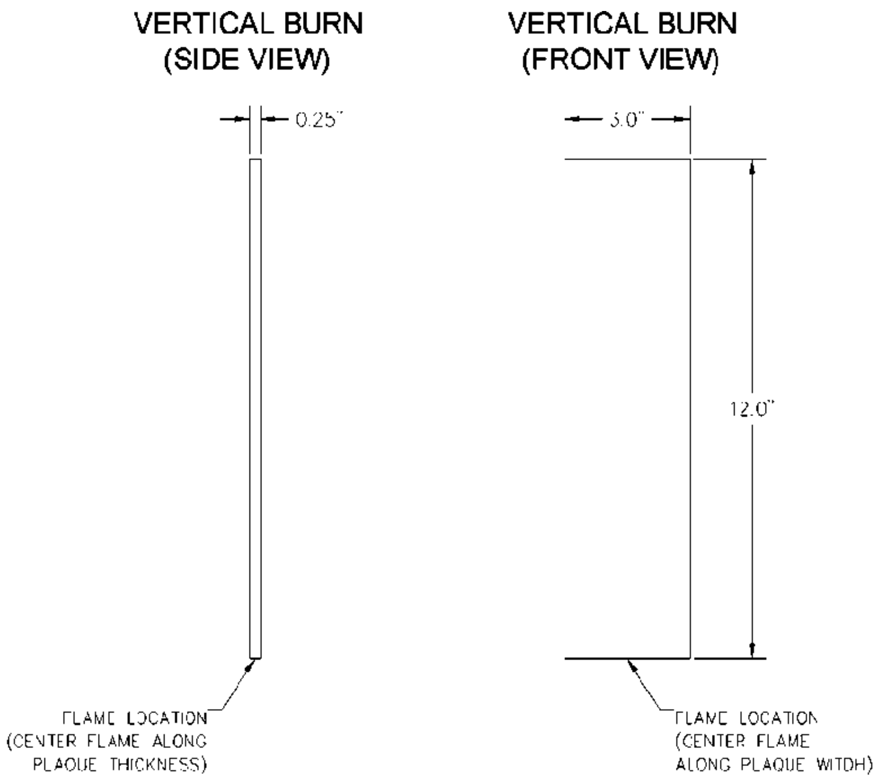
4 VALIDATION PROCESS OF MOCs IDENTIFIED IN POLICY MEMO

4.1 INDUSTRY PROPOSAL

4.1.1 Vertical Bunsen burner (VBB) [14 CFR25.853(a)]

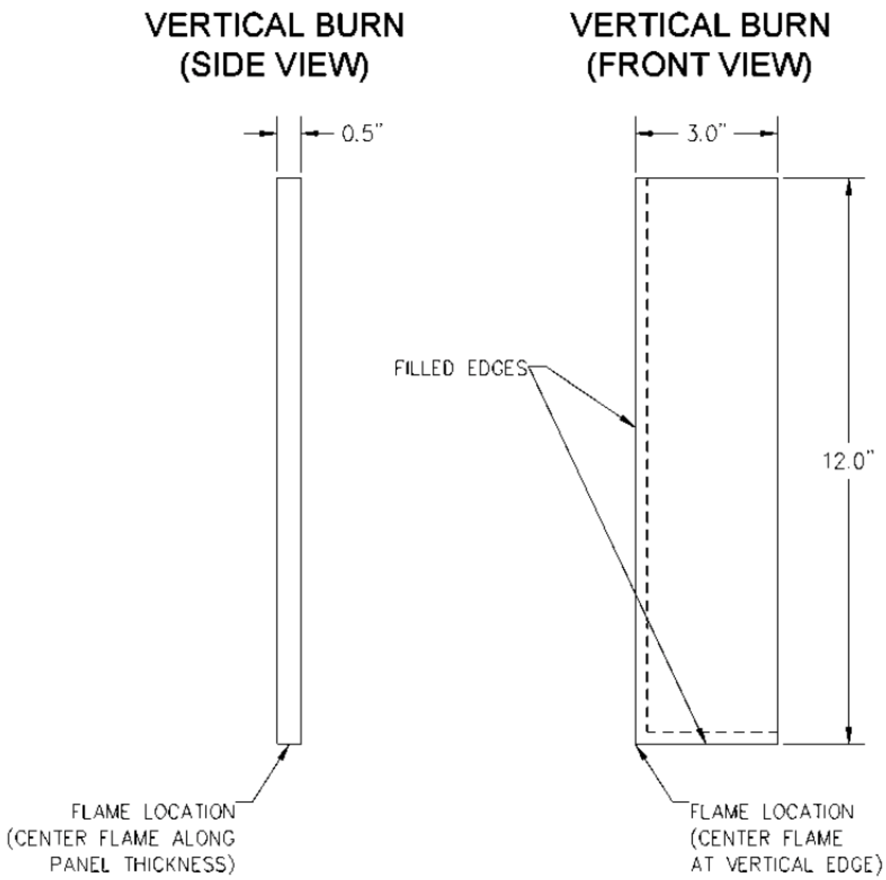
For VBB testing in Part 1 and Part 2, the industry team would like to propose the following as a means of validating the MOCs identified.
Bunsen burner data will be generated by two configurations: a) on plaques made entirely of the edge filler material, and b) a standardized honeycomb panel with the edge filler installed. 12-second and 60-second tests will be conducted.
The initial evaluation would be to test 3 specimen in a "brick' form, nominal ¼" x 3" x 12", per 14 CFR 25.853(a)(1)(ii) (12 sec VBB) as this is the MoC defined in the draft policy. The flame would be placed in the center of the horizontal (3") edge. The flame would be placed per Figure III.

Figure III. Edge Fill Brick (Plaque) Test Configuration



Industry will conduct both 14 CFR 25.853(a)(1)(i) and (ii) (60 sec VBB and 12 sec VBB) test on a 3 specimen set of standard base panel (60 sec VBB Compliant panel) edge filled with a material.. The flame would be placed as per Figure IV.

Figure IV - Edge Fill Standard Panel Test Configuration



The panels would be either cored back 1/8" to 1" nominally and fill with the edge fill material in accordance with the applicable process specification requirements or the foam or edge fill material would be co-cured in the panels during forming. These edges would then be trimmed after panel cure to the specified dimension. Cored back coupon sets would be done in accordance with standard process used by the manufacturer.
The flame would be placed on the exposed edge in the corner of the test panel not the center of the 3" horizontal edge.

Based on the above results, materials that exhibit the worst and best flammability properties will be used in a larger panel to conduct a foam block test, to represent a more realistic in-flight fire scenario to demonstrate the fire worthiness of the edge fill on the part. Successful foam block test results will provide the supporting justification for accepting the proposed MoC.

For information and comparative purposes, the working group is performing MCC testing of edge fill materials and compare the results to VBB test results obtained from ¼" x 3" x 12" bricks. MCC would provide fundamental material properties of the edge fill materials that could be used as a means of comparing different edge fill materials to one another. MCC results would also be used to try and establish a correlation with VBB such that edge fill materials could be certified by MCC testing alone and used in any basic panel already certified using 60-sec VBB with no further testing required.

4.1.2 Heat Release (HR) & Smoke Density (SD) Testing [14 CFR25.853(d)]

For Heat Release and Smoke Density per 14 CFR 25.853(d) in Attachment 2 Part 1 and Part 2 by reference to Part 1 defines the need for test based on the standard heat release/smoke density size criteria. The industry team recommends that no test is required with a size limit of no more than 1.0" deep of the edge fill. There is a historic precedent that only large area panels are tested in 14 CFR 25.853(d) and that edge fill is not part of the exposed panel surface area. The area of Edge fill is small relative to the panel size.Quantities are small relative to the panel size, panels are cored back typically 1/8"- 1" in depth and then often covered with a decorative edge cover material. Therefore, it is the industry team's perspective that the contribution is negligible.

To further demonstrate that the localized edge fill has minimal impact on the heat release of the panel a test configuration was defined as shown in figure V. This test panel with a ½ " channel cut down the standard panel. This channel will be filled with the edge fill material from the top edge to the other leaving the face sheet intact on one size and tested as a heat release specimen. This method was chosen to mimic edge fill material that would be found in a panel and giving the maximum exposure. These test results are provided as reference supporting the localized edge fill has minimal impact on a larger panel.

Figure V.

Design Attributes of Edge Fill Materials:

Edge Fill bonded into a Sandwich Panel has the attributes described below. These design attributes establish that edge fill material is rather localized feature in the cabin. While they are typically contiguous which might contribute to fire propagation and therefore testing in VBB is prudent, the quantity is small and therefore has a low probability of contributing to the HRR/OSU aspect of cabin fire safety.

A. Edge Fill is not a significant part of the sandwich panel. Typically 1/8”- 1”inch of the edge of the panel contains edge fill. This constitutes a small amount of the total volume.
B. Edge Fill is typically contiguous on a particular edge, but not necessarily found on all edges.
C. When found in the aircraft cabin, the edge fill material is often covered with a decorative laminate or edge trim material, which these coverings themselves already meets 14 CFR 25.853(a) and/or (d)
D. Edge Fill is used to prevent moisture ingress into the edge of the panel to prevent delamination.
E. Adding edge fill adds weight and manufacturing cost. Designers will minimize its use to those areas where either moisture ingress prevention (as per “D” above) is required and/or a smooth surface for application of decorative (as per “C” above) is required.

4.2 PROPOSED STANDARD TO MEET

Industry proposes the following Method of Compliance which is modified from the FAA draft Policy Memo.

Figure VI

Proposed Method of Compliance

Reference Number	Feature/ Construction	25.853(a) Bunsen Burner Test Requirements/Similarity	25.853(d) Heat Release Requirements/Similarity
33	Edge potting and/or edge foam	The edge fill in a panel may be shown compliant using one of the following options: Option 1: Test a plaque of edge fill material by itself per Appendix F - Part I, (a)(1)(ii).(12 sec) (Plaque of nominal size: 0.25" x 3" x 12") configured per Figure III in 4.1 above. Option 2: Test a standard panel (see para. 3.2.B) containing the edge fill material per Appendix F - Part I, (a)(1)(i). (60second vertical burn). (Standard Panel 3" x 12" with 0.125" to 1" of the edge fill material), configured per Figure IV in Part 4.1 above.	No Test Required when less than 1" of edge fill material is used. If greater than 1" based on the size criteria 1. Test required if greater than 2 sq ft. 2. No test if less than 1 sq ft and 3. Further considerations required between 1 & 2 sq ft.

Testing per the hierarchy of Figure VI, Option 1 allows a plaque of edge fill material per Figure III be exposed to a 12 second VBB and if the average of the 3 specimens pass, then the results can be used to show compliance for all panels where the edge fill material is used. Option 2 allows a fabricated section of a 60 second compliant standard panel with the edge fill material per Figure IV to be tested to a 60 second VBB. If the average of 3 specimens pass, then the results can be used to show compliance for all panels where the edge fill material is used. Decoratives and other edge treatments are not part of the testing.

> **Note**: The team agreed that material properties developed from the various methods should not be compared to current regulatory requirements. As an example, the OSU requirements of 65/65 is not an absolute requirement as this requirement was developed for large sandwich panels correlated from full scale tests. MCC data is another example of data that should be used to characterize the material properties and not directly compared to polymer family rankings in the literature (e.g. good flammability resistance vs. poor flammability resistance). This type of data (OSU &MCC) will simply be used to characterize material/configuration for further correlation to larger scale configuration tests.

5. DATA/ANALYSIS

5.1 EXISTING TEST DATA

The industry has very little compliance data on edge fill due to the industry practice that only sandwich panels are to be tested. The industry team has called upon its' members to submit any existing flammability data per 25.853(a) to support the MOC.
A test report of the supporting test data is posted to the SharePoint.

5.2 PROPOSAL OF TESTS TO BE PERFORMED

Using multiple common edge fill materials (6-12), material properties will be generated using MCC, VBB and OSU. Specimen samples with 1/8" core back edges will be tested using the foam block test to determine ignition and flame propagation behavior and correlate back to material test results.

5.2.1 VBB [14 CFR25.853(a)]:

Bunsen Burner and Foam Block:
a. Brick samples will be tested in VBB test per 14 CFR 25.853App F, Part I, (a)(1)(i), (a)(1)(ii),. per Figure III and comparative data in Panel constructions will be made per the proposed MOC in 4.1 per Figure IV above.
b. Material samples will be provided for MCC evaluation.
c. Foam block testing of select materials that provide good and poor Bunsen burner performance will be conducted.

5.2.2 HRR [14CFR25.853(d)]:

HRR:
No testing was required because the MOC is limiting the size criteria of edge fill to a small size. Although some reference data is required for comparison purposes. The working group has devised a method of testing materials for OSU, as per Figure V.

5.2.3. Micro Combustion Calorimetry

MCC:
The working group also will perform MCC testing of edge fill materials. MCC would provide fundamental material properties of the edge fill materials that could be used as a means of comparing different edge fill materials to one another. MCC results would also be used to try and establish a correlation with HRR of a standard configuration such that edge fill materials could be certified by MCC testing alone and used in any basic panel already HRR/SD-certified with no further testing required. This approach requires a formal FAA defined approach.

5.2.4. Foam Block Test

Foam Block tests have been performed on a potting compound applied into a panel edge .

Each sample has been tested from a horizontal orientation, and in a near vertical position at 65 ± 5 degrees. This slight incline ensures direct flame impingement onto the potting compound.

The foam block fire source is a 4" X 4" X 9" (± 0.5") piece of polyurethane foam. During testing it has been positioned on a steel tray with a ¼" pointed steel rod welded to it in the vertical position such that the foam block is slid over the rod to hold it in place. A picture of a foam block is found in Figure 5.3.3.8-6. A picture of the steel holding tray with the steel rod is found in Figure 5.3.3.8-7. Prior to testing the bottom of the foam block has been coated with 10 ml of heptane. This has been done by measuring the heptane using a graduated cylinder (or equivalent) and pouring it in the steel tray. The bottom of foam block is used to soak up the 10 ml heptane. A picture of the steel tray used for the heptane is found in Figure 5.3.3.8-8. Prior to soaking up the heptane, the foam block is placed over the steel rod to bore a hole down the center. This allows for easier mounting of the block over the rod once the heptane has been soaked up by the block. The function of the heptane is to aid in ignition of the foam block.

Figure 5.3.3.8-1 - Foam Block Fire Source

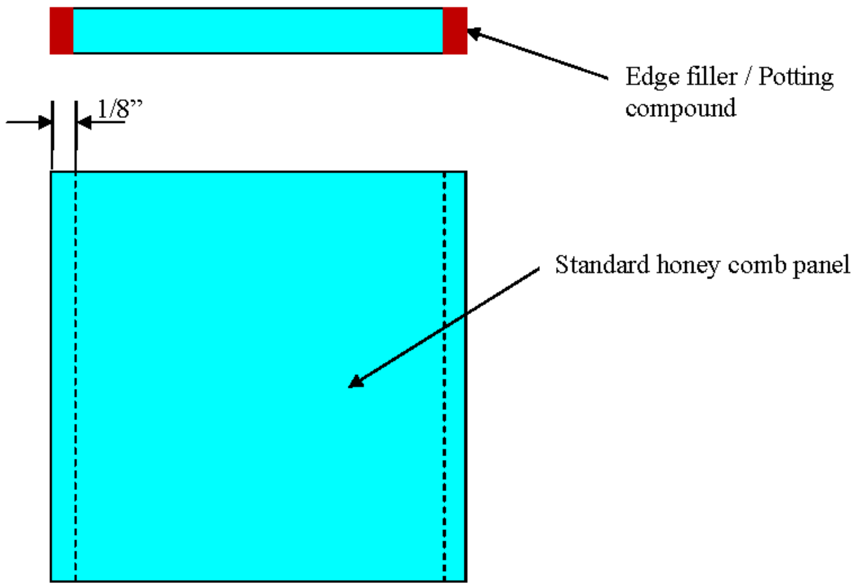
Figure 5.3.3.8-2 - Steel Tray with Pointed Steel Rod

Figure 5.3.3.8-3 - Steel Tray Used for Soaking Bottom of Foam Block with Heptane

The following procedure has been used for the foam block fire test method:

1. Position test article as defined in the individual test setup sections (See Section 5.4.2)
2. Create a hole down the center of the foam block to be used during testing by sliding it down the length of the rod on the steel tray (See Figure 5.3.3.8-7) and removing it.
3. Measure 10 ml of heptane and pour it into steel soaking tray (See Figure 5.3.3.8-8).
4. Soak up heptane with bottom of the polyurethane foam block.
5. Mount foam block on the steel tray, sliding the block over the pointed steel rod so that the bottom of the block is in contact with the tray (See Figure 5.3.3.8-6).
6. Place the steel tray in test position next to the test article in accordance with the individual test setup sections (See Section 5.4.2). Foam block centerline shall be lined up with the slot potted with potting compound. Spacer material may be used as a shop option to meet this dimension.
7. Within 15 minutes of soaking up the heptane with the block, ignite the bottom of the foam block to begin the test.

5.3.3.2 Testsample preparation



5.3.3.3 Foam Block Test Setup Configurations

- **Horizontal Orientation**

In the case of the horizontal orientation, the foam block has been placed within the distance shown.

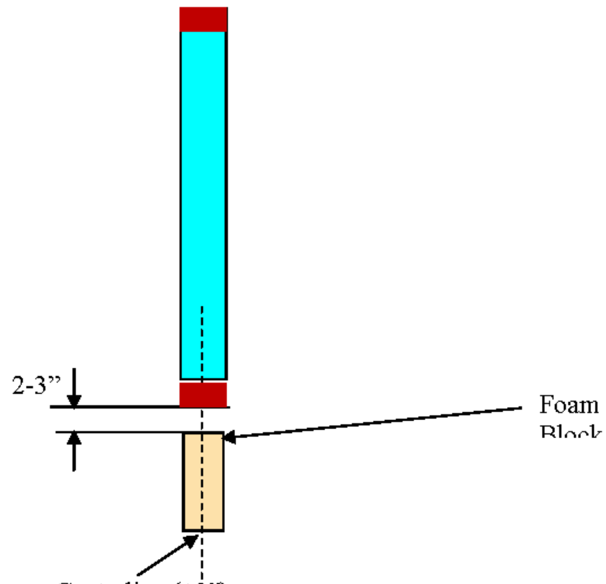


Figure: Horizontal Foam Block Test Configuration – End View

- **65 ± 5 degree Orientation**

In the case of 65 degree Orientation the foam block will be placed as close as possible within the distance shown.

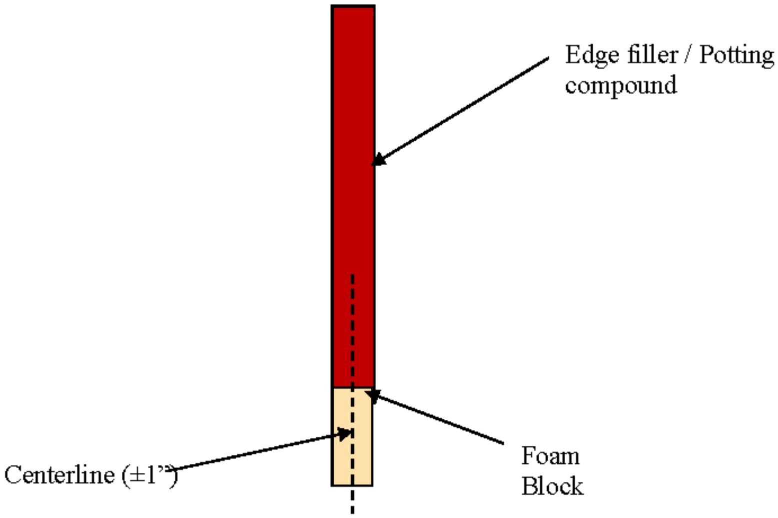


Figure 5.3.3.8-4 - 65 ± 5 degree Test Configuration - Front View

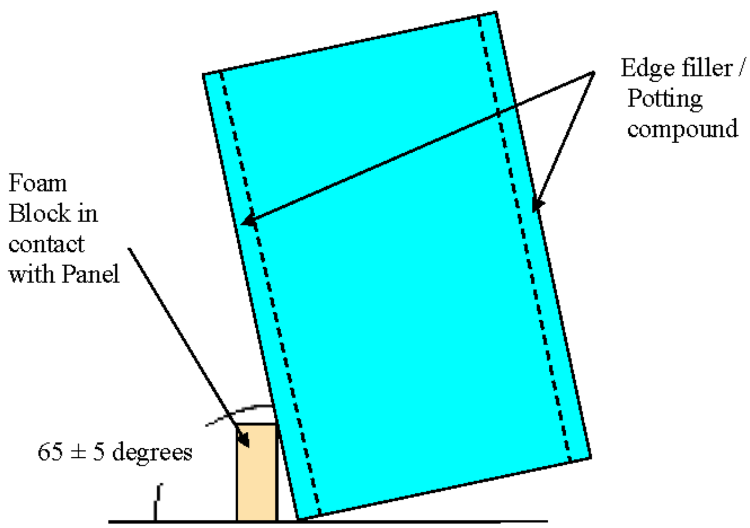


Figure 5.3.3.8-5: 65 ± 5 degree Test Configuration - Side View

5.3.3.4 Foam Block acceptance criteria

The foam block test acceptance criteria as defined in the Issue Paper CS-1 are as follows:

1. There must be no flame propagation beyond 2-inches from the area of direct flame impingement from the fire source.
2. The flame time may not exceed 30 seconds.

5.3 TEST RESULTS

5.3.1 VBB

Results were provided by several suppliers and tested at 3 different locations. Both Edge Filled panels and “bricks” of materials were tested per Section 4.1.1 above.

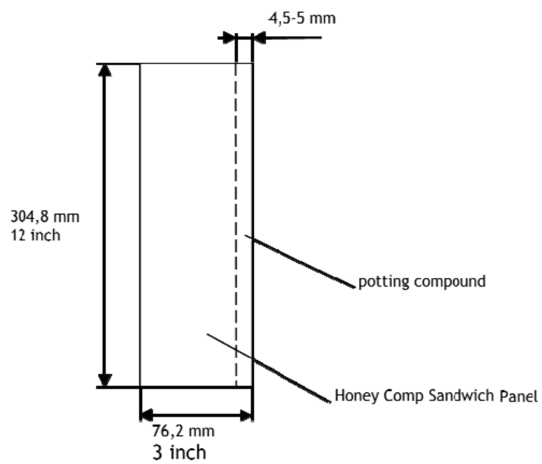


Table A. Test Results C&D Zodiac

F1 Requirement: Flame extinguishing time = 15 [s] / Burn Legth [inch] = 6 — (green) = pass
F2 Requirement: Flame extinguishing time = 15 [s] / Burn Legth [inch] = 8 — (yellow) = stand alone (brick test)

TEST PLAN	ITEM	SIDE	TEST TYPE	FLAME EX	BURN LENGTH	DRIP TIME	EDGE FILL MATERIAL	PANEL TYPE	PANEL THK	DESCRIPTION
CDRD33-2	A75	1	F1	1,6	3,5	NO DRIP	CDM212-00 TYPE 1	CDM058-60	.750"	PANEL WITH DÉCOR ON 1 SIDE
CDRD33-2	A75	2	F1	1,7	3,6	NO DRIP	CDM212-00 TYPE 1	CDM058-60	.750"	PANEL WITH DÉCOR ON 1 SIDE
CDRD33-2	A76	1	F1	6,8	3,4	NO DRIP	CDM212-00 TYPE 1	CDM099-30	.500"	PANEL (BARE)
CDRD33-2	A77	1	F1	1,3	3,0	NO DRIP	CDM212-00 TYPE 1	CDM065-60	1.000"	PANEL (BARE)
CDRD33-2	A78	1	F1	2,7	3,3	NO DRIP	CDM212-00 TYPE 1	CDM099-30	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRD33-2	A78	2	F1	4,7	3,8	NO DRIP	CDM212-00 TYPE 1	CDM099-30	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRD33-2	A79	1	F1	5,3	2,9	NO DRIP	CDM212-00 TYPE 1	CDM099-30	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRD33-2	A79	2	F1	5,8	3,6	NO DRIP	CDM212-00 TYPE 1	CDM099-30	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRD33-2	E47	1	F1	6,0	2,6	NO DRIP	CDM212-00 TYPE 1	CDM081-20	.250"	PANEL (BARE)
CDRD33-2	E47	2	F1	4,0	3,2	NO DRIP	CDM212-00 TYPE 1	CDM081-20	.250"	PANEL (BARE)

CDRA25.1-2	C1	1	F1	1,9	3,4	NO DRIP	CDM212-00 TYPE 18	CDM050-60	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRA25.1-2	C1.1	1	F1	0,9	3,1	NO DRIP	CDM212-00 TYPE 18	CDM050-60	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRA25.1-2	C1.1	2	F1	0,9	2,9	NO DRIP	CDM212-00 TYPE 18	CDM050-60	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRA25.1-2	C2	1	F1	0,0	3,5	NO DRIP	CDM212-00 TYPE 18	CDM050-60	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRA25.1-2	C2.1	1	F1	0,0	3,3	NO DRIP	CDM212-00 TYPE 18	CDM050-60	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52-2	D63	1	F1	2,0	2,4	NO DRIP	CDM212-00 TYPE 1	CDM050-60	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52-2	D63	2	F1	1,6	2,7	NO DRIP	CDM212-00 TYPE 1	CDM050-60	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52-2	D63.1	1	F1	4,2	2,6	NO DRIP	CDM212-00 TYPE 1	CDM050-60	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52-2	D63.1	2	F1	4,7	2,8	NO DRIP	CDM212-00 TYPE 1	CDM050-60	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52-2	A90	1	F1	6,4	4,4	NO DRIP	CDM212-00 TYPE 1	CDM050-60	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52-2	A90	2	F1	8,0	4,3	NO DRIP	CDM212-00 TYPE 1	CDM050-60	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52-2	A90.1	1	F1	5,6	3,3	NO DRIP	CDM212-00 TYPE 1	CDM050-60	.500"	PANEL WITH DÉCOR ON 1 SIDE

TEST PLAN	ITEM	SIDE	TEST TYPE	FLAME EX	BURN LENGTH	DRIP TIME	EDGE FILL MATERIAL	PANEL TYPE	PANEL THK	DESCRIPTION
CDRD52	A90.	2	F1	5,3	3,4	NO	CDM212-00	CDM050-	.500"	PANEL WITH DÉCOR ON 1

-2	1					DRIP	TYPE 1	60		SIDE
CDRD52 -2	A91	1	F1	5,7	2,7	NO DRIP	CDM212-00 TYPE 1	CDM058-60	.750"	PANEL WITH DÉCOR ON 2 SIDES
CDRD52 -2	A91	2	F1	3,0	3,1	NO DRIP	CDM212-00 TYPE 1	CDM058-60	.750"	PANEL WITH DÉCOR ON 2 SIDES
CDRD52 -2	A91. 1	1	F1	3,5	3,2	NO DRIP	CDM212-00 TYPE 1	CDM058-60	.750"	PANEL WITH DÉCOR ON 2 SIDES
CDRD52 -2	A91. 1	2	F1	0,8	3,9	NO DRIP	CDM212-00 TYPE 1	CDM058-60	.750"	PANEL WITH DÉCOR ON 2 SIDES
CDRD52 -2	B86	1	F1	3,4	2,3	NO DRIP	CDM212-00 TYPE 1	CDM050-60	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52 -2	B86	2	F1	3,9	2,8	NO DRIP	CDM212-00 TYPE 1	CDM050-60	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52 -2	B86. 1	1	F1	8,3	2,5	NO DRIP	CDM212-00 TYPE 1	CDM050-60	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52 -2	B86. 1	2	F1	4,8	3,1	NO DRIP	CDM212-00 TYPE 1	CDM050-60	.500"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52 -2	B87	1	F1	4,1	2,3	NO DRIP	CDM212-00 TYPE 1	CDM058-60	.750"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52 -2	B87	2	F1	3,4	3,2	NO DRIP	CDM212-00 TYPE 1	CDM058-60	.750"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52 -2	B87. 1	1	F1	2,2	3,5	NO DRIP	CDM212-00 TYPE 1	CDM058-60	.750"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52 -2	B87. 1	2	F1	2,2	3,2	NO DRIP	CDM212-00 TYPE 1	CDM058-60	.750"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52 -2	B91	1	F1	8,2	3,2	NO DRIP	CDM212-00 TYPE 1	CDM031-60	.250"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52 -2	B91	2	F1	8,9	2,9	NO DRIP	CDM212-00 TYPE 1	CDM031-60	.250"	PANEL WITH DÉCOR ON 1 SIDE
CDRD52	B91.	1	F1	10,5	3,0	NO	CDM212-00	CDM031-	.250"	PANEL WITH DÉCOR ON 1

-2	1					DRIP	TYPE 1	60		SIDE
CDRD52 -2	B91. 1	2	F1	8,3	3,0	NO DRIP	CDM212-00 TYPE 1	CDM031-60	.250"	PANEL WITH DÉCOR ON 1 SIDE
R&D	N/A	1	F1	2,9	0,0	NO DRIP	CDM212-00 TYPE 18	N/A	N/A	EDGE FILL TESTED ALONE 0.5 " x 0.5" x 12" Stick
R&D	N/A	1	F2	1,8	0,0	NO DRIP	CDM212-00 TYPE 18	N/A	N/A	EDGE FILL TESTED ALONE 0.5 " x 0.5" x 12" Stick

FOR TEST SPECIMENS WITH DÉCOR ON 1 SIDE, DÉCOR SIDE IS SIDE 1.
EACH ROW OF TEST RESULTS ABOVE ARE FROM 1 SET OF TESTS
3 TEST SPECIMENS = 1 SET OF TESTS
SEE TEST DATA SHEET FOR REFERENCE

Table B. Test Results SELL GmbH

F1 Requirement: Flame extinguishing time = 15 [s] / Burn Length [inch] = 6
F2 Requirement: Flame extinguishing time = 15 [s] / Burn Length [inch] = 8

= pass
=stand alone (brick test)

ITEM	Sample build up	TEST TYPE	FLAME EX	BURN LENGTH	DRIP TIME	EDGE FILL MATERIAL	PANEL TYPE	PANEL THK	DESCRIPTION
K 311	see Sketch 1	F1	0.0	4,3	NO DRIP	3M Scotch Weld 3524 B/A-AF	Sell 16 E	10 mm	PANEL without decore
K 312	see Sketch 1	F1	0.0	4,4	NO DRIP	3M Scotch Weld 3524 B/A-AF	Sell 18 E	22 mm	PANEL without decore
K 313	see Sketch 1	F1	0.0	4,2	NO DRIP	3M Scotch Weld 3524 B/A-AF	Sell 16ET	10 mm	PANEL with tedlar foil sides
K 314	see Sketch 1	F1	0.0	4,3	NO DRIP	3M Scotch Weld 3524 B/A-AF	Sell 18ET	22 mm	PANEL with tedlar foil sides
K 315	see Sketch 1	F1	0.0	3,9	NO DRIP	3M Scotch Weld 3524 B/A-AF	Sell 616	10mm	PANEL without decore
K 316	see Sketch 1	F1	0.0	4,5	NO DRIP	3M Scotch Weld 3524 B/A-AF	Sell 618	22mm	PANEL without decore
K 317	see Sketch 1	F1	0.0	4,0	NO DRIP	3M Scotch Weld 3524 B/A-AF	Sell 16EOX W-direction	10mm	PANEL without decore
K 318	see Sketch 1	F1	0.0	3,9	NO DRIP	3M Scotch Weld 3524 B/A-AF	Sell 16EOX L-direction	10mm	PANEL without decore
K 319	see Sketch 1	F2	0.0	1,4	NO DRIP	3M Scotch Weld 3524 B/A-AF	Sell 16 E	10 mm	PANEL without decore
K 320	see Sketch 1	F2	0.0	1,6	NO DRIP	3M Scotch Weld 3524 B/A-AF	Sell 18 E	22 mm	PANEL without decore

K 321	see Sketch 1	F2	0.0	1,9	NO DRIP	3M Scotch Weld 3524 B/A-AF	Sell 16ET	10 mm	PANEL with tedlar foil sides
K 322	see Sketch 1	F2	0.0	2,3	NO DRIP	3M Scotch Weld 3524 B/A-AF	Sell 18ET	22 mm	PANEL with tedlar foil sides
K 323	see Sketch 1	F2	1.0	1,6	NO DRIP	3M Scotch Weld 3524 B/A-AF	Sell 616	10mm	PANEL without decore
K 324	see Sketch 1	F2	0.0	1,9	NO DRIP	3M Scotch Weld 3524 B/A-AF	Sell 618	22mm	PANEL without decore
K 325	see Sketch 1	F2	0.0	2,0	NO DRIP	3M Scotch Weld 3524 B/A-AF	Sell 16EOX W-direction	10mm	PANEL without decore
K 326	see Sketch 1	F2	0.0	1,9	NO DRIP	3M Scotch Weld 3524 B/A-AF	Sell 16EOX L-direction	10mm	PANEL without decore
K 288	3"x12"x0.125"	F1	1,6	2,0	NO DRIP	3M Scotch Weld 3550 B/A-FST	Brick test	0.125"	EDGE FILL TESTED A
F7009	0.5“x0.5“x12“	F2	0.0	3.1	NO DRIP	3M Scotch Weld 3550 B/A-FST	Brick test	0.125"	EDGE FILL TESTED A
K 327	see Sketch 1	F1	0.0	4,3	NO DRIP	3M Scotch Weld 3550 B/A-FST	Sell 16 E	10 mm	PANEL without decore
K 328	see Sketch 1	F1	0.0	1,3	NO DRIP	3M Scotch Weld 3550 B/A-FST	Sell 18 E	22 mm	PANEL without decore
K 329	see Sketch 1	F1	0.0	2,1	NO DRIP	3M Scotch Weld 3550 B/A-FST	Sell 16ET	10 mm	PANEL with tedlar foil sides
K 330	see Sketch 1	F1	0.0	1,2	NO DRIP	3M Scotch Weld 3550 B/A-FST	Sell 18ET	22 mm	PANEL with tedlar foil sides

FAA Memorandum
ANM-115-09-XXX "Policy Statement on Flammability Testing of Interior Materials"
Parts 1 and 2, Reference Item No. 33 "Edge Fill Materials"

ITEM	Sample build up	TEST TYPE	FLAME EX	BURN LENGTH	DRIP TIME	EDGE FILL MATERIAL	PANEL TYPE	PANEL THK	DESCRIPTION
K 331	see Sketch 1	F1	0.0	2,4	NO DRIP	3M Scotch Weld 3550 B/A-FST	Sell 616	10mm	PANEL without decore
K 332	see Sketch 1	F1	0.0	1,7	NO DRIP	3M Scotch Weld 3550 B/A-FST	Sell 618	22mm	PANEL without decore
K 333	see Sketch 1	F1	0.0	2,0	NO DRIP	3M Scotch Weld 3550 B/A-FST	Sell 16EOX W-direction	10mm	PANEL without decore
K 334	see Sketch 1	F1	0,0	2,2	NO DRIP	3M Scotch Weld 3550 B/A-FST	Sell 16EOX L-direction	10mm	PANEL without decore
K 335	see Sketch 1	F2	0.0	0,5	NO DRIP	3M Scotch Weld 3550 B/A-FST	Sell 16 E	10 mm	PANEL WITH DÉCOR OI SIDES
K 336	see Sketch 1	F2	0.0	0,2	NO DRIP	3M Scotch Weld 3550 B/A-FST	Sell 18 E	22 mm	PANEL WITH DÉCOR OI SIDES
K 337	see Sketch 1	F2	0.0	0,4	NO DRIP	3M Scotch Weld 3550 B/A-FST	Sell 16ET	10 mm	PANEL WITH DÉCOR OI SIDE
K 338	see Sketch 1	F2	0.0	0,3	NO DRIP	3M Scotch Weld 3550 B/A-FST	Sell 18ET	22 mm	PANEL WITH DÉCOR OI SIDE
K 339	see Sketch 1	F2	0.0	0,7	NO DRIP	3M Scotch Weld 3550 B/A-FST	Sell 616	10mm	PANEL WITH DÉCOR OI SIDE
K 340	see Sketch 1	F2	0.0	0,4	NO DRIP	3M Scotch Weld 3550 B/A-FST	Sell 618	22mm	PANEL WITH DÉCOR OI SIDE
K 341	see Sketch 1	F2	0.0	0,5	NO DRIP	3M Scotch Weld 3550 B/A-FST	Sell 16EOX W-direction	10mm	PANEL WITH DÉCOR OI SIDE
K 342	see Sketch 1	F2	0.0	0,4	NO DRIP	3M Scotch Weld 3550 B/A-FST	Sell 16EOX L-direction	10mm	PANEL WITH DÉCOR OI SIDE

Table C Test Results 3M

I. Brick Test

Material Description:		Brick Edge Fill SW3550			12s	Date completed: 12/22/2010
Sample	**Burn Time**	**Burrn Length**	**Drips**	**Drip Burn**	**Pass/Fail**	**Comments**
Number	Sec	inches	Y/N	sec		
1	<1	0.0795	N	NA	Pass	some smoke, less than 3505
2	<1	0.1	N	NA	Pass	some smoke, less than 3506
3	<1	0.096	N	NA	Pass	some smoke, less than 3507
4	<1	0.1265	N	NA	Pass	some smoke, less than 3508
5	<1	0.3035	N	NA	Pass	some smoke, less than 3509
6	<1	0.256	N	NA	Pass	some smoke, less than 3510
Material Description:		**Brick Edge Fill SW3505 FR**			**12s**	Date completed: 12/22/2010
Sample	**Burn Time**	**Burrn Length**	**Drips**	**Drip Burn**	**Pass/Fail**	**Comments**
Number	Sec	inches	Y/N	sec		
1	<1	0.8635	N	NA	Pass	Some smoke
2	<1	0.5835	N	NA	Pass	Some smoke
3	<1	0.49	N	NA	Pass	Some smoke
4	<1	0.399	N	NA	Pass	Some smoke
5	<1	0.507	N	NA	Pass	Some smoke
6	<1	0.7015	N	NA	Pass	Some smoke
Material Description:		Brick Edge Fill EC3524			**12s**	Date completed: 12/22/2010
Sample	**Burn Time**	**Burrn Length**	**Drips**	**Drip Burn**	**Pass/Fail**	**Comments**
Number	Sec	inches	Y/N	sec		
1	2.13	8.75+	N	NA	Fail	lots of smoke
2	12.32	8.75+	N	NA	Fail	lots of smoke
3	<1	6.5	N	NA	Fail	lots of smoke

Material Description:	Brick Edge Fill SW3550				60s	Date completed:3/17/2010
Sample	**Burn Time**	**Burrn Length**	**Drips**	**Drip Burn**	**Pass/Fail**	**Comments**
Number	Sec	inches	Y/N	sec		
1	3	1.75	N	X	Pass	Less smoke than 3505
2	0	2	N	X	Pass	Less smoke than 3505; some ash fell into flame; popping
3	0	1.75	N	X	Pass	Less smoke than 3505; some ash fell into flame

Material Description:		**Brick Edge Fill SW3505 FR**			**60s**	Date completed:3/17/2010
Sample	**Burn Time**	**Burrn Length**	**Drips**	**Drip Burn**	**Pass/Fail**	**Comments**
Number	Sec	inches	Y/N	sec		
1	0	2.25	N	X	Pass	A lot of smoke
2	0	2	N	X	Pass	A lot of smoke
3	0	1	N	X	Pass	A lot of smoke, less burn remnants

Material Description:		Brick Edge Fill EC3524			**60s**	Date completed:3/17/2010
Sample	**Burn Time**	**Burrn Length**	**Drips**	**Drip Burn**	**Pass/Fail**	**Comments**
Number	Sec	inches	Y/N	sec		
1	1	7.5	N	X	Fail	Heavy smoke
2	62	8.5	N	X	Fail	Heavy smoke; longer burn
3	33	8.5	N	X	Fail	Heavy smoke; large flame

II.Panels

Panel	CMD-50-50			**3550 FST Panels**	**12s**	Date completed: 10/27/2010
Sample	**Burn Time**	**Burrn Length**	**Drips**	**Drip Burn Time**	**Pass/Fail**	**Comments**
Number	Sec	inches	Y/N	sec		
1	<1	0,2135	N	NA	Pass	little smoke
2	<1	0,0082	N	NA	Pass	little smoke
3	<1	0,1035	N	NA	Pass	little smoke
Panel	CMD-50-50			**3550 FST Panels**	**60s**	Date completed: 10/27/2010
Sample	**Burn Time**	**Burrn Length**	**Drips**	**Drip Burn Time**	**Pass/Fail**	**Comments**
Number	Sec	inches	Y/N	sec		
1	<1	0,5015	N	NA	Pass	more smoke than 12s, but not much
2	<1	0,8765	N	NA	Pass	more smoke than 12s, but not much
3	<1	0,6855	N	NA	Pass	more smoke than 12s, but not much
Panel	CMD-50-50			**3505 FR Panels**	**12s**	Date completed: 10/27/2010
Sample	**Burn Time**	**Burrn Length**	**Drips**	**Drip Burn Time**	**Pass/Fail**	**Comments**
Number	Sec	inches	Y/N	sec		
1	<1	0,204	N	NA	Pass	little smoke
2	1	0,329	N	NA	Pass	little smoke
3	<1	0,363	N	NA	Pass	little smoke

Panel	CMD-50-50			3505 FR Panels	60s	Date completed: 10/27/2010
Sample	**Burn Time**	**Burrn Length**	**Drips**	**Drip Burn Time**	**Pass/Fail**	**Comments**
Number	Sec	inches	Y/N	sec		
1	<1	0,4305	N	NA	Pass	some smoke, charred on bottom
2	<1	0,6885	N	NA	Pass	some smoke, charred on bottom
3	<1	0,7755	N	NA	Pass	some smoke, charred on bottom
Panel	CMD-50-50			**3524 Panels**	**12s**	Date completed: 10/27/2010
Sample	**Burn Time**	**Burrn Length**	**Drips**	**Drip Burn Time**	**Pass/Fail**	**Comments**
Number	Sec	inches	Y/N	sec		
1	2,1	4,6045	N	NA	Pass	little smoke
2	3,19	4,2915	N	NA	Pass	little smoke
3	<1	3,923	N	NA	Pass	little smoke
Panel	CMD-50-50			**3524 Panels**	**60s**	Date completed: 10/27/2010
Sample	**Burn Time**	**Burrn Length**	**Drips**	**Drip Burn Time**	**Pass/Fail**	**Comments**
Number	Sec	inches	Y/N	sec		
1	1	7,375	N	NA	Fail	some smoke
2	1	10,5	N	NA	Fail	some smoke
3	2,66	8,5	N	NA	Fail	some smoke

Part 5.3.2 Heat Release & MCC

Part 5.3.2.1 14 CFR 25.853(d) Heat Release (OSU) plaque Test

Heat Release tests have been performed in accordance to the proposal for Item 33 “edge fill” on potting compound applied into a half inch wide slot in a standard panel type.
Test have been performed in accordance with DOT/FAA/AR-00/12 Aircraft Materials Fire Test Handbook
Chapter 5
To determine the specific heat release, MCC tests have been performed in addition to the OSU test scenario to determine a possible correlation between the Heat Release (OSU) and the MCC

Sketch: Heat Release test sample configuration pre potting

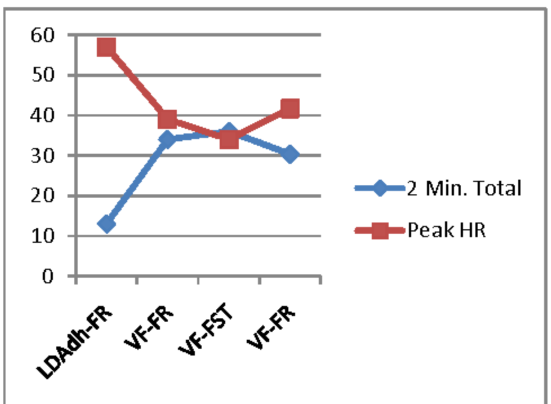
Heat Release
Table D.

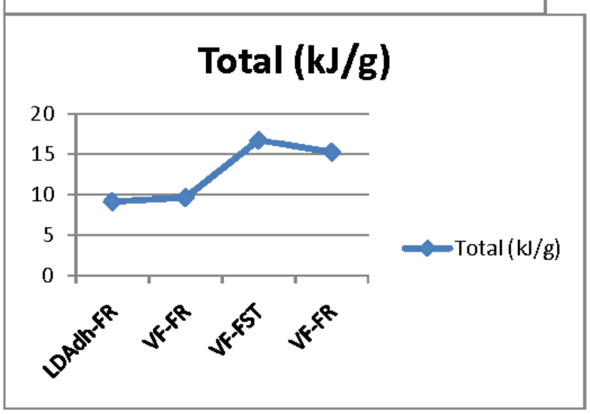
		HRR			
Material	Code Desc	2 Min. Total	Peak HR	Peak Time	Pass/Fail
EC3545	LDAdh-FR	13	57	297	P
EC3524	VF-FR	34	39	201	P
EC3550	VF-FST	36	34	192	P
SW3505	VF-FR	30	42	201	P

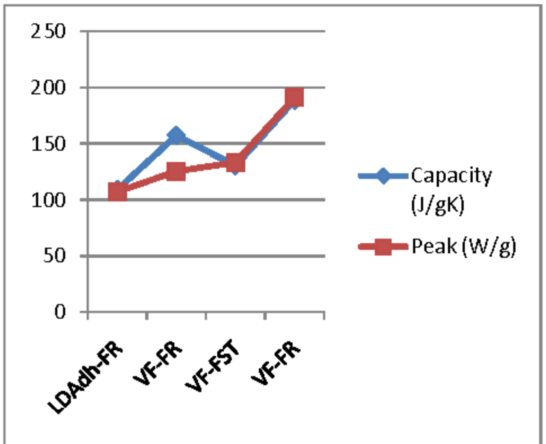
Part 5.3.1.3 MCC Data
MCC was conducted on each specimen per section 5.3.3.
Results are shown in Table E.

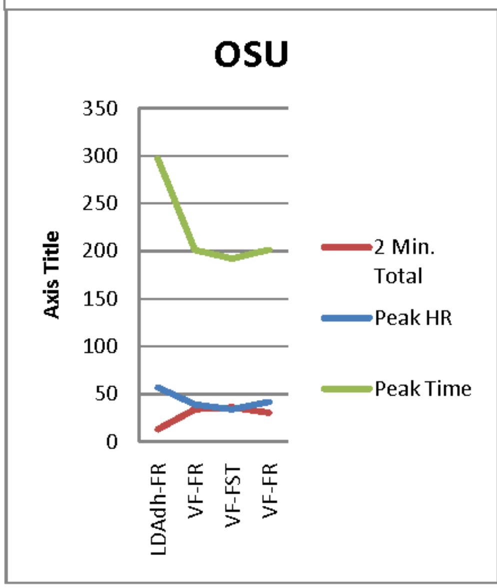
Table E.

		MCC				
Material	Code Desc	Capacity (J/gK)	Peak (W/g)	Total (kJ/g)	Temp deg C	Char %
EC3545	LDAdh-FR	109	107	9,1	341,2	48
EC3524	VF-FR	157,3	125,4	9,6	358,8	30,1
EC3550	VF-FST	130,3	133,1	16,7	354,6	48,2
SW3505	VF-FR	188,7	191	15,2	356,1	32,2






250
200
150
100
50
0
LDAdh-FR
VF-FR
VF-FST
VF-FR
Capacity (J/gK)
Peak (W/g)


OSU
Axis Title
350
300
250
200
150
100
50
0
LDAdh-FR
VF-FR
VF-FST
VF-FR
2 Min. Total
Peak HR
Peak Time

5.3.3Foam Block Test

Foam Block tests have been performed on a potting compound applied into a panel edge .

Each sample has been tested from a horizontal orientation, and in a near vertical position at 65 ± 5 degrees. This slight incline ensures direct flame impingement onto the potting compound.

The foam block fire source is a 4” X 4” X 9” (± 0.5”) piece of polyurethane foam. During testing it has been positioned on a steel tray with a ¼” pointed steel rod welded to it in the vertical position such that the foam block is slid over the rod to hold it in place. A picture of a foam block is found in Figure 5.3.3.8-6. A picture of the steel holding tray with the steel rod is found in Figure 5.3.3.8-7. Prior to testing the bottom of the foam block has been coated with 10 ml of heptane. This has been done by measuring the heptane using a graduated cylinder (or equivalent) and pouring it in the steel tray. The bottom of foam block is used to soak up the 10 ml heptane. A picture of the steel tray used for the heptane is found in Figure 5.3.3.8-8. Prior to soaking up the heptane, the foam block is placed over the steel rod to bore a hole down the center. This allows for easier mounting of the block over the rod once the heptane has been soaked up by the block. The function of the heptane is to aid in ignition of the foam block.

Figure 5.3.3.8-6 - Foam Block Fire Source

Figure 5.3.3.8-7 - Steel Tray with Pointed Steel Rod

Figure 5.3.3.8-8 - Steel Tray Used for Soaking Bottom of Foam Block with Heptane

The following procedure has been used for the foam block fire test method:

8. Position test article as defined in the individual test setup sections (See Section 5.4.2)
9. Create a hole down the center of the foam block to be used during testing by sliding it down the length of the rod on the steel tray (See Figure 5.3.3.8-7) and removing it.
10. Measure 10 ml of heptane and pour it into steel soaking tray (See Figure 5.3.3.8-8).
11. Soak up heptane with bottom of the polyurethane foam block.
12. Mount foam block on the steel tray, sliding the block over the pointed steel rod so that the bottom of the block is in contact with the tray (See Figure 5.3.3.8-6).
13. Place the steel tray in test position next to the test article in accordance with the individual test setup sections (See Section 5.4.2). Foam block centerline shall be lined up with the slot potted with potting compound. Spacer material may be used as a shop option to meet this dimension.
14. Within 15 minutes of soaking up the heptane with the block, ignite the bottom of the foam block to begin the test.

5.3.3.5 Test sample preparation

Samples were prepared per Section 5.2.4

5.3.3.6 Foam Block Test Setup Configurations

The configuration is described in 5.2.4.

- **Horizontal Orientation**

In the case of the horizontal orientation, the foam block has been placed within the distance shown in Section 5.2.4.

- **65 ± 5 degree Orientation**

In the case of 65 degree Orientation the foam block will be placed as close as possible within the distance shown in Section 5.2.4.

5.3.3.7 Foam Block acceptance criteria

The foam block test acceptance criteria as defined in the Issue Paper CS-1 are as follows:

1. There must be no flame propagation beyond 2-inches from the area of direct flame impingement from the fire source.
2. The flame time may not exceed 30 seconds.

5.3.3.8 Summary of Test Results

Sample K-0443 Potting compound 3M SW 3524 B/A AF	Potting compound applied into the panel edge Foam Block tests	
	PASS	FAIL
Sample K 0443	X	
Sample K 0443 65°inclined	X	
Results see page	36 to 42	

Sample K-0444 Potting compound 3M SW 3500 B/A FST	Potting compound applied into the panel edge Foam Block tests	
	PASS	FAIL
Sample K 0444	X	
Sample K 0444 65°inclined	X	
Results see page	Attached below.	

5.3.3.8 FOAM BLOCK TEST RESULTS

FOAM BLOCK TEST DATA SHEET

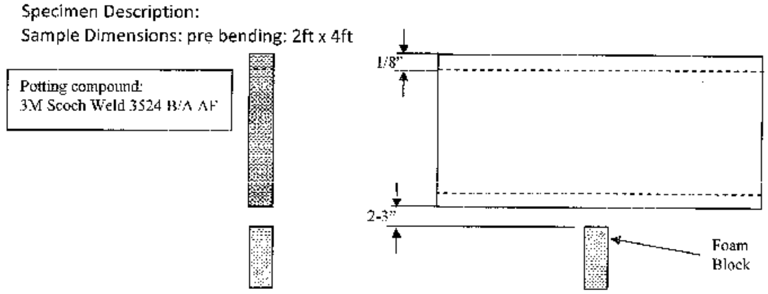
Identification : K 0443			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D. Boesser	Witnessed by: T. Braeuer

Test Observations		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	-------------

Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments
Deflagration of the potting compound in a small area of the panel edge during the test

Specimen Description:
Sample Dimensions: pre bending: 2ft x 4ft



Foam Block test at horizontal direction during test (non fire retardant potting compound)

Potted edge after test (non fire retardant potting compound)

FOAM BLOCK TEST DATA SHEET

Identification : K 0443			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D. Boesser	Witnessed by: T. Braeuer

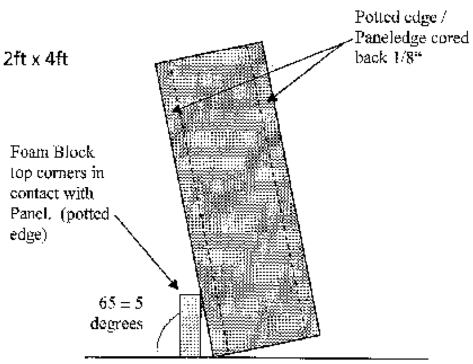
Test Observations		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	--------------

Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments
Deflagration of the potting compound in a small area of the panel edge during the test

Specimen Description:
Sample Dimensions: pre bending: 2ft x 4ft

Potting compound:
3M Scoch Weld 3524 B/A AF



Foam Block test setup with a 65° incline pre testing (non fire retardant potting compound)

Foam Block test with a 65° incline during test (non fire retardant potting compound)

Potted edge after test (non fire retardant potting compound)

FOAM BLOCK TEST DATA SHEET

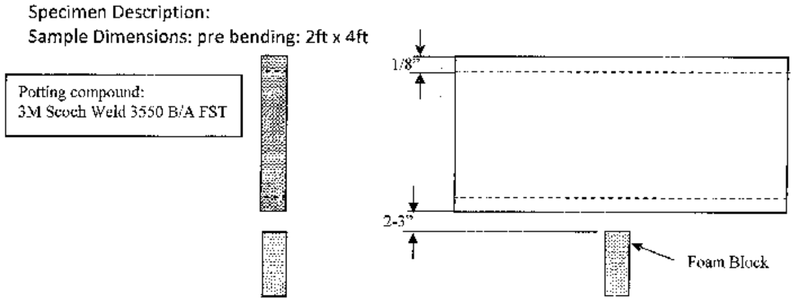
Identification : K 0444			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D. Boesser	Witnessed by: T. Braeuer

Test Observations		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	--------------

Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments
Deflagration of the potting compound in a small area of the panel edge during the test

Specimen Description:
Sample Dimensions: pre bending: 2ft x 4ft



Foam Block test at horizontal direction during test (fire retardant potting compound)

Potted edge after test (fire retardant potting compound)

FOAM BLOCK TEST DATA SHEET

Identification : K 0444			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D. Boesser	Witnessed by: T. Braeuer

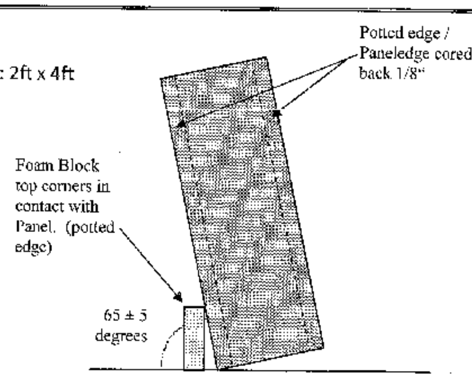
Test Observations		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	--------------

Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments
Deflagration of the potting compound in a small area of the panel edge during the test

Specimen Description:
Sample Dimensions: pre bending: 2ft x 4ft

Potting compound:
3M Scoch Weld 3550 B/A FST



Foam Block test setup with a 65° incline pre testing (non fire retardant potting compound)

Potted edge after test (fire retardant potting compound)

5.4 ANALYSIS OF TEST RESULTS
Figure IX

Scenarios for Bunsen Burner					
	"Brick" of Material		Edge Fill in Panel		
	12 sec VBB	60 Sec VBB	12 sec VBB	60 Sec VBB	Foam Block
Product 1	Pass	Pass	Pass	Pass	Pass
Product 2	Pass	Fail	Pass	Pass	Pass
Product 3	Pass	Fail	Pass	Fail	Pass
Product 4	Fail	Fail	Pass	Pass	Pass
Product 5	Fail	Fail	Pass	Fail (1)	Pass
Product 6	Fail	Fail	Fail (1)	Fail (1)	Pass
Product 7 (2)	Fail	Fail	Fail	Fail	Fail (2)

Notes: (1) Fails extinguishing time but passes burn length and drip extinguishing time.
(2) This scenario is not believed to exist, since product 6 would represent the worse case material used by industry in this configuration.

VBB Results

The above scenario was proposed to address the method of compliance found in Section 4.2. Several different specimens were tested and all were found to give results that mimic either product 1 or product 5 when tested. The materials that were found that fail the 12 sec brick test also fail the 60 sec edge fill test. (Scenario Product 5) The data shows that those passed the 12 sec brick, also pass the 60 sec edge fill VBB. (Scenario Product 1) See Table C. However in the case of Product 5, it was not a case of extinguish time failure but rather burn length failure for the edge filled material. In the two cases tested, the Foam Block Test resulted in a pass. Configurations of Product 1 & 5 specimen were tested in Foam Block and both were found to pass as found in section 5.3.3.8

Panels of different thicknesses were tested to determine impact of panel thickness on edge filled panels. See Tables A & B. No appreciable differences were observed in extinguish time nor burn length. A difference in burn length can be observed however between products that are Product 1 like vs Product 4 or 5 like.

HRR
Materials were tested per Figure V. with the results per Table D. All specimen passed in this configuration. Though not found in the table, two specimen were submitted as neat blocks and were found to give off too much energy to be a viable test method without destroying the test equipment. In both cases the test was stopped after the first of three specimens. The method of slotting a panel on one face ½" wide gives a more "real world" test. The results support the no test required requirement per the proposal in Section 4.2.

MCC
The MCC data Table E did not show a correlation to HRR. It did show some correlation to VBB compliance. The product that failed both the 12 sec brick & 60 sec edge filled panel also had the lowest chair within the group. More work will need to be done to evaluate this as a method for evaluation of Void Fillers.

6. CONCLUSION

The data supports the proposed MoC in section 4 .The standard test configuration and flame placement supporting the part 1 to meet compliance as per industry practice should be configured as per the standardized test method as found in Figure IV above as found in Part 4.2 above.

The Industry group recommends that no HRR/OSU (14 CFR 25.853(d) testing be required by defining a size limit on the depth of the edge fill material. If the edge fill configuration is greater than 1.0" the standard heat release size criteria would be utilized.

7. ABBREVIATIONS

FAA – Federal Aviation Administration
MOC – Method of Compliance
CFR – Code of Federal Regulations
TBD – To Be Determined

FAA Memorandum
ANM-115-09-XXX “Policy Statement on Flammability Testing of Interior Materials”
Parts 1 and 2, Reference Item No. 33 “Edge Fill Materials”

AC – Advisor Circular
MCC – Micro Combustion Calorimetry
VBB – Vertical Bunsen Burner Test per 14 CFR 25.853(a) and App F, Part I
HRR – Heat Release Rate per 14 CFR 25.853(d), App F, Part IV
SD – Smoke Density per 14 CFR 25.853(d), App F, Part V

8. REFERENCES

A. Gardlin, Jeff, FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of interior Materials, Department of Transportation, Federal Aviation Administration, August 2009
B. FAA Handbook, FAA Technical Center, Report DOT/FAA/AR-00/42,
C. FAA Memorandum ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials, Reference Items 33

Appendix A

A test report for Item 33 "edge fill" has been submitted to the SharePoint.

APPENDIX AA—ITEM 42: BONDED INSERTS

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM PROPOSAL

Part 1, Reference Item #42, “Bonded Inserts”

Final Report, Issue 4
2011-October-7

CONTENTS

FAA Memorandum
ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”
Part 1, Reference Item #42, “**Bonded Inserts**”

REVISION HISTORY

REV	DESCRIPTION	DATE	ISSUED BY
Draft	Initial Draft	2010-Feb-19	Dan Slaton
A	Updated based on inputs from March 2, meeting. Section 4.3 to clarify “Clickbonds,” updated Section 4.1 Design Attributes item 4 and 10, updated section 5.2 Foam Block Test configuration proposal, added Team Member test summary to section 5.3, corrected Decision Flow decision gate 4.	2010-Mar-15	Dan Slaton
Issue 1	Prepare document for FAA submittal. Update to materials being currently evaluated.	2010-April-28	Dan Slaton
Issue 2, Draft 1	Update for PEER REVIEW: Updated information from June and October team meetings. Clarified sections based on FAA inputs, and developed approach to validate heat release/smoke by generating data with “attached” features.	2010-November-22	Dan Slaton
Issue 2, Draft 2	Updated information from June and October team meetings, and Peer Review from November. Clarified sections based on FAA inputs posted 1-14-2011, and developed approach to validate heat release/smoke by generating data with “attached” features and multiple inserts in an OSU sample.	2011-March-25	Dan Slaton
Issue 4	Updated with final conclusions and data summary.	2011-October-7	Dan Slaton

1. INTRODUCTION

As a general industry practice, bonded inserts are not tested as part showing flammability compliance of interior panels. Some applicants have procedures to evaluate the potting/adhesive materials in a "brick" form using the Bunsen burner test, but most have simply considered bonded inserts as "small parts" requiring no test. The way inserts are installed has been the basis for having no appreciable effect on the results of flammability testing (vertical burn, heat release and smoke emission).

Due to a lack of standardization across industry flammability practices, the FAA has decided to publish a draft version of FAA Memorandum ANM-115-09-XXX, "Policy Statement on Flammability Testing of Interior Materials" (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials, based on the FAA's technical judgment of what is acceptable and within the scope of current regulations. There are two categories to this guidance, grouped in this order:

- Methods that are acceptable and can be used as shown (Attachment 2, Part 1).
- Methods that are expected to be acceptable but require test data to support them (Attachment 2, Part 2).

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry teams are also reviewing the Part 1 items to provide definitions and descriptions of terms to enable consistent interpretation and implementation across the aerospace industry.

Item 42 "Bonded Inserts" has been reviewed by the industry team and is submitting the following report for FAA approval. The data developed by the industry team members over the last couple years provides support of the draft policy MoC.

2. INDUSTRY TEAM LEADER AND SUPPORT TEAM

During an industry meeting on 24 September 2009 in Huntington Beach, CA, and the FAA Materials Fire Test Working Group meeting on 21 October 2009 in Atlantic City, NJ, the following individuals have volunteered to form the industry team for reference item #42:

2.1 TEAM LEADER

- Slaton, Daniel (Boeing)

2.2 SUPPORT TEAM

- Eberly, Dana (Northwest Airlines)
- Sattayatam, Pom (C&D Zodiac)
- Story, Charles W. C. (Magee Plastics Co.)
- Zimmerman, Patrick (3M)
- Hurst, Cheryl (American Airlines)
- Boesser, Klaus (Sell GmbH)
- Lyon, Rich (FAA, TC)
- Bunn, Greg (Magnolia)
- Lullam, Ian (Bombardier)
- Smit, Wim (Driessen)
- Lucas, David (Cessna)
- Smith, Jeff (Gulfstream)
- Kessler, Chris (Anolis Interiors)
- Marter, Bill (Magnolia)
- Shelton, Bradley (Dausault Falcon jet)
- Wilson, Chuck (Gulfstream)

This list is by no means all those who provided inputs, but represents many of the active industry participants.

3. PROJECT DEFINITION

3.1 CURRENT FAA PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version has been uploaded to the FAA website on 20 August, 2009. Attachment 2, Part 1 and 2, reference item #42 reads as follows (see Figure 1):

Part 1, methods of compliance that do not require supporting data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
42	Bonded Inserts	Test adhesive to 12-second vertical	See part 2 of this attachment

Part 2, methods of compliance that require supporting data

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
42	Bonded Inserts	No test required.	No test required.

Figure 1: Attachment 2, Part 2, Reference Item #42

The industry team supports the Part 1 proposal for 25.853(a) and recommends maintaining the acceptance criteria as one option. The validation effort focused on the Part 2 criteria as an optional MoC.

3.2 DEFINITION OF TERMS

In the interest of the overall stated goal of standardization of industry flammability practices, a clear definition of the term ‘bonded insert’ should be provided so that confusion between different parties over the meaning shall be avoided. The industry task group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

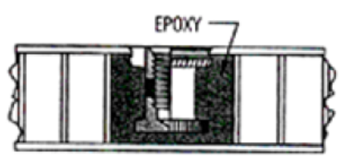
3.3 BONDED

Bonded refers to the use of adhesives, glue, or potting compounds as part of the installation of a fastener insert into a panel. From here forward, the bonding material will be described as an adhesive. Adhesive materials can be used to pre-pot the panel or may be “wet” installed by injecting the adhesive around the insert in the panel. Some inserts have an external flange and the adhesive may only be applied to the faying surface bond between the flange of the insert and the panel surface.

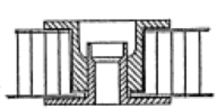
3.4 INSERT

Inserts are defined in the “fastener” category. Two main insert designs are used predominantly in interior panel fabrication. The first is a blind insert that contains an internal retaining nut. Blind inserts are commonly metal construction. The second common insert is a flanged insert, either one piece or two, and creates a hole “through” the panel for a bolt/screw to be inserted through the panel. “Through” inserts can be plastic or metal. Fastener attachments bonded to the surface of panels (e.g. “Clickbonds”) are not considered inserts and are covered under bonded details. See attached figures to illustrate the common insert types:

- Blind Insert: Hole drilled in panel and adhesive injected around the insert through holes in the insert flange. Some installation processes remove additional core up to 3X the diamter of the insert after drilling the hole.



- Flanged Insert; Hole drilled through the panel and a two piece or one piece is installed with adhesive under flanges.



BEFORE FLARING

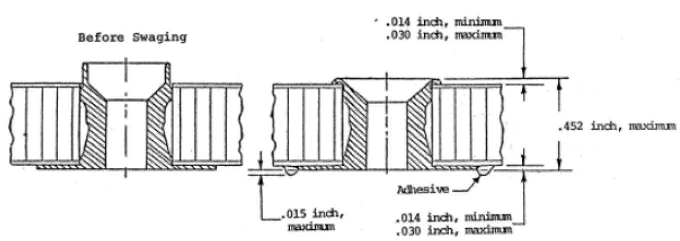
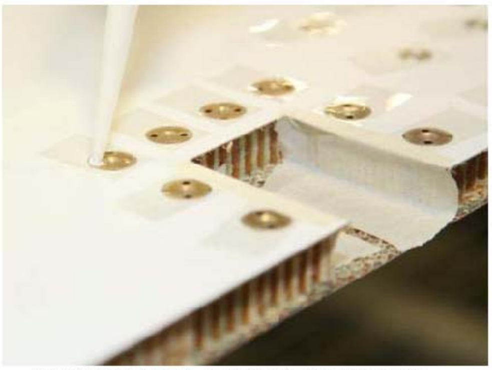
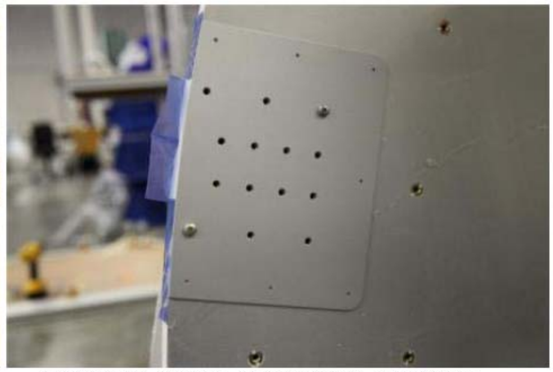
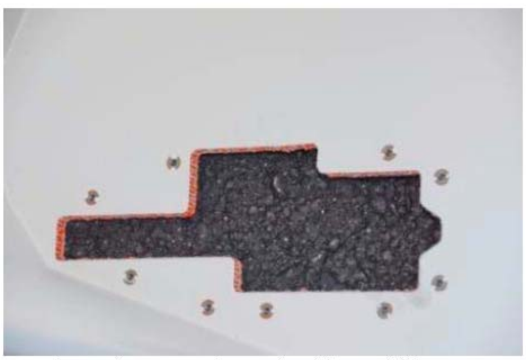


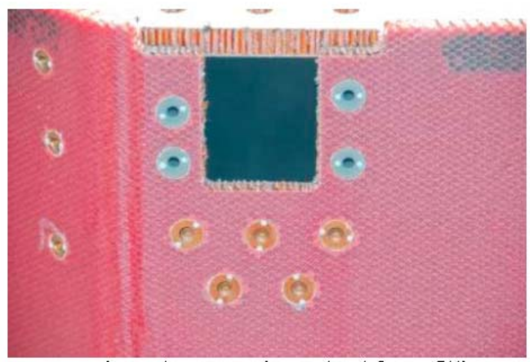
Figure 19 INSERT PROTRUSION REQUIREMENTS

Representative assemblies are shown below illustrating localized and lineally applied inserts.


Inserts around a cutout for a fitting


Inserts in center of panel for attaching wire bundles


Inserts around a cutout for a fitting.


Inserts around a cutout for a fitting.


Inserts along a panel edge for attaching trim


Inserts inside a stowbin for attaching trim

4. VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

The use of this MOC has been grouped by the FAA into Part 2 for both 14 CFR 25.853 (a) and (d). This means that the FAA will require additional supporting data to accept this method to show compliance for this design feature. The predominant concern of bonded features is the adhesive materials and not the insert itself. The installed configuration that includes the insert will be evaluated to support the final MoC.

The use of bonded inserts in aircraft interiors is common. It is currently a well established industry practice that bonded inserts have no test requirement for flammability in accordance with 14 CFR 25.853 (a) and (d). The industry team has determined that industry and many regulatory agencies have considered bonded inserts to be "small parts" resulting in no test requirement for both 14 CFR 25.853 (a) and (d) based primarily on the fact that inserts are considered "small parts" and require no testing per 14 CFR 25.853(a), Appendix F, Part I, (a)(1)(v). Some industry participants have had internal requirements that the adhesive/potting material meet the 12-second Bunsen burner requirement when tested in a "brick" or a plaque of material.

To provide a context of bonded inserts in aircraft interior designs, attributes of bonded inserts described below provide the basis for technical rationale to support this "no test" requirement. The goal of describing these attributes is to provide the context of inserts in panels and when this MoC is appropriate to apply. Using inserts as described below will ensure that designs meet the localized feature criteria and support the service experience that no difference in cabin fire safety will be observed when using different bonded inserts/adhesives/potting compounds.

Design Attributes of Bonded Inserts:
Inserts bonded into panels have attributes described below. These design attributes establish bonded inserts as small localized features within the cabin.

1) Inserts are not a significant part of the overall “panel” as determined by surface area comparisons (see schematic in item 10 below).

2) Individual bonded inserts are discrete “small parts.” Traditional usage/spacing does not contribute to flame propagation across the panel or between inserts.

3) Bonding material (adhesive / potting compound) is not exposed and is fully embedded within the panel or shielded by the insert flange

4) No continuous adhesive used between two potted inserts. When bonding an insert into a panel, the insert is first installed into a hole in the panel. Adhesive is then injected through holes on the insert flange to fill the space around the insert which fills the honeycomb core less than 3 times the diameter of the insert. Local areas intended to provide high loading may have close spacing between inserts. Utilization of closely spaced inserts where a large single block of potting is used is rare, but this configuration is beyond the scope of this MoC.

5) Inserts are commonly used for attaching other smaller components such as a shelf, bracket, trim detail, etc… and generally require a “linear” application of inserts and thus the quantity of inserts in a local area would not be significant.

6) When used to attach parts, the part being attached will physically limit the number of inserts installed on the underlying panel. On rare occasions unused inserts remain in a panel due to unique customer options. Specific quantities of unused inserts are not known, but the quantities are low as customer options involve localized designs such as additional magazine rack, localized hooks, different wire bundles, etc…The goal of the industry team is to show that exposed inserts is worse case and does not significantly impact flammability properties regarding flame propagation and heat release.

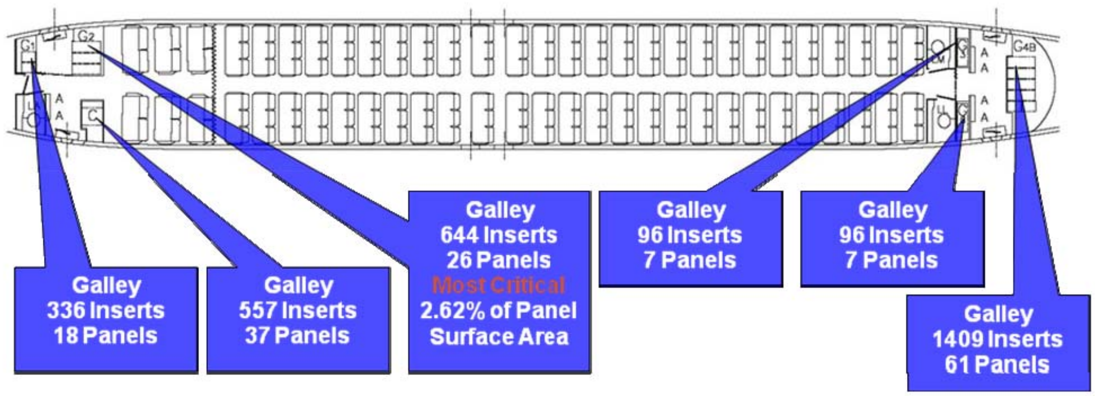
7) The attached component will fully cover the insert making the insert & bonding material fully shielded.

8) Adding inserts adds part cost/weight and manufacturing/assembly cost. Designs will minimize the use of inserts to the minimum number required for the design.

9) For highly loaded parts, there may be a concentration of inserts for strength requirements (e.g. tie down fittings) but the numbers of inserts within the 1 – 2 square foot area are on the order of 10 – 20 inserts at most. The vast majority of insert usage is for either attaching panels together or attaching lightly loaded features which by-design requires small numbers of lineally applied inserts (e.g. magazine racks, trim strips).

10) Commodities that contain many inserts (greater than 100) will usually have several different panels used to fabricate the assembly. The surface area of all inserts in the assembly is usually less than 3% of the total panel surface area of the assembly. This small percentage is not considered significant considering the “large surface area” criteria of the heat release regulation. Commodities where inserts are common are

galleys and lavatories. The schematic below illustrates the use of inserts and their relative small area compared to the overall assembly. In comparison to a commodity such as a galley where the maximum usage of inserts described above often occurs, if all inserts within the full cabin are compared to the total area of exposed panels in the full cabin, the percentage area will be considerably lower than 3% since sidewall, ceiling, and stowage bin assemblies which make up the predominate exposed surfaces within the cabin, contain fewer inserts per area than galleys/lavatories (less complex assemblies in terms of multiple panels and attached features).



In addition to the descriptions provided above, the industry team is in full agreement that the original intent of Amendment 25-61 (Heat Release/SD) was to address the large panel surface areas of interior parts. The requirement was developed based on testing basic honeycomb panel material and did not include small localized features such as bonded inserts. The historical industry practice of considering inserts as small parts/no test requirement is based on the intent of the regulation as well as the supporting design attributes. The data being generated through this proposal will provide additional knowledge for validation and acceptance of the MoC.

4.2 PROPOSED STANDARD TO MEET

Attachment 2, Part 1, reference item #42 defines a 12-second VBB test of the adhesive to show compliance with 25.853(a). The industry team is proposing a standardized specimen of 0.25” x 3” x 12” to validate material performance of the adhesive. Being a Part 1 criterion, this is already an acceptable MoC. The industry team supports this as one option as it provides a common adhesive test that can be utilized by other adhesive features besides bonded inserts.

The industry team also supports Attachment 2, Part 2,item #42 which defines a “no test” requirement as a second MoC option. This is the proposal the industry team intends to validate, concluding that bonded inserts have no appreciable effect on the overall flame propagation and heat release properties of interior assemblies. If necessary, the team will revisit the standard heat release size criteria of 1ft^2 to 2ft^2 and consider a standardized method for calculating the area of bonded inserts in a panel, but the industry team is confident that bonded inserts and the way they are used will not impact heat release within the cabin.

Attachment 2, Part 2, reference item #42 defines “no test requirement” for both 25.853(a) and (d). This is the standard being validated by the Industry Team.

The plan proposed by the Industry Team to validate the “no test” requirement includes generating material characterization data on a range of common industry adhesive materials, and then correlating these results to larger intermediate scale testing of panel insert configurations. This approach is similar to the way a regulatory requirement is developed. Generically the following steps are as follows:

1) Material characterization (material and small scale configs)
2) Design configuration tests (intermediate and installed configuration tests)
3) Analysis/correlation of intermediate scale and installed configuration test results to material property test results
4) Establish requirement level (or no test requirement) and refinement of criteria (size/location, design aspects, etc…) as necessary to protect the level of cabin safety desired.

The first step is to generate flammability properties on various adhesives/potting compounds used for bonded inserts. These tests will provide basic material characteristics to use in further analysis of larger scale and installed configuration tests. Foam block testing will be used to evaluate insert types, location, orientation, installed configuration, and quantity of inserts used in interior panel configurations. OSU and smoke configurations with “attached features” will be evaluated. The material characterization tests will include Bunsen burner, Microscale Combustion Calorimetry (MCC), and OSU/SD. By developing material characterization properties and then comparing to results in larger interior configurations, the proper requirements can be defined.

IMPORTANT CAUTION: *The team agreed that material properties developed from the various test methods should not be compared to current regulatory requirements. As an example, the OSU requirement of 65/65 is not an absolute requirement as this requirement was developed for large honeycomb panels correlated from full scale tests. This value is not meaningful unless the entire exposed panel has the “density/spacing” of inserts, which is not the case in actual design practice. MCC data is another example of data that should be used only to characterize the material properties and not directly compared to polymer family rankings in literature (e.g good flammability resistance versus poor flammability resistance). This type of data (OSU and MCC) will simply be used to characterize the material/configuration for further correlation to larger scale configuration test results.*

To assess bonded inserts using a threat based approach, foam block testing will evaluate the flame propagation behavior for the in-flight fire scenario. For evaluating the post-crash fire survivability threat, it was determined that full scale testing is not viable both from a resource perspective and since designs using bonded inserts such as lavatories, galleys, and closets would make for complicated full scale testing. The approach identified is to evaluate OSU using panels with “attached items” to determine the performance of installed configurations and samples with multiple inserts. Results from the threat based approach will provide flammability knowledge about bonded inserts, including ignition potential, flame propagation, and time dependant combustion dynamics.

Also, given that inserts are fully enclosed by the panel and covered by attached features, foam block test results will be beneficial in understanding the ignition potential and combustion rates for bonded inserts. When items are not exposed, ignition potential is less likely and the combustion rates are slower over time. Collectively, the data on installed configurations with “attached items” will provide validation that bonded inserts do not have an appreciable impact on panel performance. Taken in combination with design practice that utilizes inserts in localized areas, the “no test” requirement can be validated.

5. DATA / ANALYSIS

5.1 EXISTING TEST DATA

The industry has very little compliance data on bonded inserts, due to industry practice that “small parts” are not tested. Some preliminary data has been jointly developed by the industry team and described in section 5.3.

5.2 PROPOSAL OF TESTS TO BE PERFORMED

Using multiple common adhesive and potting compound materials (~8 – 12), material properties will be generated using MCC, Bunsen Burner, OSU and Smoke Density. Larger panels with multiple inserts will then be tested using the foam block test to determine the ignition and flame propagation behavior. OSU testing will be performed with various materials representing “attached features.” This will allow comparison of results to the base material characteristics. The number of panels, adhesives, and inserts used for foam block and OSU/Smoke testing with “attached features” will be determined based on the material property test results. In general, the poorest and best performing adhesive materials will be used to assess the installed configurations. Foam block test results will be correlated to determine a relationship to material properties and/or panel configurations to establish the necessary requirements and criteria for bonded inserts. For the OSU testing of “attached features,” four materials were selected to represent the “attached features.” These three are representative of materials used in the type of parts attached to panels such as brackets, magazine pockets, shelves, trim strips, rub strips, etc…

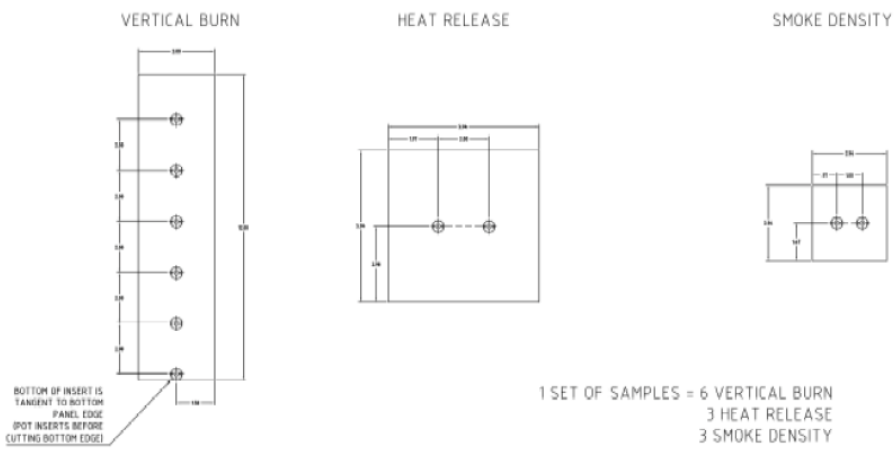
Attached feature materials for OSU/Smoke testing:

1) Aluminum sheet; 0.06” – 0.08”
2) Thermoplastic sheet; 0.06 – 0.125”
3) Composite panel; 0.125” – 0.25” honeycomb panel

Note: It is noted that OSU data on attached features may identify some interactions between the thermoplastic part and the honeycomb panel separate from interactions with the inserts. This will need to be understood before coming to conclusions on the effects that an attached item has on bonded insert flammability.

The initial material characterization testing will compare a single and double insert installed in an OSU/SD specimen and compared to a control panel. The panel, insert and adhesive mass will be measured to further in future analysis of MCC data concepts for calculating weighted mass calculations. Bunsen burner specimens will include multiple inserts along the length with the first one cut at the tangent of the potting material.

- **Bunsen Burner, Heat Release (OSU), and Smoke Density Test Configurations:**



- **Adhesive Test Configuration:**

To evaluate the adhesive material by itself, a standardized specimen plaque of 0.125” - 0.25” thick will be used establish material performance of the adhesive in Bunsen burner and OSU/Smoke. A small quantity of the adhesive by itself will be used to generate MCC data.

- **Foam Block Test Configurations:**

The foam block test will assess ignition and flame spread to determine if and how inserts contribute to a fire scenario. The foam block test is robust enough to provide the test data necessary to assess fire performance of in-flight a fire scenarios, but will provide valuable information on the flammability properties of the installed configuration relative to ignition potential, flame propagation, and combustion rate dynamics.

The following types of configurations are being considered by the industry team for testing:

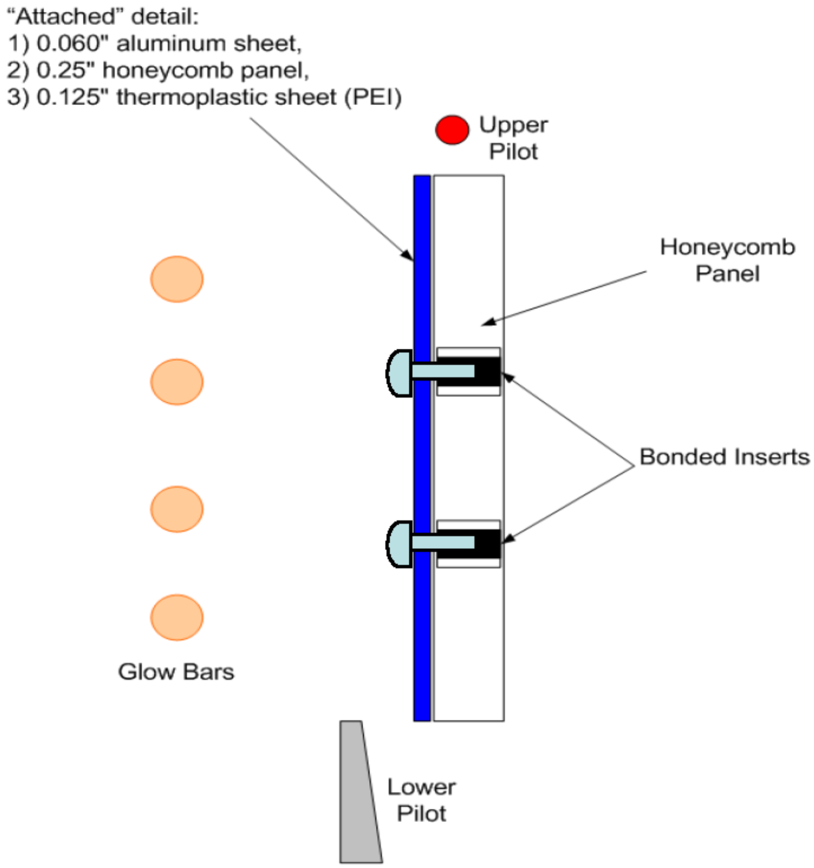
1) Localized patterns (e.g fire extinguisher bracket)
2) Panel edge patterns for attaching trim
3) Rows of Inserts for attaching shelves

The foam block test panel will be approximately 3’ x 5’ honeycomb panel, using standard panel materials. The standard panels will have multiple rows of inserts with different insert spacing to be determined. The team will be considering 1”, 2” and 3” spacing as an initial proposal. This spacing is not meant to define the spacing as a hard requirement, but is meant as a general worse case. Although there may be some localized installations requiring high loads with slightly smaller spacing, this is not common. Full definition of the panel types, insert types, and adhesive materials will be developed based on material characteristic test results. Testing will evaluate the panel without an attached element as worse case.

- **<u>OSU testing of Attached Features:</u>**

OSU test samples will be tested with representative "attached features" installed on the test samples. Comparing these results to the basic material/panel results will provide an understanding of the flammability performance of the actual installed configurations with the goal of validating robust flammability resistance in a post-crash fire scenario. Initial testing indicated that the attached features provide a barrier/shield against the pilot flame/radiant heat and thus have low heat release properties.

The following test configuration is proposed for testing:

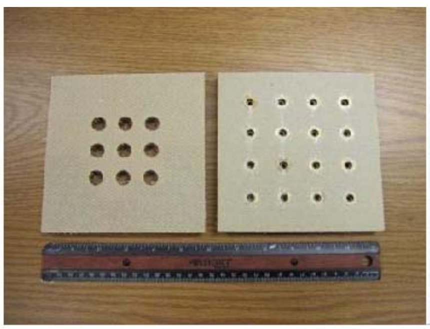


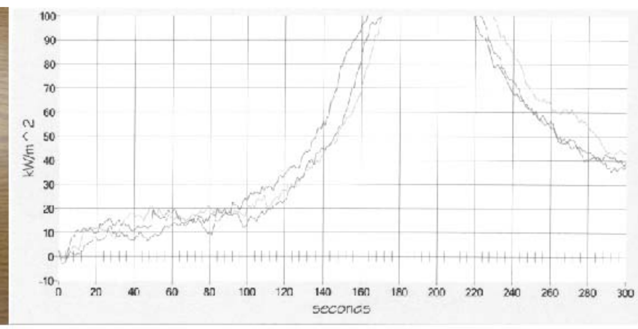
OSU Configuration – Bonded Inserts with Attached Panel

Note: The 2 inserts will be oriented horizontally in the test fixture rather than as shown in the sketch above.

Additional OSU specimens were tested with 9 and 16 inserts installed. Specimens with both good and poor performing adhesives will be used. These specimens will be tested in a worse case configuration without any attached features to understand the combustion dynamics.

Initial results indicated slow developing heat release rates with peak heat release occurring 3 – 4 minutes into the test. This is not unexpected as the adhesive is not directly exposed to the flames and the higher sample mass (e.g. adhesive and inserts embedded in the panel) slows the combustion dynamics. With an attached feature this rate would be slower yet. An example of the heat release specimens (9 and 16 inserts) and the heat release curve with multiple inserts without an attached feature is shown below:





At the beginning of the project, the Industry Team developed a plan to evaluate adhesives used to bond inserts by evaluating adhesives and panels with bonded inserts using Bunsen burner, MCC, OSU/SD of base panels with exposed inserts, and foam block of larger panels with exposed inserts of various spacing. After reviewing the initial test results, the team decided to perform OSU of panels with “attached items” and OSU specimens with 9 and 16 inserts installed. There was discussion that the 9 and 16 inserts panels were not representative of actual installations (see photos in section 3.4) but the team did agree to test these to gain a general understanding of trends.

5.3 TEST RESULTS

The following data summary was available as preliminary data as performed by the FAA Technical Center. This data provides an understanding about the range of flammability properties of different adhesives indicating that adhesive materials and different chemistries can have a range of heat release and char yields properties depending on whether they are reinforced/filled or have fire retardant components.

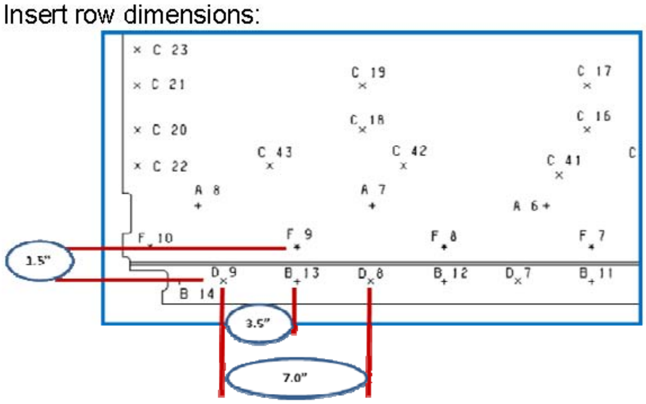
a. MCC data on Magnolia materials, FAATC tested. (Presentation by FAA, January 2010). https://portal.cdzodiac.com/sites/FSTG/GeneralDocumentLibrary/FSTG%20Meeting%20Jan%202010%20(Clearwater%20Beach,%20FL)/MICROSCALE%20CHARACTERIZATION%20OF%20AC%20ADHESIVE-FLAMMABILITY.ppt

b. MCC data comparison of adhesive materials, FAATC tested. (Presentation by FAA, March 2010 and October 2010). This activity is still in development as a separate but

related activity. This provides results on a wide range of adhesives used for bonding/potting applications.
March 2010:
http://www.fire.tc.faa.gov/pdf/materials/March10Meeting/lyons-0310-adehsives.pdf
October 2010:
http://www.fire.tc.faa.gov/2010Conference/files/Advanced_Material_Research_I/SafronavaSimilarity/SafronavaSimilarityPres.pdf

c. Foam block testing on bonded insert in an overhead stowage bin (Boeing data). No ignition or flame propagation was observed even without the trim piece attached.

Insert row dimensions:



The industry members below provided Bunsen burner, foam block, OSU/SD, and MCC data on adhesives and panels with bonded inserts:

- Boeing:
  - Two adhesives, three insert types (2 metal, 1 plastic)
- Magee Plastics:
  - Three adhesives, one insert (metal)
- C&D:
  - Three adhesives, three inserts (1 metal, 2 plastic)
- Bombardier:
  - Two adhesive materials, one insert (metal)

During the development of the data, modified configurations were identified with additional inserts, attached features, etc… For each industry member the following specific data was generated:

- Boeing (Appendix A)
  - 60-sec VBB with bonded inserts
  - 12-sec VBB with bonded inserts
  - 15-sec HBB with bonded inserts
  - OSU/SD on panels with bonded inserts (2 inserts)
  - OSU on panels with 9 and 16 inserts
  - OSU on panels with varying number of inserts with attached features (aluminum, thin composite panel, thermoplastic panel)
  - Foam Block tests on bonded inserts with different spacing using a poor performing adhesive
  - OSU data on adhesive plaque
  - MCC data on adhesive

- Magee Plastics (Appendix B):
  - 60-sec VBB with bonded inserts
  - 12-sec VBB with bonded inserts
  - 15-sec HBB with bonded inserts
  - OSU/SD on panels with bonded inserts (1 and 2 inserts)
  - OSU on panels with 9 and 16 inserts
  - OSU on panels with varying number of inserts with attached features (aluminum, thin composite panel, thermoplastic panel)
  - OSU data on adhesive plaque
  - MCC data on adhesive

- C&D Zodiak (Appendix C)
  - 60-sec VBB with bonded inserts
  - 12-sec VBB with bonded inserts
  - 15-sec HBB with bonded inserts
  - OSU/SD on panels with bonded inserts (1 and 2 inserts)
  - OSU on panels with 9 and 16 inserts
  - OSU on panels with varying number of inserts with attached features (aluminum, thin composite panel, thermoplastic panel)
  - MCC data on adhesive

- Bombardier (Appendix D)
  - 60-sec VBB with bonded inserts
  - 12-sec VBB with bonded inserts
  - 15-sec HBB with bonded inserts
  - OSU/SD on panels with bonded inserts (1 and 2 inserts)
  - MCC data on adhesive

A data summary of the results is presented in each referenced Appendix. Appendix E contains a summary of all MCC and OSU on plaques.

5.4 ANALYSIS OF TEST RESULTS

The data generated by each industry member has been evaluated separately and summarized in Appendices to this final report. Included in this section is a general summary of the analysis. Overall the flammability behavior seen from the data submitted by each industry member shows the same trends.

Vertical Bunsen burner results on panels with bonded inserts showed that burn lengths were dictated by the honeycomb panel materials and were not impacted by the different insert adhesives. The after flame times did vary depending on the adhesive since the specimen was cut to expose the adhesive to the flame. The adhesives that were filled/fire retarded had shorter after flame times than those that were not fire retarded. Those that were not fire retarded often had after flame times exceeding the regulation requirements. Horizontal Bunsen burner test results met the regulation requirements for all adhesives supporting that even if the adhesive is exposed, it would not propagate along the panel surface.

Foam block testing of larger panels with exposed bonded inserts did not ignite or propagate flame for insert spacing as close as 1”. Details of the test configuration and results are found in Appendix A.

Smoke density results varied for panels with 1 and 2 insert exposed depending on the adhesives used. Some adhesives showed an increase in smoke density output when 2 inserts were used compared to a single insert while other adhesives did not show significant differences. The results were well within the smoke optical density requirements.

Heat release testing was attempted on adhesive resin plaques even though this configuration was not representative of installed configurations. The FAA Technical Center graciously offered to test plaques and it quickly became clear that when a large quantity of adhesive is completely exposed the heat release properties of the bulk adhesives are very high. Only a few different adhesives were evaluated over concern that combustion may cause damage to the OSU machine. Although very little testing was performed, it was clear from the data that was generated that variation exists across different adhesives. MCC results on the adhesives provided another good understanding of bulk material characteristics of the adhesives in terms of heat release and char yields. Those adhesives with fillers/fire retardants had higher char yields and lower heat release rates than unfilled adhesives. The MCC results allowed selection of good and poor performing adhesives for further evaluation of inserts installed in honeycomb panels. Data is summarized in Appendix E.

Heat release test results of panels with exposed bonded inserts indicated that as the number of inserts increases, the heat release peaks increase while the 2-minute totals are reduced. The peak heat release for all samples occurs late into the 5 minute test as the combustion process slowly gets underway while the internal adhesive becomes involved. When an “attached feature” is included in the tested configuration, heat release results are dominated by the attached feature regardless of whether the attached feature is aluminum, composite panel, or thermoplastic, and the adhesive had no affect on the results.

Overall, the industry team is satisfied with the large amount of data on different panels, different adhesives and different inserts. Defining the attributes of bonded insert used in traditional aerospace design provides the context and intent for the application of this MoC. The data has provided confirmation that bonded inserts used in aerospace applications will not impact flammability performance of interior commodities.

6. CONCLUSION

The industry team agrees with the FAA's position on item #42 Bonded Inserts for both 14 CFR 25.853 (a) and (d), and has provided additional criteria to ensure that the current industry practice and general usage of bonded inserts in aerospace interiors is defined. The flammability performance of bonded inserts does not adversely impact the flammability performance of installed interior commodities regardless of the adhesive material used. As defined in this report, the proposed MoC is applicable when inserts are bonded individually in localized areas and where the adhesive diameter is approximately 3 times (or less) the insert diameter. This will minimize the bulk adhesive used. This MoC is not applicable where a block of adhesive/potting compound is installed in a panel and then multiple inserts are installed in this "block" of adhesive. This MoC does not require any spacing criteria, although this MoC is not applicable to a "pegboard" configuration where a significant portion of a panel has multiple inserts in a pattern to accommodate the attachment of an item in different areas of the panel.

Based on industry definition of bonded insert attributes used in aerospace designs and the results of the flammability testing performed and analyzed as part of this document, the industry team recommends providing the improved definitions provided in this final report and adopting the draft policy with additional criteria defined below.

Reference Number	Feature / Construction	25.853(a) Bunsen Burner Test Requirement/Similarity	25.853(d) Heat Release and Smoke Test Requirement/Similarity
42	Bonded Inserts	No test requirement for bonded inserts that are potted individually with adhesive localized to each insert. The bonded inserts shall not make up a majority of the panel area.	No test requirement for bonded inserts that are potted individually with adhesive localized to each insert. The bonded inserts shall not make up a majority of the panel area.

7. ABBREVIATIONS

FAA	=	Federal Aviation Administration
MOC	=	Methods (or Means) of Compliance
CFR	=	Code of Federal Regulations

8 REFERENCES

[1] Gardlin, Jeff, *FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of Interior Materials*, Department of Transportation, Federal Aviation Administration, August 2009.

[2] n.n., *14 CFR Part 25, [Docket No. 24594; Amendment No. 25-61], Improved Flammability Standards for Materials Used in the Interiors of Transport Category Airplane Cabins,* Department of Transportation, Federal Aviation Administration, July 1986.

[3] n.n., *14 CFR Part 25, [Docket No. 24594; Amendment No. 25-66], Improved Flammability Standards for Materials Used in the Interiors of Transport Category Airplane Cabins*, Department of Transportation, Federal Aviation Administration, August 1988.

APPENDIX A
Boeing Data

In support of the industry team, Boeing provided test data using two different insert adhesives. One is considered a “potting material” that contains fillers and fire retardants to enable it to pass a 12-second Bunsen burner test required as part of Boeing’s material specification requirements. The specific product is Magnolia 92-1 and is considered a good performing adhesive. The second material is a 2-part adhesive that does not contain fire retardants. The specific product is 3M EC2615 and is considered a poor performing adhesive due to the long extinguishing times often observed in a vertical Bunsen burner test.

These two adhesives were evaluated when used to install inserts in a standard phenolic honeycomb panel using three different types of inserts; 1) metal, blind insert, 2) metal, through, 3) plastic, through. Panels with inserts were tested using Bunsen burner, foam block testing, OSU/Smoke, and MCC. In addition to these basic tests on the panels with the inserts exposed, OSU was also performed on panels with a varying number of inserts with “attached” features secured to the inserts to evaluate the performance of as-installed configurations. Data is summarized below:

Bunsen Burner Results:

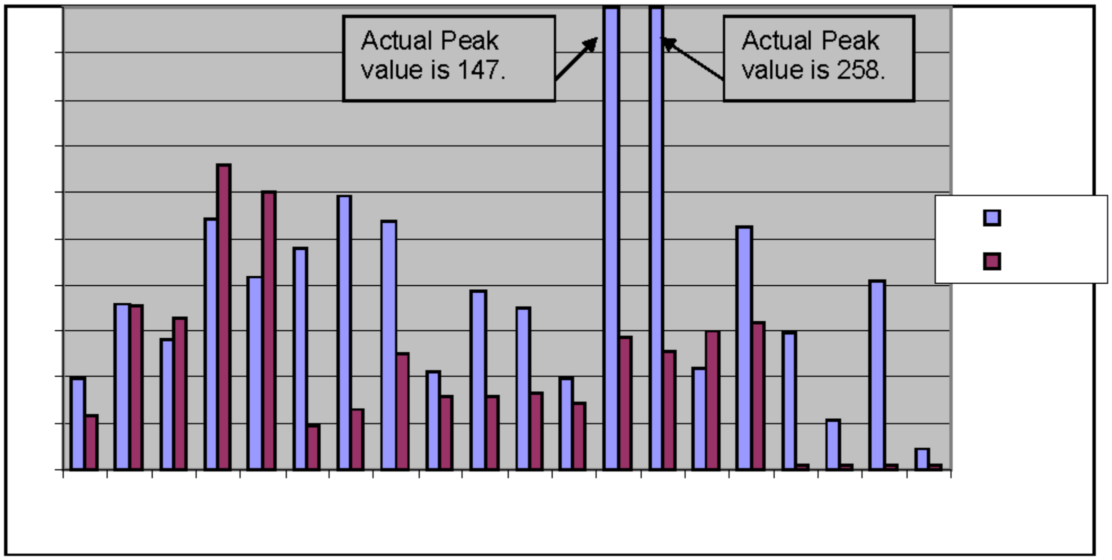
The Bunsen burner results demonstrate that burn length on the surface of the panel is mainly driven by the properties of the honeycomb panel and not significantly impacted by the type of adhesive or insert. The extinguishing time results illustrate the potential for some adhesives to have long extinguishing times since the adhesive is directly exposed to the Bunsen burner flame as the sample is cross-sectioned through the adhesive. The horizontal test confirms that no propagation occurs from one insert to another, again the panel material drives the results.

			F1			F2			F3
Insert	Insert Type	Adhesive	EXT TIME	LENGTH	DRIP	EXT TIME	LENGTH	DRIP	BURN RATE
None	None	None	0	1.5	NB	0	0.6	NB	0
Metal	Blind	EC2615	86	2.6	NB	0	0.4	NB	0
Metal	Thru	EC2615	226	2.9	NB	2.6	0.3	NB	0
Plastic	Thru	EC2615	0	1.6	NB	0	0.6	NB	0
Metal	Blind	92-1	0	1.9	NB	0	0.4	NB	0
Metal	Thru	92-1	0	1.7	NB	0	0.4	NB	0
Plastic	Thru	92-1	0	1.6	NB	0	0.4	NB	0

OSU Results:

Considerable OSU testing was performed on many different configurations. Some of the testing was performed at the FAATC and others performed at Boeing. Where the same configuration was tested at both labs, there were some difference in the results, illustrating the variation in the OSU test apparatus. Even so, the results provided a good understanding of OSU performance of panels with inserts in several different configurations. Samples with 2, 9, and 16 inserts were evaluated with the inserts exposed. Samples with 2 and 9 inserts with secured “attached” features were also tested. The attached features consisted of 0.06” aluminum sheet, 0.125 thermoplastic sheet, and 0.25” composite panel. The results provided an understanding of the combustion dynamics with an embedded bonded insert and the protection that attached features provide. The attached feature creates a barrier to the base panel where the insert is installed. The results are summarized below:

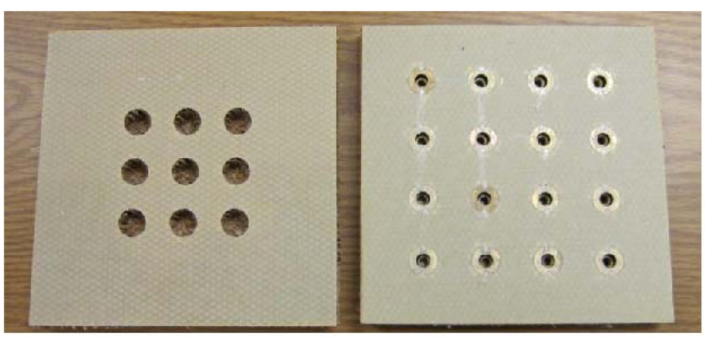
	Panel Description	**Peak**	**2-min Total**
1	Control, Base Panel 0.5" (Tested at FAATC, 1/2011)	19.6	11.6
2	Control, Base Panel 0.5" (Tested at Boeing, 2/2011)	35.9	35.4
3	Control, Base Panel w/2 holes (Tested at Boeing)	28.4	32.9
4	Control, Base Panel w/9 holes (Tested at Boeing)	54.3	65.9
5	Control, Base Panel w/16 holes (Tested at Boeing)	41.6	60.0
6	2 Insert, metal Thru (EC2615) (Tested at FAATC, 1/2011)	47.80	9.40
7	2 Insert, metal Blind (EC2615) (Tested at FAATC, 1/2011)	59.00	12.80
8	2 Insert, metal Blind (EC2615) Boeing	53.80	25.10
9	2 inserts, Plastic (EC2615) (Tested at FAATC, 1/2011)	21.30	15.90
10	2 Insert, metal, Thru (92-1) (Tested at FAATC, 1/2011)	38.50	15.50
11	2 Insert, metal, Blind (92-1) (Tested at FAATC, 1/2011)	34.90	16.60
12	2 inserts, Plastic (92-1)	19.80	14.50
13	9 inserts, Metal, Blind (EC2615)	146.7	28.80
14	16 inserts, Metal, Blind (EC2615)	258.5	25.40
15	"Attached Feature" - 0.25" composite panel	21.89	29.93
16	2 insert w/attached 0.25" composite panel (EC2615)	52.3	31.8
17	"Attached Feature" - 0.06" thermoplastic sheet	29.4	1.0
18	"Attached Feature" - 0.06" thermoplastic sheet with 9 screws	10.8	1.0
19	9 insert w/attached 0.06" thermoplastic sheet (EC2615)	40.7	1.0
20	2 insert w/attached 0.06" aluminum sheet (EC2615)	4.4	1.0



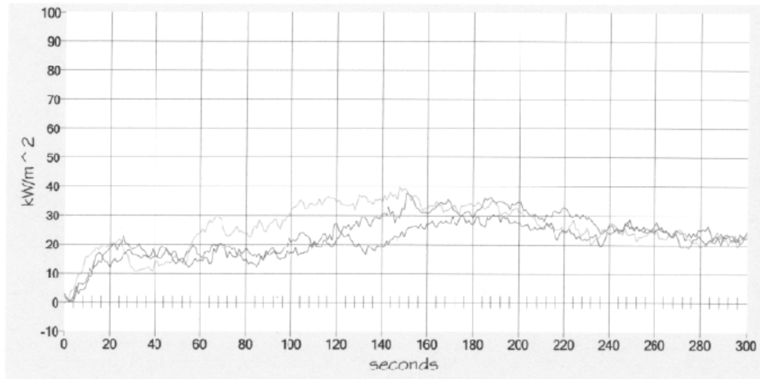
Boeing OSU Results

The results show very clear trends on the performance of a panel and the effect of inserts and attached features. The following general observations are noted:

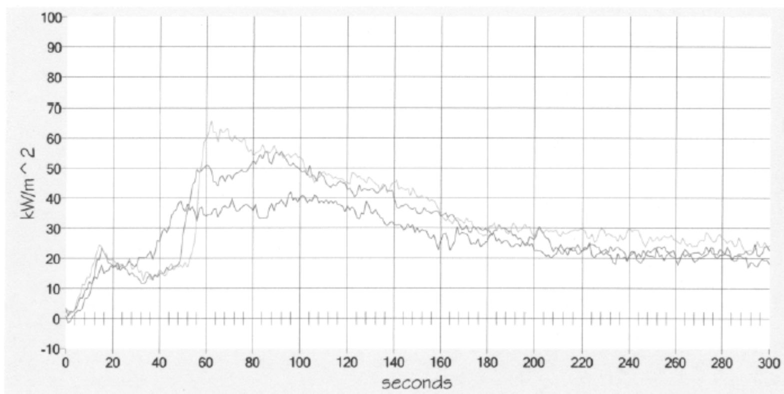
1. Using a base panel that has OSU peak/total values of approximately 35/35, cutting 2 holes in the panel for inserts and testing without the inserts does not change the results significantly. By cutting 9 or 16 holes in the panel raises the OSU values. By exposing the core, total combustion is greater. These results demonstrate the excellent protection that the composite skin provides to the honeycomb construction by creating a barrier to the exposed pilot flame and heat flux.



OSU panels with 9 holes OSU Panel with 16 inserts

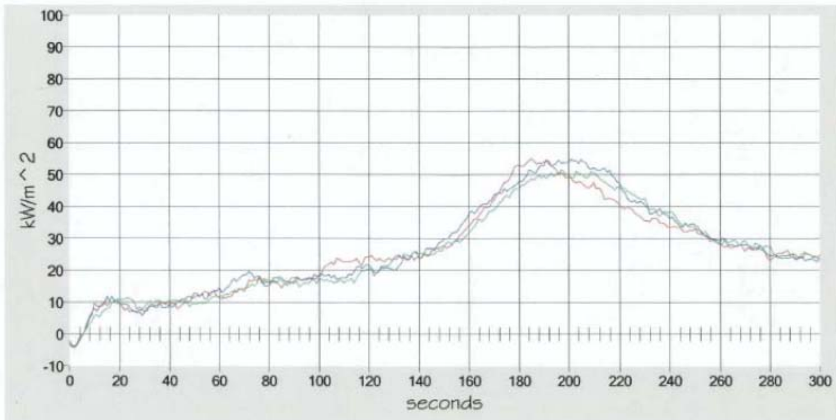


OSU of Base Panel; 35/35



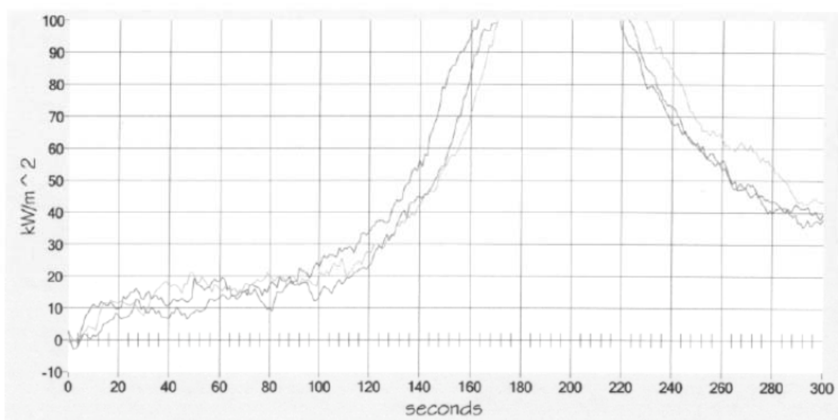
OSU with 9 holes for inserts; 54/66

2. A panel with 2 bonded inserts (exposed; no attached feature) provides an OSU value of 54/25 KW/m2. The total HR is lower and the HR peak is elevated. The time at which peak occurs is 3 – 4 minutes into the test, demonstrating the barrier/heat sink properties being provided by the insert/adhesive mass during the initial part of the test.



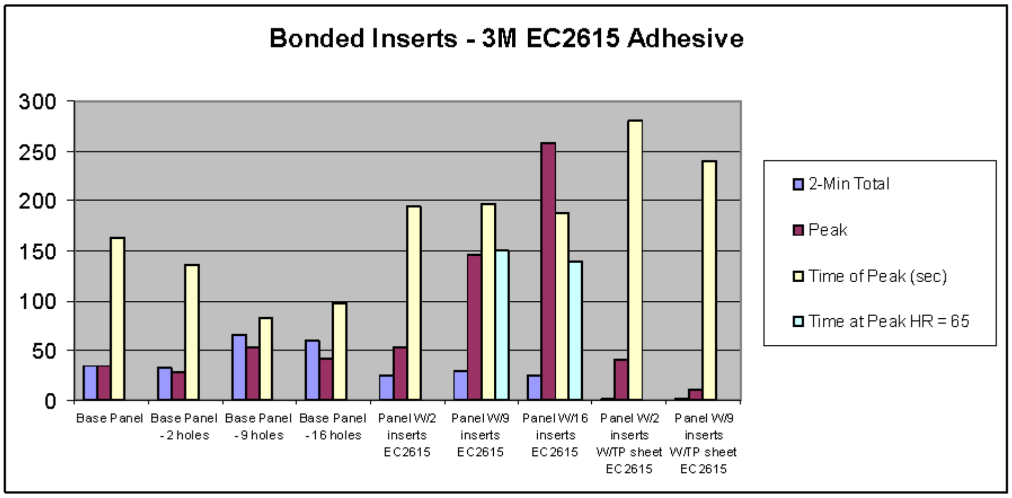
OSU of 2 Bonded Inserts Exposed; 54/25

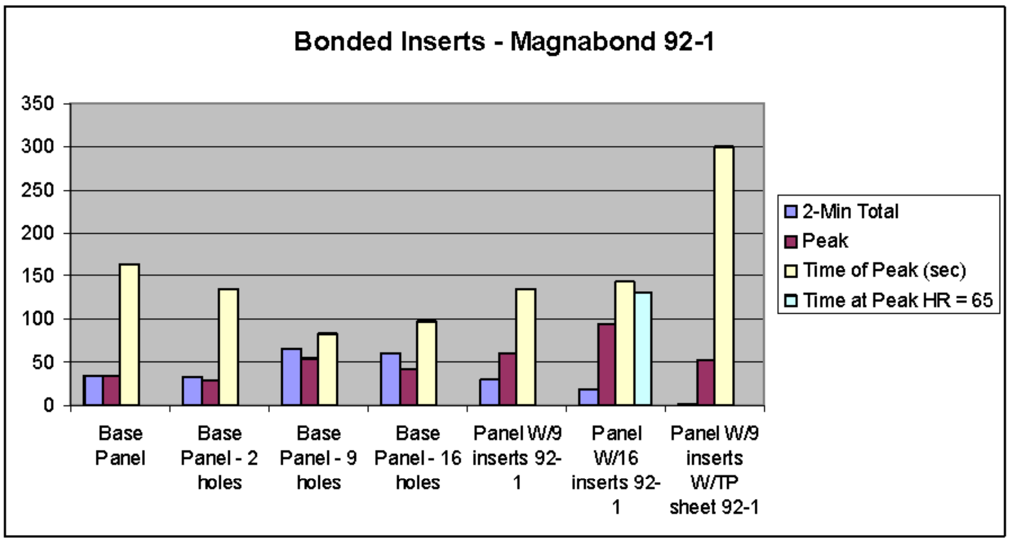
3. Configurations with 9 and 16 inserts in the OSU specimen indicate similar trends seen in the the 2 insert panel where the peak HR is elevated yet is happening more than 3 minutes into the test. The peak HR is higher with 9 inserts compared with 2, and higher with 16 inserts than 9, which indicates that with more inserts and adhesives, more material will eventually engage in the combustion process. This behavior is observed with both adhesives with the non-fire retarded adhesive having higher HR peaks.



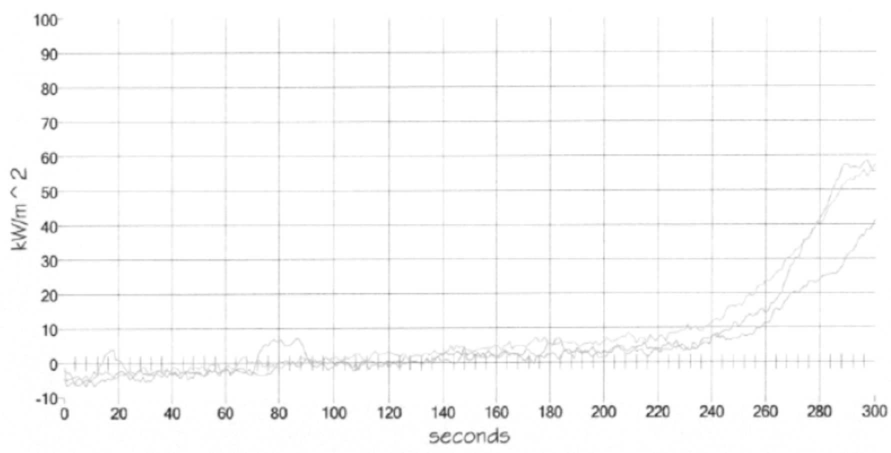
OSU with 9 bonded inserts exposed; 146/29

Another observation of these OSU specimens with several exposed bonded inserts is the time at which the heat release rate exceeds 65. The summary charts below provide a comparison of the different configurations for each adhesive. For samples with 9 and 16 inserts, the peak HR is much higher than 65, yet is happening very late in the test at 3 minutes or later. The time at which the HR reaches 65 is also quite late in the test (over 2 minutes) demonstrating the slow progressing combustion of the overall panel and the internal adhesive. These same samples when tested with a representative attached feature show that the inserts and underlying panel have little impact on the OSU results, which are driven by the attached feature.





4. Configurations tested with an attached panel representative of an actual installation illustrate that the attached item creates a protective barrier and further delays combustion of the insert adhesive the involvement of the insert and underlying panel is insignificantly involved in the OSU results. The OSU results are similar to the OSU properties of the attached panel by itself. Aluminum sheet created a complete barrier shield and resulted in no HR peak and totals. The composite and thermoplastic sheet did indicate that some minimal contribution was provided by the underlying panel with inserts, but it is not significant. A run chart of the 9 insert panel with the non-fire retarded adhesive is shown below.



OSU with 9 bonded inserts with attached thermoplastic sheet; 52/1

Smoke Optical Density Results:

The smoke optical density results indicate that panels with exposed inserts result in higher levels of smoke emission than the base panel. All results were well below the 200 Ds limit. The non-fire retarded adhesive had lower smoke results than the fire retarded adhesive, demonstrating that the fire retardants used to provide improved Bunsen burner properties can have a tendency to create higher levels of smoke. This trend is not uncommon and generally known within the industry.

Panel	Smoke Optical Density
Control Panel, Bare, 0.5"	4.3
2 Insert, metal Thru (EC2615)	7.30
2 Insert, metal Blind (EC2615)	28.20
2 inserts, plastic Thru (EC2615)	24.00
2 Insert, metal, Thru (92-1)	106.40
2 Insert, metal, Blind (92-1)	42.60
2 inserts, Plastic, Thru (92-1)	37.6

Summary:

OSU test results showed a consistent behavior of having slow progressing combustion when the inserts are exposed (no attached feature). This slow progressing behavior is independent of whether the adhesive is fire retarded or not, although non-fire retarded adhesives have higher peak values.

Test results with attached panels demonstrate very similar behavior to the attached panel when tested alone. This demonstrates that the attached item creates a barrier which protects the inserts from direct flame/heat impingement which essentially eliminates any contribution of heat release from the insert adhesive.

These results support that bonded inserts used in designs meeting the boundary conditions defined do not pose a post-crash fire risk. This testing was designed to be worse case by evaluating the exposed bonded inserts using a non-fire retarded adhesive. These results support the “no test” requirement for bonded inserts.

APPENDIX A-1
Foam Block Test Results

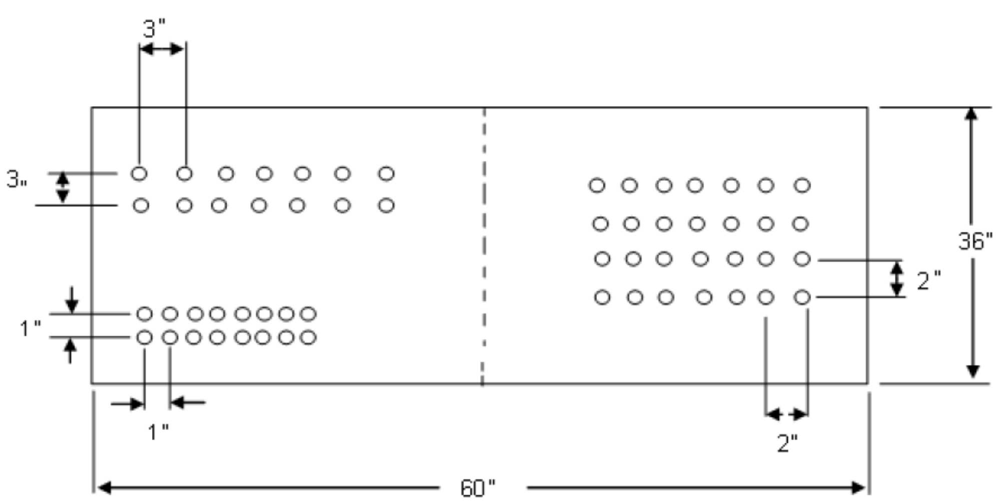
Overview:
Boeing has generated flammability foam block data to support a common Method of Compliance for all bonded inserts. This data summary is being submitted to the Industry Team item #42 to support the proposal for "no test requirement."

Test Configuration Summary:
The test parts consisted of a standard nonmetallic honeycomb panel construction with one ply of phenolic preimpregnated glass fabric on each surface. Metal inserts were potted using a 2-part epoxy (3M EC-2615 B/A) that does not contain fire retardants. Insert spacing of 1, 2 and 3" were evaluated. The inserts were tested exposed without any attached features and represents worse case fire impingement. The areas with inserts were subjected to the foam block ignition with the panel oriented horizontally and at a 65 degree incline.

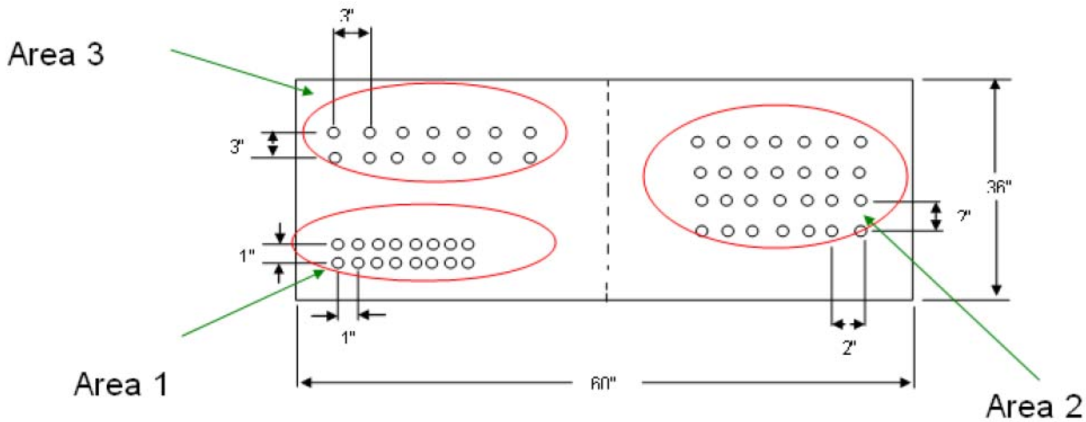
Test Plan for Foam Block Testing:
Panel:
- Nonmetallic honeycomb panel 60.0" x 36.0" x 0.5"
- 1 Layer of phenolic preimpregnated glass fabric (on each surface)
- No decorative laminates

Inserts:
- Metallic blind inserts, hole in panel drilled at 0.575"
- 0.561" diameter
- 0.375" length

Adhesive:
- Two part epoxy compound 3M EC-2615 B/A
- Adhesive injected around insert through holes in flange of insert



Two panels were tested in the three areas of the panel as shown in the sketch below. Areas 1, 2 and 3 contain potted inserts with 1", 2" and 3" spacing (center to center) respectively.


Area 3
3"
3"
36"
2"
1"
1"
2"
60"
Area 1
Area 2

<u>Test Configurations:</u>

Panel 1	Panel 2
Area 1: Horizontal Test (P1-HORIZ-A1)	Area 1: 65 degrees Test (P2-65Deg-A1)
Area 2: Horizontal Test (P1-HORIZ-A2)	Area 2: 65 Degrees Test (P2-65Deg-A2)
Area 3: 65 degrees Test (P1-65DEG-A3)	Area 3 Horizontal Test (P2-HORIZ-A3)

Foam block testing was performed on two configurations in a horizontal orientation to obtain direct flame impingement and at a 65 degree incline to evaluate vertical flame propagation as shown in the figures below.

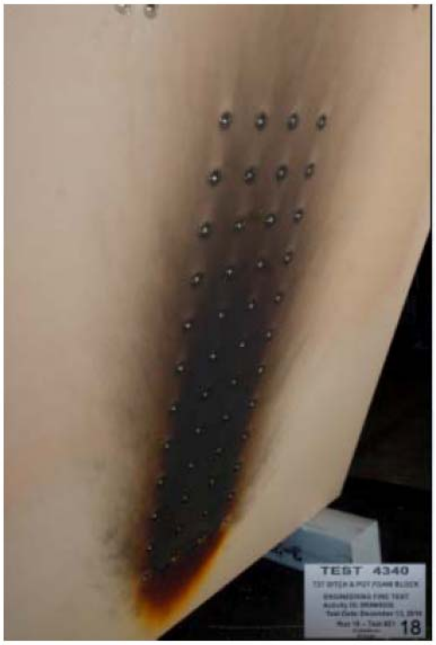
65 Degree Incline Orientation

Horizontal Orientation

Summary of Test Results:

<u>65 Degree Foam Tests:</u>
The pictures below show the 65 degree results of the foam block test in all three areas of the panel (1”, 2” and 3” insert distance). The test showed the following observations:

P2-65-Deg-A1 (1” spacing) **P1-65Deg-A2 (3” spacing)**



P1-65Deg Test-A3 (2” spacing)

Summary of test observations:

1) No ignition of panel or adhesive
2) No Flame propagation
3) No panel flame penetration

Horizontal Foam Block Tests Results:
The pictures below show the 65 degree results of the foam block test in all test areas (1", 2" and 3" insert distance). The test showed the following observations:

P1-Horiz-A1 (1" spacing)

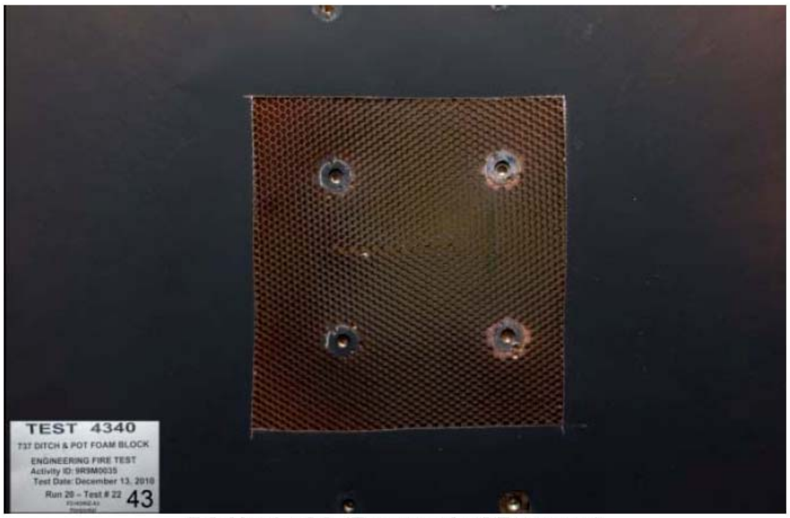
P1-Horiz-A2 (2" spacing)

P2-Horiz-A3 (3" spacing)

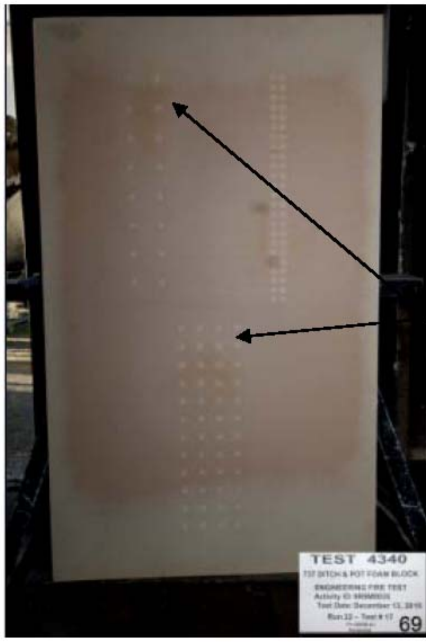
Summary of test observations:
- No Ignition after flame
- No flame propagation
- No fire flame penetration

Fire Penetration

Removal of the phenolic fiberglass skin after the horizontal test was performed to further inspect the panel for any major damage and fire penetration. As observed in picture below (Removal of Prepreg), there is no major fire damage to the core or adhesive surrounding the inserts. Additionally, the “backside” picture shows the backside of panel 2 after being tested in all three areas. No fire penetration is shown.



P2-Horiz-A3 (Removal of Prepreg)



Backside of Panel 2 after testing – Slight discoloration of heat effected area

P2-Horiz-A3 (Backside)

<u>Summary:</u>
Foam block test results showed very consistent flammability resistance regardless of insert spacing distance or test sample orientation. For all six foam block tests the same observations were made:

- No adhesive ignition
- No flame propagation
- No fire flame penetration

These results demonstrate that bonded inserts do not pose an in-flight fire risk. This testing was designed to be worse case by evaluating the exposed bonded inserts and using a non-fire retarded adhesive, and support the "no test" requirement for bonded inserts.

APPENDIX B
Magee Plastics Data

Magee Plastics provided substantial data on three adhesives as follows:
1) 3M DP100 – 2-part epoxy, non-fire retarded
2) 3M DP110 – 2-part epoxy, non-fire retarded
3) Epocast 1617 – 2 part epoxy, potting material, with fillers and FRs

These materials were evaluated in standard phenolic honeycomb panels with metal inserts.

All the data is reported in Test Report MFR-20100101, Revision E dated March 25. 2011. A summary of the data is provided below.

Bunsen Burner Results:

The Bunsen burner results indicate long extinguishing times while the burn lengths are small. These results are typical when a cross-section is taken through the bonded insert exposing the internal adhesive to the direct flame. The burn length is slightly longer when compared to the control panel, but even with the long extinguishing time, the burn lengths are not significantly impacted.

Magee Bunsen Burner Data

	F1			F2			F3
	EXT TIME	LENGTH	DRIP	EXT TIME	LENGTH	DRIP	BURN RATE
Control Panel	0	0.9	NB	0	0.3	NB	0
3M DP100	226	2.6	NB	316	2.23	NB	0
3M DP110	343	2.6	NB	274 *	1.2	2.3	0
Epocast 1617	17.3	2.3	NB	0	1.1	NB	0

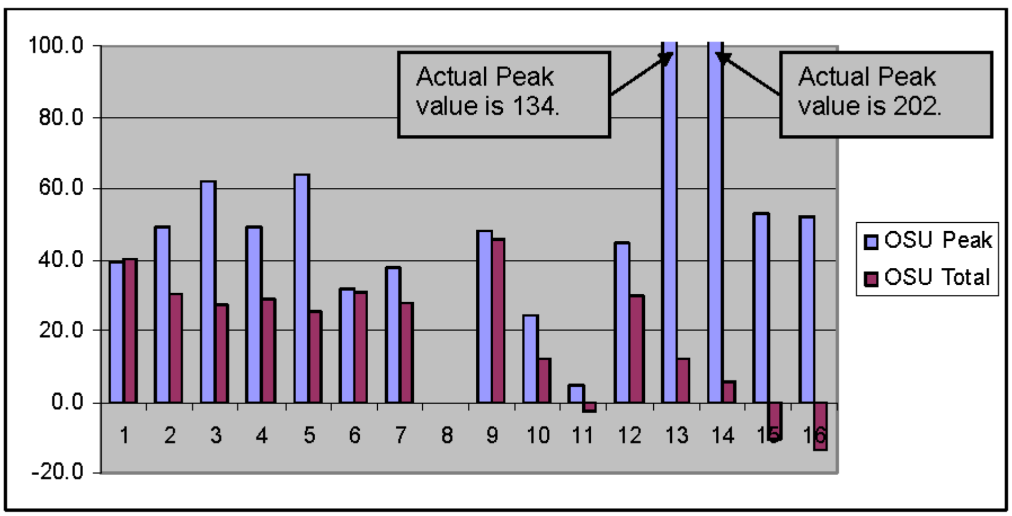
* Individuals of 0, 373, 449

OSU Results:

The OSU results show that there are differences between the adhesive types likely due to the chemical composition and filler/fire retardant levels. The OSU run graph illustrates the slow rate of combustion due to the honeycomb panel and insert/adheisve mass creating a slow developing combustion profile. The peak heat release continues to rise during the 4 minute test as the internal adhesive slowly develops and contributes to the heat release. In most cases the peak is occurring 3 to 4 minutes into the test.

The OSU results which include representative attached features confirm that the attached feature drives the OSU results and creates a barrier that protects the underlying panel containing the insert/adhesive. See table and graph below.

Config	Description	OSU Peak	OSU Total
1	Control, **Panel 0.5"**	39.2	40.3
2	1 Insert, metal (DP100)	49.30	30.30
3	2 Insert, metal (DP100)	62.00	27.60
4	1 Insert, metal (DP110)	49.10	28.70
5	2 Insert, metal (DP110)	64.10	25.20
6	1 Insert, metal (Epocast 1617)	31.80	30.80
7	2 Insert, metal (Epocast 1617)	37.90	27.80
8	"Attached Feature" 0.25" panel (#12)	TBD	TBD
9	"Attached Feature" 0.08" TP Kydex (#14)	48.16	45.47
10	2 insert w/attached 0.25" composite panel (#15)	24.50	12.10
11	2 Insert w/alum 0.063" (#16)	4.7	-2.7
12	2 insert w/TP 0.08" Kydex (#17)	44.5	29.9
13	9 inserts (#19)	133.6	11.9
14	16 inserts (#18)	202.2	5.5
15	9 inserts w/TP 0.08" Kydex (#21)	53.3	-10.4
16	16 inserts w/TP 0.08" Kydex (#20)	52.1	-13.4



Magee Plastics OSU Results

Smoke Optical Density Results:

The Smoke optical density results illustrate that different adhesives can have different levels of smoke emission. This is due to the different chemical composition of the adhesives. Some adhesives have low smoke emission while some have higher values into the mid 100’s. When comparing the results of a single insert with a sample with two inserts, some adhesives show little difference while one shows an increase from 1 to 2 inserts due to the increased volume of adhesive. Also it is noted that the combustion dynamics shows the smoke release is happening late in the test illustrating the affect the composite skin and insert mass has on protecting and delaying combustion of the internal insert adhesive. When comparing these results with the Bunsen burner and OSU results, there is not always a correlation between smoke release and flammability properties.

	Smoke Optical Density
A = Control, **Panel 0.5"**	7.2
B = 1 Insert, metal (DP100)	12.35
C = 2 Insert, metal (DP100)	11.02
D = 1 Insert, metal (DP110)	11.06
E = 2 Insert, metal (DP110)	9.19
F = 1 Insert, metal (Epocast 1617)	73.45
G = 2 Insert, metal (Epocast 1617)	130.45
H1 = 0.25" panel (attached item #12)	TBD
H2 = 0.08" TP Kydex (Attached item (#14)	146.70
H = 2 insert w/attached 0.25" composite panel (#15)	7.90
I = 2 Insert w/alum 0.063" (#16)	0.6
J = 2 insert w/TP 0.08" Kydex (#17)	106.6

APPENDIX C
C&D Zodiak Data

C&D Zodiak provided a large quantity of data using three different adhesives and different inserts installed in different thickness honeycomb panels. The three adhesives used are as follows:

1) L-318FR – 2-part epoxy adhesive with FRs
2) Epibond 420 – 2-part non fire retarded epoxy
3) Epocast 1618 – 2-part epoxy potting material with fillers and FRs

A summary of the results is provided below.

Bunsen Burner Results:

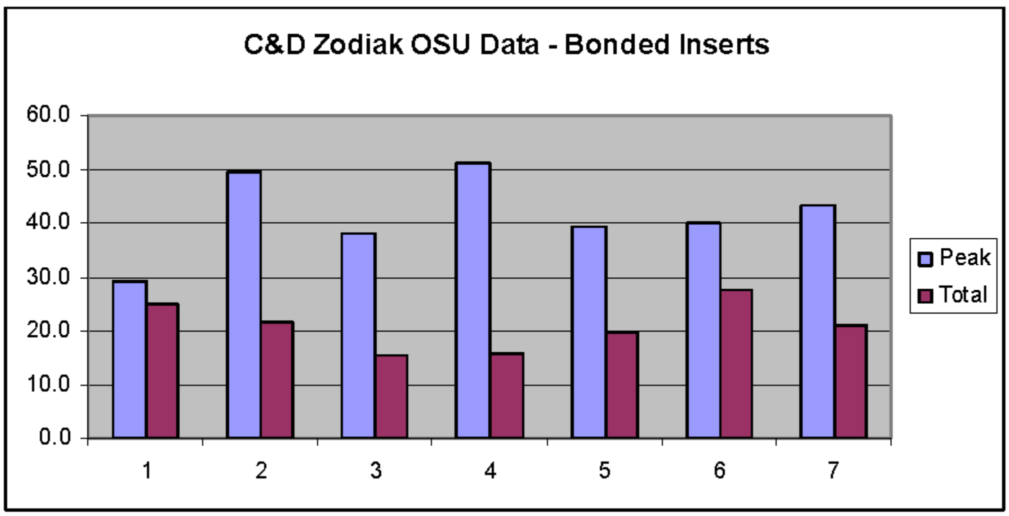
The Bunsen burner results indicate long extinguishing times in the 60-sec VBB while the burn lengths are small. For some adhesives there is a relationship to the panel thickness, with the 0.25” panel showing longer extinguishing times as compared with 0.5” and 0.75” panels. The sample mass reduces the potential for combustion to continue which is consistent with the “thin for thick” compliance MoC when testing with the Bunsen burner. These results are typical when a cross-section is taken through the bonded insert exposing the internal adhesive to the direct flame. The burn length is slightly longer when compared to the control panel. Even with the long extinguishing time, the burn lengths are not significantly impacting the burn length.

			F1			F2			F3
	Insert	Adhesive	EXT TIME	LENGTH	DRIP	EXT TIME	LENGTH	DRIP	BURN RATE
Control Panel 0.25"	None	None	0.0	1.1	ND	0.0	0.6	ND	0
Control Panel 0.5"	None	None	0.0	1.0	ND	0.0	0.5	ND	0
Panel 0.25"	metal	318	53.1	1.8	ND	0	0.1	ND	0
Panel 0.5"	metal	318	6.7	1.6	ND	0.0	0.1	ND	0
Panel 0.5"	plastic	318	0.0	1.7	ND	0.0	0.2	ND	0
Panel 0.75"	metal	318	0.0	1.5	ND	0.0	0.2	ND	0
Panel 0.25"	metal	1618	47.2	2.4	ND	0.0	2.3	ND	0
Panel 0.5"	metal	1618	28.1	1.9	ND	0.0	0.2	ND	0
Panel 0.5"	plastic	1618	6.6	1.6	ND	0.0	0.2	ND	0
Panel 0.25"	metal	420	45+	2.4	ND	0.0	0.2	ND	0
Panel 0.5"	metal	420	60+	2.6	ND	0.8	0.2	ND	0
Panel 0.5"	plastic	420	60+	2.1	ND	0.0	2.1	ND	0

OSU Results:

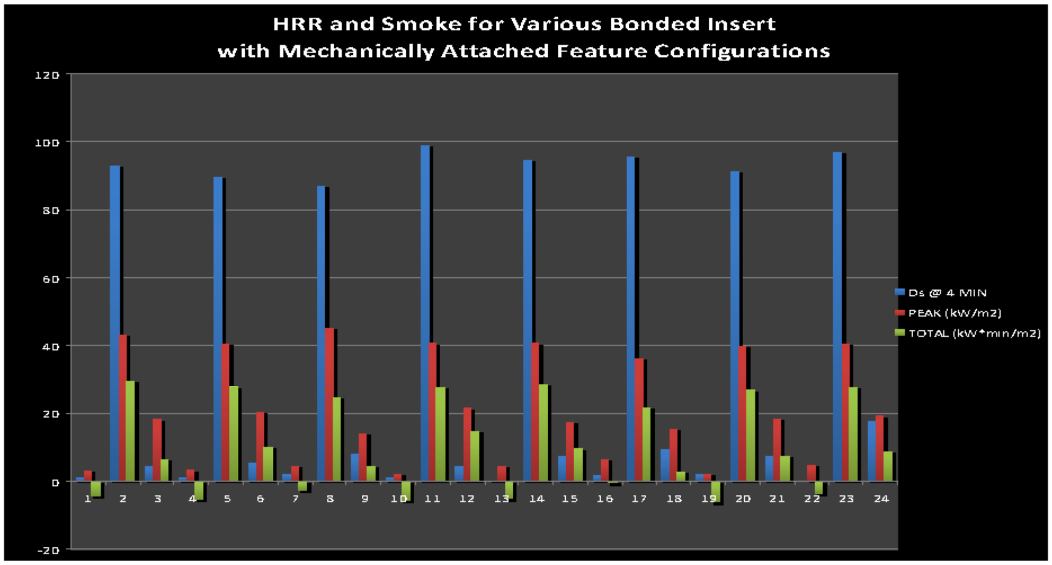
OSU results on 0.,5” honeycomb panels with 2 exposed inserts installed are shown below. The results demonstrate similar performance as other member data, where the peak HR is higher than the base panel, and total HR is generally lower.

Sample	Description	Peak	Total
1	Control, **Panel 0.5"**	29.2	25.0
2	2 Insert, metal (Adhesive 318)	49.38	21.75
3	2 Insert, metal (Adhesive 1618)	37.91	15.32
4	2 Insert, metal (Adhesive 420)	51.01	15.89
5	2 Insert, non-metal (Adhesive 318)	39.21	19.51
6	2 Insert, non-metal (Adhesive 1618)	39.98	27.47
7	2 Insert, non-metal (Adhesive 420)	43.40	20.96



OSU results with attached features indicate the results are dominated by the performance of the attached feature. Data on 4 different adhesives, with metal and plastic inserts, indicate no significant difference between the different adhesives or the inserts. With 0.06” aluminum sheet as the attached feature, the peak HRR, total HR, and smoke density values are essentially zero as the aluminum acts as a barrier to the underlying panel. When using 0.125” Boltaron as the attached feature, the peak heat release values are all around 40 while the total heat release is around 25. The smoke density values are around 80 – 90. These values are similar to the Boltaron by itself (peak HRR = x, total HR = x, smoke = y). When using a thin honeycomb panel, the results are around 20/20 which is similar to the panel tested alone. See table and graph below.

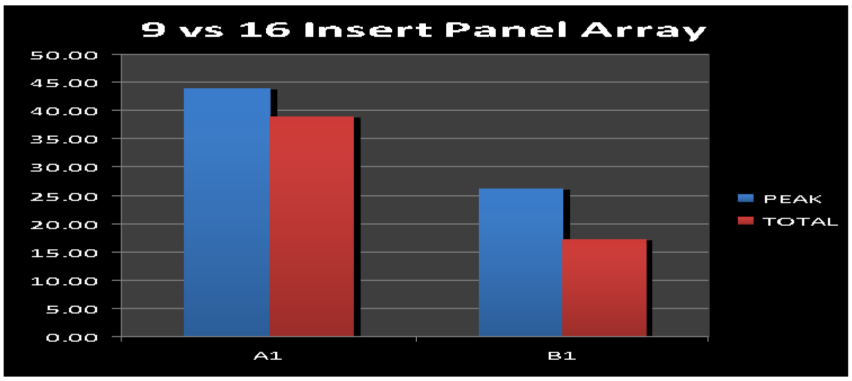
					HEAT RELEASE		SMOKE DENSITY
ITEM #	POTTING ADHESIVE	PANEL	INSERT MATERIAL	ATTACHED SURFACE	PEAK (kW/m^2)	TOTAL (kW*min/m^2)	D_s @ 4 MIN
1	L-318	CDM050-60 (.500")	METAL	ALUMINUM (.060")	3.11	-4.37	1
2	L-318	CDM050-60 (.500")	METAL	BOLTARON 9815E (.125")	43.20	29.68	93
3	L-318	CDM050-60 (.500")	METAL	CDM031-60 (.250")	18.23	6.62	5
4	L-318	CDM050-60 (.500")	PLASTIC	ALUMINUM (.060")	3.42	-5.36	1
5	L-318	CDM050-60 (.500")	PLASTIC	BOLTARON 9815E (.125")	40.47	27.80	90
6	L-318	CDM050-60 (.500")	PLASTIC	CDM031-60 (.250")	20.60	10.06	6
7	EPIBOND 420	CDM050-60 (.500")	METAL	ALUMINUM (.060")	4.55	-2.60	2
8	EPIBOND 420	CDM050-60 (.500")	METAL	BOLTARON 9815E (.125")	45.33	24.62	87
9	EPIBOND 420	CDM050-60 (.500")	METAL	CDM031-60 (.250")	14.22	4.59	8
10	EPIBOND 420	CDM050-60 (.500")	PLASTIC	ALUMINUM (.060")	2.09	-5.64	1
11	EPIBOND 420	CDM050-60 (.500")	PLASTIC	BOLTARON 9815E (.125")	40.75	27.66	99
12	EPIBOND 420	CDM050-60 (.500")	PLASTIC	CDM031-60 (.250")	21.53	14.68	4
13	EPOCAST 1618	CDM050-60 (.500")	METAL	ALUMINUM (.060")	4.44	-5.17	0
14	EPOCAST 1618	CDM050-60 (.500")	METAL	BOLTARON 9815E (.125")	40.67	28.62	95
15	EPOCAST 1618	CDM050-60 (.500")	METAL	CDM031-60 (.250")	17.40	9.74	7
16	EPOCAST 1618	CDM050-60 (.500")	PLASTIC	ALUMINUM (.060")	6.59	-0.55	2
17	EPOCAST 1618	CDM050-60 (.500")	PLASTIC	BOLTARON 9815E (.125")	36.16	21.79	96
18	EPOCAST 1618	CDM050-60 (.500")	PLASTIC	CDM031-60 (.250")	15.50	2.91	9
19	EPOCAST 1628	CDM050-60 (.500")	METAL	ALUMINUM (.060")	2.28	-6.01	2
20	EPOCAST 1628	CDM050-60 (.500")	METAL	BOLTARON 9815E (.125")	40.10	26.77	91
21	EPOCAST 1628	CDM050-60 (.500")	METAL	CDM031-60 (.250")	18.47	7.71	8
22	EPOCAST 1628	CDM050-60 (.500")	PLASTIC	ALUMINUM (.060")	4.75	-3.46	0
23	EPOCAST 1628	CDM050-60 (.500")	PLASTIC	BOLTARON 9815E (.125")	40.61	27.61	97
24	EPOCAST 1628	CDM050-60 (.500")	PLASTIC	CDM031-60 (.250")	19.36	8.87	18



OSU results with 9 and 16 inserts using a worse case adhesive with an attached thermoplastic sheet are shown below. The results confirm that the attached thermoplastic sheet protects the underlying panel/inserts and almost eliminates the contribution of the insert adhesive.

ITEM #	POTTING ADHESIVE	PANEL	NUMBER OF INSERTS	INSERT MATERIAL	ATTACHED SURFACE	HEAT RELEASE PEAK	HEAT RELEASE TOTAL
A1	EPIBOND 420	CDM050-60 (.500")	9	METAL	BOLTARON 9815E (.125")	43.87	26.18
B1	EPIBOND 420	CDM050-60 (.500")	16	METAL	BOLTARON 9815E (.125")	38.79	17.36

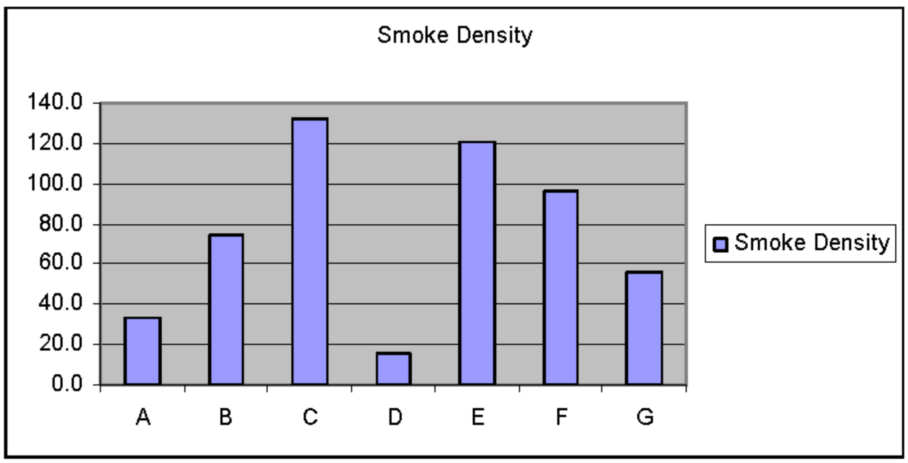
Worst case adhesive was tested per MCC/HRR results on adhesive alone
1 set (3 specimens) were tested for each test item



Smoke Optical Density Results:

Smoke optical density results in a 0.5" panel demonstrate that the adhesive in most cases has higher smoke levels compared to the base panel.

Config	Description	Smoke Density
A	Control, **Panel 0.5"**	33.0
B	2 Insert, metal (Adhesive 318)	74.0
C	2 Insert, metal (Adhesive 1618)	132.0
D	2 Insert, metal (Adhesive 420)	16.0
E	2 Insert, non-metal (Adhesive 318)	121.0
F	2 Insert, non-metal (Adhesive 1618)	96.0
G	2 Insert, non-metal (Adhesive 420)	56.0

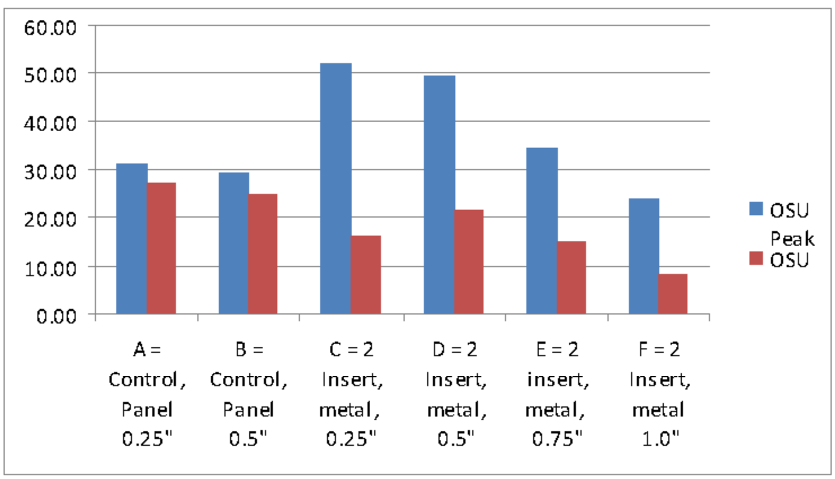


Thickness dependence of OSU and Smoke results:

Reviewing data on a common adhesive used in different thickness panels provides another interesting analysis. As can be seen in the chart below, there is a relationship to panel thickness with the HR peaks become lower as panel thickness goes up. A 0.25” and 0.5” panel provides similar results, but peaks and totals are lower with the 0.75” and 1.0” panels. This result is due to the higher mass and thickness slowing the temperature rise of the sample and creating a barrier protecting direct impingement on the internal adhesive. The smoke results show a relationship to thickness with higher levels of smoke occurring at the thinner panels.

Metal Insert with L-318 Adhesive

	OSU Peak	OSU Total	Smoke
A = Control, **Panel 0.25"**	31.11	27.04	19
B = Control, **Panel 0.5"**	29.2	25.0	33
C = 2 Insert, metal, 0.25"	52.07	16.16	176
D = 2 Insert, metal, 0.5"	49.38	21.75	74
E = 2 insert, metal, 0.75"	34.22	15.16	17
F = 2 Insert, metal 1.0"	23.84	8.03	16



APPENDIX D
Bombardier Data

Bombardier provided data on two fire retarded adhesives from Devcon Metal inserts were used installed in a 2-ply phenolic honeycomb panel with thickness of 0.47".

Bunsen Burner Results:

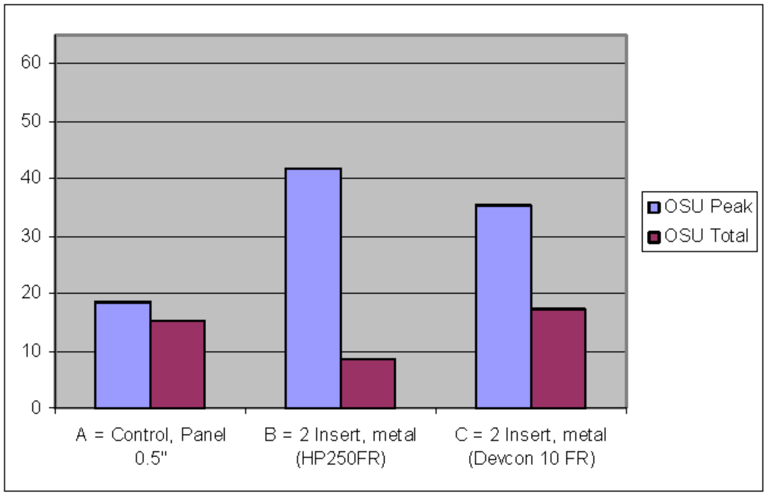
The Bunsen burner testing was only performed using the 60-second vertical test since the adhesives were known to be fire retarded. The test results area shown below.

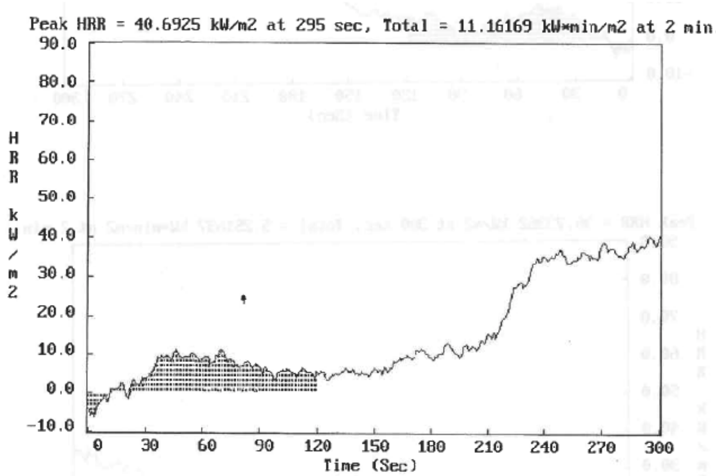
	F1		
	EXT TIME	LENGTH	DRIP
Control Panel	2	6	ND
Devcon HP250FR	0	2.6	ND
Devcon 10 FR	0	0.4	ND

OSU Results:

Heat release testing was performed on panels with 2 inserts in the exposed configuration. The results show a similar trend seen from other members with the peak HRR going up when compared to the base panel. The total HR went down for one adhesive and was about the same for the other adhesive. The peak HRR values are occurring late in the test. (See attached graph).

	OSU Peak	OSU Total
A = Control, **Panel 0.5"**	18.6	15.4
B = 2 Insert, metal (HP250FR)	41.7	8.6
C = 2 Insert, metal (Devcon 10 FR)	35.4	17.3





Panel with 2 inserts bonded with Devcon HP250FR

Smoke Optical Density Results:

The smoke optical density results showed an increase compared to the base panel.

	Smoke Density
Control, **Panel 0.5"**	10.0
2 Insert, metal (Devcon HP250FR)	76.0
2 Insert, metal (Devcon 10 FR)	57.0

APPENDIX E

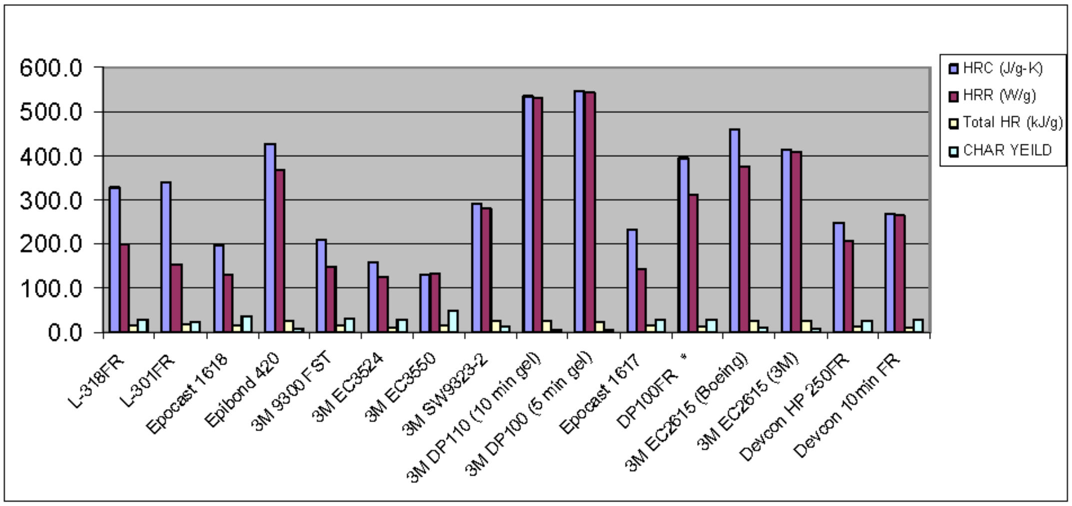
Adhesive Characterization
Microscale Combustion Calorimeter (MCC) and Adhesive Plaque OSU/SD

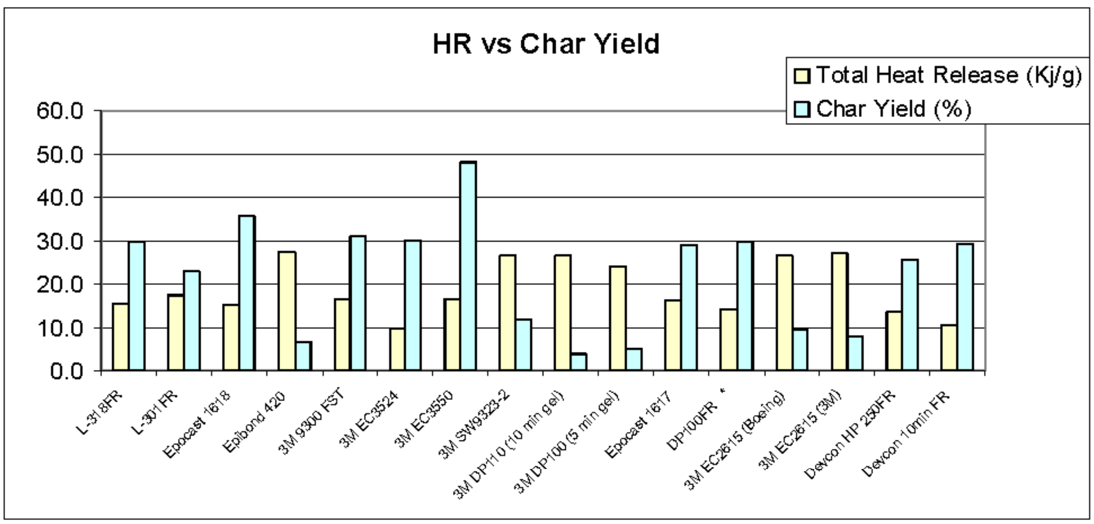
Overview:
Various MCC data was generated by industry members on several adhesives used for bonding inserts into interior panels. Some representative adhesives were chosen to perform OSU/SD on an adhesive plaque. This testing was performed to characterize the flammability properties of the adhesives to select good and poor performing adhesive for further testing.

Test Results:
A summary of results from all the industry members is shown below.

The average HRC (heat release capacity) as described by the FAA is the "capacity to release heat in a fire." HRC is an indicator of the overall flammability and HR properties of the bulk material. The HRR is the highest peak heat release rate that closely relates to the OSU Peak in concept. The FAA describes this as the "Maximum Specific Heat release rate recorded at a heating rate of 1 K/s." The Total HR is the area under the curve and is the total heat release of the bulk material and is similar to an OSU 2-min total in concept.

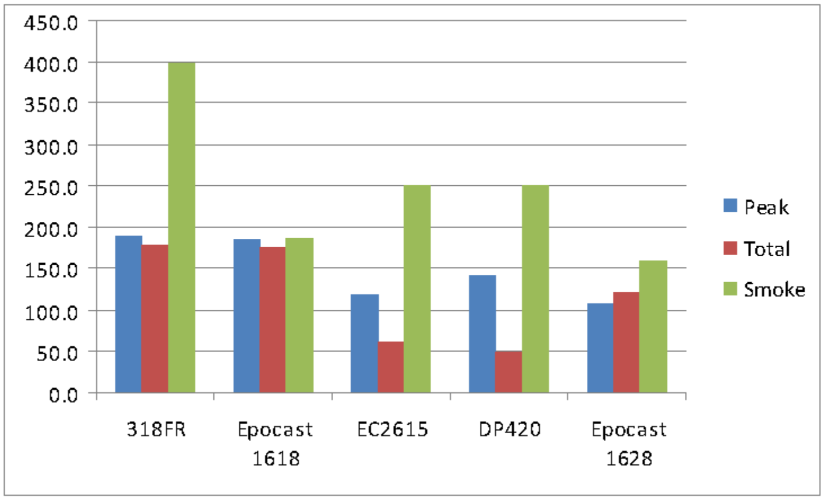
	HRC (J/g-K)	HRR (W/g)	Total HR (kJ/g)	CHAR YEILD
L-318FR	328.0	198.0	15.6	29.9
L-301FR	338.0	152.8	17.4	22.9
Epocast 1618	196.0	129.0	15.2	35.8
Epibond 420	425.0	367.0	27.4	6.7
3M 9300 FST	208.0	149.0	16.5	31.1
3M EC3524	157.3	125.4	9.6	30.1
3M EC3550	130.3	133.1	16.7	48.2
3M SW9323-2	291.7	280.0	26.5	12.0
3M DP110 (10 min gel)	535.0	530.0	26.6	4.0
3M DP110 (5 min gel)	545.0	541.0	24.1	5.0
Epocast 1617	232.0	142.0	16.3	29.0
DP100FR	393.0	313.0	14.0	30.0
3M EC2615 (Boeing)	460.5	376.2	26.5	9.5
3M EC2615 (3M)	412.0	407.0	27.0	8.0
Devcon HP 250FR	249.0	207.0	13.5	25.8
Devcon 10min FR	268.0	264.0	10.5	29.3


600.0
500.0
400.0
300.0
200.0
100.0
0.0
HRC (J/g-K)
HRR (W/g)
Total HR (kJ/g)
CHAR YEILD
L-318FR
L-301FR
Epocast 1618
Epibond 420
3M 9300 FST
3M EC3524
3M EC3550
3M SW9323-2
3M DP110 (10 min gel)
3M DP100 (5 min gel)
Epocast 1617
DP100FR *
3M EC2615 (Boeing)
3M EC2615 (3M)
Devcon HP 250FR
Devcon 10min FR


HR vs Char Yield
Total Heat Release (Kj/g)
Char Yield (%)
60.0
50.0
40.0
30.0
20.0
10.0
0.0
L-318FR
L-301FR
Epocast 1618
Epibond 420
3M 9300 FST
3M EC3524
3M EC3550
3M SW9323-2
3M DP110 (10 min gel)
3M DP100 (5 min gel)
Epocast 1617
DP100FR *
3M EC2615 (Boeing)
3M EC2615 (3M)
Devcon HP 250FR
Devcon 10min FR

OSU/SD Test results on adhesive plaque:

	Peak	Total	Smoke
318FR	188.0	179.0	400
Epocast 1618	185.00	176.00	186
EC2615	118.00	62.00	250
DP420	143.00	48.60	250
Epocast 1628	108.00	121.00	159



MCC Data on Epoxy Adhesive Materials

Test Result Summary:
The MCC results show trends a range of properties on adhesives. The benefit of these results was to categorize good performing materials (lower HRR and Total HR and higher Char Yields) from adhesives with less fire resistant characteristics. This helped validate that a full range of good and poor fire resistant adhesives were used in insert/panel testing.

As expected, the OSU/SD data on a few representative materials in an adhesive plaque 0.125” thick demonstrated very high heat release properties. There appeared to be some correlation to whether the adhesive had fire retardants/fillers but overall the values were extremely high. Due to the aggressive combustion behavior of the bulk materials testing was not continued.

Conclusions:
Although there is a wide range of fire resistance levels of adhesives in the bulk form, the results on panels with installed inserts did not indicate significant differences in the installed configurations regardless of adhesive material used.

APPENDIX BB—ITEMS 43a-f: BONDED JOINTS

Industrial Flammability Standardization Task Group

Industry Team Proposal - Reference Items No. 43a to 43f

Revision C – December 21, 2011

Revision Summary:

Revision NC – Initial release, 12-14-2010
Revision A – FAA Jeff Gardlin Comments of 01-25-11 Addressed 02-02-11
Revision A Draft 2– FTSWG Meeting Input 3-2-11
Revision A Final Draft 1- SharePoint Feedback (Vote) 4-12-11
Revision B Final Draft 1– Added data and conclusions to proposal as final document
Revision C - Added clarifications to MoCs and Figure IV

Generic Fire Properties Test Report
For bonded joint constructions
Reference to Items 43a to 43f

Contents

Generic Fire Properties Test Report
For bonded joint constructions
Reference to Items 43a to 43f

ACTIVE PAGE LIST

Page	Rev.	Page	Rev.	Page	Rev.	Page	Rev.	Page	Rev
1	C	44	B	87	B	130	B	173	B
2	C	45	B	88	B	131	B	174	B
3	C	46	B	89	B	132	B	175	B
4	C	47	B	90	B	133	B	176	B
5	C	48	B	91	B	134	B	177	B
6	NC	49	B	92	B	135	B	178	B
7	NC	50	B	93	B	136	B		
8	NC	51	B	94	B	137	B		
9	B	52	B	95	B	138	B		
10	NC	53	B	96	B	139	B		
11	A	54	B	97	B	140	B		
12	A	55	B	98	B	141	B		
13	A	56	B	99	B	142	B		
14	C	57	B	100	B	143	B		
15	NC	58	B	101	B	144	B		
16	NC	59	B	102	B	145	B		
17	C	60	B	103	B	146	B		
18	C	61	B	104	B	147	B		
19	A	62	B	105	B	148	B		
20	B	63	B	106	B	149	B		
21	A	64	B	107	B	150	B		
22	NC	65	B	108	B	151	B		
23	NC	66	B	109	B	152	B		
24	A	67	B	110	B	153	B		
25	A	68	B	111	B	154	B		
26	C	69	B	112	B	155	B		
27	NC	70	B	113	B	156	B		
28	B	71	B	114	B	157	B		
29	B	72	B	115	B	158	B		
30	B	73	B	116	B	159	B		
31	B	74	B	117	B	160	B		
32	B	75	B	118	B	161	B		
33	B	76	B	119	B	162	B		
34	B	77	B	120	B	163	B		
35	B	78	B	121	B	164	B		
36	B	79	B	122	B	165	B		
37	B	80	B	123	B	166	B		
38	B	81	B	124	B	167	B		
39	B	82	B	125	B	168	B		
40	B	83	B	126	B	169	B		
41	B	84	B	127	B	170	B		
42	B	85	B	128	B	171	B		
43	B	86	B	129	B	172	B		

Generic Fire Properties Test Report
For bonded joint constructions
Reference to Items 43a to 43f

REVISION HISTORY

Rev	Description	Date	Issued By
NC	Initial release.	12-14-2010	PGZ
A	Updated proposal to incorporate FAA (Jeff Gardlin) and FSTG comments	4-12-11	PGZ, DB,DS
B Final Draft 1	Replaced Test Plan with Test Report	9-9-2011	DB,DS,PGZ
C	Added clarifications to MoCs, Figure IV, and cut and fold section 3.2.D.4.	12-21-2011	DBS

Generic Fire Properties Test Report
For bonded joint constructions
Reference to Items 43a to 43f

1 INTRODUCTION

Bonded joint constructions are employed to attach the edges of honeycomb panels together in the manufacture of aircraft interior monuments like wardrobes, bulkheads, galley and lavatories. Several types of bonded joint attachment are being used in typical aircraft monument construction including but not limited to: Mortise & Tenon, Ditch & Pot, Cut and Fold, Tab & Slot, T Joints and Pins. Adhesive materials are increasingly being employed to bond the honeycomb panels together in these construction joints, replacing mechanical systems using potted fasteners. The quantities of adhesive used depend on the panel joint attachment configuration and length.

Due to a lack of standardization across the industry in the method of compliance with the flammability requirements of 14 CFR part 25 for commonly constructed parts, construction details, and materials used in the manufacture of aircraft interior components, the FAA has published a draft version of the FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”. In this document, the FAA provides guidance on acceptable methods of compliance (MOC) for various features or constructions.

Attachment 2 of this Policy Memo is divided into two parts as defined below:

1. Attachment 2, Part 1: - Acceptable methods without additional data
2. Attachment 2, Part 2: - Methods of compliance that require supporting data

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry team also is reviewing the Part 1 items to provide definitions, descriptions of terms to enable consistent interpretation and implementation across the aerospace industry. The industry team has reviewed Items 43a to f, and is submitting the following concurrence, justification and proposal.

2 INDUSTRY TEAM LEADERS & SUPPORT TEAM

2.1 TEAM LEADERS

- Klaus Boesser (SELL-Zodiac)
- Patrick G. Zimmerman (3M)

2.2 SUPPORT TEAM

- Dan Slaton (Boeing)
- Daniel Boesser (SELL – Zodiac)
- Dirk Langer (SELL-Zodiac)
- Michael Jensen (Boeing)
- Scott Campbell (C&D Zodiac)
- Pom Sattayatam (C&D Zodiac)
- Hector Alcorta (Bombardier)
- Chuck Wilson (Gulfstream)

3 PROJECT DEFINITION

3.1 Current Proposal

Currently, ANM-115-09-XXX is available as an undated draft. The current version is available from the FAA website as of 20 August 2009. Part 1 and Part 2, reference items 43a to 43f read as shown below in Figure 1 and Figure 2:

Figure 1
Part 1, Acceptable Method without Additional Data

Reference Number	Feature/Construction	25.853(a) Bunsen Burner Test Requirements/Similarity	25.853(d) Heat Release Requirements/Similarity
43a	Ditch and pot	Test panel and adhesive together (60-second vertical).	Test Criteria is decided based on the size criteria 1. Test required if greater than 2 sq ft. 2. No test if less than 1 sq ft and 3. Further considerations required between 1 &2 sq ft. (per item 28)
43d	Cut and fold	Test panel and adhesive together (60-second vertical).	Test Criteria is decided based on the size criteria 1. Test required if greater than 2 sq ft. 2. No test if less than 1 sq ft and 3. Further considerations required between 1 &2 sq ft. (per item 28)
43b	Tab and slot	See part 2 of this attachment.	No test requirement.
43c	Mortise and Tenon	See part 2 of this attachment.	No test requirement.
43e	T-joints	See part 2 of this attachment.	No test requirement.
43f	Bonded pins	See part 2 of this attachment.	No test requirement.

Figure 2
Part 2, Methods of compliance that require supporting data

Reference Number	Feature/Construction	25.853(a) Bunsen Burner Test Requirements/Similarity	25.853(d) Heat Release Requirements/Similarity
43a	Ditch and pot	See part 1 of this attachment.	No Test Requirement.
43b	Tab and slot	No test requirement. Traditionally industry has not tested these features.	No Test Requirement.
43c	Mortise and Tenon	No test requirement. Traditionally industry has not tested these features.	No Test Requirement
43d	Cut and fold	See part 1 of this attachment.	No Test Requirement.
43e	T-joints	No test requirement. Traditionally industry has not tested these features.	No Test Requirement
43f	Pins	No test requirement.	No Test Requirement

3.2 Definition of Terms
In the Interest of the overall stated goal of standardization of industry flammability practices, clear definitions of terms are stated here;
A. Standard Panel:
A honeycomb panel with one or two ply non-metallic skins, nominally 6.35 to 13 mm (0.25 - .51") thick non-metallic honeycomb core, which meets 14 CRF 25.853(a), Appendix F, Part 1(a)(1)(i)

B. Core Back
The process of removing the core (e.g. honeycomb), from the edge of a panel back a determined dimension, while maintaining the upper and lower skins.

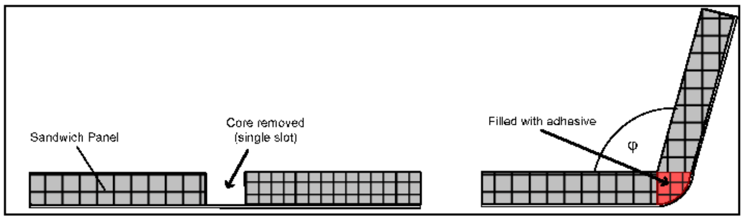
C. Adhesive or Bonding Material
The material used to bond a cut edge of a panel. Often two part materials made up of a base resin and accelerator. Usually requires a period of time (several minutes to several hours) depending on temperature to dry or cure to handling strength.

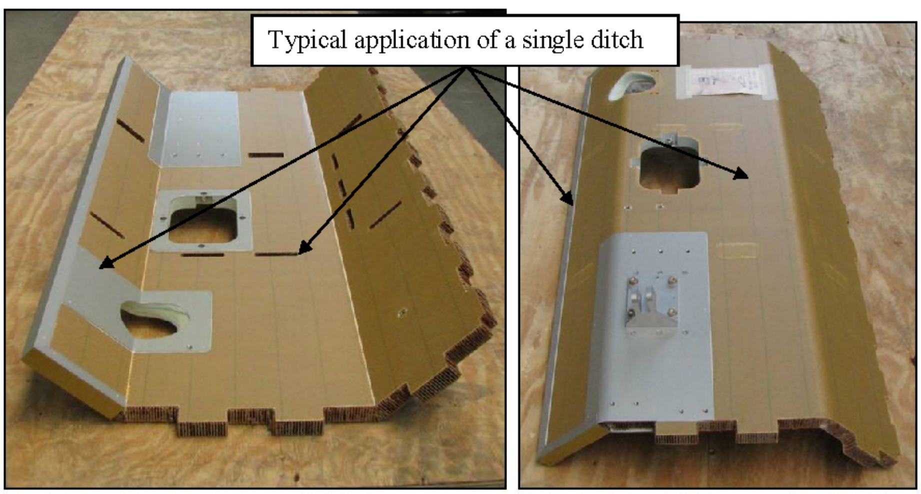
D. Joint Types Per reference 43

1. Ditch & Pot

a. Single Slot:

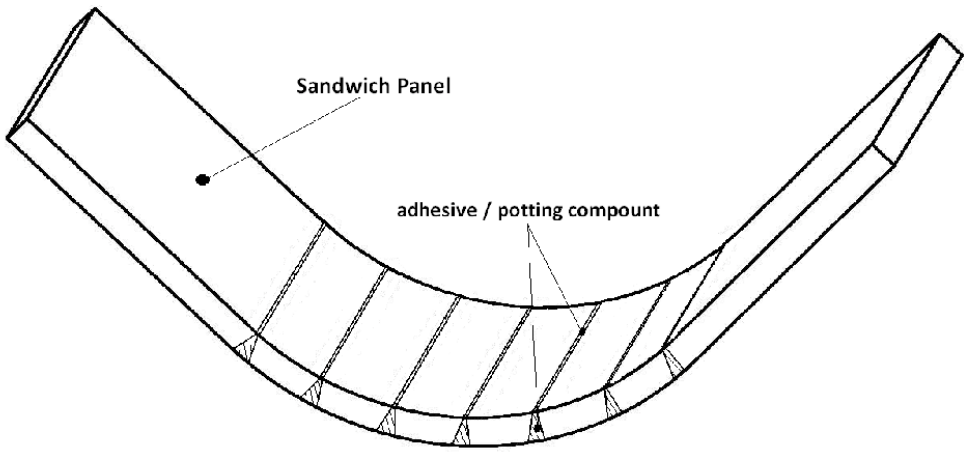
Single ditches are applied to fold a panel and build a single joint angle. Single ditches can occur more than one time on the same panel surface and create discrete panel surfaces between the joints:



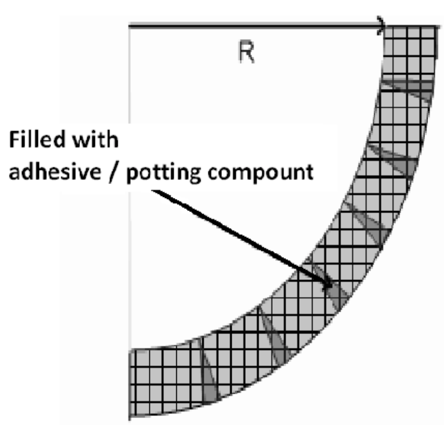


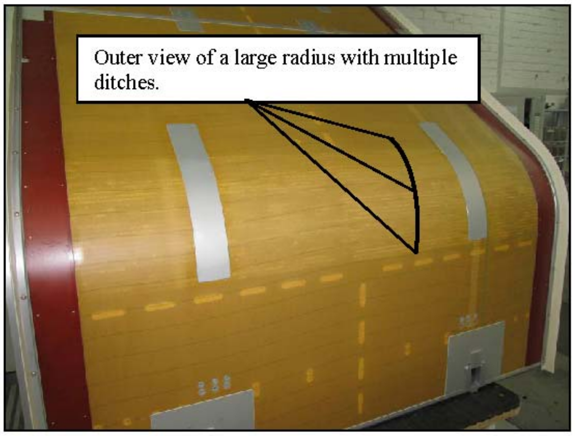
b. Multiple Slots:
Multiple ditches in close proximity are applied to form a constant large radius:

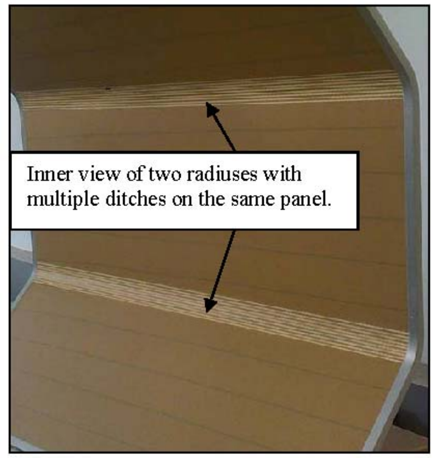
b.1. Inside Adhesive Slots



b.2 Outside Adhesive Slots





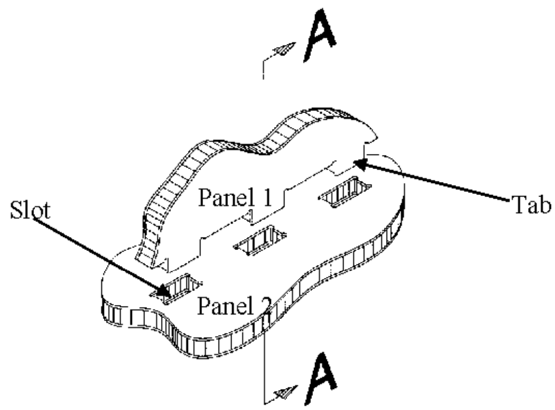


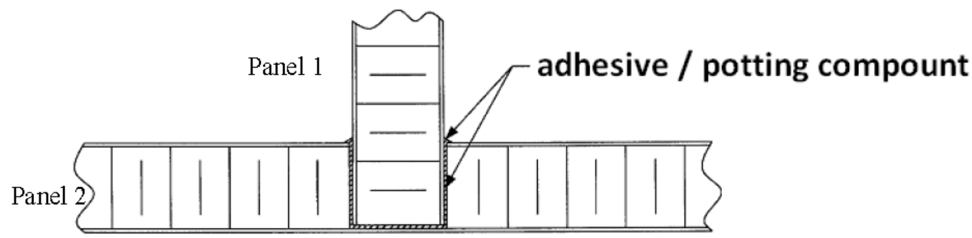
Multiple ditches are also applied to build a (contour-) surface:

2. Tab & Slot

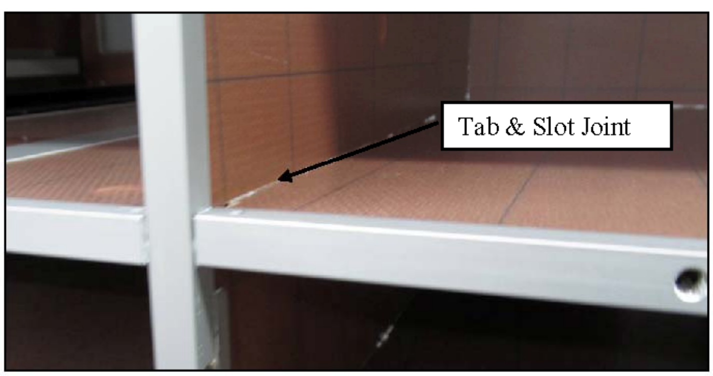
Tab & slot is used to build T-joints with two panels:

The tabs on the edge of panel 1 are bonded into the slots on the surface of panel 2:





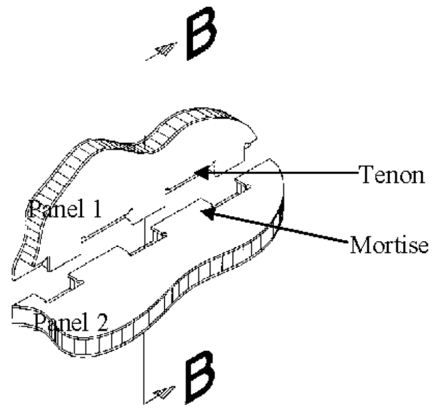
SECTION A-A



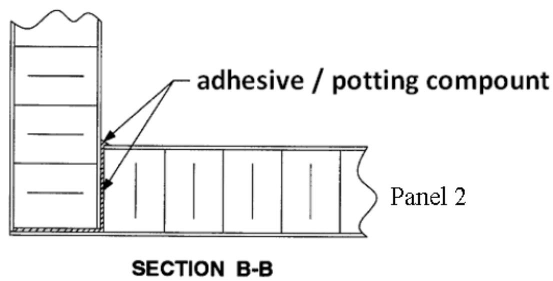
3. Mortise & Tenon

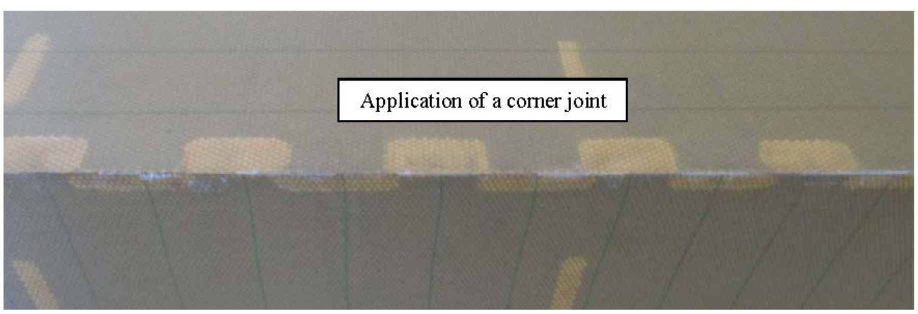
Mortise & Tenon is used to make a corner joint:

The edge of panel 1 with mortise and Tenon shape is bonded to its counterpart on the edge of panel 2:



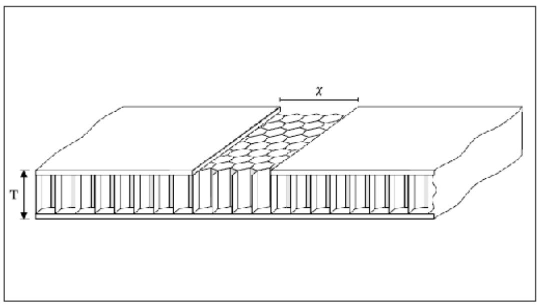
The gaps between mortise and Tenon and the corner are filled with adhesive / potting compound:

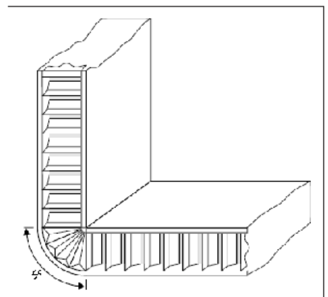




4. Cut and Fold

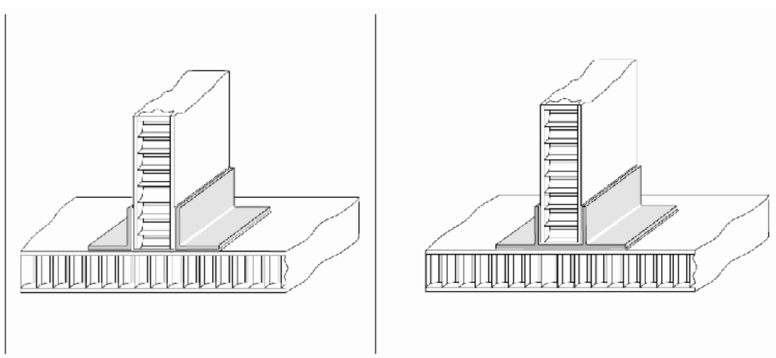
The most common process to create a cut and fold joint is to remove the skin plies on one side. This is generally done without removing core, but removing some core can be part of the manufacturing process. Adhesive / potting compound is then applied to the surface of the core and the panel folded. The excess adhesive squeeze-out is removed leaving a small fillet. A cut and fold joint can also be obtained by folding the panel first and then a bead/fillet of adhesive applied to the joint. The finished joint is similar to an inside ditch and pot joint.





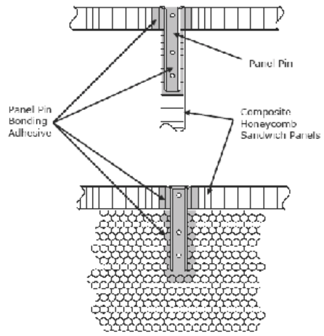
Adhesive is applied where face is removed.

5. T Joints



Adhesive applied either between face of panels to plates or edge to face of panel. No material will be cored back.

6. Bonded Pins



Adhesive is applied to fill the pin and the surrounding honeycomb.

E. Adhesive Plaque
A specimen of the material to be tested that is made from 100% of the adhesive or bonding material. Plaques are sometimes referred to as a "brick."

F. Monuments
A monument is a functional interiors component which makes up the passenger cabin of the airplane. Examples are, but not limited to, Lavatories, Galleys, Bulk Heads, Class dividers, Closets, etc.

3.3 Test Panel Orientation

Samples are to be tested according to the Fire Test Handbook [B] Chapter 1, unless the team proposes an alternative method.

4 VALIDATION PROCESSES OF MOCs IDENTIFIED IN POLICY MEMO

4.1 INDUSTRY PROPOSAL

Vertical Bunsen burner [14 CFR25.853(a)]

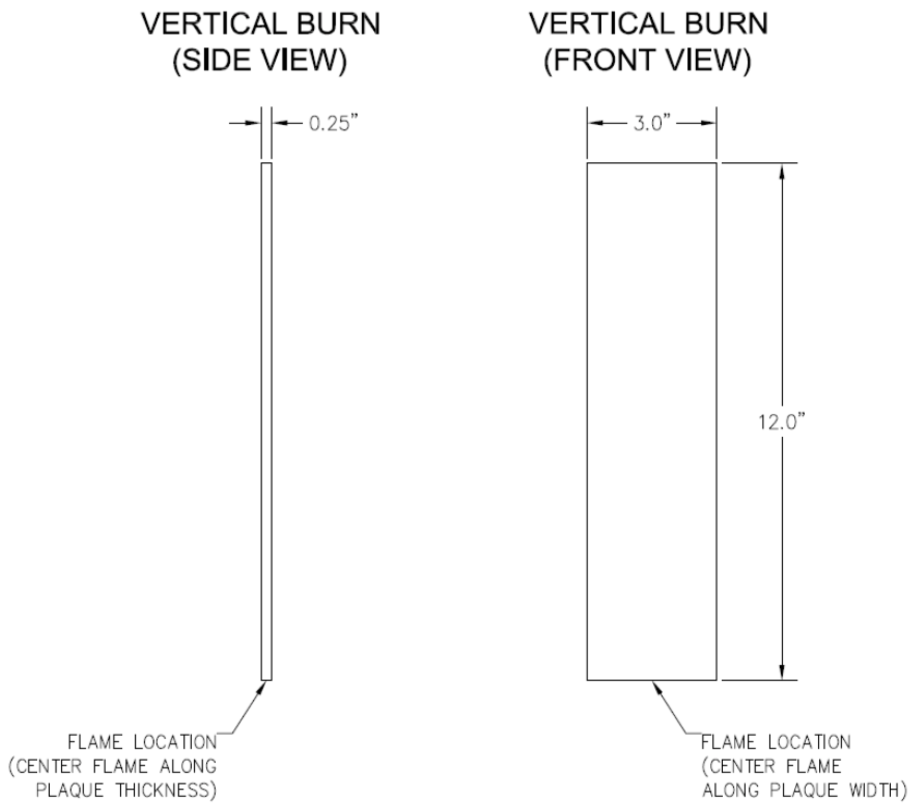
For VBB testing in Part 1 and Part 2, the industry team would like to propose the following as a means of validating the MOCs identified.

Bunsen burner data will be generated on plaques made of the adhesive material, and a standardized 60 sec VBB compliant honeycomb panel with the adhesive installed in the joint configuration to be used in the monument in question. Vertical 12-second and 60-second will be tested.

The initial evaluation would be to test a material in a "plaque' form a nominal1/4" x 3" x 12" per 14 CFR 25.853(a)(1)(ii) (12 sec VBB) and 14 CFR 25.853(a)(1)(i) (60 sec VBB) the later as this is the MoC defined in the draft policy. The flame would be placed in the center of the horizontal (3") edge. As per Figure III.

Generic Fire Properties Test Report
For bonded joint constructions
Reference to Items 43a to 43f

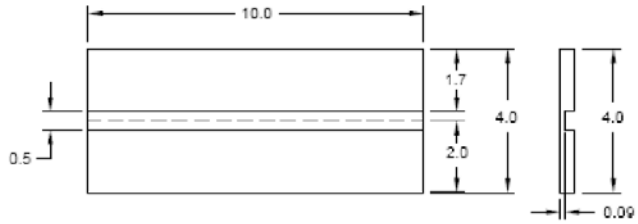
Figure III.

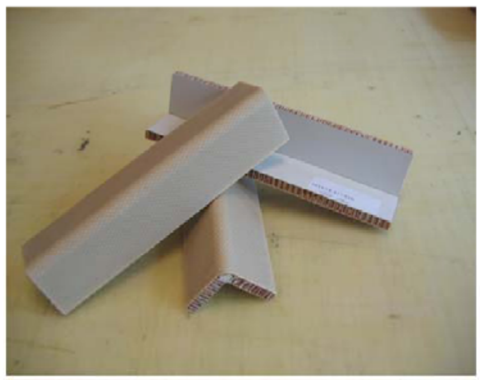


Industry would also conduct both 14 CFR 25.853(a)(1)(i) and (ii) (60 sec VBB and 12 sec VBB) test on a 3 specimen set of standard panels (60 second VBB compliant panel) adhesively bonded with a material in the joint configurations. The panel would be a standard panel nominal 0.25"-0.5" x 3.0" x 12.0". The Flame will be placed on the joint with the greatest exposure of adhesive, e.g. Figure IVC inside corner.

Figure IVA. Inside Joints

Inside Joint, 90 Degree – Bunsen Burner
The following specimen construction is used for establishing 60-second vertical Bunsen burner properties of an inside joint. Burn length and drip extinguishing time is recorded. The specimen is fabricated from a standard honeycomb panel nominal 0.25" – 0.5" x 4" x 10" minimum. The adhesive joint runs the length of the specimen. The specimen configuration shown below is filled with adhesive and then folded to 90 degrees (+/- 5) and allowed to cure. Photographs of arepresentative test sample are provided. Dimensions are reference only.





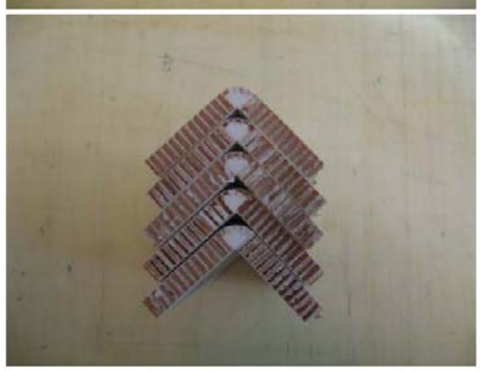


Figure IVB. Outside Joints

Outside Joint, 145 Degree – Bunsen Burner

The following specimen construction is used for establishing 60-second vertical Bunsen burner properties of an outside joint. Burn length and drip extinguishing time is recorded. The specimen is fabricated from a standard honeycomb panel nominal 0.25" – 0.50" x 4" x 10" minimum. The adhesive joint runs the length of the specimen. The specimen configuration is bent to an angle of 145+-5 degree, held in place and the joint filled with adhesive and allowed to cure. Photographs of a representative test sample are provided. Dimensions are reference only.

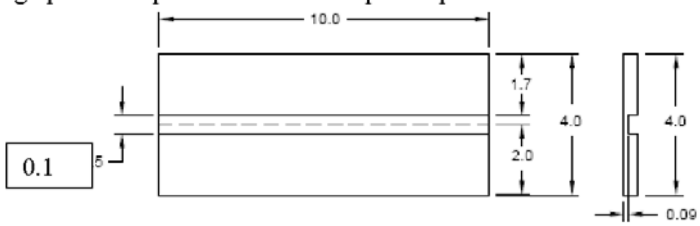


Figure IVC. Flame Placement

A generic corner joint indicating the location of the flame centered just below the honeycomb skin.

The flame would be placed on the inside or outside joint with the greatest adhesive exposed in the corner of the test panel not the center of the 3" horizontal edge. Coupon sets would be cored back ¼" – 1/8" depending on the joint type. If the adhesive is not exposed on the bottom edge of the test panel, the panel will be cut to expose adhesive to the flame.

Based on the above results, materials that exhibit the least and best (i.e. materials that fail or pass) properties can be used in a larger panel to conduct a foam block test, to represent a more realistic in-flight fire scenario to demonstrate the fire worthiness of the adhesive on the part. Successful foam block test results will provide the supporting justification for accepting the proposed MoC Option 4. Appendix A of this proposal is a summary of Boeing testing on ditch-and-pot joints. A non-fire retarded adhesive was evaluated in many different panel/joint configurations. The results support a no test requirement for all bonded joints.

For information and comparative purposes, the working group also recommends performing MCC testing of edge fill materials and compare the results to VBB test results obtained from nominal ¼" x 3" x 12" plaques. MCC would provide fundamental material properties of the edge fill materials that could be used as a means of comparing different edge fill materials to one another. MCC results would also be used to try and establish a correlation with VBB such that edge fill materials could be validated by MCC testing alone and used in any basic panel already certified using 60-sec VBB with no further testing required.

Heat Release (HR) & Smoke Density (SD) Testing [14 CFR25.853(d)]

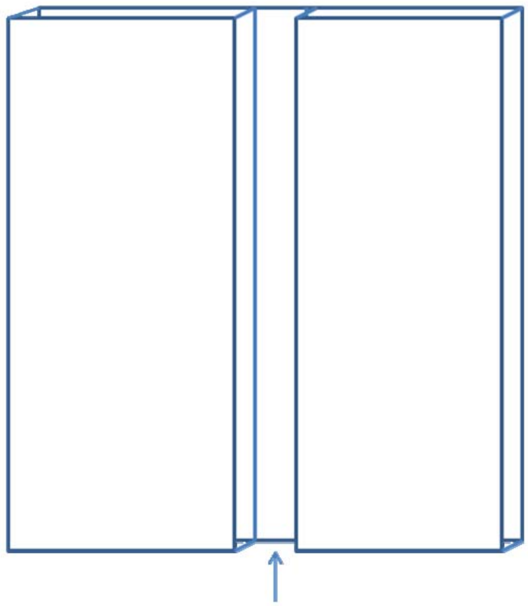
For Heat Release and Smoke Density per 14 CFR 25.853(d) in Attachment 2 Part 1 and Part 2 by reference to Part 1 defines the need for test based on the standard heat release/smoke density size criteria for Ditch and Pot and Cut and Fold only. All others are exempt per Part 1. The industry team recommends that no test is required when a single angle made with a ditch and pot or cut and fold to make a joint, has a size limit of no more than 1.0" width of exposed adhesive material. (See 3.2.1a &3.2.4) There is a historic precedent that only large area panels are tested in 14 CFR 25.853(d) and that adhesive is not part of the exposed panel surface area. Adhesive quantities are small for a single glue line relative to the panel size. Panels are cored back typically no more than thickness of the panel in depth, then folded or pressed into the joint type and then often covered with a decorative material. Therefore, it is the industry team's perspective that the contribution is negligible.

Multiple ditch and pot or cut and fold cuts in a single panel (see 3.2.1b) makes for a larger area, single radius panel to create a surface and then are to be tested according 14CFR 25.853(d) and thus default to Part 1.

The plan proposed by the Industry team to validate "no test" required includes setting a limit on size based on current industry practice. Generating material characterization data on a range of common industry "adhesive" materials using OSU/SD will not provide meaningful results as the OSU requirements were not established on bonded joints conditions. Setting the size criteria establishes and aligns with the proposal for bonded details and edge fill, and restricts the area of adhesive on large panels.

To further demonstrate that the localized adhesive has minimal impact on the heat release of the panel a test configuration was defined as shown in figure V. This test panel with a ½ " channel cut down the standard panel. This channel will be filled with the adhesive material from the top edge to the other leaving the face sheet intact on one size and tested as a heat release specimen. This method was chosen to mimic adhesive material that would be found in a panel and giving the maximum exposure. These test results are provided as reference supporting the localized adhesive material has minimal impact on a larger panel.

Figure V. OSU Test Specimen – Engineering Evaluation



Design Attributes of Adhesive Materials:

Adhesively bonded Sandwich Panels have the attributes described below. These design attributes establish that adhesive material is rather localized feature in the cabin. While they are typically contiguous which might contribute to fire propagation and therefore testing in VBB is prudent, the quantity is small and therefore has a low probability of contributing to the HRR/OSU aspect of cabin fire safety.

A. Adhesive is not a significant part of the sandwich panel. Typically less than 0.5 inch of the edge of the 2 joined panels i.e. 0.25inches each contain adhesive. This constitutes a small amount of the total volume.
B. Adhesive is typically contiguous on a particular edge, i.e. those edges being bonded together, but not necessarily found on all edges.
C. When found in the aircraft cabin, the adhesive material is often covered with a decorative laminate or edge trim material, which these coverings themselves already meets 14 CFR 25.853(a) and/or (d)
D. Adhesive is used to bond two panels together in the joint configuration of choice to maximize bond strength.
E. Within the size limits, adding adhesive adds weight and manufacturing cost. Designers will minimize its use to those areas where a joint configuration gives the best design strength (as per "D") is required and/or a smooth surface for application of decorative (as per "C") is required.

4.2 PROPOSED STANDARD TO MEET

Once validated, the test methods described in section 4.1 above will be defined with appropriate boundary conditions for the MOC's

Note: The team agreed that material properties developed from the various methods should not be compared to current regulatory requirements. As an example, the OSU requirements of 65/65 is not an absolute requirement as this requirement was developed for large sandwich panels correlated from full scale tests. MCC data is another example of data that should be used to characterize the material properties and not directly compared to polymer family rankings in the literature (e.g. good flammability resistance vs. poor flammability resistance). This type of data (OSU &MCC) will simply be used to characterize material/configuration for further correlation to larger scale configuration tests.

5 DATA/ANALYSIS

Using multiple common adhesive materials (6-12), the material properties will be generated using MCC, VBB, OSU and Smoke Density. Using good and poor performing fire resistant adhesives, larger specimen samples will be tested using the foam block test to determine ignition and flame propagation behavior.

Much of the testing will be performed on worse case joint construction which has been determined to be the Ditch and Pot joint as this joint construction has the greatest amount of exposed adhesive. Exposed adhesive and the potential to propagate a flame is the main concern, while a lingering flame on the cut edge of the Bunsen burner specimen is less of a concern. Results on the DAP joint construction will be applied to the other joint constructions.

5.1 EXISTING TEST DATA

The industry has very little compliance data on adhesive bonded joints due to the industry practice that only sandwich panels are to be tested. The industry team has called upon its' members to submit any existing flammability data per 25.853(a) to support the MOC.

5.2 PROPOSAL OF TESTS TO BE PERFORMED

Using multiple common adhesive materials (6-12) material properties will be generated using MCC, VBB, OSU and Smoke Density. Specimen samples using a common joint configuration will also be tested using the foam block test to determine ignition and flame propagation behavior and correlate back to material test results.

5.2.1 VBB [14 CFR25.853(a)]:

Bunsen burner and Foam Block:

a. Adhesive plaque samples would be tested per Figure III in VBB test per 14 CFR 25.853(a)(1)(i), and (a)(1)(ii). Comparative data to standard panel constructions would be made as per the proposed MOC in 4.1 tested per Figure IV per 14 CFR 25.853(a)(1)(i).
b. Material samples would be provided for MCC evaluation.
c. Foam block testing of select materials that provide good and poor Bunsen burner performance.

5.2.2 HRR [14 CFR25.853(d)]: HRR:
No testing is proposed, by limiting the size criteria of the adhesive to 1 inch or less of exposed adhesive and a single cut on an edge, e.g. Single Cut Ditch and Pot found in 3.2.D.1.a. Although some reference data is required for comparison purposes. The working group has devised a method of testing materials for OSU, as per Figure V.

If the configuration used multiple ditches to form a constant large radius as shown in Part 3.2.D.1.b or c, then HRR testing would be proposed per the size criteria in ANM-115-09-XXX Part 1.

The working group also recommends performing MCC testing of adhesive materials. MCC would provide fundamental material properties of the adhesive materials that could be used as a means of comparing different adhesive materials to one another. MCC data will be used as one of the tools to determine good and poor performing adhesives. MCC results could also be used to try and establish a correlation with HRR of a standard configuration such that adhesive materials could be validated by MCC testing alone and used in any basic panel already HRR/SD-certified with no further testing required. The MCC/OSU correlation requires a formal FAA agreed approach and will need more industry/FAA discussion that is likely outside of this MoC development.

5.3 TEST RESULTS
The following table format will be used to collect the test results.

Figure VI.

Adhesive Material by Itself

Product Designation	Manufacturer	Material by itself					
		12 sec VBB			60 sec VBB		
		FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Product 1							
Product 2							
Product 3							
Product 4							
etc							

Figure VII.

Adhesive Material Applied to a Panel

Product Designation	Manufacturer	Material applied to a panel					
		12 sec VBB			60 sec VBB		
		FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Product 1							
Product 2							
Product 3							
Product 4							
etc							

The actual data can be found in Appendices A-D

5.4 ANALYSIS OF TEST RESULTS

Analysis of the data has been done to identify correlation approaches and validate the proposed MoC options. The Analysis details can be found in Appendices A-D.

6. CONCLUSION

The industry proposes optional MoC's that have been validated using the data generated on different adhesives. For Bunsen burner, option 1 defines three different options supporting the announcement "similarity to base panel". The second is to test a plaque of adhesive material as per our proposed MOC to demonstrate the VBB "no test requirement" for 25.853(a). This has been validated in Appendices B-D. The third method is to test the adhesive in a standard honeycomb panel with a cross section of the joint construction to Appendix F Part I (a)(1)(i). This has validated in Appendices B-D.
Fourth is to test the applicable standard joint construction to the Foam Block test method and additionally the joint construction has to meet the 60 sec VBB requirement for burn length and drip extinguishing time. This has been validated in Appendices A-C.
Last Method to show compliance for Bunsen burner is to test the as installed configuration to the applicable requirements in Appendix F, Part 1(a)(1)(i).

For heat release and smoke per 14 CFR 25.853(d), testing will not be required if the adhesive joint is 1" inch or less and a single cut. If outside the scope of the criteria for HRR, then testing is based on the standard size criteria. This has been validated in Appendix B.

See Figure IX for the full definition of the MoCs
Per 14 CFR25.853(a)

Generic Fire Properties Test Report
For bonded joint constructions
Reference to Items 43a to 43f
Figure IX: Methods of Compliance for Bonded Joint Constructions

Reference Number	Feature/ Construction	25.853(a) Bunsen Burner Test Requirements/Similarity	25.853(d) Heat Release Requirements/Similarity
43 a through f	43a: Ditch and Pot 43b:Tab and Slot 43c: Mortise and Tenon 43d: Cut and Fold 43e: T-joints 43f: Pins	Compliance of a bonded joint construction can be shown by: Option 1: similarity to the base panel when the following are met: 1) The Adhesive is an epoxy based material 2) Panel is a honeycomb core panel with composite skins. Meeting 14CFR 25.853(a), Appendix F, Part 1 (a)(1)(i), 60 sec VBB, which is the compliance data used for similarity analysis. 3) Joint construction other than an outside bend Ditch and Pot joint. (e.g. inside cut) Option 2: Test a plaque of adhesive by itself per appendix F - part I,(a)(1)(ii).(12 sec) (Plaque of nominal size: 0.25” x 3” x 12”) Configured as per Figure III in 4.1 above. Option 3: Test the Adhesive in a standard honeycomb panel in accordance with Appendix F Part I (a)(1)(i) Per Figure IV in 4.1. The appropriate DAP joint configuration shall be used (inside or outside DAP joint. Note; The inside DAP joint will validate the other joint types of tab and slot, mortise and tenon, T-joints, and pin joints). Once qualified in this manner, the adhesive may be used in any honeycomb panel configuration and shown to be compliant by similarity. Option 4: Test the adhesive in a standard honeycomb panel in accordance with the Foam Block test method defined in Appendix A and in accordance with Appendix F Part I (a)(1)(i) using test specimens per Figure IV in 4.1. The test results shall meet burn length and drip extinguishing time only. The appropriate DAP joint configuration shall be used (inside or outside DAP joint. Note; The inside DAP joint will validate the other joint types of tab and slot, mortise and tenon, T-joints, and pin joints). Once qualified in this manner the adhesive may be used in another honeycomb panel configuration and shown compliant by similarity. Option 5: Test the “as installed” configuration to the applicable requirements in Appendix F, Part 1(a)(1)(i).	For ditch and pot and cut and fold joints: No test requirement, if the exposed adhesive is 1” or less and a single cut. If beyond this criteria then test criteria is decided based on the size criteria 1. Test required if greater than 2 sq ft. 2. No test if less than 1 sq ft and 3. Further considerations required between 1 & 2 sq ft. For Tab and slot, Mortise and Tenon, T-joints, Bonded Pins: No test requirement.

7. ABBREVIATIONS

FAA – Federal Aviation Administration
MOC – Method of Compliance
CFR – Code of Federal Regulations
TBD – To Be Determined
AC – Advisor Circular
MCC – Microscale Combustion Calorimeter
VBB – Vertical Bunsen burner: Test per 14 CFR 25.853(a) and App F, Part I
HRR – Heat Release Rate per 14 CFR 25.853(d), App F, Part IV
SD – Smoke Density per 14 CFR 25.853(d), App F, Part V
DAP – Ditch and Pot Joints

8. REFERENCES

A. Gardlin, Jeff, FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of interior Materials, Department of Transportation, Federal Aviation Administration, August 2009

B. FAA Handbook, FAA Technical Center, Report DOT/FAA/AR-00/42, Aircraft Materials Fire Test Handbook, April 2000

Generic Fire Properties Test Report
For bonded joint constructions
Reference to Items 43a to 43f
APPENDIX A

Summary of Boeing data supporting Industry Standardization Team #43, Bonded Joint Constructions, 14CFR25.853(a)

Overview:
Boeing has generated flammability data to support a common Method of Compliance for all bonded joint constructions. This data summary is being submitted to the Industry Team #43 to support the proposal for "no test requirement." A complete report of the 60-second Bunsen burner and foam block test results will be provided to the FAA as Boeing proprietary data.

As described in the Industry Team Proposal for item #43, there are different types of bonded joint constructions used across industry. All construction techniques use similar amounts of adhesive along the length of a panel edge. The ditch and pot joint construction has been identified as the most critical joint construction as the adhesive is exposed in some cases and a larger bulk of adhesive is exists locally along the joint. Ditch and pot joints are created by cutting a slot in the honeycomb panel with the final folded joint being filled with adhesive. Both inside and outside folds are used in design. Inside joints result in fully contained non-exposed adhesive, while outside joints often have a small width of exposed adhesive.

A wide range of ditch and pot joints were used to evaluate flammability performance using the 60-second vertical Bunsen burner and foam block test methods. This joint type is considered a worse case joint construction due to the exposed adhesive and the localized bulk of the adhesive. A non-fire retardant adhesive was used and provides a worse case adhesive to evaluate and draw conclusions about all adhesives used in bonded joint configurations.

Test Configuration Summary:
Testing was conducted on a variety of honeycomb panel constructions using a 2-part epoxy that does not contain fire retardants. The adhesive does not meet the 12-second or 60-second vertical Bunsen burner test requirements using a 0.125" adhesive plaque or a bent honeycomb panel. When tested by itself the material ignites and continues to burn after removing the flame resulting in failure of the extinguishing time and burn length. This material meets the 15-second horizontal test requirements when tested by itself.

When tested in a bent panel using the 60-second vertical Bunsen burner, the extinguishing time requirement is exceeded while the burn length and drip extinguishing time requirements are met.

This adhesive has also been tested in the Microscale Combustion Calorimeter and found to be in the poorest performing adhesives with the high Heat Release Capacity (HRC) and Heat of Combustion (HRc) values compared to many other adhesives/potting compounds. (Ref. FAATC Oct 26, 2010 presentation, "Microscale Combustion Calorimetry to Demonstrate Similarity of Adhesives").

This range of testing confirms a worse case adhesive.

Generic Fire Properties Test Report
For bonded joint constructions
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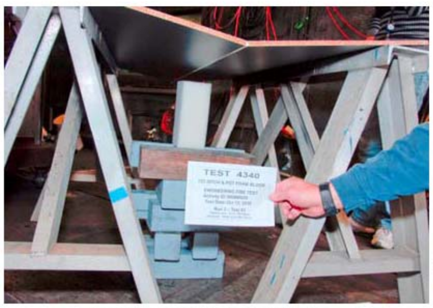
Test Plan:
To establish the test matrix, Boeing interior designs were evaluated to define the boundary conditions of joint angle, panel construction/thickness, and decorative laminate covering. Commodities include, stowage bins, closets, partitions, lavatories and galleys. The following conditions were identified and tested:

- Inside joint angles; 34° to 169°
- Outside joint angles; 134° to 162°
- Panel thickness; 0.375" and 0.5"
- With and without decorative laminates

Foam block testing was performed on a wide variety of configurations in a horizontal orientation to obtain direct flame impingement and at a 65 degree incline to evaluate vertical flame propagation.



Horizontal Orientation

65 Degree Incline

Summary of Test Results:
The 60-second vertical Bunsen burner tests showed consistent performance regardless of joint configuration. The inside joints showed burn lengths consistent with the base panel properties. The outside joints showed slightly more burn length in some cases but the range is well within the range of variation seen in the Bunsen burner test. As expected, the self extinguishing times were in excess of the requirements, as the localized flame at the bottom edge of the specimen continued to burn until it finally self extinguished. No correlation to joint configuration was able to be established and the variation in extinguishing times is likely due to the localized condition of the adhesive DAP specimen.

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A summary of the 60-second Bunsen burner results are shown below:

Joint Construction	Burn Length	Self Extinguishing Time	Drip Extinguishin g Time
Inside	0.5" to 1.75"	70 - 240 seconds	No Drip
Outside	1.25" to 4.25"	160 - 470 seconds	No Drip

Foam block test results showed very consistent flammability resistance regardless of the joint configuration or test sample orientation. A summary of results is as follows:

a) No adhesive ignition
b) No flame propagation, beyond the area of direct flame impingement.

This testing indicates the DAP configuration is determining the flammability properties more so than the adhesive properties.

Conclusions:
Bunsen burner and foam block testing was performed utilizing a non-fire retarded epoxy adhesive in various panel configurations with a ditch and pot joint. Testing a bent panel in the Bunsen burner met the 60-second burn length and drip extinguishing time requirements, while the self extinguishing times exceeded the 15 second requirement.

Using a larger foam block ignition source, larger panels were used to evaluate the flammability performance of realistic installation configurations. The foam block test results showed no ignition or flame propagation beyond direct flame impingement.

These results demonstrate that the ditch and pot joint construction technique does not pose an in-flight fire risk. The results indicate that the flammability performance of ditch and pot joint configurations is driven by the overall joint construction and not by the flammability properties of the adhesive. Since these results were performed on a worse case adhesive and the worse case joint construction technique, these results provide supporting data for the other joint constructions described in item #43, and support a “no test requirement” for all bonded joint constructions.

Generic Fire Properties Test Report
For bonded joint constructions
Reference to Items 43a to 43f
Appendix B

FAA Memorandum
ANM-115-09-XXX
Policy Statement on Flammability Testing of Interior Materials
Reference Items 43a to 43f

Title	: Generic Fire Properties Test Report For bonded joint constructions Reference to Items 43a to 43f
Revision	: Rev B

1.0 TABLE OF CONTENTS

Part I Test Plan

2.0 REVISIONS

Révision	Description	Date	Signature
„new“	New Document	May. – 06 2011	Prepared :D. Boesser
„A“	- Added description to VBB-Tests photographs - Revised datasheet K 0418 / page 49 - Remuneration of specimens	Jun.-09 2011	Prepared :D. Boesser
“B”	- Added Heat Release results	Jul.-26 2011	Prepared : D.Boesser
			Prepared :
			Prepared :

3.0 GENERAL

This fire properties test report defines the test procedures for bonded joint constructions listed in the table below using a structural adhesive or a potting compound and an unpainted / undecorated standard panel.

Reference Number	Feature/Construction
43a	Ditch & Pot
43b	Tab & Slot
43c	Mortise & Tenon
43d	Cut & Fold
43e	T-joints
43f	Bonded Pins

The standard panel used for tests was a sandwich panel with a 2 ply phenolic fiberglass skin on each side bonded to a honeycomb core. The standard base panel meets the 60 sec VBB requirements. Thickness of the used panels was 10mm (~0.4”).

Tests have been performed on the adhesive material by itself (brick test) as well as on the adhesive material applied in a standard panel (bonded joint construction).

Other adhesives (excluded from this test report) have been tested on panels between 0.25” and 0.5” and indicate no effect of adhesive performance based on panel thickness or face skin layup.

Based on the high amount of adhesive, Ditch & Pot joints have been tested as a worse case joint representing all other joint configurations (Item 43b –f).
Flammability class F1 (60 sec. VBB) and F2 (12 sec. VBB) as well as Foam block tests have been performed
The test procedures and the test sample configurations are defined in detail in chapter 6 and 7.

In contrast to Ditch & Pot joints, mortise & Tenon joints are using a small amount of adhesive.
To confirm similar performances to Ditch & Pot joints, mortise and Tenon joints have been tested to Flammability class F1 (60 sec VBB) and F2 (12 sec VBB).

4.0 TEST SPECIMEN SUMMARY

Specimen No.		Test mode	Test Facility
tbd		Heat Release (plaque) test	3M
1	K-0399	VBB test on DAP joint (inner single ditch 90° angle)	SELL
	K-0400		
2	K-0402		
1	K-0407	Foam Block test on DAP joint (inner single ditch 90° angle)	SELL
	K-0408		
2	K-0409		
	K-0410		
3	K-0403	VBB test on DAP joint (outer single ditch 145° angle)	SELL
	K-0404		
4	K-0405		
	K-0406		
3	K-0411	Foam Block test on DAP joint (outer single ditch 145° angle)	SELL
	K-0412		
4	K-0413		
	K-0414		
5	K-0415	VBB test on DAP joint (inner multiple ditch 1", 3" and 5" radius) 90 ° angle	SELL
	K-0416		
6	F-6790		
	F-6790		
7	K-0417		
	K-0418		
8	F-6791		
	F-6791		
9	K-0419		
	K-0420		
10	F-6792		
	F-6792		
11	K-0421	Foam Block test on DAP joint (inner multiple ditch 1", 3" and 5" radius) 90 ° angle	SELL
	K-0422		
12	K-0423		
	K-0424		
13	K-0425		
	K-0426		
14	K-0427		
	K-0428		
15	K-0429		
	K-0430		
16	K-0431		
	K-0432		
17	K-0433	VBB test on Mortise & Tenon joints	SELL
	K-0434		
18	K-0435		
	K-0436		

5.0 DESCRIPTION OF TEST PROCEDURES

5.1 14 CFR 25.853(a)(1)(i) and (ii) Vertical Bunsen Burner Test (VBB)

60 second Vertical Bunsen Burner as well 12 second vertical Bunsen Burner tests have been performed in acc. to DOT/FAA/AR-00/12 Aircraft Materials Fire Test Handbook Chapter 1

5.2 14 CFR 25.853(d) Heat Release (OSU) Test.

Heat Release tests have been performed in accordance with DOT/FAA/AR-00/12 Aircraft Materials Fire Test Handbook Chapter 5

5.3 Foam Block Test

Foam Block tests have been performed on different Ditch & Pot joints.

Each joint has been tested from the cut side in a horizontal orientation, and in a near vertical position at 65 ± 5 degrees. This slight incline ensures direct flame impingement onto the joint.

The foam block fire source is a 4” X 4” X 9” (± 0.5”) piece of polyurethane foam. The foam was obtained from “Douglas Industries” and is Engineering furnished. During testing the foam block has been positioned on a steel tray with a 6 mm (~0.24”) pointed steel rod welded to it in the vertical position such that the foam block is slid over the rod to hold it in place. A picture of a foam block is found in Figure 5-1. A picture of the steel holding tray with the steel rod is found in Figure 5-2. Prior to testing the bottom of the foam block has been coated with 10 ml of heptane. This has been done by measuring the heptane using a graduated cylinder (or equivalent) and pouring it in the steel tray. The bottom of foam block is used to soak up the 10 ml heptane. A picture of the steel tray used for the heptane is found in Figure 5-3. Prior to soaking up the heptane, the foam block is placed over the steel rod to bore a hole down the center. This allows for easier mounting of the block over the rod once the heptane has been soaked up by the block. The function of the heptane is to aid in ignition of the foam block.

Figure 5-1 - Foam Block Fire Source

Figure 5-2 - Steel Tray with Pointed Steel Rod

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Figure 5-3 - Steel Tray Used for Soaking Bottom of Foam Block with Heptane

The following procedure has been used for the foam block fire test method:

1. Position test article as defined in the individual test setup sections (See Section 5.3.1)
2. Create a hole down the center of the foam block to be used during testing by sliding it down the length of the rod on the steel tray (See Figure 5-2) and removing it.
3. Measure 10 ml of heptane and pour it into steel soaking tray (See Figure 5-3).
4. Soak up heptane with bottom of the polyurethane foam block.
5. Mount foam block on the steel tray, sliding the block over the pointed steel rod so that the bottom of the block is in contact with the tray (See Figure 5-1).
6. Place the steel tray in test position next to the test article in accordance with the individual test setup sections (See Section 5.3.1). Foam block centerline shall be lined up with the DAP joint. Spacer material may be used as a shop option to meet this dimension.
7. Within 15 minutes of soaking up the heptane with the block, ignite the bottom of the foam block to begin the test.

5.3.1 Foam Block Test Setup Configurations

- **Inside Joint, Horizontal Orientation**

All Horizontal Foam Block tests for Inside Joints have been run in the same manner. Figure 5-4 and Figure 5-5 show the location of the foam block relative to the test article.

In the case of severely acute angles the foam block will be placed as close as possible within the distance shown. It is acceptable for the foam block to be more than 3” away from the DAP joint in cases where compression of the foam limits the proximity to the DAP joint; in this case the edges of the foam block will be in contact with the panel. Any instances where the top surface of the foam block is more than 3” from the DAP joint will be noted on the data sheet.

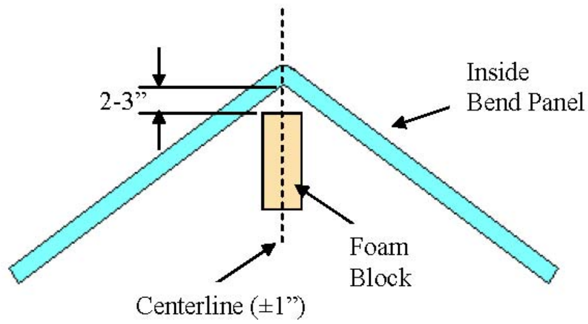

Figure 5-4 - Inside Joint Horizontal Test Configuration – Front View

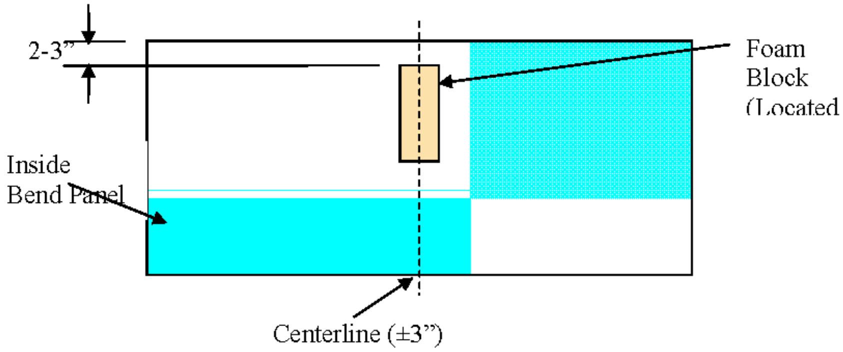

Figure 5-5 - Inside Joint Horizontal Test Configuration – Side View

- **Inside Joint, 65 ± 5 degree Orientation**

All 65 degree Foam Block tests for Inside Joints have been run in the same manner. Figure 5-6, Figure 5-7 and Figure 5-8 show the location of the foam block relative to the test article.

In the case of severely acute angles the foam block will be placed as close as possible within the distance shown. It is acceptable for the foam block to be more than 3" away from the DAP joint in cases where compression of the foam limits the proximity to the DAP joint; in this case the edges of the foam block will be in contact with the panel. Any instances where the top edge of the foam block is more than 3" from the DAP joint will be noted on the data sheet.

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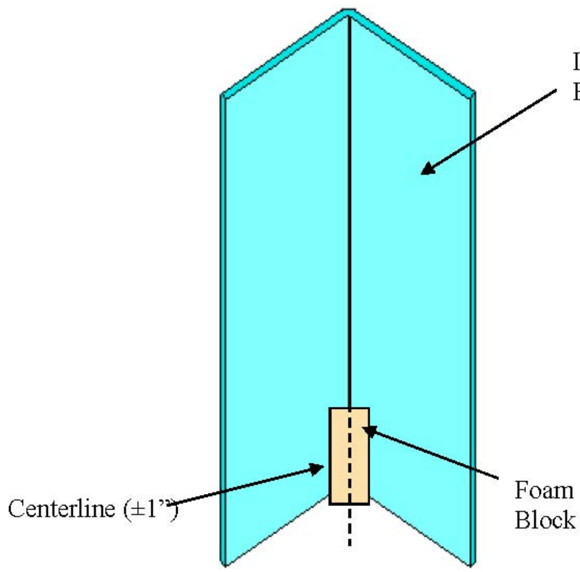


Figure 5-6 - Inside Joint 65 ± 5 degree Test Configuration - Front View

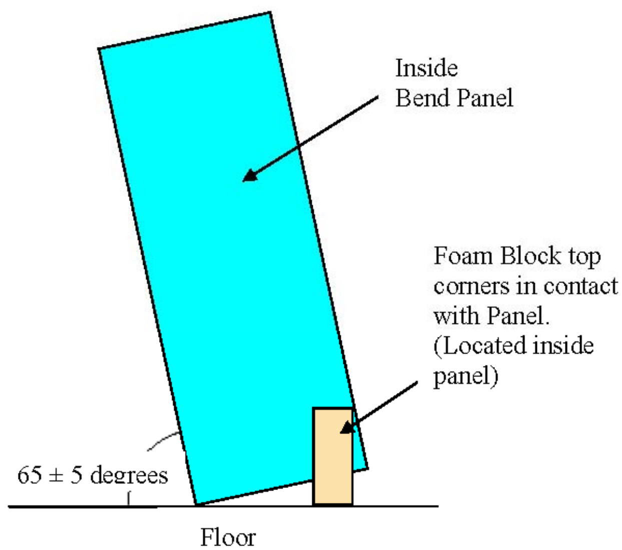


Figure 5-7 - Inside Joint 65 ± 5 degree Test Configuration - Side View

Rev "new"

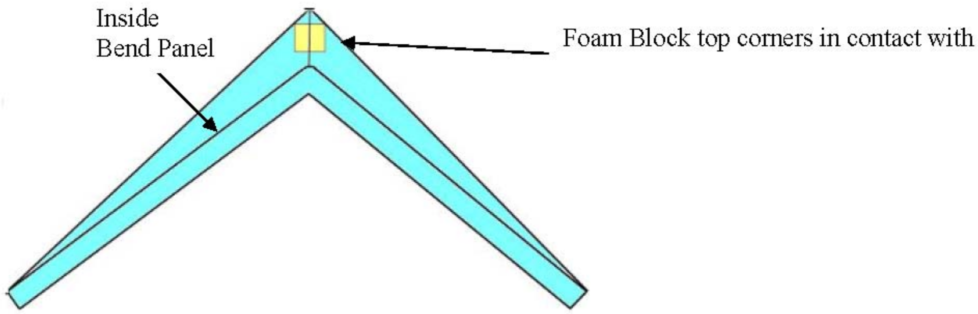


Figure 5-8 - Inside Joint 65 ± 5 degree Test Configuration - Top View

- **Outside Joint, Horizontal Orientation**

All Horizontal Foam Block tests for Outside Joints have been run in the same manner. Figure 5-9 and Figure 5-10 show the location of the foam block relative to the test article.

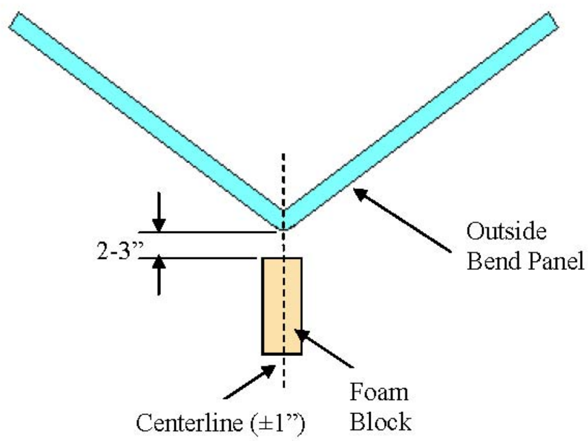


Figure 5-9 - Outside Joint Horizontal Test Configuration - Front View

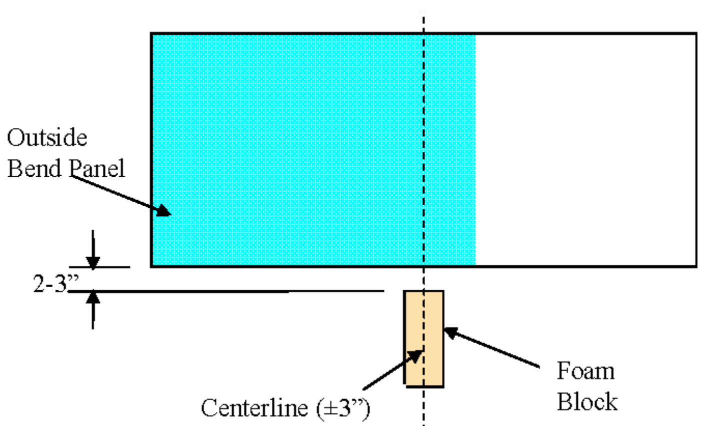


Figure 5-10 - Outside Joint Horizontal Test Configuration - Side View

- **Outside Joint, 65 ± 5 degree Orientation**

All 65 degree Foam Block tests for Outside Joints have been run in the same manner. Figure 5-11 and Figure 5-12 show the location of the foam block relative to the test article.

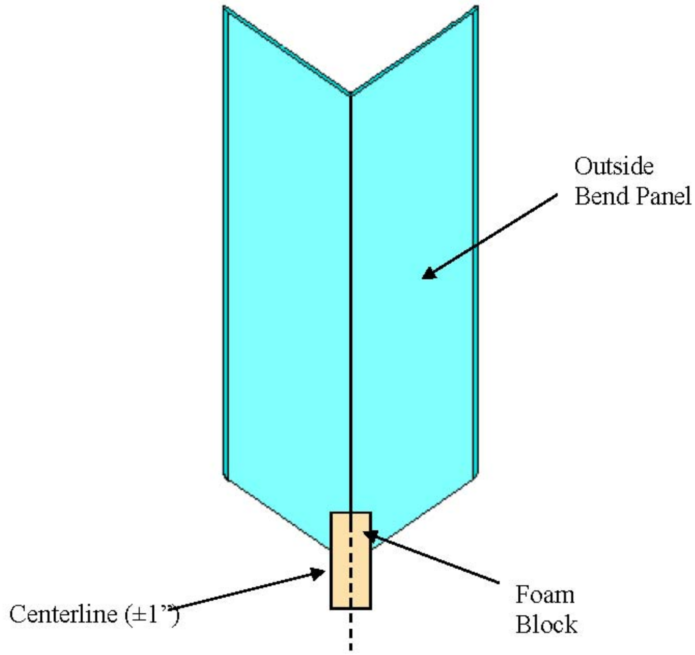


Figure 5-11 - Outside Joint 65 ± 5 degree Test Configuration - Front View

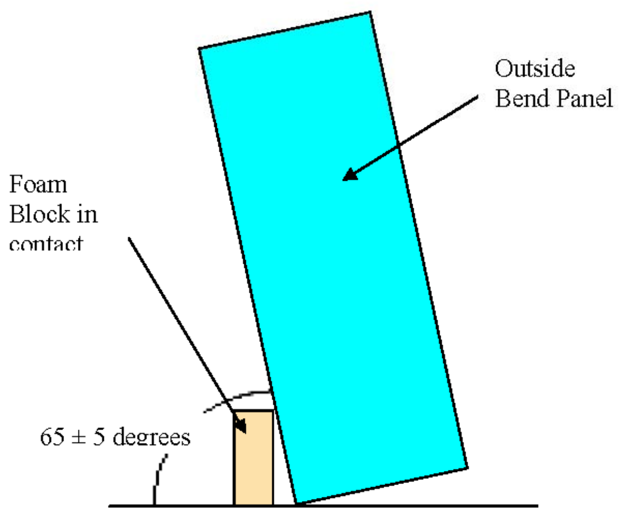


Figure 5-12 - Outside Joint 65 ± 5 degree Test Configuration - Side View

5.4 Foam Block acceptance criteria

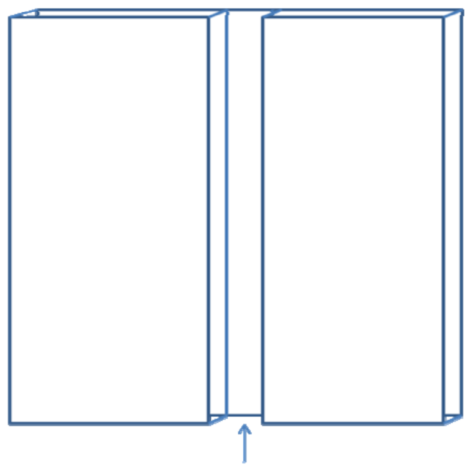
The foam block test acceptance criteria as defined in the Issue Paper CS-1 are as follows:

1. There must be no flame propagation beyond 2-inches from the area of direct flame impingement from the fire source.
2. The flame time may not exceed 30 seconds.

6.0 FIRE PROPERTIES SPECIMEN DISCRIPTION

6.1 Heat Release (OSU) test on a plaque of adhesive

Heat Release tests have been performed in accordance to the proposal for Item 43 "bonded joints" on structural adhesive applied into a half inch wide slot in a standard panel type.
Test have been performed in accordance with DOT/FAA/AR-00/12 Aircraft Materials Fire Test Handbook
Chapter 5
To determine the specific heat release, MCC tests have been performed in addition to the OSU test scenario to determine a possible correlation between the Heat Release (OSU) and the MCC



Sketch: Heat Release test sample configuration pre potting

Generic Fire Properties Test Report
For bonded joint constructions
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Test Results:

Average Values

		HRR			
Material	Code Desc	2 Min. Total	Peak HR	Peak Time	Pass/Fail
DP-110	Adh-1	28	70	298	F
EC2615	Adh -2	27	91	292	P
SW9323-2	Adh -3	57	71	299	F
SW7246-2	Adh-FST-1	22	33	291	F
EC9300	Adh- FST 2	49	42	167	P
DP-100FR	Adh FR	32	44	286	P

		MCC				
Material	Code Desc	Capacity (J/gK)	Peak (W/g)	Total (kJ/g)	Temp deg C	Char %
DP-110	Adh-1	604,6	593,9	24,6	385,5	4
EC2615	Adh -2	673	677	25,4	405	9
SW9323-2	Adh -3	292	280	26,4	388	12
SW7246-2	Adh-FST-1	118	121,5	12,8	389	44,6
EC9300	Adh- FST 2	162	157	16,9	381,3	29
DP-100FR	Adh FR	408	397,7	12,2	325,1	27

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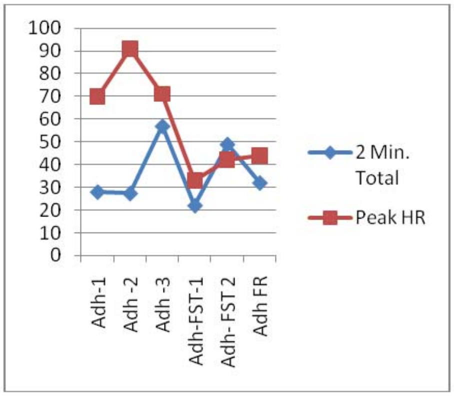

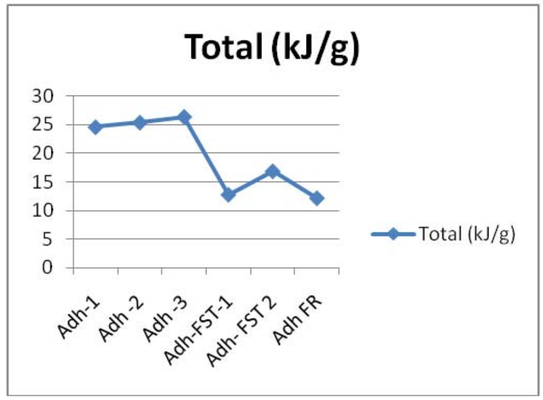

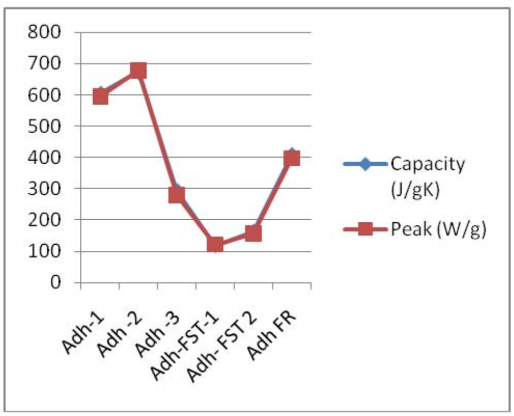

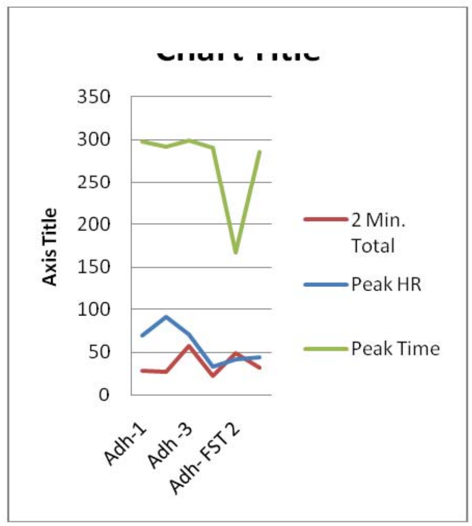

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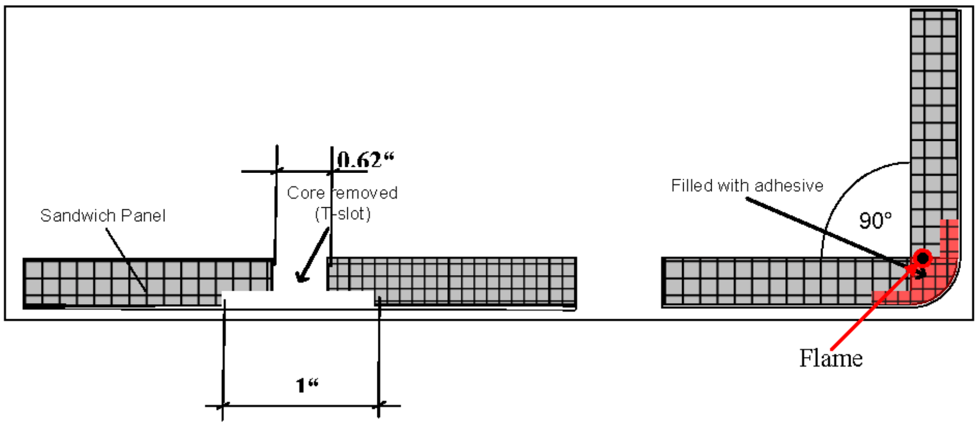
6.2 Item 43a "Ditch & Pot"

6.2.1 Test sample configuration for adhesive applied in a panel (single ditch)

Panel Dimensions for 12sec VBB and 60sec VBB test specimen 4 pre potting 3" x 12"

Panel Dimensions for Foam Block test specimen No. 5 and 6 pre potting 3ft x 4ft



Specimen No. 1 Adhesive 3M SW 9323-2 B/A (non fire retardant)	Adhesive applied to a panel (single ditch) Specimen No 1					
	12 sec. VBB K-0400			60 sec. VBB K-0399		
	FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Sample 1	0	0.5	0	134	4.9	0
Sample 2	0	0.7	0	>180*	>10*	0
Sample 3	0	0.6	0	145	4.5	0
Average	0	0.6	0	~153	~6.5	0
Results see page	57 to 58			55 to 56		

Specimen No. 2 Adhesive 3M SW 9300 B/A FST (fire retardant)	Adhesive applied to a panel (single ditch) Specimen No 2 K-0402		
	12 sec. VBB		
	FET (s)	BL (in)	Drips ET (s)
Sample 1	0	0.8	0
Sample 2	0	0.9	0
Sample 3	0	0.8	0
Average	0	0.8	0
Results see page	59 to 60		

*** Flame has been extinguished intentionally**

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Specimen No. 1 Adhesive 3M SW 9323-2 B/A (non fire retardant)	Adhesive applied to a panel (single ditch 90° bend) Foam Block tests	
	PASS	FAIL
Sample K 0407	X	
Sample K 0408 65°inclined	X	
Results see page	101 to 106	

Specimen No. 2 Adhesive 3M SW 9300 B/A FST (fire retardant)	Adhesive applied to a panel (single ditch 90°bend) Foam Block tests	
	PASS	FAIL
Sample K 0409	X	
Sample K 0410 65° inclined	X	
Results see page	107 to 112	

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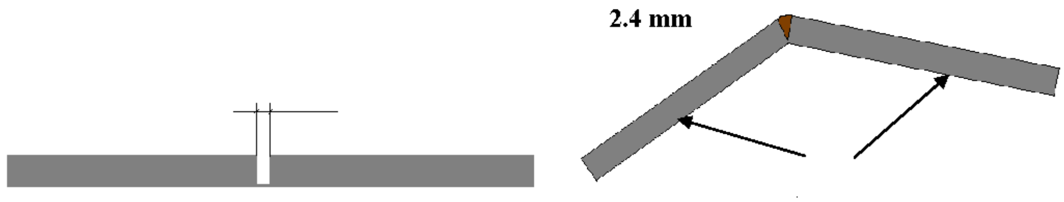

Specimen No. 3 Adhesive 3M SW 9323-2 B/A (non fire retardant)	Adhesive applied to a panel (single ditch 145° outside bend) Specimen No 3 **145°**					
	12 sec. VBB K-0404			60 sec. VBB K-0403		
	FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Sample 1	>120*	6.2	0	>240*	>10*	0
Sample 2	>120*	3.6	0	--------	>10*	0
Sample 3	>120*	3.4	0	--------	>10*	0
Average	>120*	3.4	0	--------	>10*	0
Results see page	64 to 65			61 to 63		

Specimen No. 4 Adhesive 3M SW 9300 B/A FST (fire retardant)	Adhesive applied to a panel (single ditch 145° outside bend) Specimen No 4					
	12 sec. VBB K-0406			60 sec. VBB K-0405		
	FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Sample 1	0	0.6	0	6	3.8	0
Sample 2	0	0.8	0	3	3.8	0
Sample 3	0	0.7	0	0	2.6	0
Average	0	0.7	0	3	3.4	0
Results see page	68 to 69			66 to 67		

*** Flame has been extinguished intentionally**

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For bonded joint constructions
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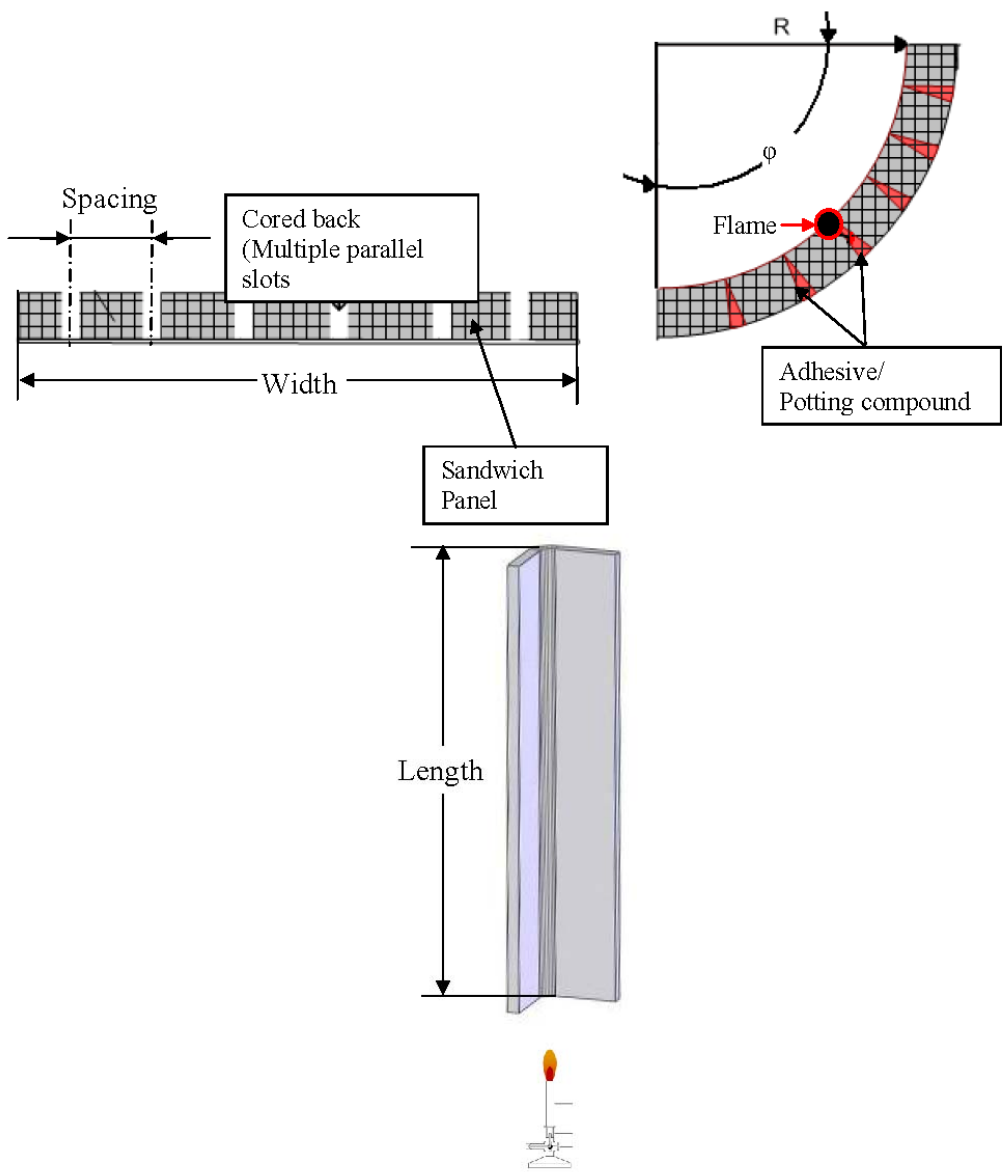
Specimen No. 3 Adhesive 3M SW 9323-2 B/A (non fire retardant)	Adhesive applied to a panel (single ditch 145° outside bend) Foam Block tests	
	PASS	FAIL
Sample K 0411	X	
Sample K 0412 65° inclined	X	
Results see pages	113 to 118	

Specimen No. 4 Adhesive 3M SW 9300 B/A FST (fire retardant)	Adhesive applied to a panel (single ditch 145° outside bend) Foam Block tests	
	PASS	FAIL
Sample K 0413	X	
Sample K 0414 65° inclined	X	
Results see pages	119 to 124	

6.2.2 Test sample configuration for adhesive applied in a panel (<u>multiple ditch</u>)

Radius	Angle (φ)	Ditch configuration		Sample dimensions (pre potting)	
		No of ditches	Spacing between the ditches Center to center [inch]	Length VBB / Foam Block	Width VBB / Foam Block
1”	90 degree	9	0.2	12” / 4ft	3” / 3ft
3”	90 degree	13	0.4	12” / 4ft	6.5” / 3ft
5”	90 degree	21	0.4	12” / 4ft	10” / 3ft



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Adhesive 3M SW 9323-2 B/A (non fire retardant)		Adhesive applied to a panel (multiple ditch)					
		12 sec. VBB K-0416			60 sec. VBB K-0415		
		FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Specimen No. 5 1" Radius	Sample 1	>120*	>6*	0	>120*	>8*	0
	Sample 2	>120*	>6*	0	>120*	>8*	0
	Sample 3	>120*	>6*	0	>120*	>8*	0
Average		>120*	>6*	0	>120*	>8*	0
Results see page		73 to 74			70 to 72		

Adhesive 3M SW 9300-2 B/A FST (fire retardant)		Adhesive applied to a panel (multiple ditch)					
		12 sec. VBB F-6790			60 sec. VBB F-6790		
		FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Specimen No. 6 1" Radius	Sample 1	0	0.3	0	0	2.0	0
	Sample 2	0	0.3	0	0	1.9	0
	Sample 3	0	0.5	0	0	1.9	0
Average		0	0.4	0	0	1.9	0
Results see page		76			75		

Adhesive 3M SW 9323-2 B/A (non fire retardant)		Adhesive applied to a panel (multiple ditch)					
		12 sec. VBB K-0418			60 sec. VBB K-0417		
		FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Specimen No. 7 3" Radius	Sample 1	>60*	1.3	0	>120*	5.8	0
	Sample 2	43	1.4	0	>120*	5.8	0
	Sample 3	>120*	3.5	0	>120*	>6*	0
Average		74	2.1	0	>120*	5.9	0
Results see page		80 to 81			77 to 79		

Adhesive 3M SW 9300-2 B/A FST (fire retardant)		Adhesive applied to a panel (multiple ditch)					
		12 sec. VBB F-6791			60 sec. VBB F-6791		
		FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Specimen No. 8 3" Radius	Sample 1	0	0.0	0	0	0.7	0
	Sample 2	0	0.1	0	6	1.8	0
	Sample 3	0	0.1	0	0	1.8	0
Average		0	0.1	0	2	1.4	0
Results see page		83			82		

* Flame has been extinguished intentionally

Generic Fire Properties Test Report
For bonded joint constructions
Reference to Items 43a to 43f

Adhesive 3M SW 9323-2 B/A (non fire retardant)		Adhesive applied to a panel (multiple ditch)					
		12 sec. VBB K-0420			60 sec. VBB K-0419		
		FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Specimen No. 9 5" Radius	Sample 1	16	1.3	0	>120*	5.4	0
	Sample 2	>120*	1.2	0	>120*	6.0	0
	Sample 3	115	1.4	0	>120*	>6*	0
Average		84	1.3	0	>120*	5.8	0
Results see page		87 to 88			84 to 86		

Adhesive 3M SW 9300-2 B/A FST (fire retardant)		Adhesive applied to a panel (multiple ditch)					
		12 sec. VBB F-6792			60 sec. VBB F-6792		
		FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Specimen No. 10 5" Radius	Sample 1	0	0.1	0	6	1.1	0
	Sample 2	0	0.0	0	0	1.3	0
	Sample 3	0	0.1	0	0	0.6	0
Average		0	0.1	0	2	1.0	0
Results see page		90			89		

Specimen No. 11 Adhesive 3M SW 9323-2 B/A	(multiple ditch 1") Foam Block tests	
	PASS	FAIL
Sample K 0421	X	
Sample K 0422 65° inclined	X	
Results see pages	125 to 130	

Specimen No. 12 Adhesive 3M SW 9300 B/A FST	(multiple ditch 1") Foam Block tests	
	PASS	FAIL
Sample K 0423	X	
Sample K 0424 65° inclined	X	
Results see page	131 to 136	

Specimen No. 13 Adhesive 3M SW 9323-2 B/A	(multiple ditch 3") Foam Block tests	
	PASS	FAIL
Sample K 0425	X	
Sample K 0426 65° inclined	X	
Results see pages	137 to 142	

Specimen No. 14 Adhesive 3M SW 9300 B/A FST	(multiple ditch 3") Foam Block tests	
	PASS	FAIL
Sample K 0427	X	
Sample K 0428 65° inclined	X	
Results see pages	143 to 149	

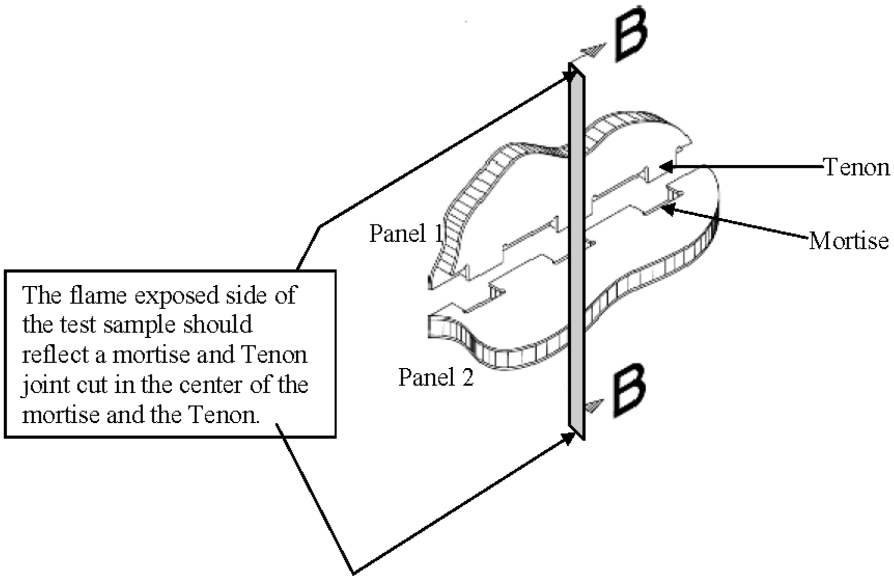
Specimen No. 15 Adhesive 3M SW 9323-2 B/A	(multiple ditch 5") Foam Block tests	
	PASS	FAIL
Sample K 0429	X	
Sample K 0430 65° inclined	X	
Results see pages	150 to 155	

Specimen No. 16 Adhesive 3M SW 9300 B/A FST	(multiple ditch 5") Foam Block tests	
	PASS	FAIL
Sample K 0431	X	
Sample K 0432 65° inclined	X	
Results see pages	156 to 161	

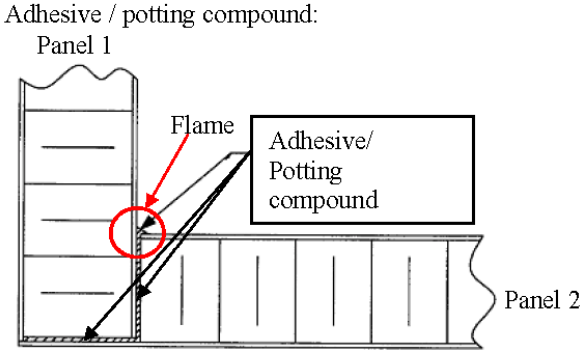
* Flame has been extinguished intentionally

6.3 Item 43c "Mortise & Tenon"

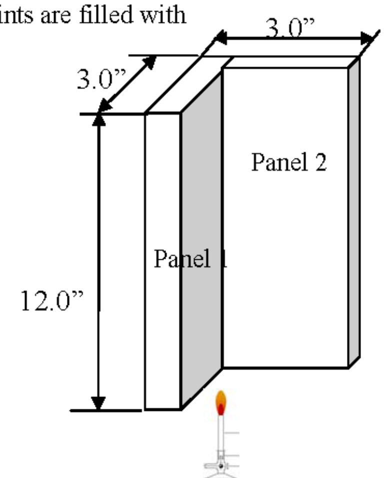
The edge of panel 1 with mortises and Tenon shape is bonded to its counterpart on the edge of panel 2:



The gaps between the "mortise and Tenon"- / "tab and slot"-joints are filled with Adhesive / potting compound:



SECTION B-B



Specimen No. 17 Adhesive 3M SW 9323-2 B/A (non fire retardant)	Adhesive applied to a panel (Mortise & Tenon)					
	12 sec. VBB K-0434			60 sec. VBB K0433		
	FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Sample 1	0	0.9	0	82	5.6	0
Sample 2	0	1.2	0	95	6.1	0
Sample 3	0	1.0	0	80	5.3	0
Average	0	1.0	0	86	5.7	0
Results see page	96 to 97			91 to 95		

Generic Fire Properties Test Report
For bonded joint constructions
Reference to Items 43a to 43f

Specimen No. 18 Adhesive 3M SW 9300 B/A FST (fire retardant)	Adhesive applied to a panel (Mortise & Tenon)					
	12 sec. VBB K-0436			60 sec. VBB K0435		
	FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Sample 1	0	0.4	0	0	1.0	0
Sample 2	0	0.7	0	3	1.2	0
Sample 3	0	0.2	0	0	1.2	0
Average	0	0.4	0	1	1.5	0
Results see page	99 to 100			98		

PART II TEST REPORT

7.0 TEST DATASHEETS

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Flammability Data Sheet **Test Method : F1**

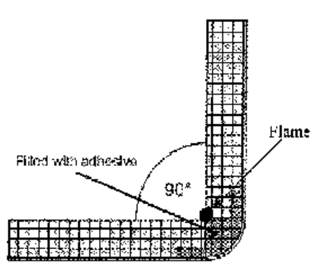
Identification : Sample No K-0399			
Document No :			BSL-FI-11-035
Manufacturer : SELL GmbH			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Feb-21-2011	Tested by: D.Boesser
Witnessed by: K.Boesser	Flame Temperature: 859°C / 1578°F	Tested in accordance with: FAR Part 25.853 (a)	

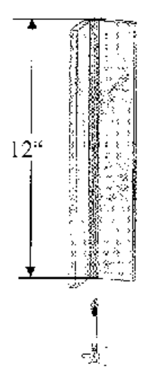
Method		Ignition time and material position			
FAIL	**F1**	**60 second vertical**		F4	15 second horizontal
	F2	12 second vertical		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	**15 sec. (avg.)**	**6 inch (avg.)**	**3 seconds**			
F2	15 sec. (avg.)	8 inch (avg.)	5 seconds			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F1**	134 sec.	4.9 inch	0 sec.			
2	**F1**	>180 sec.	>10 inch	0 sec.			
3	**F1**	145 sec.	4.5 inch	0 sec.			
Average		**~153 sec.**	**~6.5 inch**	**0 sec.**			

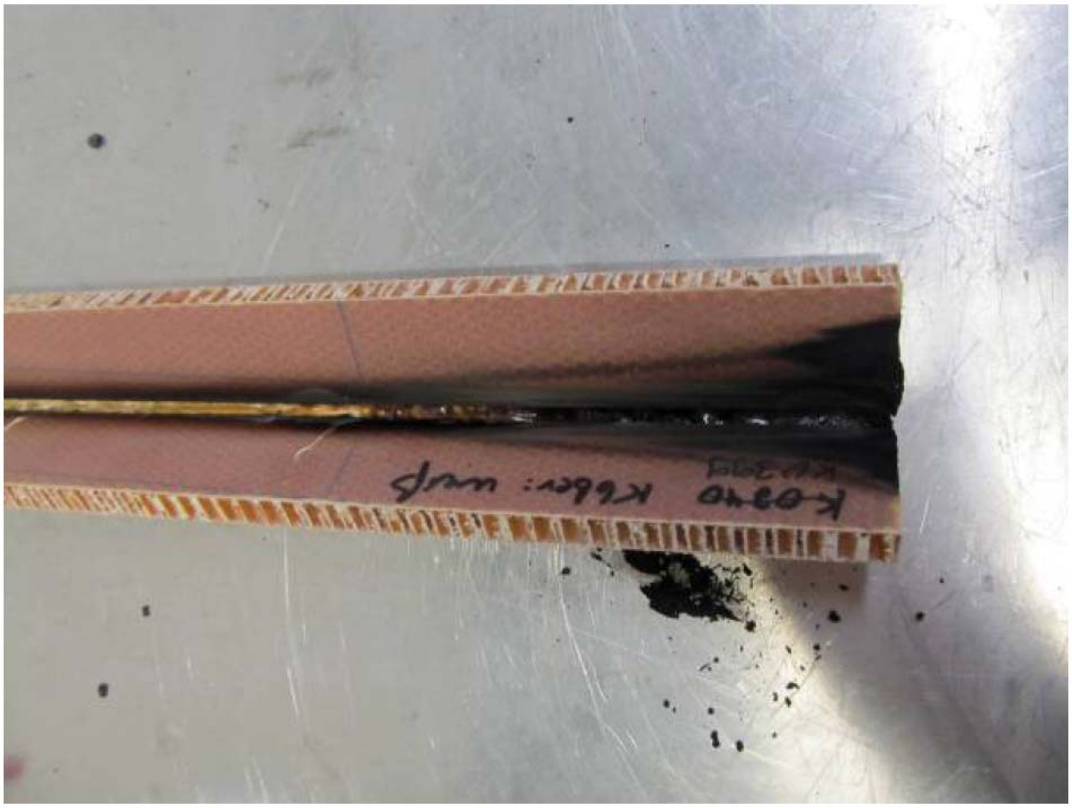
Comments (e.g. penetration, etc.) : None
Result :





Adhesive Type:
3M Scotch-Weld 9323-2 B/A

Photo of Sample K-0399: 90° single ditch after 60 sec. VBB test (worst case adhesive)



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Flammability Data Sheet

Test Method : F2

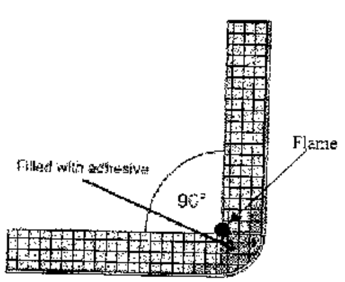
Identification : Sample No K-0400			
Document No :			BSL-FI-11-044
Manufacturer : SELL GmbH			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Feb-21-2011	Tested by: D.Boesser
Witnessed by: K.Boesser	Flame Temperature: 859°C / 1578°F	Tested in accordance with: FAR Part 25.853 (a)	

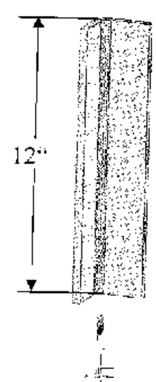
Method		Ignition time and material position			
	F1	60 second vertical		F4	15 second horizontal
PASS	**F2**	**12 second vertical**		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	15 sec. (avg.)	6 inch (avg.)	3 seconds			
F2	**15 sec. (avg.)**	**8 inch (avg.)**	**5 seconds**			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F2**	0 sec.	0,5 inch	0 sec.			
2	**F2**	0 sec.	0,7 inch	0 sec.			
3	**F2**	0 sec.	0,6 inch	0 sec.			
Average		**0 sec.**	**0.6 inch**	**0 sec.**			

Comments (e.g. penetration, etc.) : None
Result :





Adhesive Type:
3M Scotch-Weld 9323-2 B/A

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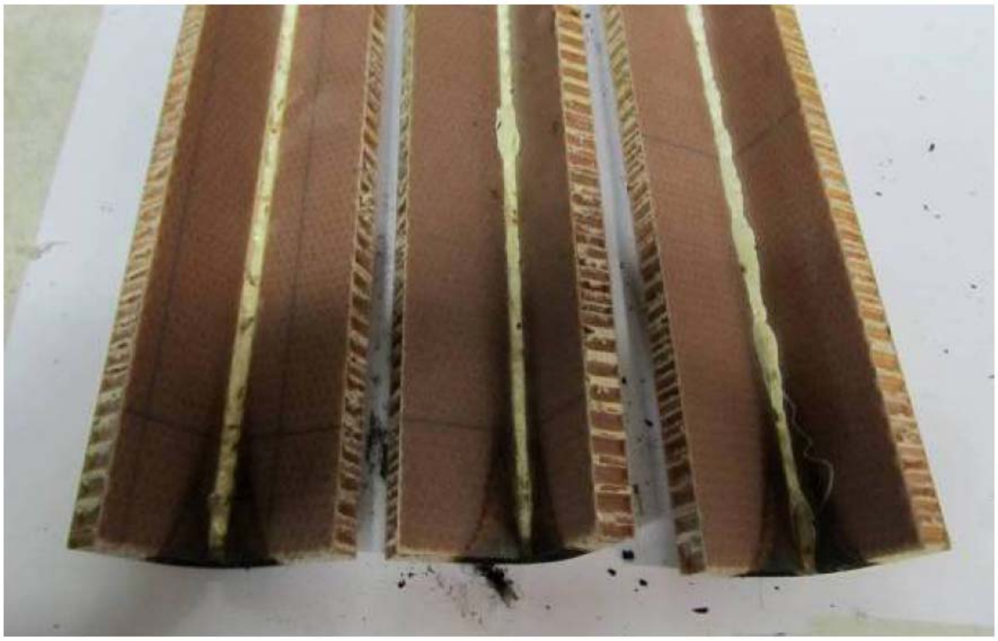
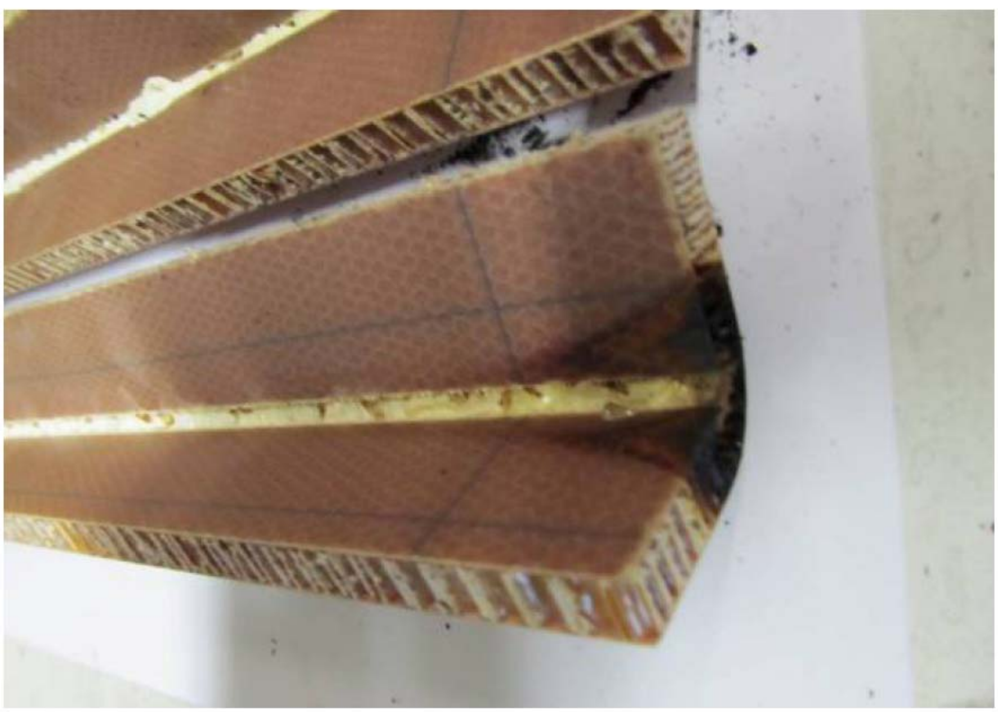
Photos of Sample K-0400: 90° single ditch after 12 sec. VBB test (worst case adhesive)





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Flammability Data Sheet **Test Method : F2**

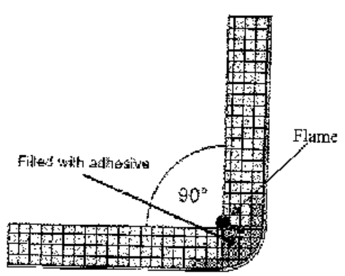
Identification : Sample No K-0402			
Document No :			BSL-Fl-11-045
Manufacturer : SELL GmbH			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Feb-21-2011	Tested by: D.Boesser
Witnessed by: K.Boesser	Flame Temperature: 859°C / 1578°F	Tested in accordance with: FAR Part 25.853 (a)	

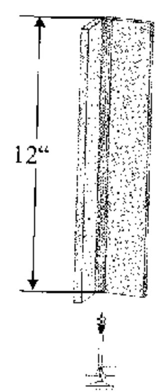
Method		Ignition time and material position			
	F1	60 second vertical		F4	15 second horizontal
PASS	**F2**	**12 second vertical**		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	15 sec. (avg.)	6 inch (avg.)	3 seconds			
F2	**15 sec. (avg.)**	**8 inch (avg.)**	**5 seconds**			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F2**	0sec.	0,8 inch	sec.			
2	**F2**	0sec.	0,9 inch	sec.			
3	**F2**	0sec.	0,8 inch	sec.			
Average		**0sec.**	**0,8 inch**	**sec.**			

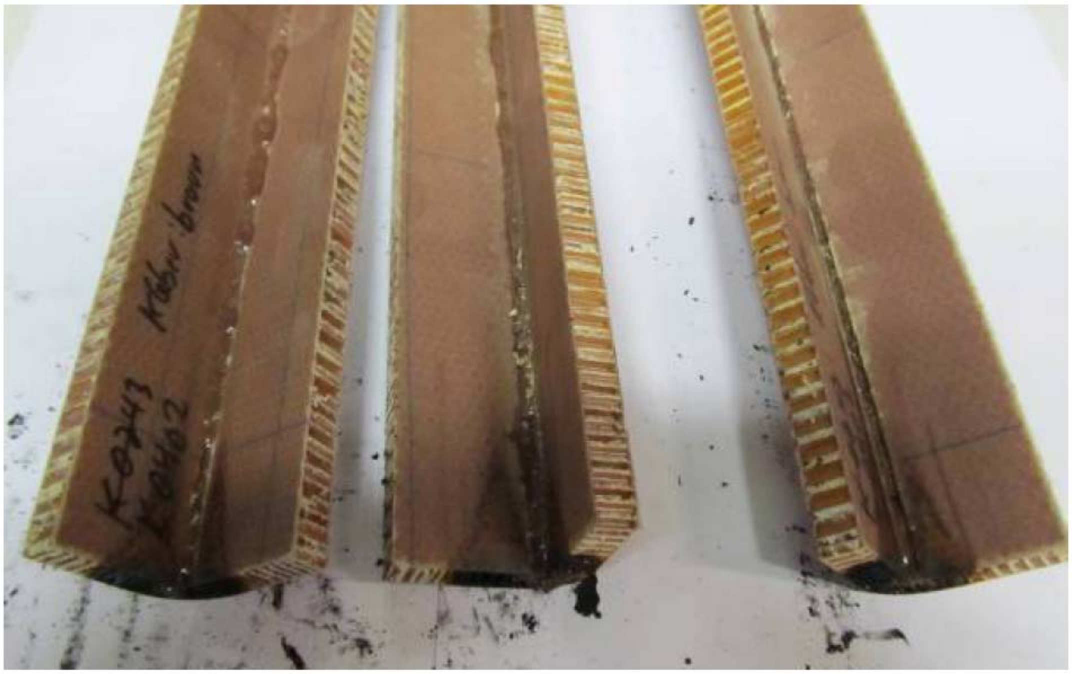
Comments (e.g. penetration, etc.) : None
Result :





Adhesive Type:
3M Scotch-Weld 9300-2 B/A

Photos of Sample K-0402: 90° single ditch after 12 sec. VBB test (adhesive with fire retardants)



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Flammability Data Sheet

Test Method : F1

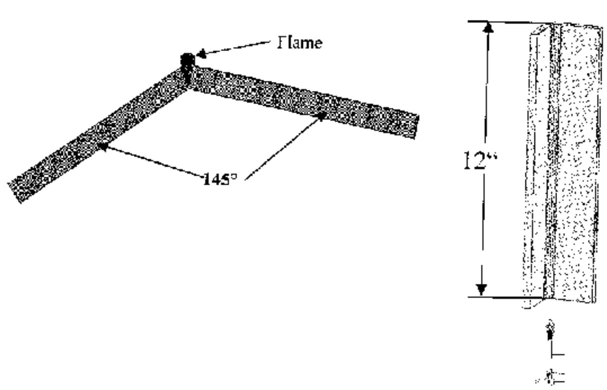
Identification : Sample No K-0403			
Document No :			BSL-Fl-11-037
Manufacturer : SELL GmbH			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Feb-21-2011	Tested by: D.Boesser
Witnessed by: K.Boesser	Flame Temperature: 859°C / 1578°F	Tested in accordance with: FAR Part 25.853 (a)	

Method		Ignition time and material position			
FAIL	**F1**	**60 second vertical**		F4	15 second horizontal
	F2	12 second vertical		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	**15 sec. (avg.)**	**6 inch (avg.)**	**3 seconds**			
F2	15 sec. (avg.)	8 inch (avg.)	5 seconds			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F1**	> 240 sec.	>10 inch	0 sec.			
2	**F1**	--sec.	>10 inch	0 sec.			
3	**F1**	--sec.	>10 inch	0 sec.			
Average		**--sec.**	**>10 inch**	**0 sec.**			

Comments (e.g. penetration, etc.) : adhesive remains burning untill the adhesive is burned down completely.



Adhesive Type:
3M Scotch-Weld 9323-2 B/A

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Photos of Sample K-0403: 145° outside ditch pre testing (worst case adhesive)

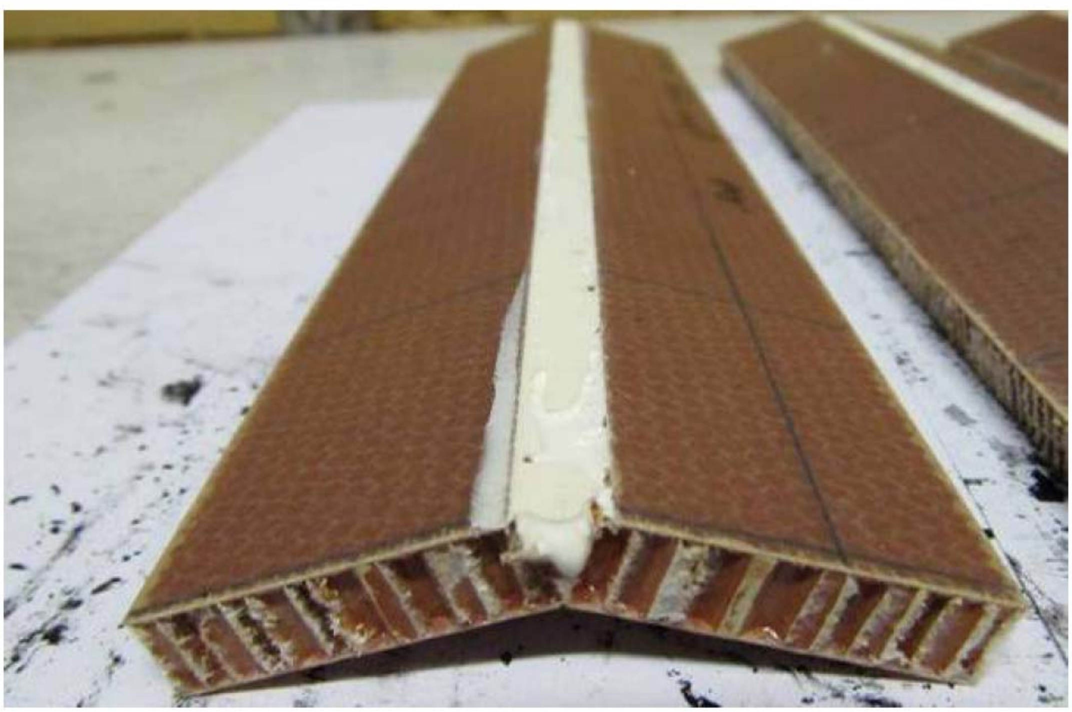

Photo of Sample K-0403: 145°outside ditch after 60 sec. VBB test (worst case adhesive)
The flame has been extinguished after 240 seconds intentionally.

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Flammability Data Sheet

Test Method : F2

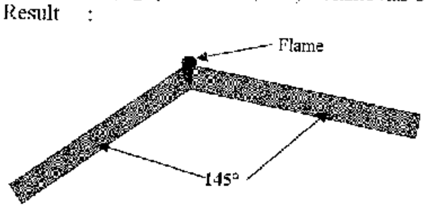
Identification : Sample No K-0404			
Document No :			BSL-FI-11-046
Manufacturer : SELL GmbH			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Feb-21-2011	Tested by: D.Boesser
Witnessed by: K.Boesser	Flame Temperature: 859°C / 1578°F	Tested in accordance with: FAR Part 25.853 (a)	

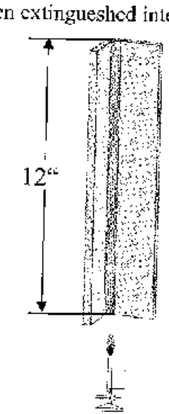
Method		Ignition time and material position			
	F1	60 second vertical		F4	15 second horizontal
FAIL	**F2**	**12 second vertical**		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	15 sec. (avg.)	6 inch (avg.)	3 seconds			
F2	**15 sec. (avg.)**	**8 inch (avg.)**	**5 seconds**			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F2**	> 120 sec.	6.2 inch	0 sec.			
2	**F2**	> 120 sec.	3.6 inch	0 sec.			
3	**F2**	> 120 sec.	3.4 inch	0 sec.			
Average		**> 120 sec.**	**3.4 inch**	**0 sec.**			

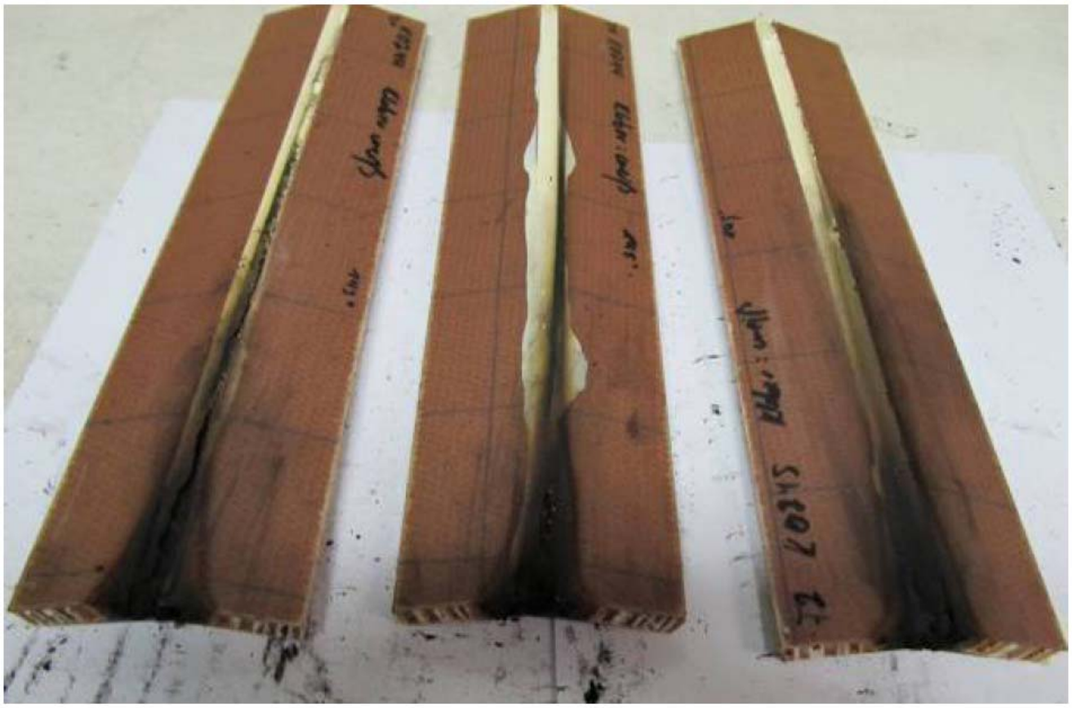
Comments (e.g. penetration, etc.) : Flame has been extingueshed intentionally after 120 sec.
Result :

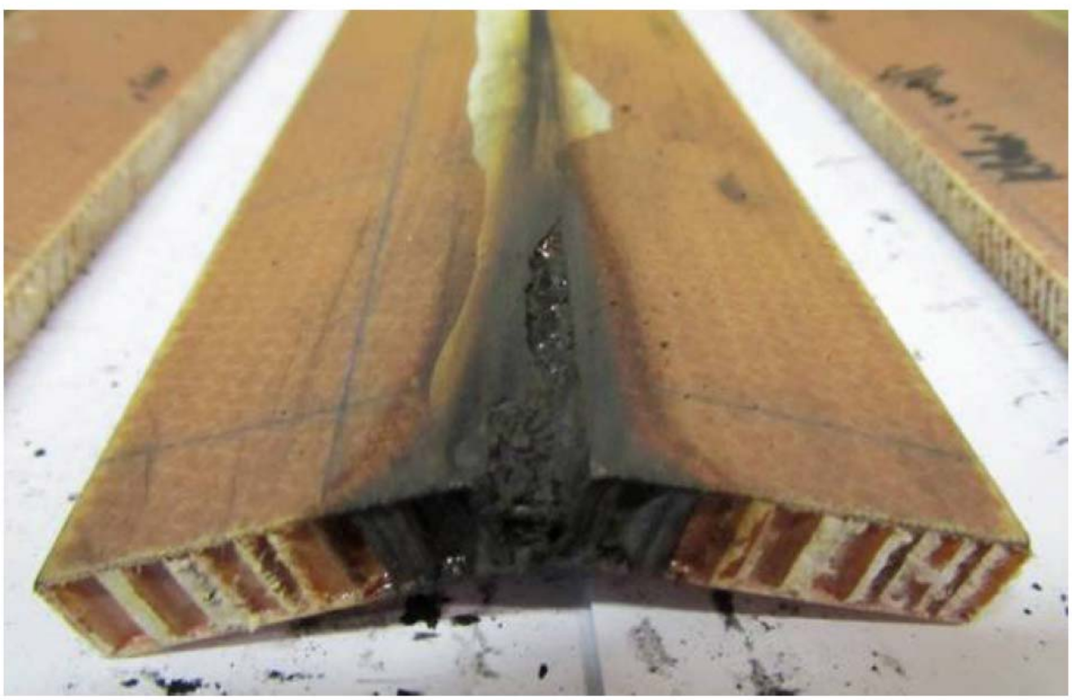




Adhesive Type:
3M Scotch-Weld 9323-2 B/A

Photos of Sample K-0404: 145°outside ditch after 12 sec. VBB test (worst case adhesive)





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Flammability Data Sheet **Test Method : F1**

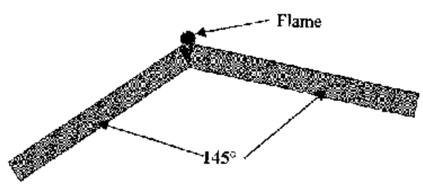
Identification : Sample No K-0405			
Document No :			BSL-FI-11-038
Manufacturer : SELL GmbH			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Feb-21-2011	Tested by: D.Boesser
Witnessed by: K.Boesser	Flame Temperature: 859°C / 1578°F	Tested in accordance with: FAR Part 25.853 (a)	

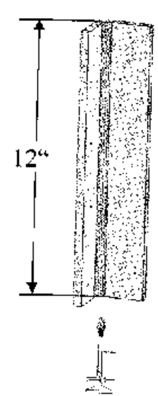
Method		Ignition time and material position			
PASS	F1	**60 second vertical**		F4	15 second horizontal
	F2	12 second vertical		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	**15 sec. (avg.)**	**6 inch (avg.)**	**3 seconds**			
F2	15 sec. (avg.)	8 inch (avg.)	5 seconds			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F1**	6 sec.	3.8 inch	0 sec.			
2	**F1**	3 sec.	3.8 inch	0 sec.			
3	**F1**	0 sec.	2.6 inch	0 sec.			
Average		**3 sec.**	**3.4 inch**	**0 sec.**			

Comments (e.g. penetration, etc.) : None
Result :





Adhesive Type:
3M Scotch-Weld 9300 B/A FST

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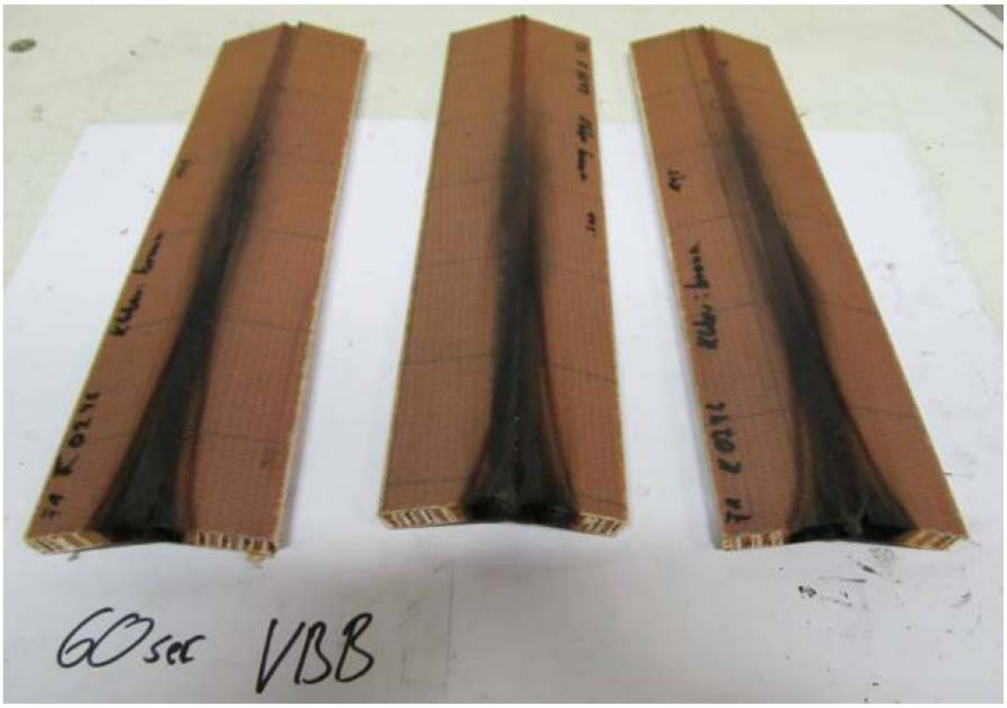
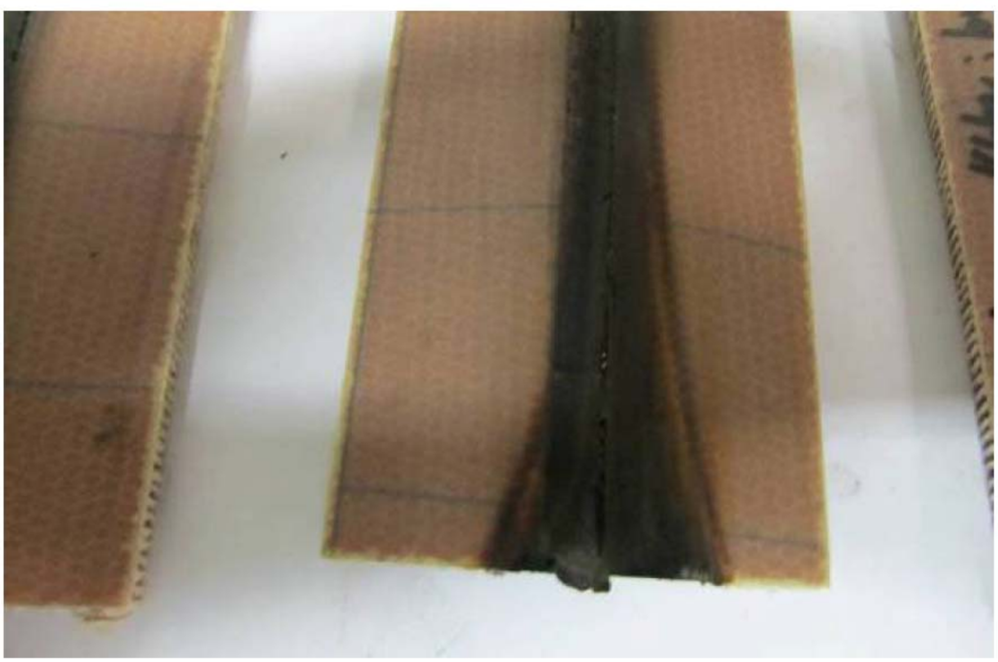
Photo of Sample K-0405: 145°outside ditch after 60 sec. VBB test (adhesive with fire retardants)





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Flammability Data Sheet **Test Method : F2**

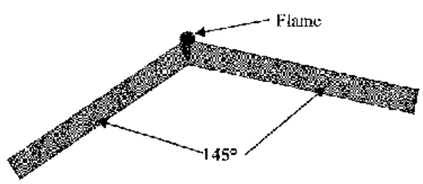
Identification : Sample No K-0406			
Document No :			BSL-Fl-11-047
Manufacturer : SELL GmbH			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Feb-21-2011	Tested by: D.Boesser
Witnessed by: K.Boesser	Flame Temperature: 859°C / 1578°F	Tested in accordance with: FAR Part 25.853 (a)	

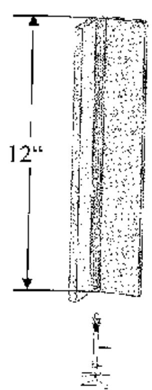
Method		Ignition time and material position			
	F1	60 second vertical		F4	15 second horizontal
PASS	**F2**	**12 second vertical**		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	15 sec. (avg.)	6 inch (avg.)	3 seconds			
F2	**15 sec. (avg.)**	**8 inch (avg.)**	**5 seconds**			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F2**	0 sec.	0.6 inch	0 sec.			
2	**F2**	0 sec.	0.8 inch	0 sec.			
3	**F2**	0 sec.	0.7 inch	0 sec.			
Average		**0 sec.**	**0.7 inch**	**0 sec.**			

Comments (e.g. penetration, etc.) : None
Result :





Adhesive Type:
3M Scotch-Weld 9300 B/A FST

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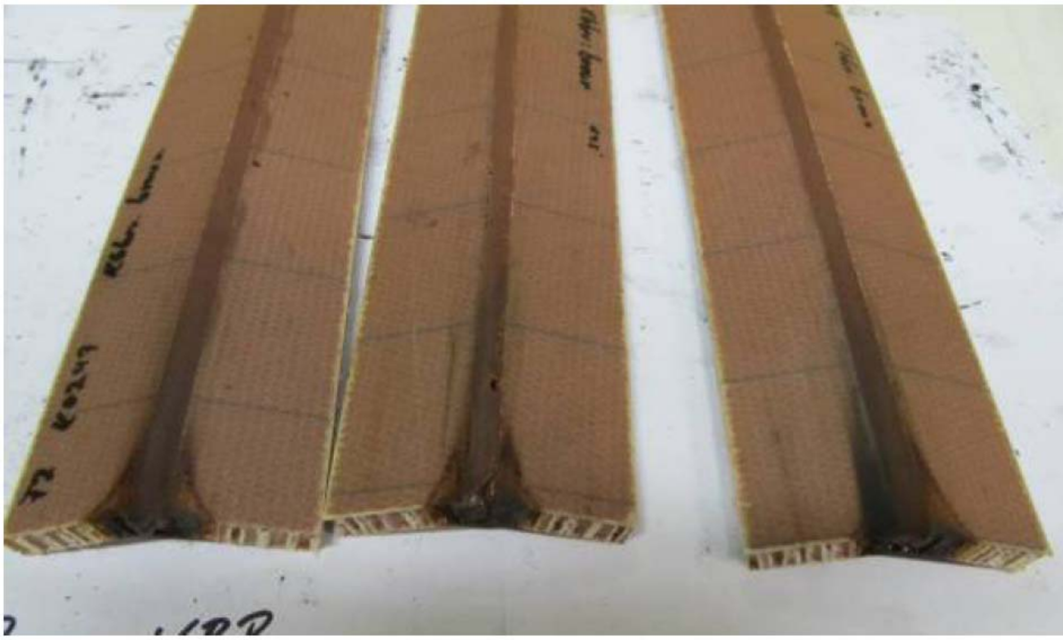
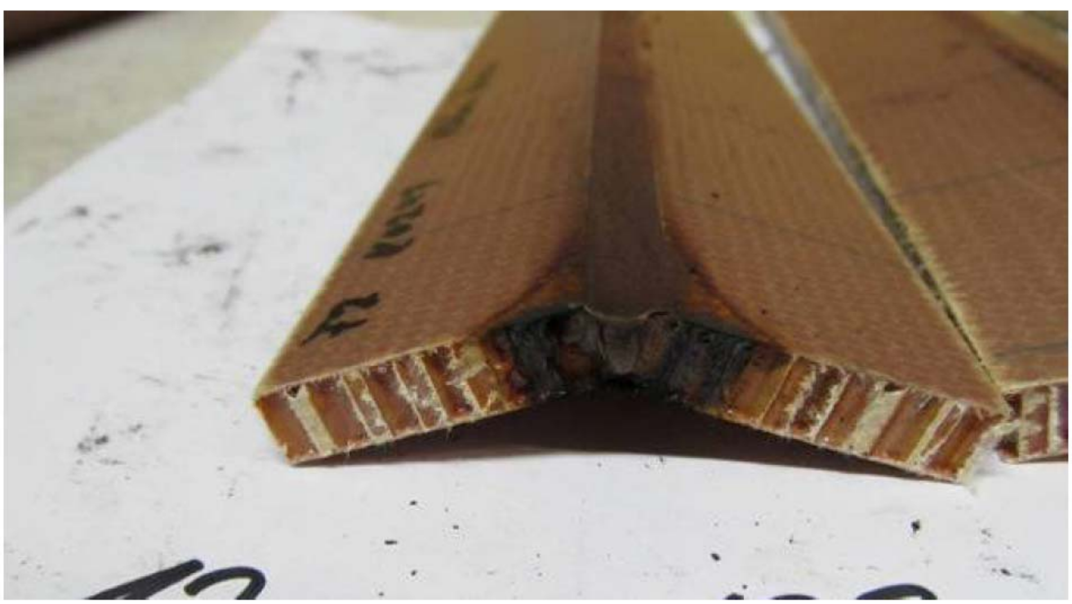
Photo of Sample K-0406: 145°outside ditch after 12 sec. VBB test (adhesive with fire retardants)





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Flammability Data Sheet **Test Method : F1**

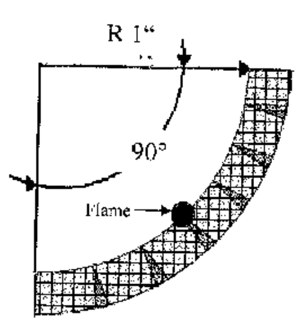
Identification : Sample No K-0415			
Document No :			BSL-FI-11-039
Manufacturer : SELL GmbH			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Feb-21-2011	Tested by: D.Boesser
Witnessed by: K.Boesser	Flame Temperature: 859°C / 1578°F	Tested in accordance with: FAR Part 25.853 (a)	

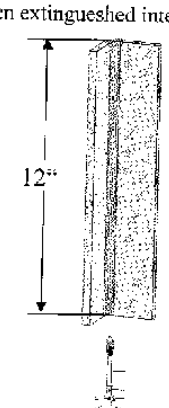
Method		Ignition time and material position			
FAIL	**F1**	**60 second vertical**		F4	15 second horizontal
	F2	12 second vertical		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	**15 sec. (avg.)**	**6 inch (avg.)**	**3 seconds**			
F2	15 sec. (avg.)	8 inch (avg.)	5 seconds			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F1**	>120 sec.	>8 inch	0 sec.			
2	**F1**	>120 sec.	>8 inch	0 sec.			
3	**F1**	>120 sec.	>8 inch	0 sec.			
Average		**>120sec.**	**>8 inch**	**0 sec.**			

Comments (e.g. penetration, etc.) : Flame has been extingueshed intentionally after 120 sec.
Result :





Adhesive Type:
3M Scotch-Weld 9323-2 B/A

Photo of Sample K-0415: multiple ditch 1" Radius / pre testing (worst case adhesive)

Photo of Sample K-0415: multiple ditch 1" Radius after 60sec VBB testing (worst case adhesive)
Flame has been extinguished after 120 seconds intentionally

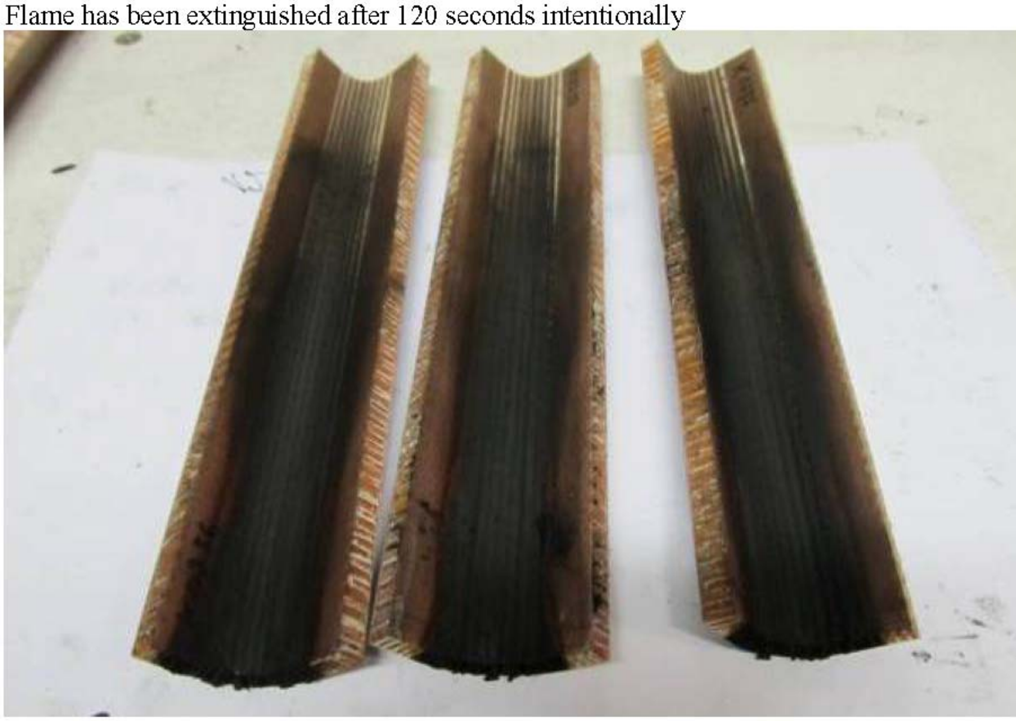
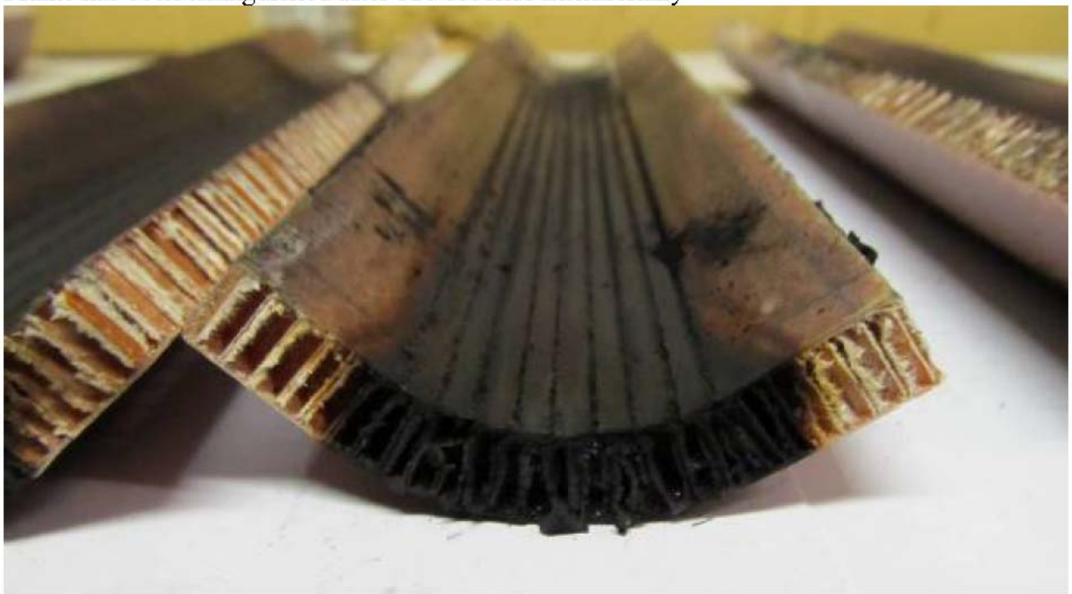


Photo of Sample K-0415: multiple ditch 1" Radius after 60sec VBB testing (worst case adhesive)
Flame has been extinguished after 120 seconds intentionally



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Flammability Data Sheet

Test Method : F2

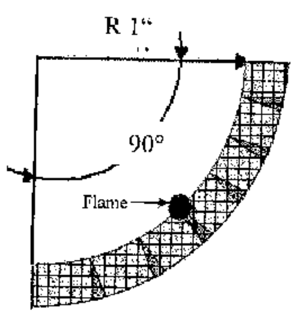
Identification : Sample No K-0416			
Document No :			BSL-Fl-11-048
Manufacturer : SELL GmbH			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Feb-21-2011	Tested by: D.Boesser
Witnessed by: K.Boesser	Flame Temperature: 859°C / 1578°F	Tested in accordance with: FAR Part 25.853 (a)	

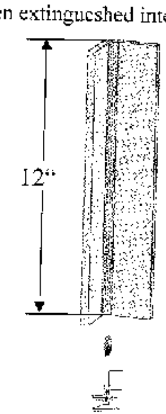
Method		Ignition time and material position			
	F1	60 second vertical		F4	15 second horizontal
FAIL	**F2**	**12 second vertical**		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	15 sec. (avg.)	6 inch (avg.)	3 seconds			
F2	**15 sec. (avg.)**	**8 inch (avg.)**	**5 seconds**			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F2**	>120 sec.	>6 inch	0 sec.			
2	**F2**	>120 sec.	>6 inch	0 sec.			
3	**F2**	>120 sec.	>6 inch	0 sec.			
Average		**>120 sec.**	**>6 Inch**	**0 sec.**			

Comments (e.g. penetration, etc.) : Flame has been extinguceshed intentionally after 120 sec.
Result :





Adhesive Type:
3M Scotch-Weld 9323-2 B/A

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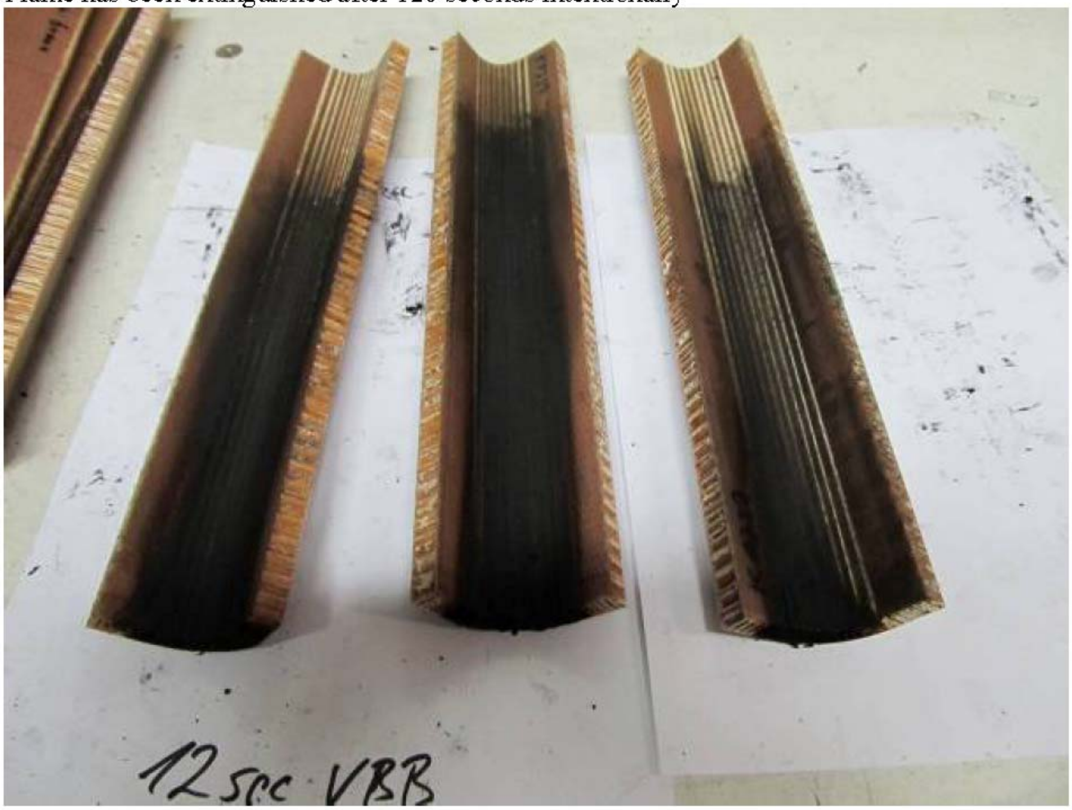
Photo of Sample K-0416: multiple ditch 1" Radius after 12sec VBB testing (worst case adhesive)
Flame has been extinguished after 120 seconds intentionally



Sample F-6790: multiple ditch 1" Radius 60sec VBB testing (adhesive with fire retardants)

Flammability Data Sheet **Test Method : F1**

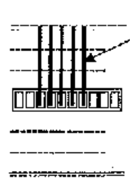
Identification : Sample No F 6790			
Document No : M9201-00-21			BSL-Fl-10-136
Manufacturer : SELL GmbH			
Aircraft Type: All	Test Location: Herborn/Germany	Test Date: May -28-2010	Tested by: A. Steinert
Witnessed by: Mr. S. Márquez	Flame Temperature: 854° C /1569 ° F	Tested in accordance with: FAR Part 25.853 (a)	

Method		Ignition time and material position			
PASS	**F1**	**60 second vertical**		F4	15 second horizontal
	F2	12 second vertical		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	**15 sec. (avg.)**	**6 inch (avg.)**	**3 seconds**			
F2	15 sec. (avg.)	8 inch (avg.)	5 seconds			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

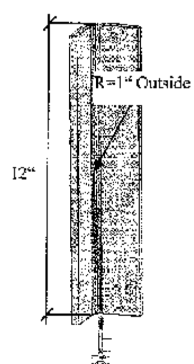
TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F1**	0.0 sec.	2.0 inch	0.0 sec.			
2	**F1**	0.0 sec.	1.9 inch	0.0 sec.			
3	**F1**	0.0 sec.	1.9 inch	0.0 sec.			
Average		**0.0 sec.**	**1.9 inch**	**0.0 sec.**			

Comments (e.g. penetration, etc.) : None
Result :



: FLAME EXPOSED SIDE (F 6790)
ADHESIVE : SCOTCH WELD 9300 B/A FST
TOP SKIN 1 : FIBREGLASS PREPREG SELL 1000.2
TOP SKIN 2 : FIBREGLASS PREPREG SELL 1001.2
BONDING AID : SELL 1100
CORE : SELL 1203-9.3

BONDING AID : SELL 1100
TOP SKIN 2 : FIBREGLASS PREPREG SELL 1001.2
TOP SKIN 1 : FIBREGLASS PREPREG SELL 1000.2



FAA Memorandum
ANM-115-09-XXX "Policy Statement on Flammability Testing of Interior Materials"
Parts 1 and 2, Reference Items 43a to 43f

Sample F-6790: multiple ditch 1" Radius 12sec VBB testing (adhesive with fire retardants)

Flammability Data Sheet **Test Method : F2**

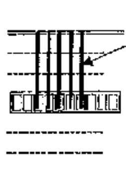
Identification : Sample No F 6790			
Document No : M9201-00-21			BSL-F2-10-140
Manufacturer : SELL GmbH			
Aircraft Type: All	Test Location: Herborn/Germany	Test Date: May -28-2010	Tested by: M. Voigt
Witnessed by: Mr. S. Marquez	Flame Temperature: 854° C /1569 ° F	Tested in accordance with: FAR Part 25.853 (a)	

Method		Ignition time and material position			
	F1	60 second vertical		F4	15 second horizontal
PASS	**F2**	**12 second vertical**		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

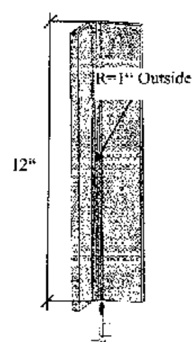
Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	15 sec. (avg.)	6 inch (avg.)	3 seconds			
F2	**15 sec. (avg.)**	**8 inch (avg.)**	**5 seconds**			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F2**	0.0 sec.	0.3 inch	0.0 sec.			
2	**F2**	0.0 sec.	0.3 inch	0.0 sec.			
3	**F2**	0.0 sec.	0.5 inch	0.0 sec.			
Average		**0.0 sec.**	**0.4 inch**	**0.0 sec.**			

Comments (e.g. penetration, etc.) : None
Result :



	: FLAME EXPOSED SIDE (F 6790)
ADHESIVE	: SCOTCH WELD 9300 B/A FST
TOP SKIN 1	: FIBREGLASS PREPREG SELL 1000.2
TOP SKIN 2	: FIBREGLASS PREPREG SELL 1001.2
BONDING AID	: SELL 1100
CORE	: SELL 1203-9.3
BONDING AID	: SELL 1100
TOP SKIN 2	: FIBREGLASS PREPREG SELL 1001.2
TOP SKIN 1	: FIBREGLASS PREPREG SELL 1000.2



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Flammability Data Sheet **Test Method : F1**

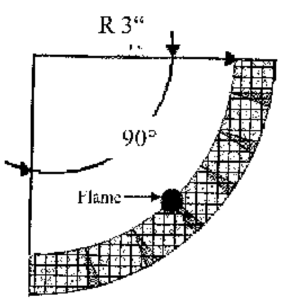
Identification : Sample No K-0417			
Document No :			BSL-FI-11-040
Manufacturer : SELL GmbH			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Feb-21-2011	Tested by: D.Boesser
Witnessed by: K.Boesser	Flame Temperature: 859°C / 1578°F	Tested in accordance with: FAR Part 25.853 (a)	

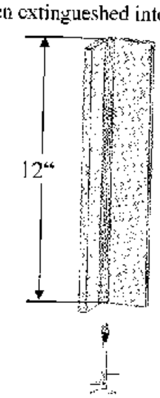
Method		Ignition time and material position			
FAIL	**F1**	**60 second vertical**		F4	15 second horizontal
	F2	12 second vertical		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	**15 sec. (avg.)**	**6 inch (avg.)**	**3 seconds**			
F2	15 sec. (avg.)	8 inch (avg.)	5 seconds			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	Ext. Time	Burn Length	Drip Durat.	Burn Rate	Penetr.	Aft.Glow
1	F1	>120 sec.	5.8 inch	0 sec.			
2	F1	>120 sec.	5.8 inch	0 sec.			
3	F1	>120 sec.	>6 inch	0 sec.			
Average		**>120 sec.**	**5.9 inch**	**0 sec.**			

Comments (e.g. penetration, etc.) : Flame has been extingueshed intentionally after 120 sec.
Result :





Adhesive Type:
3M Scotch-Weld 9323-2 B/A

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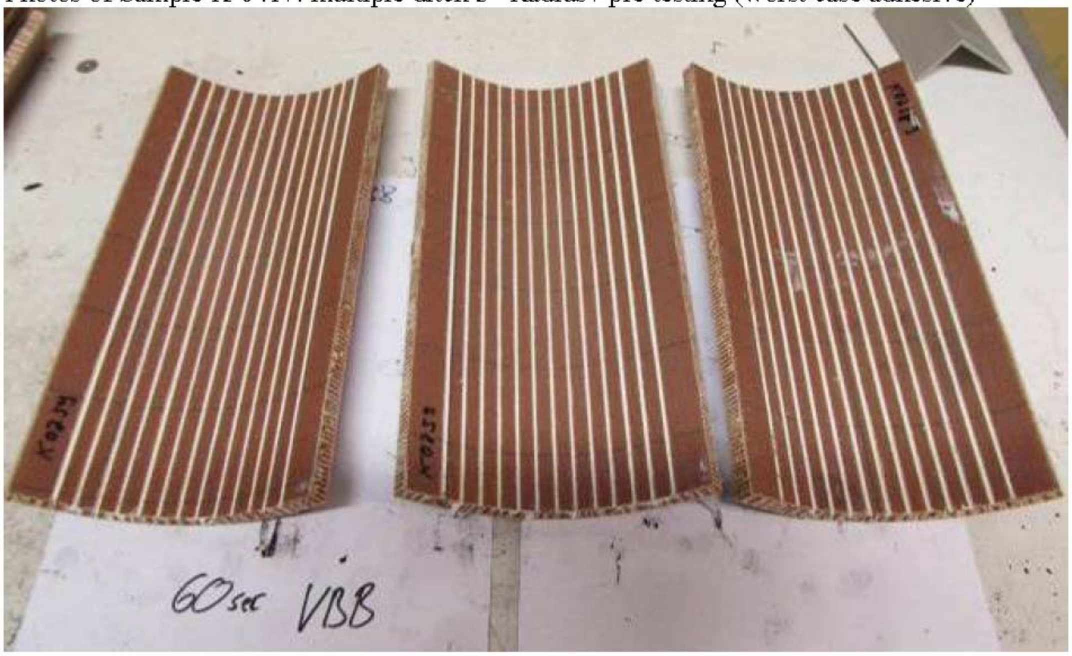
Photos of Sample K-0417: multiple ditch 3" Radius / pre testing (worst case adhesive)



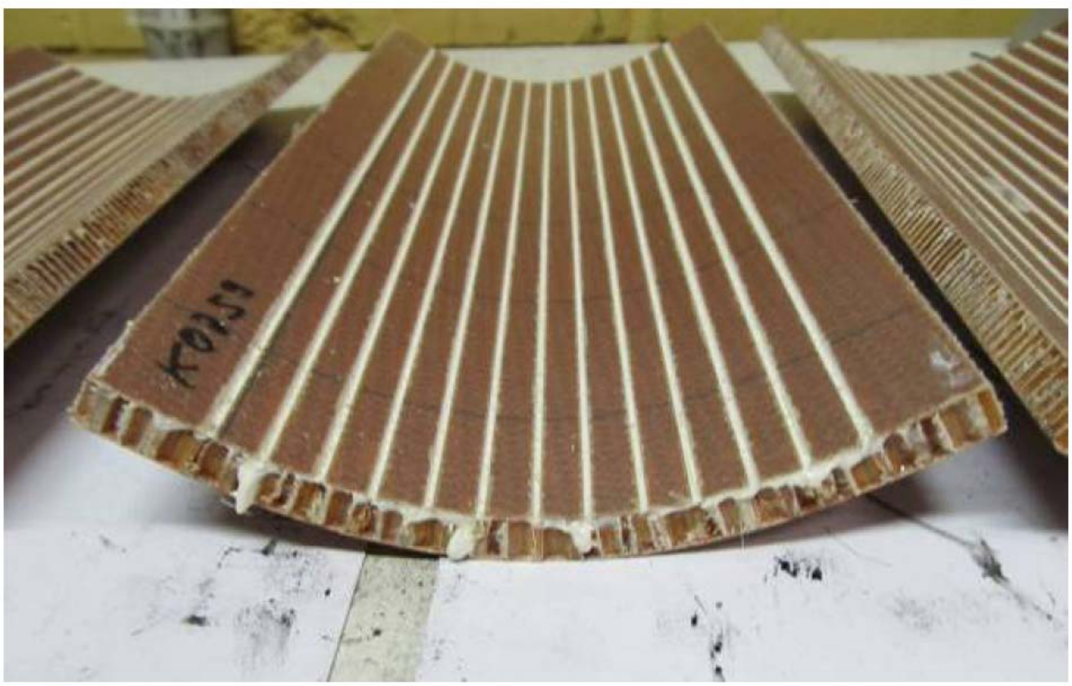
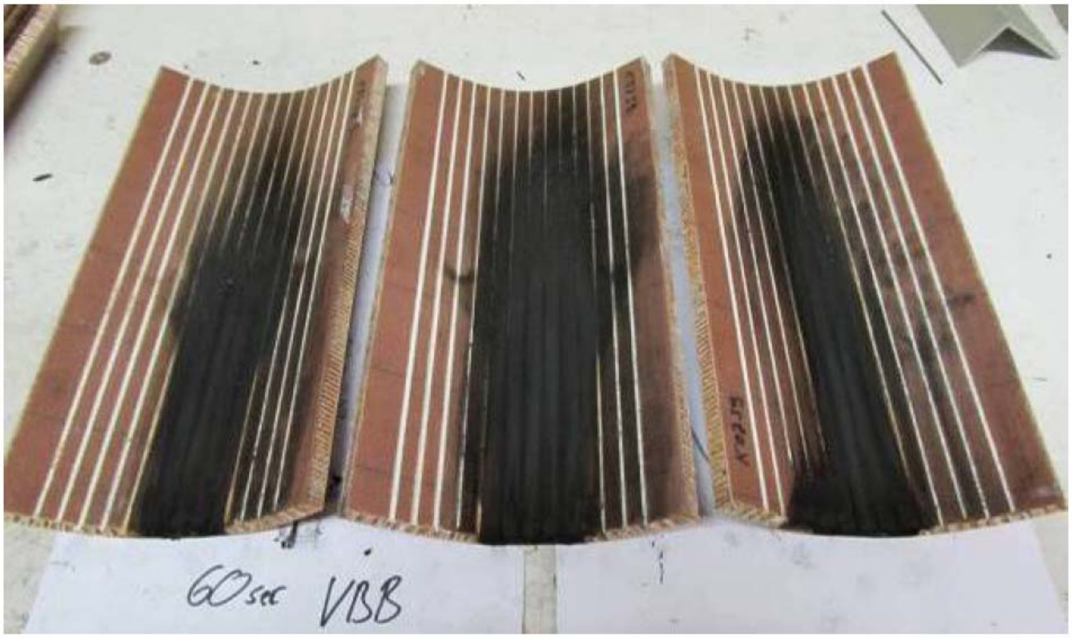
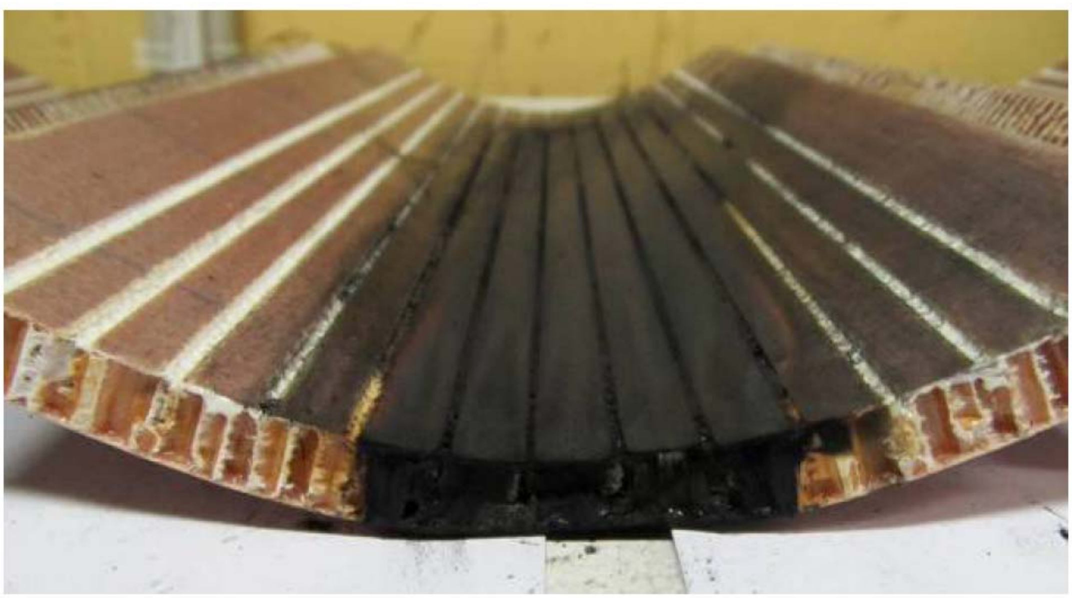


Photo of Sample K-0417: multiple ditch 3" Radius after 60 sec VBB testing (worst case adhesive)





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Flammability Data Sheet **Test Method : F2**

Identification : Sample No K-0418			
Document No :			BSL-FI-11-049
Manufacturer : SELL GmbH			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Feb-21-2011	Tested by: D. Kesser
Witnessed by: T. Braeuer	Flame Temperature: 859°C / 1578°F	Tested in accordance with: FAR Part 25.853 (a)	

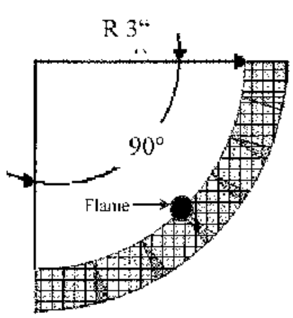
SELL GmbH TWA 7 EASA 21.J.067

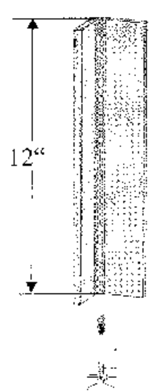
Method		Ignition time and material position			
	F1	60 second vertical		F4	15 second horizontal
FAIL	**F2**	**12 second vertical**		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	15 sec. (avg.)	6 inch (avg.)	3 seconds			
F2	**15 sec. (avg.)**	**8 inch (avg.)**	**5 seconds**			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F2**	>60 sec.	1.3 inch	0 sec.			
2	**F2**	43 sec.	1.4 inch	0 sec.			
3	**F2**	>120 sec.	3.5 inch	0 sec.			
Average		**74 sec.**	**2.1 inch**	**0 sec.**			

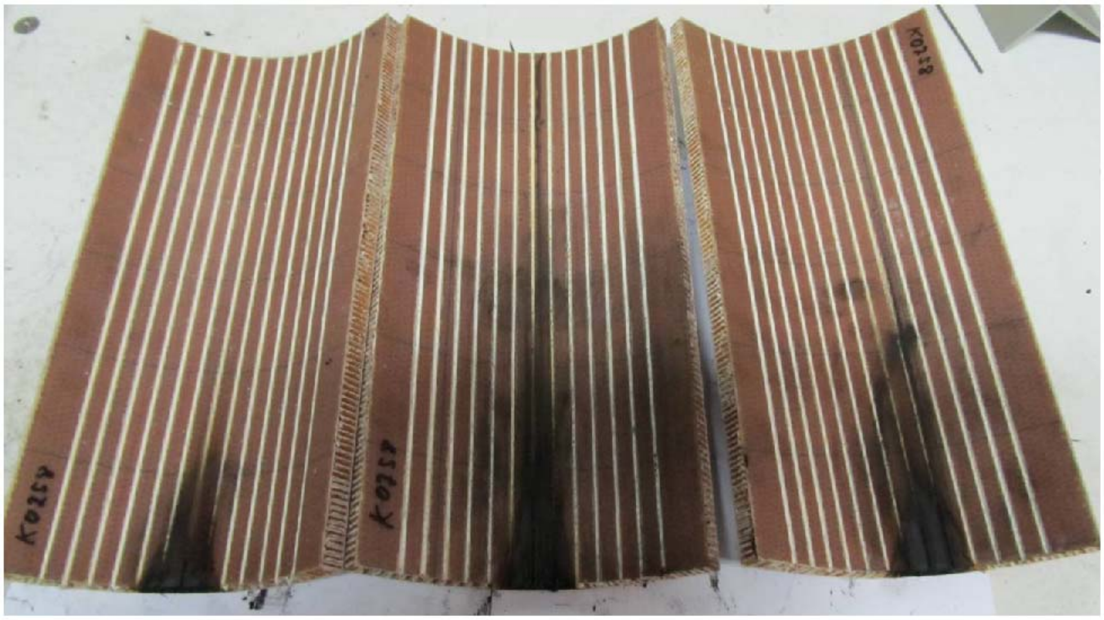
Comments (e.g. penetration, etc.) : None
Result :

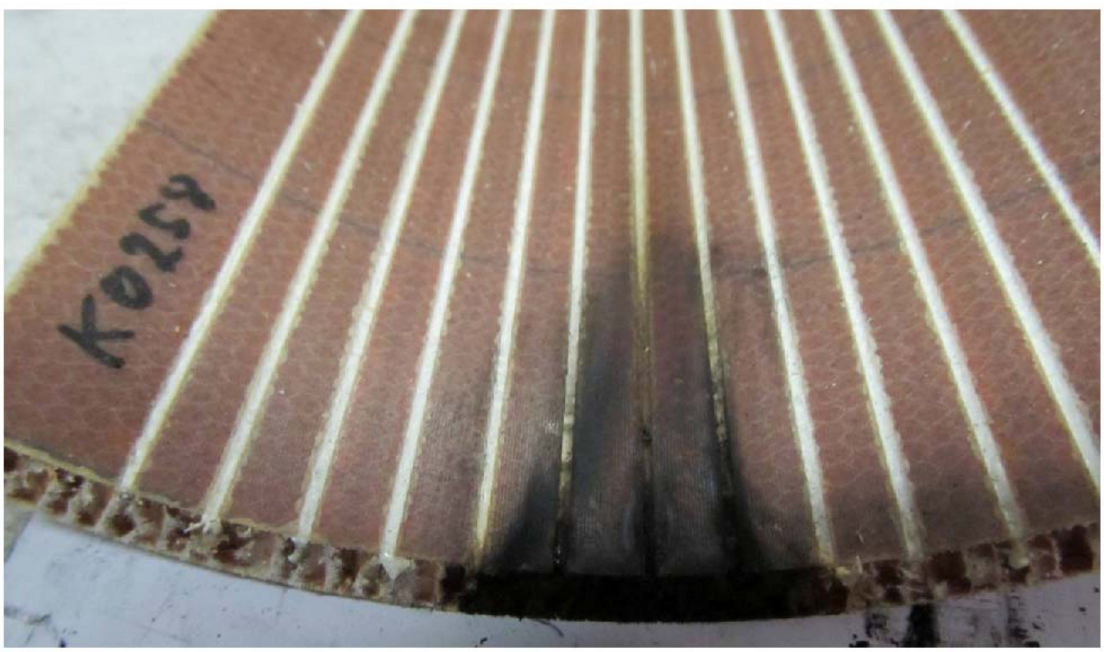




Adhesive Type:
3M Scotch-Weld 9323-2 B/A

Photo of Sample K-0418: multiple ditch 3" Radius after 12 sec VBB testing (worst case adhesive)





Sample F-6791: multiple ditch 3" Radius 60sec VBB testing (adhesive with fire retardants)

Flammability Data Sheet **Test Method : F1**

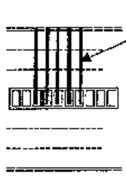
Identification : Sample No F 6791			
Document No : M9201-00-21			BSL-Fl-10-137
Manufacturer : SELL GmbH			
Aircraft Type: All	Test Location: Herborn/Germany	Test Date: May. -28-2010	Tested by: A. Steinert
Witnessed by: Mr. S. Márquez	Flame Temperature: 854° C /1569 ° F	Tested in accordance with: FAR Part 25.853 (a)	

Method		Ignition time and material position			
PASS	**F1**	**60 second vertical**		F4	15 second horizontal
	F2	12 second vertical		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

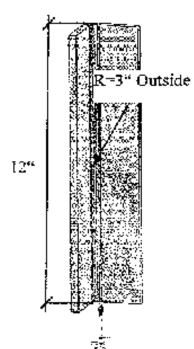
Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	**15 sec. (avg.)**	**6 inch (avg.)**	**3 seconds**			
F2	15 sec. (avg.)	8 inch (avg.)	5 seconds			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F1**	0.0 sec.	0.7 inch	0.0 sec.			
2	**F1**	6.0 sec.	1.8 inch	0.0 sec.			
3	**F1**	0.0 sec.	1.8 inch	0.0 sec.			
Average		**2.0 sec.**	**1.4 inch**	**0.0 sec.**			

Comments (e.g. penetration, etc.) : None
Result :



	: FLAME EXPOSED SIDE (F 6791)
ADHESIVE	: SCOTCH WELD 9300 B/A FST
TOP SKIN 1	: FIBREGLASS PREPREG SELL 1000.2
TOP SKIN 2	: FIBREGLASS PREPREG SELL 1001.2
BONDING AID	: SELL 1100
CORE	: SELL 1203-9.3
BONDING AID	: SELL 1100
TOP SKIN 2	: FIBREGLASS PREPREG SELL 1001.2
TOP SKIN 1	: FIBREGLASS PREPREG SELL 1000.2



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FAA Memorandum
ANM-115-09-XXX “Policy Statement on Flammability Testing of Interior Materials”
Parts 1 and 2, Reference Items 43a to 43f

Sample F-6791: multiple ditch 3” Radius 12sec VBB testing (adhesive with fire retardants)

Flammability Data Sheet **Test Method : F2**

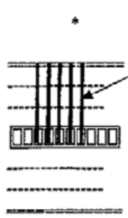
Identification : Sample No F 6791			
Document No : M9201-00-21			BSL-F2-10-141
Manufacturer : SELL GmbH			
Aircraft Type: All	Test Location: Herborn/Germany	Test Date: May. -28-2010	Tested by: M. Voigt
Witnessed by: Mr. S. Márquez	Flame Temperature: 854° C /1569 ° F	Tested in accordance with: FAR Part 25.853 (a)	

Method		Ignition time and material position			
	F1	60 second vertical		F4	15 second horizontal
PASS	**F2**	**12 second vertical**		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

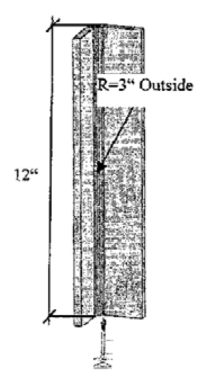
Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	15 sec. (avg.)	6 inch (avg.)	3 seconds			
F2	**15 sec. (avg.)**	**8 inch (avg.)**	**5 seconds**			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F2**	0.0 sec.	0.0 inch	0.0 sec.			
2	**F2**	0.0 sec.	0.1 inch	0.0 sec.			
3	**F2**	0.0 sec.	0.1 inch	0.0 sec.			
Average		**0.0 sec.**	**0.1 inch**	**0.0 sec.**			

Comments (e.g. penetration, etc.) : None
Result :



	: FLAME EXPOSED SIDE (F 6791)
ADHESIVE	: SCOTCH WELD 9300 B/A FST
TOP SKIN 1	: FIBREGLASS PREPREG SELL 1000.2
TOP SKIN 2	: FIBREGLASS PREPREG SELL 1001.2
BONDING AID	: SELL 1100
CORE	: SELL 1203-9.3
BONDING AID	: SELL 1100
TOP SKIN 2	: FIBREGLASS PREPREG SELL 1001.2
TOP SKIN 1	: FIBREGLASS PREPREG SELL 1000.2



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Flammability Data Sheet **Test Method : F1**

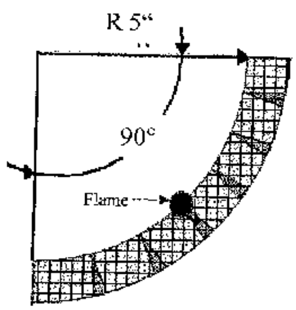
Identification : Sample No K-0419			
Document No :			BSL-FI-11-041
Manufacturer : SELL GmbH			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Feb-21-2011	Tested by: D.Boesser
Witnessed by: K.Boesser	Flame Temperature: 859°C / 1578°F	Tested in accordance with: FAR Part 25.853 (a)	

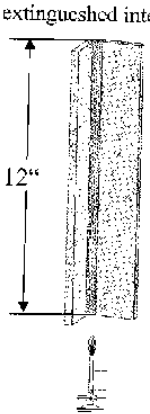
Method		Ignition time and material position			
FAIL	**F1**	**60 second vertical**		F4	15 second horizontal
	F2	12 second vertical		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	**15 sec. (avg.)**	**6 inch (avg.)**	**3 seconds**			
F2	15 sec. (avg.)	8 inch (avg.)	5 seconds			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F1**	>120 sec.	5,4 inch	0 sec.			
2	**F1**	>120 sec.	6 inch	0 sec.			
3	**F1**	>120 sec.	<6 inch	0 sec.			
Average		**>120 sec.**	**5,8 inch**	**0 sec.**			

Comments (e.g. penetration, etc.) : Flame has been extinguished intentionally after 120 sec.
Result :



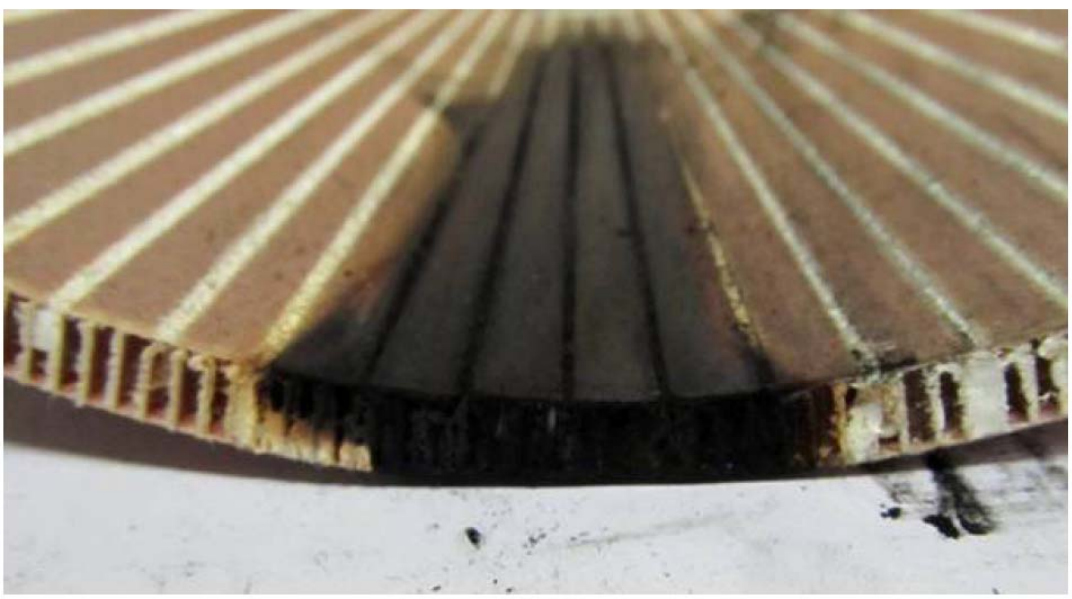


Adhesive Type:
3M Scotch-Weld 9323-2 B/A

FAA Memorandum
ANM-115-09-XXX "Policy Statement on Flammability Testing of Interior Materials"
Parts 1 and 2, Reference Items 43a to 43f

Photos of Sample K-0419: multiple ditch 5" Radius / pre testing (worst case adhesive)

Photo of Sample K-0419: multiple ditch 5" Radius after 60 sec VBB testing (worst case adhesive)



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Flammability Data Sheet

Test Method : F2

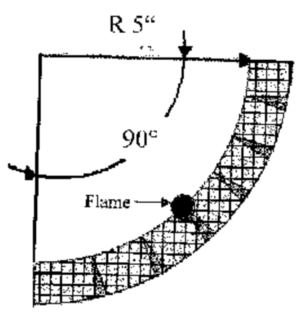
Identification : Sample No K-0420			
Document No :			BSL-FI-11-050
Manufacturer : SELL GmbH			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Feb-21-2011	Tested by: D.Boesser
Witnessed by: K.Boesser	Flame Temperature: 859°C / 1578°F	Tested in accordance with: FAR Part 25.853 (a)	

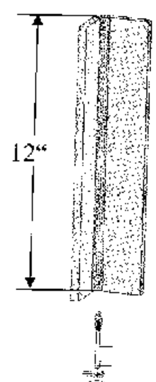
Method		Ignition time and material position			
	F1	60 second vertical		F4	15 second horizontal
FAIL	**F2**	**12 second vertical**		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	15 sec. (avg.)	6 inch (avg.)	3 seconds			
F2	**15 sec. (avg.)**	**8 inch (avg.)**	**5 seconds**			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F2**	16 sec.	1.3 inch	0 sec.			
2	**F2**	>120 sec.	1.2 inch	0 sec.			
3	**F2**	115 sec.	1.4 inch	0 sec.			
Average		**84 sec.**	**1.3 inch**	**0 sec.**			

Comments (e.g. penetration, etc.) : very small flame.
Result :





Adhesive Type:
3M Scotch-Weld 9323-2 B/A

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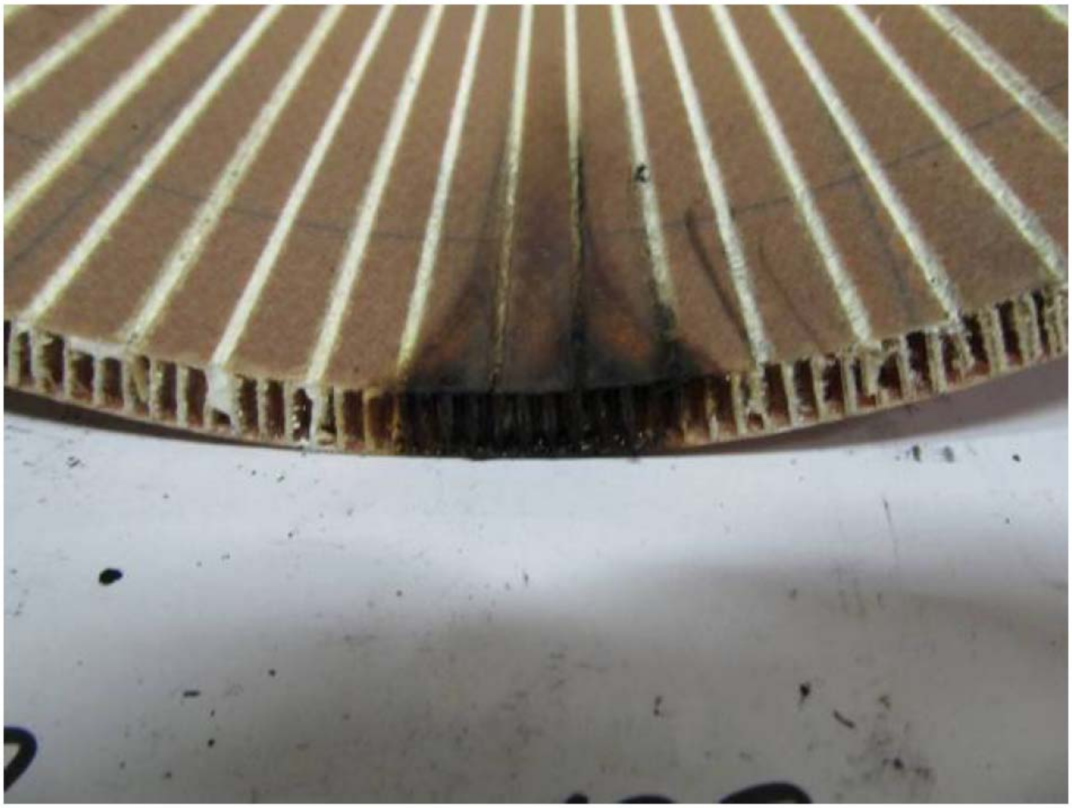
Photo of Sample K-0420: multiple ditch 5" Radius after 12 sec VBB testing (worst case adhesive)



Sample F-6792: multiple ditch 5” Radius 60sec VBB testing (adhesive with fire retardants)

Flammability Data Sheet **Test Method : F1**

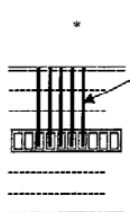
Identification : Sample No F 6792			
Document No : M9201-00-21			BSL-FI-10-138
Manufacturer : SELL GmbH			
Aircraft Type: All	Test Location: Herborn/Germany	Test Date: May -28-2010	Tested by: M. Voigt
Witnessed by: Mr. S. Márquez	Flame Temperature: 854° C /1569 ° F	Tested in accordance with: FAR Part 25.853 (a)	

Method		Ignition time and material position			
PASS	**F1**	**60 second vertical**		F4	15 second horizontal
	F2	12 second vertical		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	**15 sec. (avg.)**	**6 inch (avg.)**	**3 seconds**			
F2	15 sec. (avg.)	8 inch (avg.)	5 seconds			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

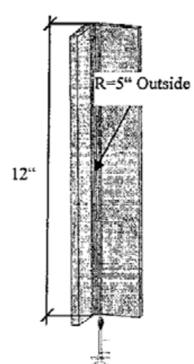
TEST VALUES							
Sample	Method	Ext. Time	Burn Length	Drip Durat.	Burn Rate	Penetr.	Aft.Glow
1	**F1**	6.0 sec.	1.1 inch	0.0 sec.			
2	**F1**	0.0 sec.	1.3 inch	0.0 sec.			
3	**F1**	0.0 sec.	0.6 inch	0.0 sec.			
Average		**2.0 sec.**	**1.0 inch**	**0.0 sec.**			

Comments (e.g. penetration, etc.) : None
Result :



: FLAME EXPOSED SIDE (**F 6792**)
ADHESIVE : SCOTCH WELD 9300 B/A FST
TOP SKIN 1 : FIBREGLASS PREPREG SELL 1000.2
TOP SKIN 2 : FIBREGLASS PREPREG SELL 1001.2
BONDING AID : SELL 1100
CORE : SELL 1203-9.3

BONDING AID : SELL 1100
TOP SKIN 2 : FIBREGLASS PREPREG SELL 1001.2
TOP SKIN 1 : FIBREGLASS PREPREG SELL 1000.2



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FAA Memorandum
ANM-115-09-XXX “Policy Statement on Flammability Testing of Interior Materials”
Parts 1 and 2, Reference Items 43a to 43f

Sample F-6792: multiple ditch 5” Radius 12sec VBB testing (adhesive with fire retardants)

Flammability Data Sheet **Test Method : F2**

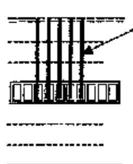
Identification : Sample No F 6792			
Document No : M9201-00-21			BSL-F2-10-142
Manufacturer : SELL GmbH			
Aircraft Type: All	Test Location: Herborn/Germany	Test Date: May -28-2010	Tested by: M. Voigt
Witnessed by: Mr. S. Marquez	Flame Temperature: 854° C /1569 ° F	Tested in accordance with: FAR Part 25.853 (a)	

Method		Ignition time and material position			
	F1	60 second vertical		F4	15 second horizontal
PASS	**F2**	**12 second vertical**		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	15 sec. (avg.)	6 inch (avg.)	3 seconds			
F2	**15 sec. (avg.)**	**8 inch (avg.)**	**5 seconds**			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

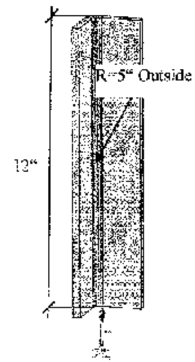
TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F2**	0.0 sec.	0.1 inch	0.0 sec.			
2	**F2**	0.0 sec.	0.0 inch	0.0 sec.			
3	**F2**	0.0 sec.	0.1 inch	0.0 sec.			
Average		**0.0 sec.**	**0.1 inch**	**0.0 sec.**			

Comments (e.g. penetration, etc.) : None
Result :



* : FLAME EXPOSED SIDE (F 6792)
ADHESIVE : SCOTCH WELD 9300 B/A FST
TOP SKIN 1 : FIBREGLASS PREPREG SELL 1000.2
TOP SKIN 2 : FIBREGLASS PREPREG SELL 1001.2
BONDING AID : SELL 1100
CORE : SELL 1203-9.3

BONDING AID : SELL 1100
TOP SKIN 2 : FIBREGLASS PREPREG SELL 1001.2
TOP SKIN 1 : FIBREGLASS PREPREG SELL 1000.2



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Flammability Data Sheet

Test Method : F1

Identification : Sample No K-0433			
Document No :			BSL-FI-11-042
Manufacturer : SELL GmbH			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Feb-21-2011	Tested by: D.Boesser
Witnessed by: K.Boesser	Flame Temperature: 859°C / 1578°F	Tested in accordance with: FAR Part 25.853 (a)	

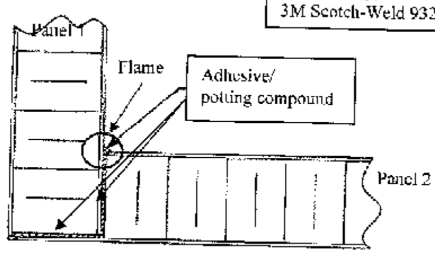
Method		Ignition time and material position			
FAIL	**F1**	**60 second vertical**		F4	15 second horizontal
	F2	12 second vertical		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	**15 sec. (avg.)**	**6 inch (avg.)**	**3 seconds**			
F2	15 sec. (avg.)	8 inch (avg.)	5 seconds			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

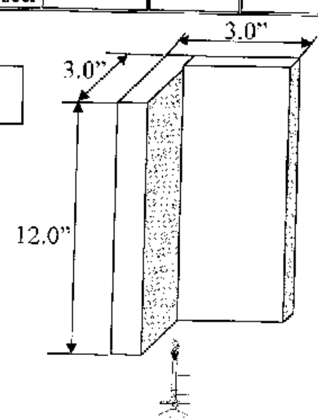
TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F1**	82 sec.	5.6 inch	0 sec.			
2	**F1**	95 sec.	6.1 inch	0 sec.			
3	**F1**	80 sec.	5.3 inch	0 sec.			
Average		**86 sec.**	**5.7 inch**	**0 sec.**			

Comments (e.g. penetration, etc.) : None
Result :

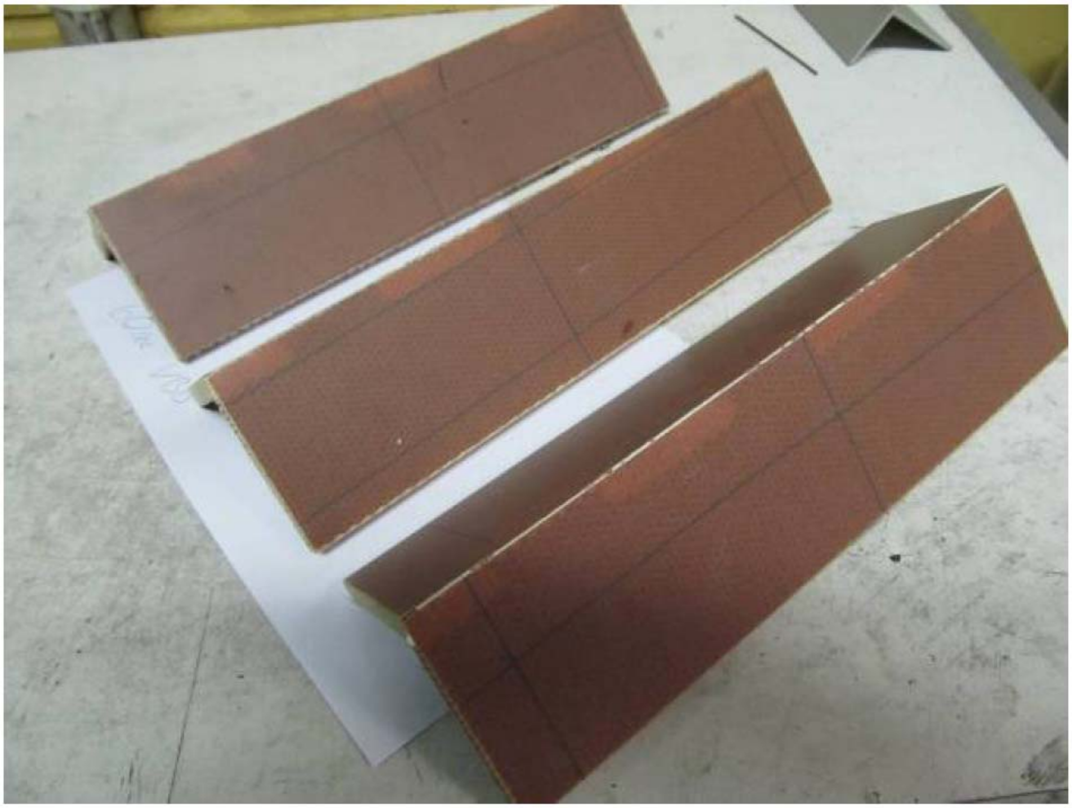
Adhesive Type:
3M Scotch-Weld 9323-2 B/A

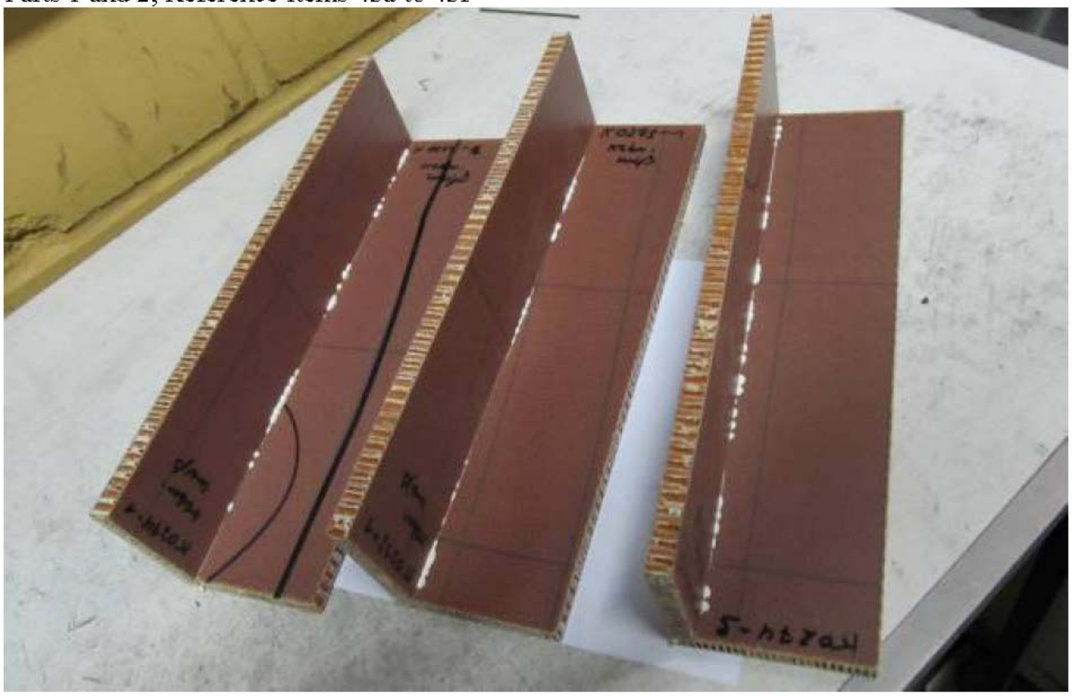


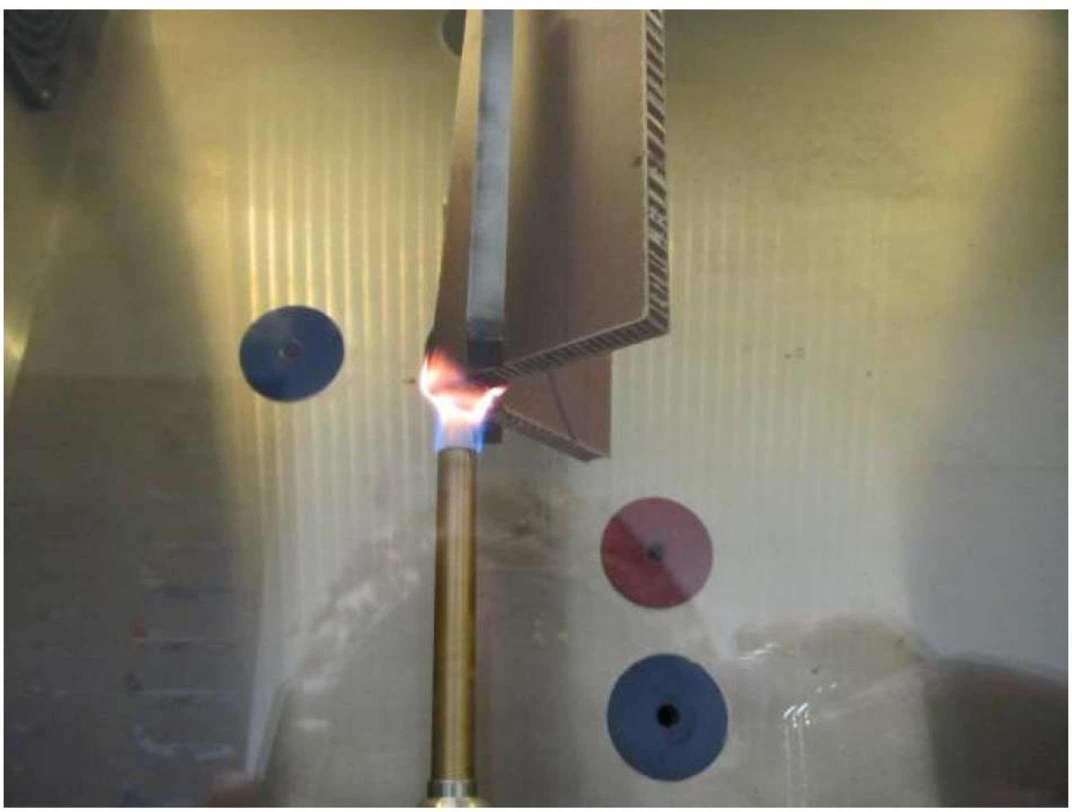
SECTION B-B



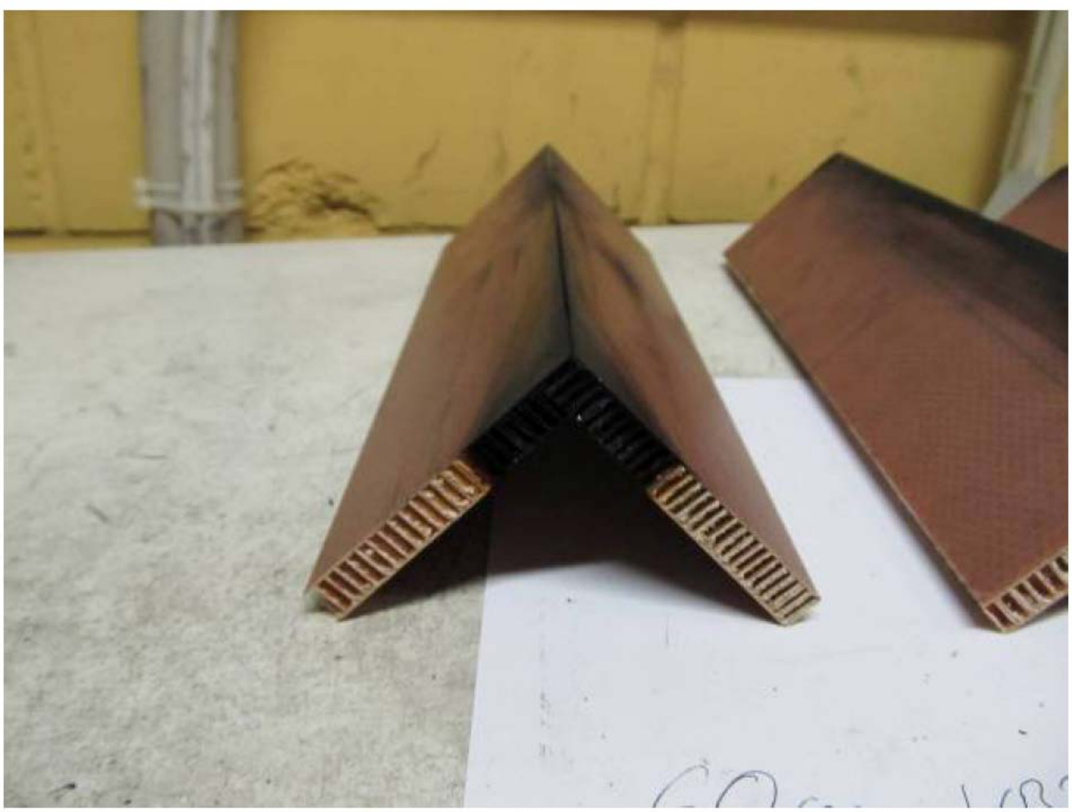
Photos of Sample K-0433: Mortise & Tenon Joint / pre testing (worst case adhesive)

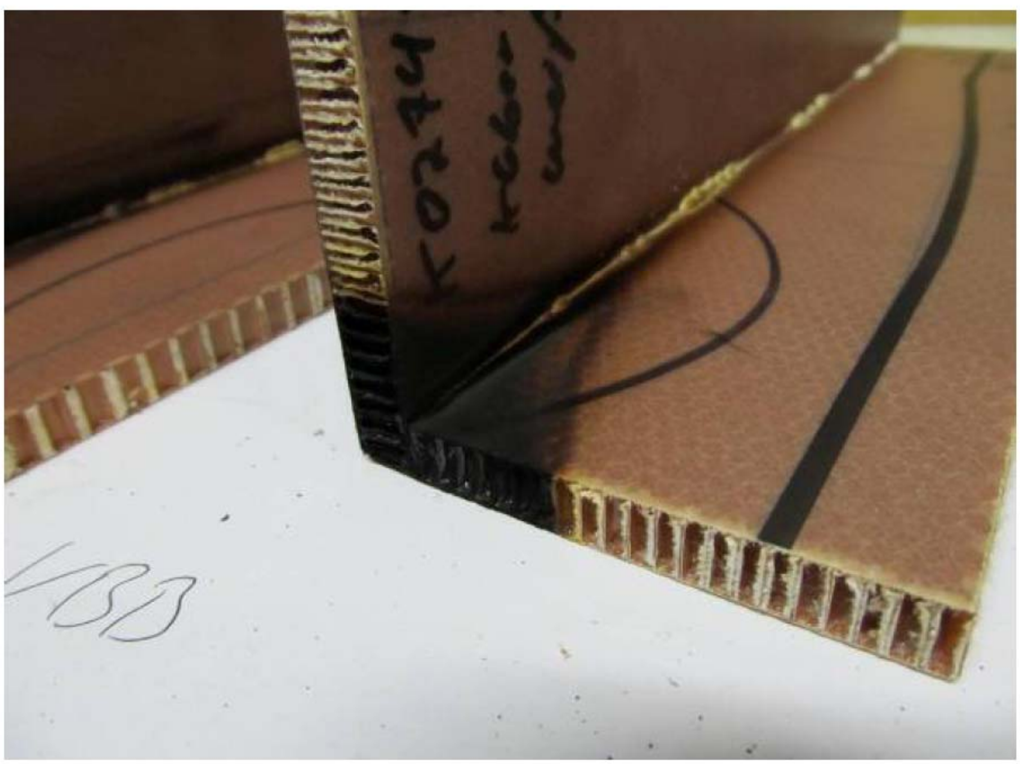






Photos of Sample K-0433: Mortise & Tenon Joint / after test 60sec VBB (worst case adhesive)





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Flammability Data Sheet **Test Method : F2**

Identification : Sample No K-0434			
Document No :			BSL-FI-11-051
Manufacturer : SELL GmbH			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Feb-21-2011	Tested by: D.Boesser
Witnessed by: K.Boesser	Flame Temperature: 859°C / 1578°F	Tested in accordance with: FAR Part 25.853 (a)	

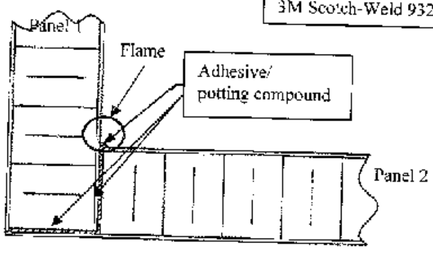
Method		Ignition time and material position			
	F1	60 second vertical		F4	15 second horizontal
PASS	**F2**	**12 second vertical**		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	15 sec. (avg.)	6 inch (avg.)	3 seconds			
F2	**15 sec. (avg.)**	**8 inch (avg.)**	**5 seconds**			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

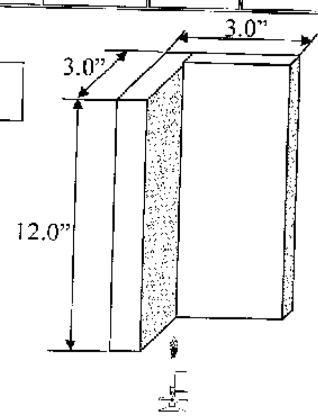
TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F2**	0.0 sec.	0.9 inch	0 sec.			
2	**F2**	0.0 sec.	1.2 inch	0 sec.			
3	**F2**	0.0 sec.	1.0 inch	0 sec.			
Average		**0.0 sec.**	**1.0 inch**	**0 sec.**			

Comments (e.g. penetration, etc.) : None
Result :

Adhesive Type:
3M Scotch-Weld 9323-2 B/A



SECTION B-B



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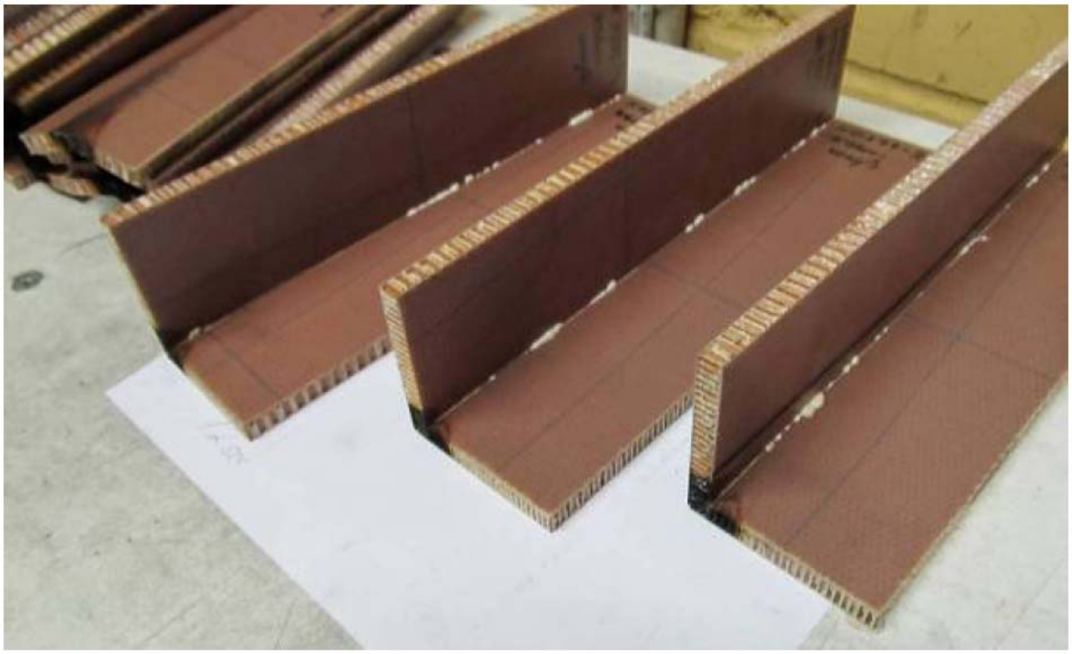
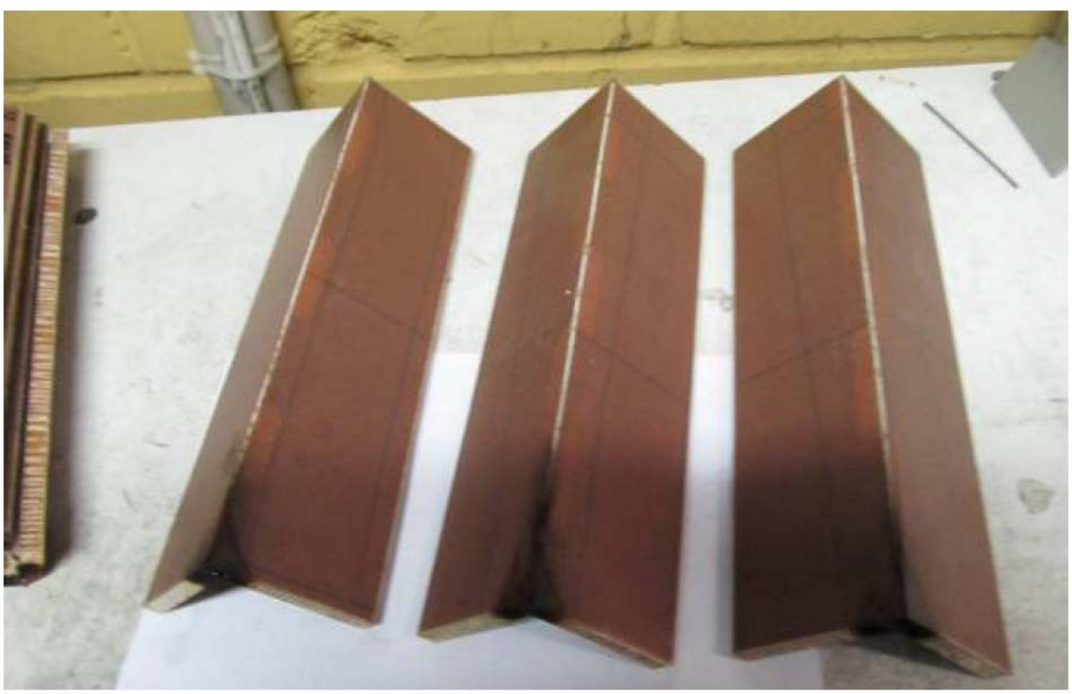
Photos of Sample K-0434: Mortise & Tenon Joint / after test 12sec VBB (worst case adhesive)





Sample K-0435-5: Mortise & Tenon Joint / 60sec VBB (adhesive with fire retardants)

Flammability Data Sheet **Test Method : F1**

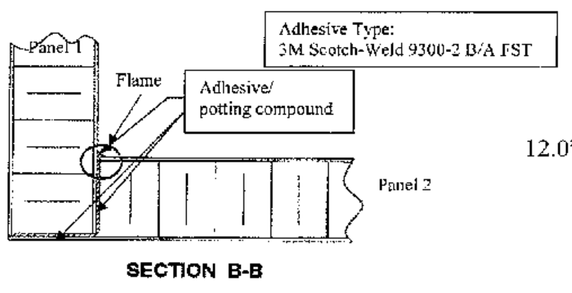
Identification : **Sample No K-0435-5**			
Document No :			BSL-FI-11-043
Manufacturer : **SELL GmbH**			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Apr-13-2011	Tested by: D.Boesser
Witnessed by: K.Boesser	Flame Temperature: 860°C / 1580°F	Tested in accordance with: FAR Part 25.853 (a)	

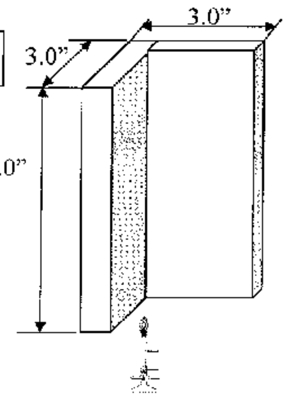
Method		Ignition time and material position			
PASS	**F1**	**60 second vertical**		F4	15 second horizontal
	F2	12 second vertical		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	**15 sec. (avg.)**	**6 inch (avg.)**	**3 seconds**			
F2	15 sec. (avg.)	8 inch (avg.)	5 seconds			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F1**	0 sec.	1.0 inch	0 sec.			
2	**F1**	3 sec.	1.2 inch	0 sec.			
3	**F1**	0 sec.	0.3 inch	0 sec.			
Average		**1 sec.**	**1.5 inch**	**0 sec.**			

Comments (e.g. penetration, etc.) :





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Flammability Data Sheet

Test Method : F2

Identification : Sample No K-0436			
Document No :			BSL-FI-11-052
Manufacturer : SELL GmbH			
Aircraft Type: ALL	Test Location: Herborn/Germany	Test Date: Feb-21-2011	Tested by: D.Boesser
Witnessed by: K.Boesser	Flame Temperature: 859°C / 1578°F	Tested in accordance with: FAR Part 25.853 (a)	

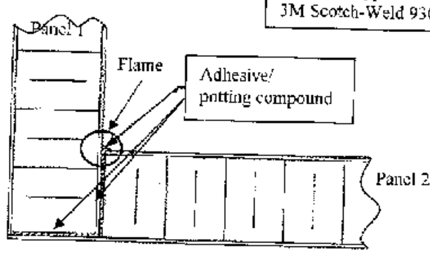
Method		Ignition time and material position			
	F1	60 second vertical		F4	15 second horizontal
PASS	**F2**	**12 second vertical**		F5	30 second 45 degree
	F3	15 second horizontal		F6	30 second 60 degree

Test Requirements (maximum average)						
Test Method	Extinguishing Time	Burn Length	Drip Duration	Burn Rate	Flame Penetration	After Glow
F1	15 sec. (avg.)	6 inch (avg.)	3 seconds			
F2	**15 sec. (avg.)**	**8 inch (avg.)**	**5 seconds**			
F3				2.5 in./min.		
F4				4.0 in./min.		
F5	15sec. (avg.)				None	10 seconds
F6	30 seconds	3 inch (avg.)	3 seconds			

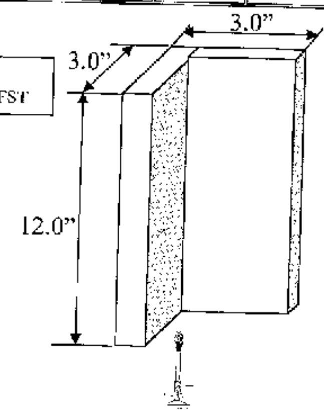
TEST VALUES							
Sample	Method	**Ext. Time**	**Burn Length**	**Drip Durat.**	Burn Rate	Penetr.	Aft.Glow
1	**F2**	0.0 sec.	0.4 inch	0 sec.			
2	**F2**	0.0 sec.	0.7 inch	0 sec.			
3	**F2**	0.0 sec.	0.2 inch	0 sec.			
Average		**0.0 sec.**	**0.4 inch**	**0 sec.**			

Comments (e.g. penetration, etc.) : None
Result :

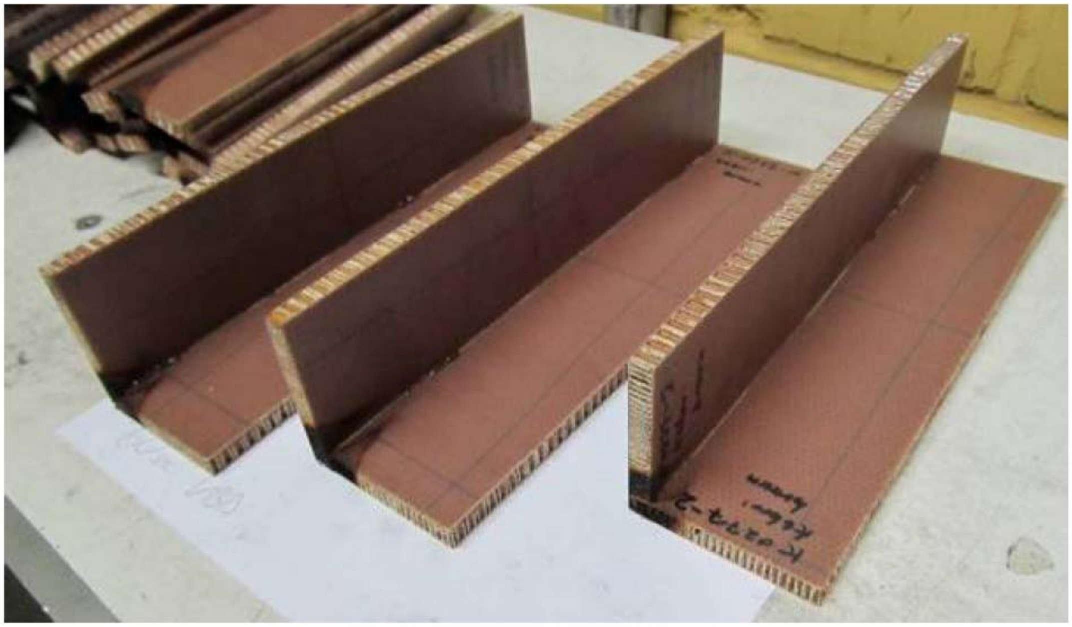
Adhesive Type:
3M Scotch-Weld 9300-2 B/A FST

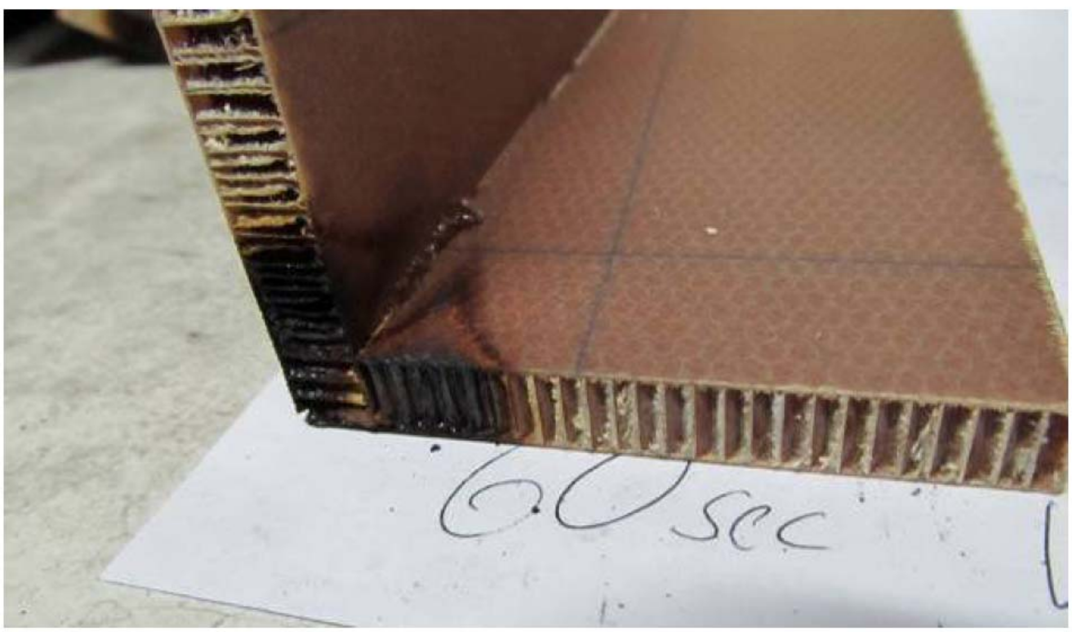


SECTION B-B



Photos of Sample K-0436: Mortise & Tenon Joint / after test 12sec VBB (adhesive with fire retardants)





SELL
CABIN INTERIORS

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

Identification : K 0407			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-25-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

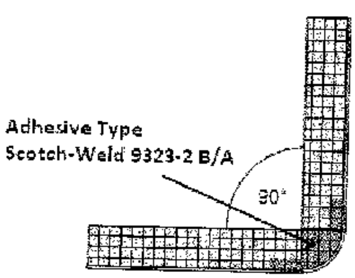
Test Sample Observations (pre testing)		
• Test Sample with a high squeeze out of adhesive		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	-------------

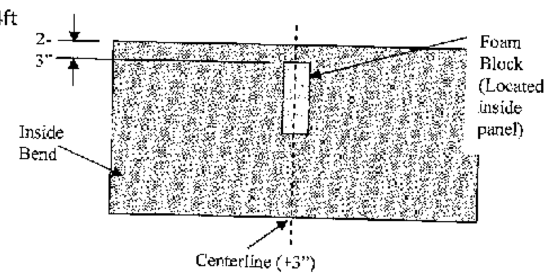
Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments

- No ignition of adhesive
- The Facesheet (Prepreg) has been stripped off in the flame exposed area of the panel
- Slightly discoloration of the backside
- Shrink marks on the panel

Specimen Description:
Sample Dimensions: pre bending: 3ft x 4ft





SELL
CABIN INTERIORS
Safety & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

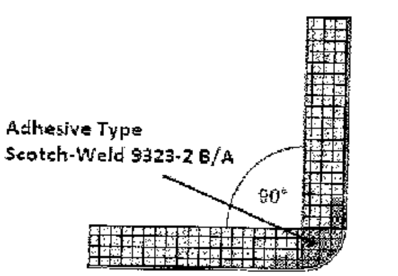
Identification : K 0408			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

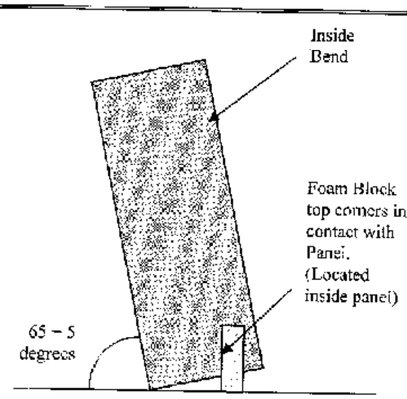
Test Sample Observations (pre testing)		
• Test Sample with a high squeeze out of adhesive		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	-------------

Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments
• No ignition of adhesive • No discoloration on the backside

Specimen Description:
Sample Dimensions: pre bending: 3ft x 4ft





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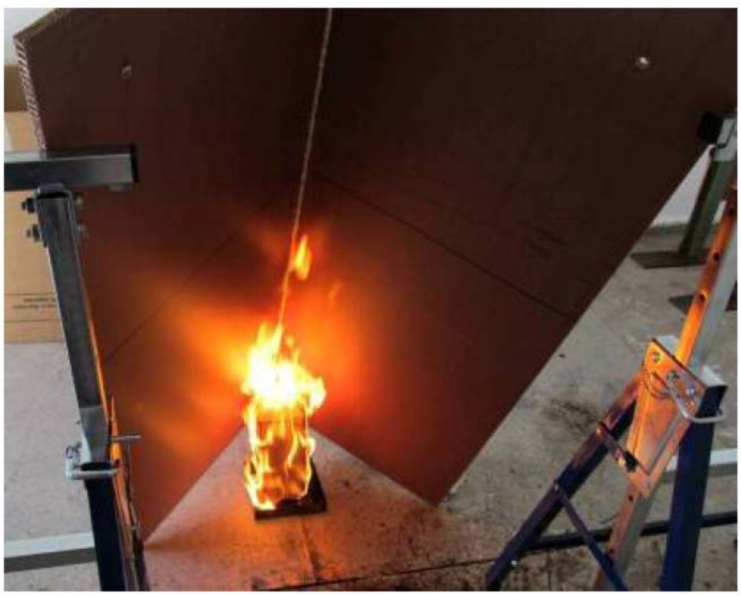
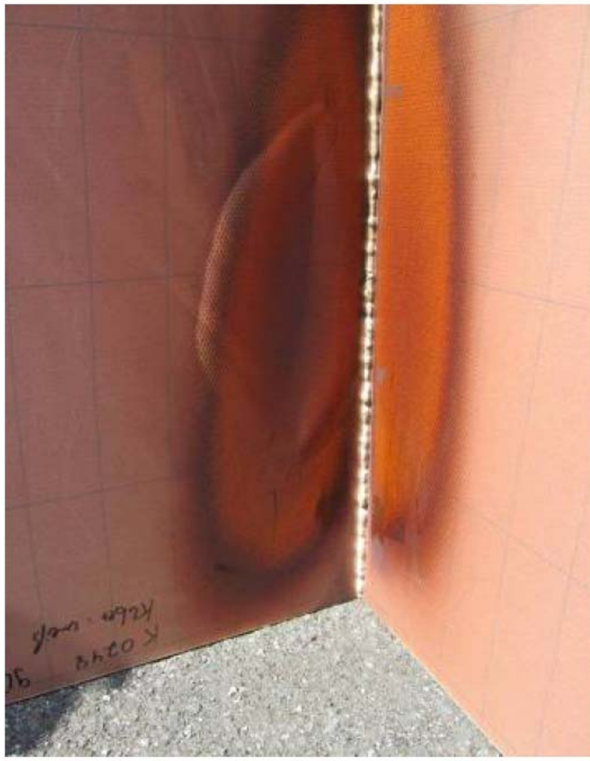
K 0408
90° single ditch
SW 9323
65° incline






K 0408
90° single ditch
SW 9323
65° incline

SELL
CABIN INTERIORS
Galley & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

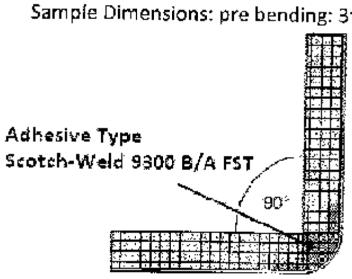
Identification : K 0409			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-25-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

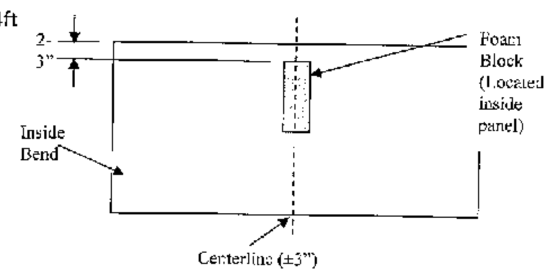
Test Sample Observations (pre testing)		
• No adhesive squeeze out		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	------------

Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments
• No ignition of adhesive • slightly discoloration on the backside

Specimen Description:
Sample Dimensions: pre bending: 3ft x 4ft





SELL
CABIN INTERIORS
Galleys & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

Identification : K 0410			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

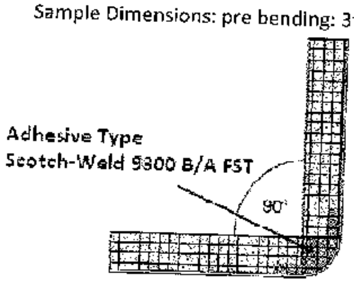
Test Sample Observations (pre testing)
• Test Sample with a squeeze out of adhesive

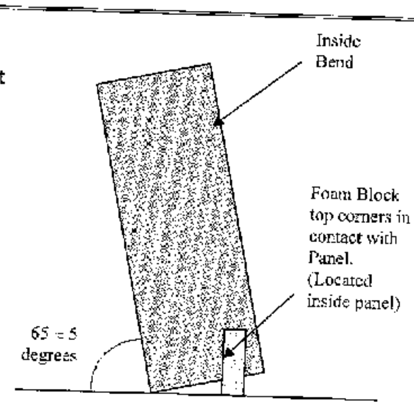
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	------------

Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments
▪ No ignition of adhesive • No discoloration on the backside

Specimen Description:
Sample Dimensions: pre bending: 3ft x 4ft






K 0410
90° single ditch
good performer
SW 9300


K 0410
90° single ditch
good performer
SW 9300

SELL
CABIN INTERIORS
Galleys & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

Identification : K 0411			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

Test Sample Observations (pre testing)		
• No adhesive squeeze out		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	-------------

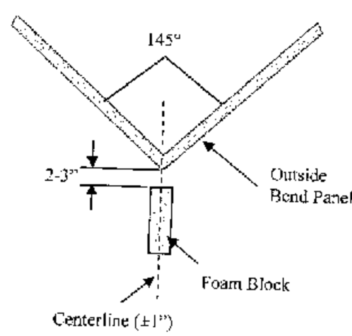
Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments

- No ignition of adhesive
- slightly discoloration on the backside

Specimen Description:
Sample Dimensions: pre bending: 3ft x 4ft

Adhesive Type:
Scotch-Weld 9323-2 B/A



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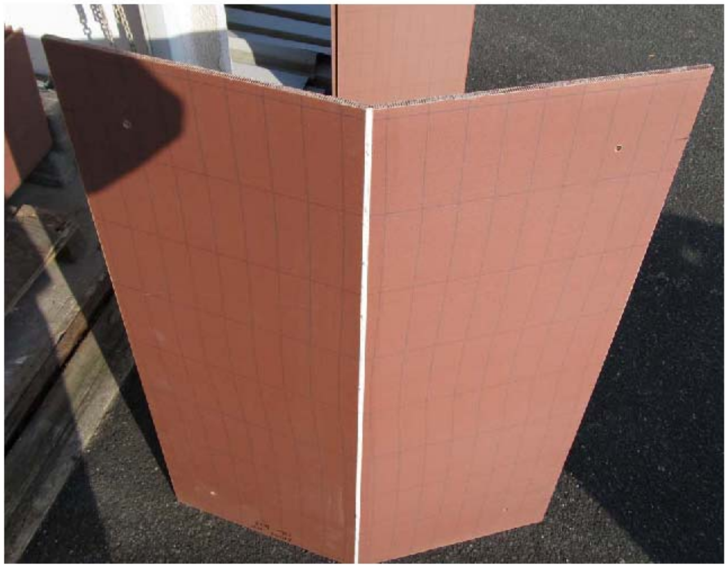


SELL
CABIN INTERIORS
Galleys & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

Identification : K 0412			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

Test Sample Observations (pre testing)
• adhesive seam with bubbles in places.

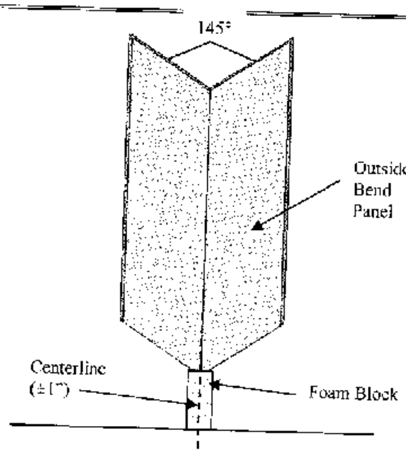
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	----------

Test results discussion		
Test results acceptable?	YES	X
	NO	

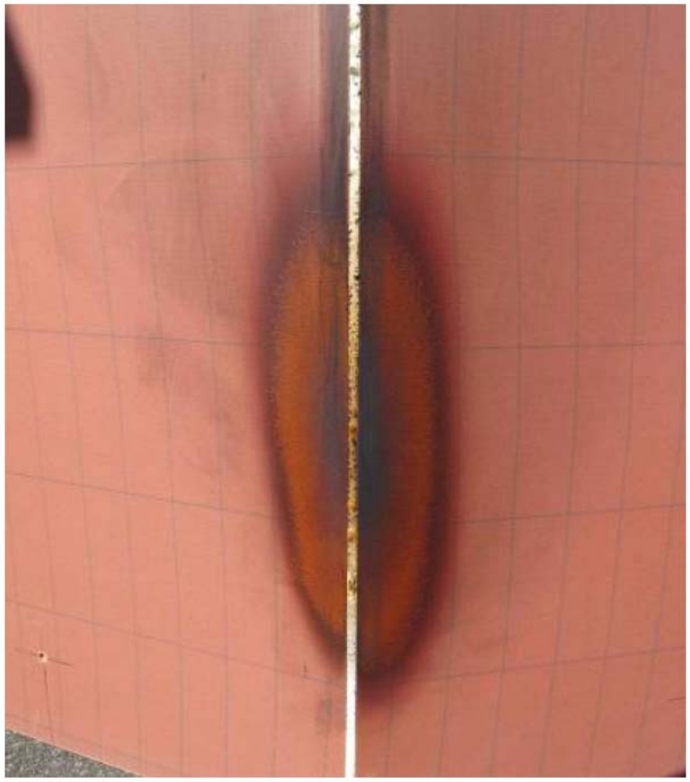
Test comments
• No ignition of adhesive • No discoloration on the backside

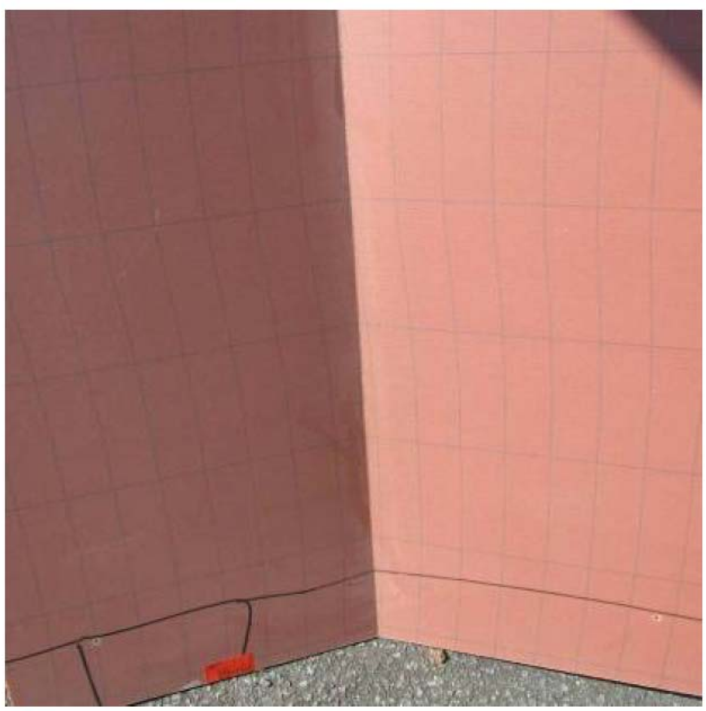
Specimen Description:
Sample Dimensions: pre bending: 3ft x 4ft
Inclined 65°

Adhesive Type:
Scotch-Weld 9323-2 B/A




K0412
145° outside slot
poor performer
65 incline





SELL
CABIN INTERIORS
Galleys & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

Identification : K 0413			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

Test Sample Observations (pre testing)
• Surface of the adhesive seam in places wavy and porous.

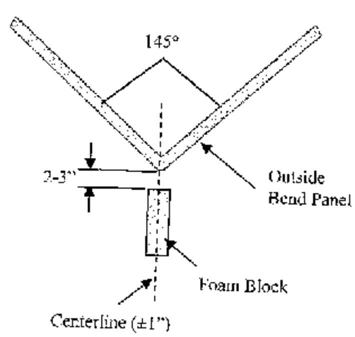
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	-------------

Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments
• No ignition of adhesive • slightly discoloration on the backside

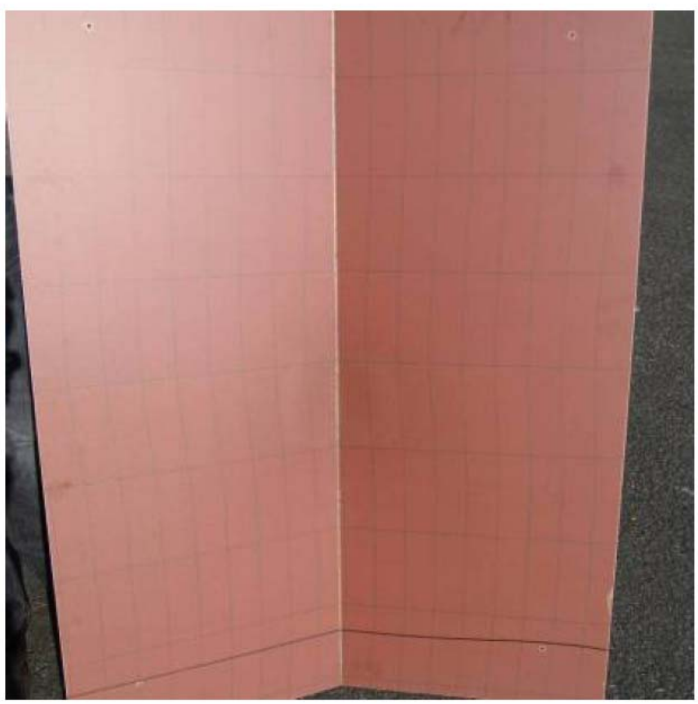
Specimen Description:
Sample Dimensions: pre bending: 3ft x 4ft

Adhesive Type:
Scotch-Weld 9300 B/A FST




145° outside slot
good performer
SW 9300
K0413


outside slot
good performer
SW 9300



SELL
CABIN INTERIORS
Galleys & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

Identification : K 0414			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

Test Sample Observations (pre testing)		
• No adhesive squeeze out		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	------------

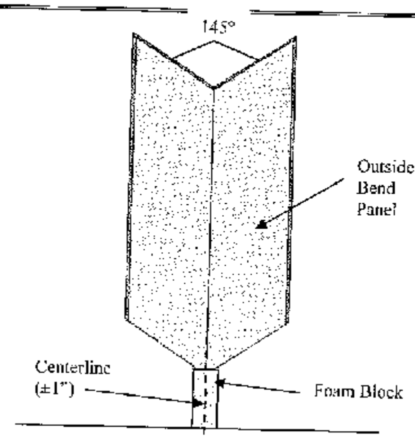
Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments

- No ignition of adhesive
- No discoloration on the backside

Specimen Description:
Sample Dimensions: pre bending: 3ft x 4ft
Inclined 65°

Adhesive Type:
Scotch-Weld 9300 B/A FST




K0414
145° outside slot
good performer
SW9300

SELL
CABIN INTERIORS

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

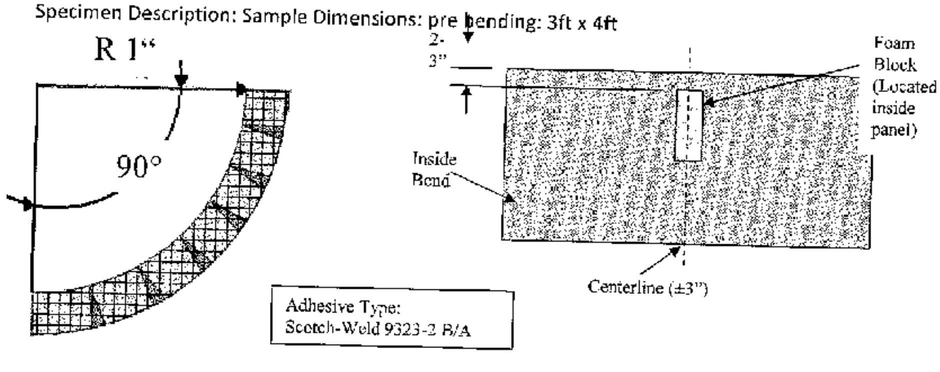
Identification : K 0421			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

Test Sample Observations (pre testing)		
• No adhesive squeeze out		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	----------

Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments
• No ignition of adhesive • No discoloration on the backside

Specimen Description: Sample Dimensions: pre bending: 3ft x 4ft




K 0421
multiple ditch R=1"
poor performer
SW 9323


multiple ditch
poor performer
SW 9323

SELL
CABIN INTERIORS
Galleys & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

Identification : K 0422			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

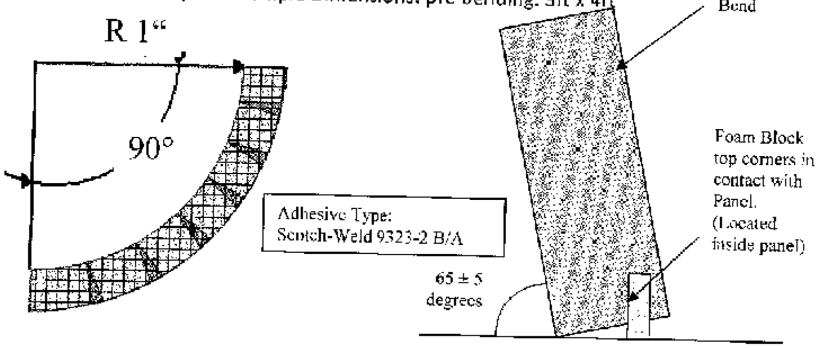
Test Sample Observations (pre testing)
• No adhesive squeeze out

Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	------------

Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments
• No ignition of adhesive • No discoloration on the backside

Specimen Description: Sample Dimensions: pre bending: 3ft x 4ft



128


K0422
multiple stitch R=1"
poor performer
SW9323
65° incline


K0422
multiple ditch R:1"
poor performer
SW9323
65° incline

SELL
CABIN INTERIORS
Galleys & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

Identification : K 0423			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

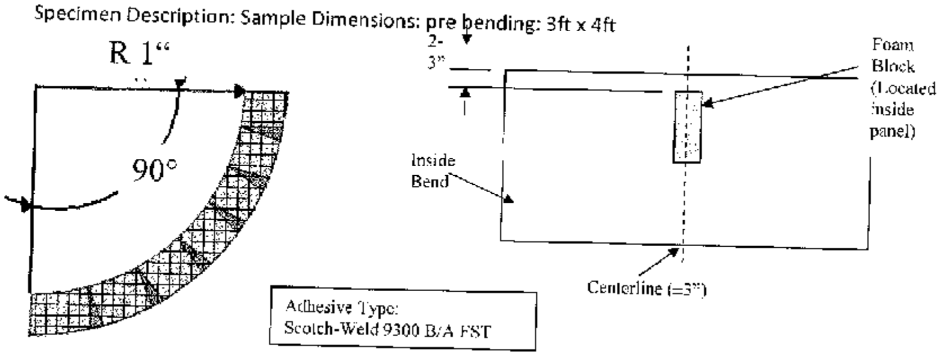
Test Sample Observations (pre testing)
• No adhesive squeeze out

Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	------------

Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments
• No ignition of adhesive • No discoloration on the backside

Specimen Description: Sample Dimensions: pre bending: 3ft x 4ft




K 0423
multiple ditch R=1"
good performer
SW 9300

SELL
CABIN INTERIORS
Galleys & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

Identification : K 0424			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

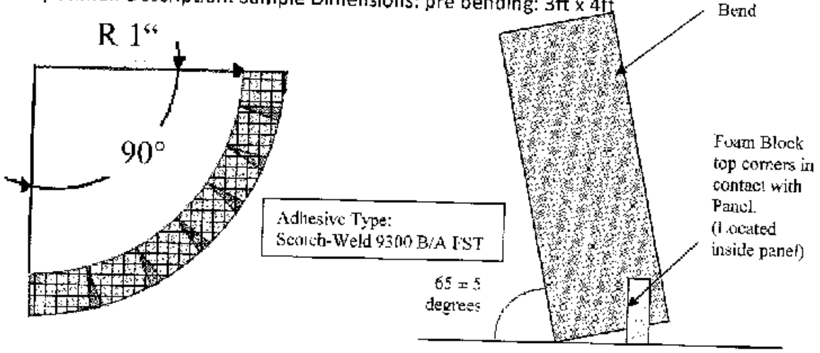
Test Sample Observations (pre testing)
• No adhesive squeeze out

Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	----------

Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments
• No ignition of adhesive • No discoloration on the backside

Specimen Description: Sample Dimensions: pre bending: 3ft x 4ft




K0424
multiple ditch R:1"
good performer
65° incline


K0424
multiple ditch R=1"
good performer
65° incline

SELL
CAB N INTERIORS
Galleys & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

Identification : K 0425			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

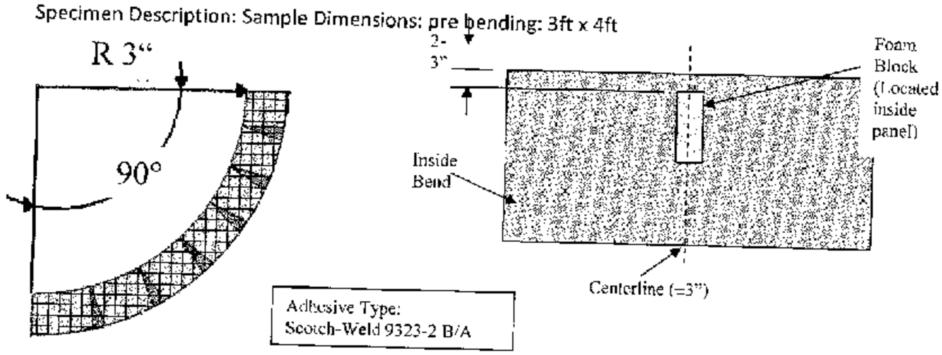
Test Sample Observations (pre testing)		
• No adhesive squeeze out		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	-------------

Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments

- No ignition of adhesive
- No discoloration on the backside

Specimen Description: Sample Dimensions: pre bending: 3ft x 4ft



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K0425
multiple ditch R=3"
Poor performer
SW9323

SELL
CABIN INTERIORS
Galleys & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

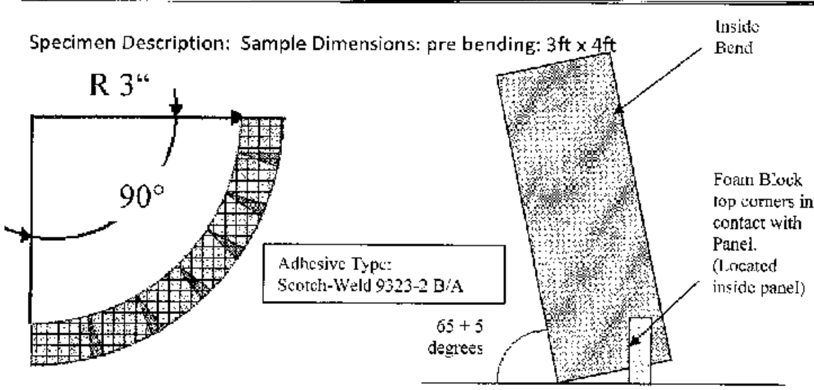
Identification : K 0426			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

Test Sample Observations (pre testing)		
• No adhesive squeeze out		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	--------------

Test results discussion		
Test results acceptable?	YES	X
	NO	

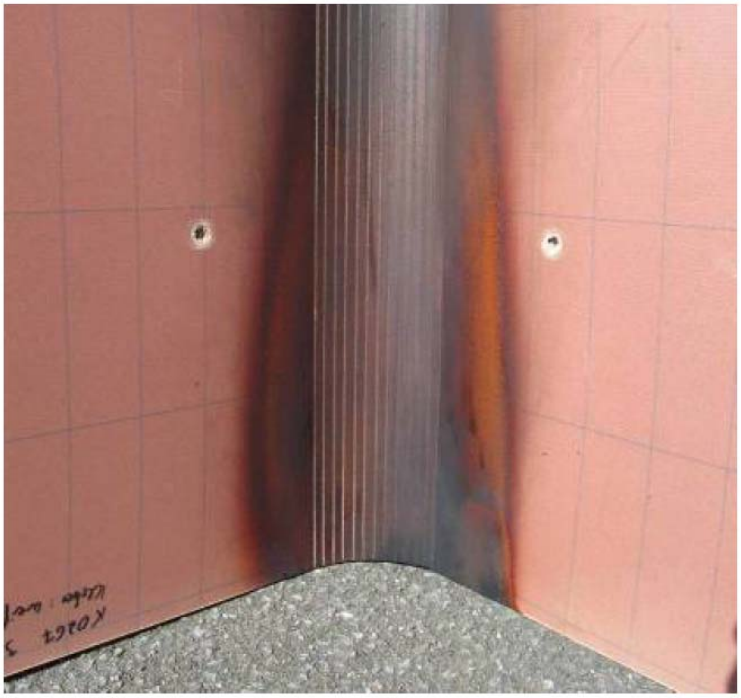
Test comments
• No ignition of adhesive • No discoloration on the backside

Specimen Description: Sample Dimensions: pre bending: 3ft x 4ft



140


KO426
multiple ditch R=3"
poor performer
SW9323
65° incline



SELL
CABIN INTERIORS
Galleys & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

Identification : K 0427			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

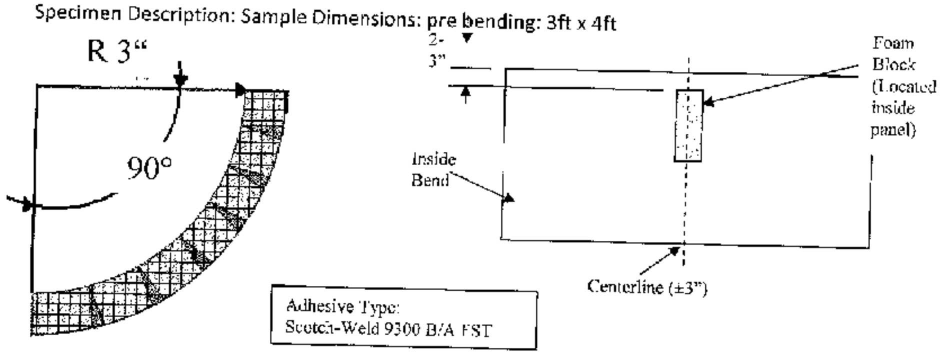
Test Sample Observations (pre testing)		
• No adhesive squeeze out		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	------------

Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments

- No ignition of adhesive
- No discoloration on the backside

Specimen Description: Sample Dimensions: pre bending: 3ft x 4ft



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K0427
multiple ditch R=3"
good performer
SW9300

SELL
CABIN INTERIORS
Galleys & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

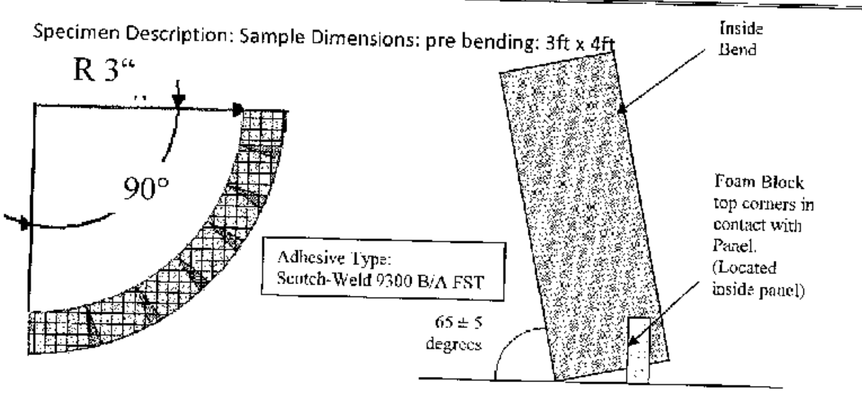
Identification : K 0428			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

Test Sample Observations (pre testing)		
• No adhesive squeeze out		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	------------

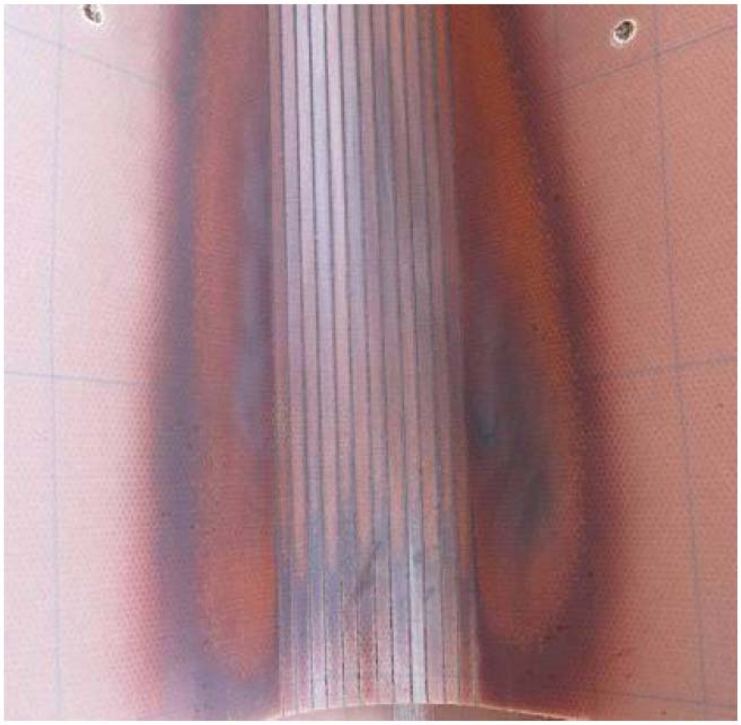
Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments
• No ignition of adhesive • No discoloration on the backside

Specimen Description: Sample Dimensions: pre bending: 3ft x 4ft




K0428
good performer
SW9300



SELL
CABIN INTERIORS
Galleys & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

Identification : K 0429			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

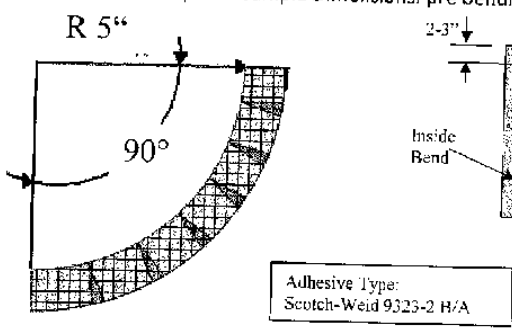
Test Sample Observations (pre testing)		
• No adhesive squeeze out		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	------------

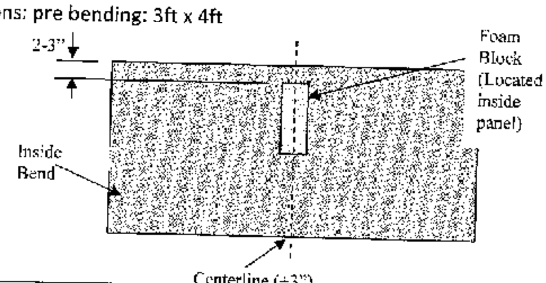
Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments

- Ignition of adhesive after the maximum flame impingement (footprint) of the foam block has been created.
- After flame time of the adhesive: 13 sec
- In spite of the after flame time no flame propagation occurs outside the exposed area
- No discoloration of the backside

Specimen Description: Sample Dimensions: pre bending: 3ft x 4ft






K0429
poor performer
SW 9323

FAA Memorandum
ANM-115-09-XXX "Policy Statement on Flammability Testing of Interior Materials"
Parts 1 and 2, Reference Items 43a to 43f

SELL
CABIN INTERIORS
Galleys & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

Identification : K 0430			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

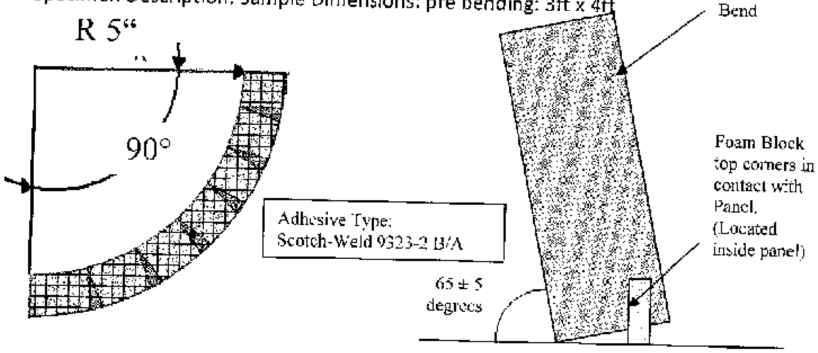
Test Sample Observations (pre testing)		
• No adhesive squeeze out		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	----------

Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments

- No ignition of adhesive
- No discoloration on the backside

Specimen Description: Sample Dimensions: pre bending: 3ft x 4ft




430
ltipleditch R=5"
or performer
w 9323
65° incline

SELL
CABIN INTERIORS
Galleys & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

Identification : K 0431			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

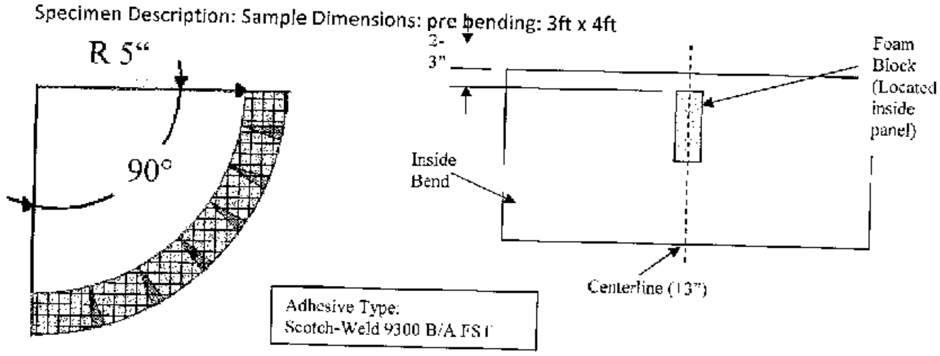
Test Sample Observations (pre testing)		
• No adhesive squeeze out		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	------------

Test results discussion		
Test results acceptable?	YES	X
	NO	

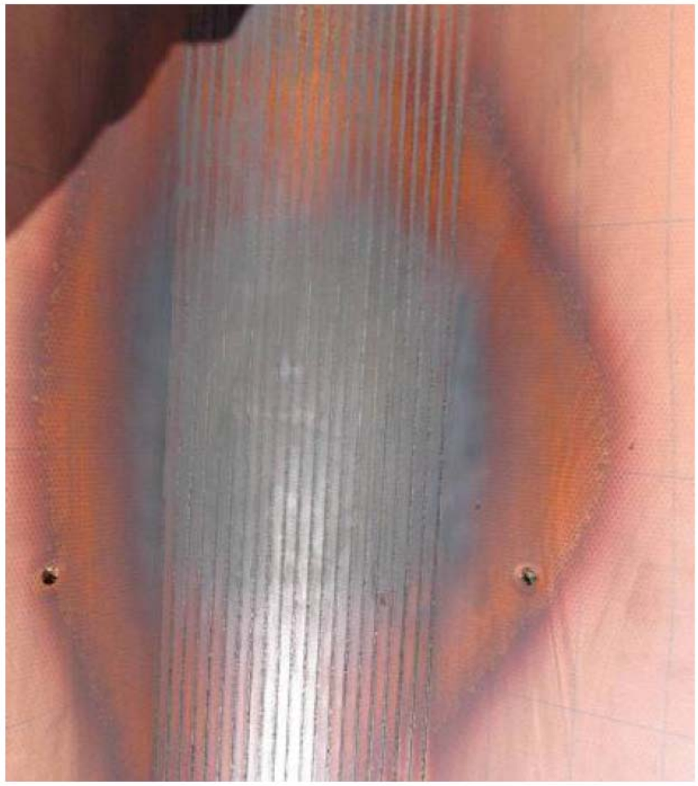
Test comments

- No ignition of adhesive
- No discoloration on the backside

Specimen Description: Sample Dimensions: pre bending: 3ft x 4ft




K0431



SELL
CABIN INTERIORS
Galleys & Equipment

ZODIAC AEROSPACE

FOAM BLOCK TEST DATA SHEET

Identification : K 0432			
Manufacturer : SELL GmbH			
Test Location: Herborn/Germany	Test Date: Mar-28-2011	Tested by: D.Boesser	Witnessed by: K.Boesser

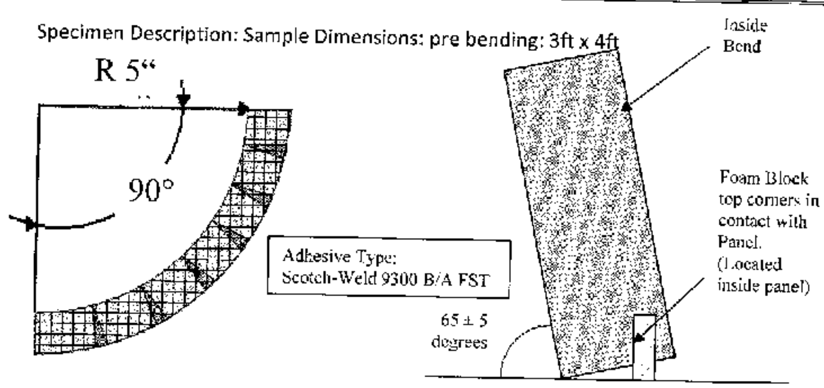
Test Sample Observations (pre testing)		
• No adhesive squeeze out		
Did Flame propagation occur outside of the flame exposed area?	YES	
	NO	X
If yes the length of flame propagation is as follows:	LENGTH	----------

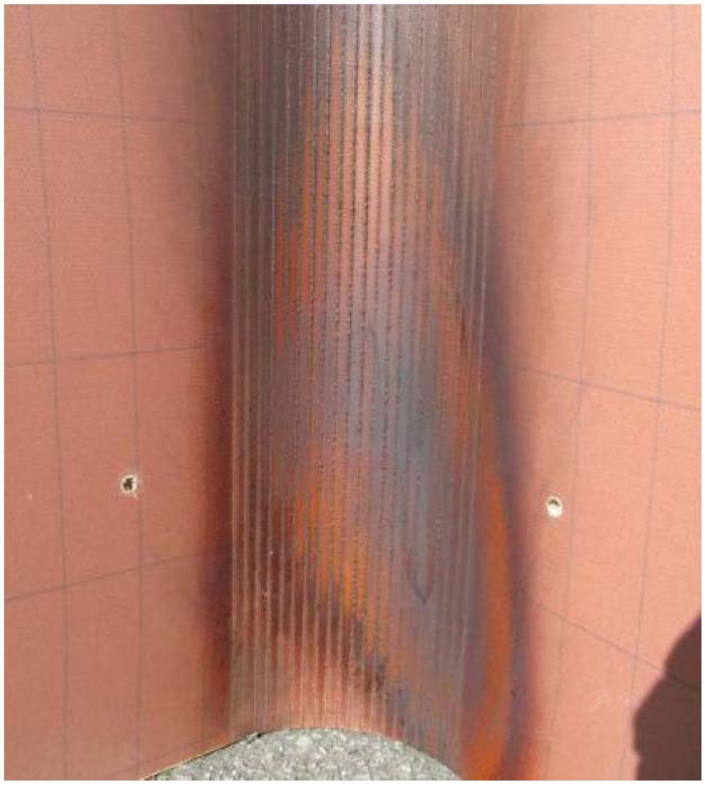
Test results discussion		
Test results acceptable?	YES	X
	NO	

Test comments

- No ignition of adhesive
- No discoloration on the backside

Specimen Description: Sample Dimensions: pre bending: 3ft x 4ft





Appendix C

Foam Block and 60-second Vertical Bunsen Burner Testing
Ditch-and-pot Adhesives – 3M DP110 and Devcon I-FR

Overview:
Boeing generated foam block test data and 60-second vertical Bunsen burner testing on two epoxy adhesives used in a ditch-and-pot joint construction. These two adhesives were chosen for evaluation as one is a non-fire retarded adhesive (3M) and the other is a fire retarded adhesive (Devcon). These two adhesives were selected based on a range of flammability properties including Bunsen burner and MCC testing. Data was generated using a base honeycomb panel with phenolic skins in three thicknesses; 0.25", 0.5" and 0.75". Both inside and outside joints were evaluated. The foam block test results for both adhesives indicated that the ditch-and-pot joint configuration has good resistance to ignition with no flame propagation. In the 60-second Bunsen burner test method, the non-fire retarded adhesive demonstrated long self extinguishing times typical of non-fire retarded adhesives in this joint configuration. All the inside joints showed acceptable burn lengths with no dripping, while the outside joints (exposed adhesive) showed some burn lengths beyond the 6" requirement. The fire retarded adhesive met all the Bunsen burner requirements. These results support the final MoC proposals.

Test Configuration Summary:
The test parts consisted of a standard nonmetallic honeycomb panel construction with one ply of phenolic pre-impregnated glass fabric on each surface. 3M DP110 and Devcon 5-Minute & 10-Minute IFR adhesives were evaluated. Some panels had a decorative laminate applied to the surface. Below is the test matrix.

Adhesive	**Joint Type/Angle**	**Panel Thickness**	**Dec Lam** (on exposed adhesive side)	**Bunsen Burner**	**Foam Block** (horizontal)	**Foam Block** (65 degree incline)
DP100 (Non-Fire Retarded	Inside/90	0.25	None	x	Test 2	Test 1
		0.5	None	x	Test 3	
		0.75	Yes	x	Test 4	
	Outside/145	0.25	Yes	x	Test 6	Test 5
		0.5	None	x	Test 7	
		0.75	Yes	x	Test 8	
Devcon IFR (Fire retarded)	Inside/90	0.25	None	x	Test A	
		0.5	None	x		
		0.75	Yes			
	Outside/145	0.25	Yes	x	Test B	
		0.5	None	x	Test C	
		0.75	Yes	x		

FAA Memorandum
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Parts 1 and 2, Reference Items 43a to 43f
Test Result Summary:

A. Microscale Combustion Calorimeter Test

MCC data was performed on each adhesive. The results indicate the 3M DP110 material to have high heat release properties with associated low char yields. This is typical of a non-fire retarded epoxy adhesive. The Devcon adhesive showed lower heat release properties in the range typically seen for fire retarded epoxy adhesives with associated higher char yields.

	HRC	HRR	HR	CHAR YEILD
3M DP110 (10 min gel)	535.0	530.0	26.6	4.0
3M DP110 (5 min gel)	545.0	541.0	24.1	5.0
Devcon 10min FR	268.0	264.0	10.5	29.3

HRC = Heat Release Capacity

HRR = Max Specific Heat Release Rate

HR = Heat of Combustion, Total

B. Bunsen burner test results

Below are the results of the Bunsen burner test results on bent panels. None of the specimens had any drips.

	Devcon 5-Minute Cure		Devcon 10-Minute Cure	
	Ext Time (sec)	Burn Length (in)	Ext Time (sec)	Burn Length (in)
Outside 0.750	0	0.3 *	Not tested	Not Tested
Outside 0.5	0	0.9 *	0	0.8
Outside 0.25	0	1.2 **	0	1.1
Inside 0.750	Not Tested	Not Tested	Not Tested	Not Tested
Inside 0.5	0	0.6 *	0	0.7 *
Inside 0.25	0	1.0 **	0	1

* one specimen
** two specimen average

	3M DP110	
	Ext Time (sec)	Burn Length (in)
Outside 0.750	**769.3**	**8.3**
Outside 0.5	**933.7**	**11**
Outside 0.25	**546.3**	**11**
Inside 0.750	**340.9**	**2.3**
Inside 0.5	**324.6**	**2**
Inside 0.25	**81.7**	**1.5**

Note: Average of 3 specimens

The results demonstrate that non-fire retarded epoxy adhesives can demonstrate long after flame times as the cross-section of the Bunsen burner specimen exposes the adhesive. The non-fire retarded adhesive when tested in an outside joint (adhesive exposed) had burn lengths that exceeded the regulatory requirements. The inside joint configuration shows typical self extinguishing times but only smalls burn lengths dictated by the honeycomb panel properties and not the adhesive.

C. <u>Foam Block Test Results</u>

Results from the foam block testing did not indicate any ignition or flame propagation beyond the direct flame impingement for either adhesive. Post-test photos are provided in this report.

<u>Conclusion:</u>
Test results showed consistent behavior in the foam block test for both adhesives with no ignition or propagation along the adhesive joint. This provides a high level of confidence of the actual performance of these joints installed in the airplane cabin regardless of whether the adhesive joint is exposed or not.

The 3M DP110 non-fire retarded adhesive demonstrated typical behavior in the 60-second vertical Bunsen burner test with long self-extinguishing times. This particular adhesive also showed that in an outside joint where the adhesive is exposed, the burn length exceeds the regulatory requirement of 6”. Inside joints where the adhesive is not exposed (being shielded from the honeycomb skins on both sides) demonstrated good burn length performance. Typical long extinguishing times were observed in the Bunsen burner due to the cross-sectional cut of the Bunsen burner sample that exposes the adhesive.

Based on these results, inside joints are robust and are supported by a “no test” means of compliance when the adhesive is epoxy and installed in a typical honeycomb panel. Outside joints are robust in the foam block test and are supported by a method of compliance using the foam block test and meeting the burn length requirement in a standard panel.

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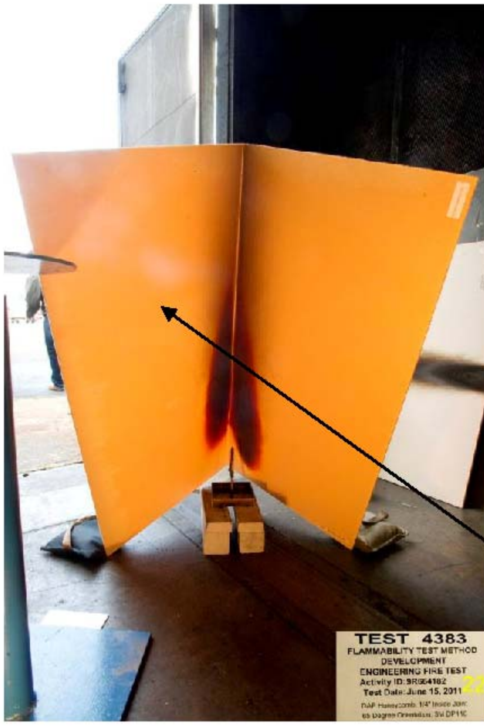
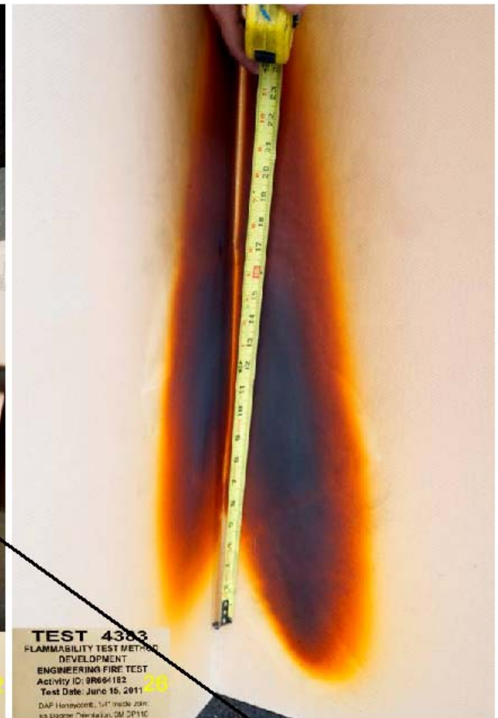
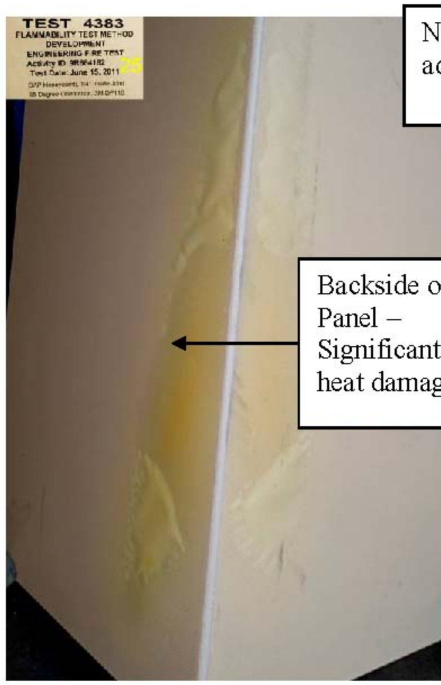
Foam Block Test Post-test photos – 3M DP110

Test #1: 3M DP110 - Inside Joint, 1/4" panel, 65 degree angle







No ignition of adhesive.

Backside of Panel – Significant heat damage

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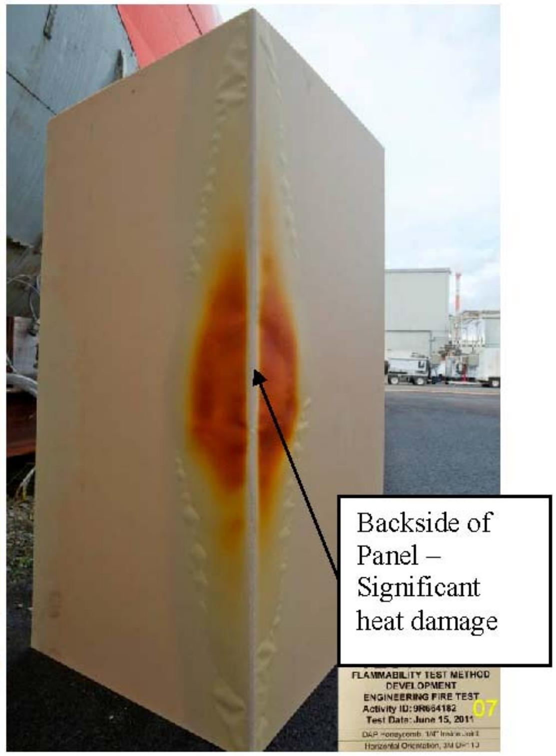
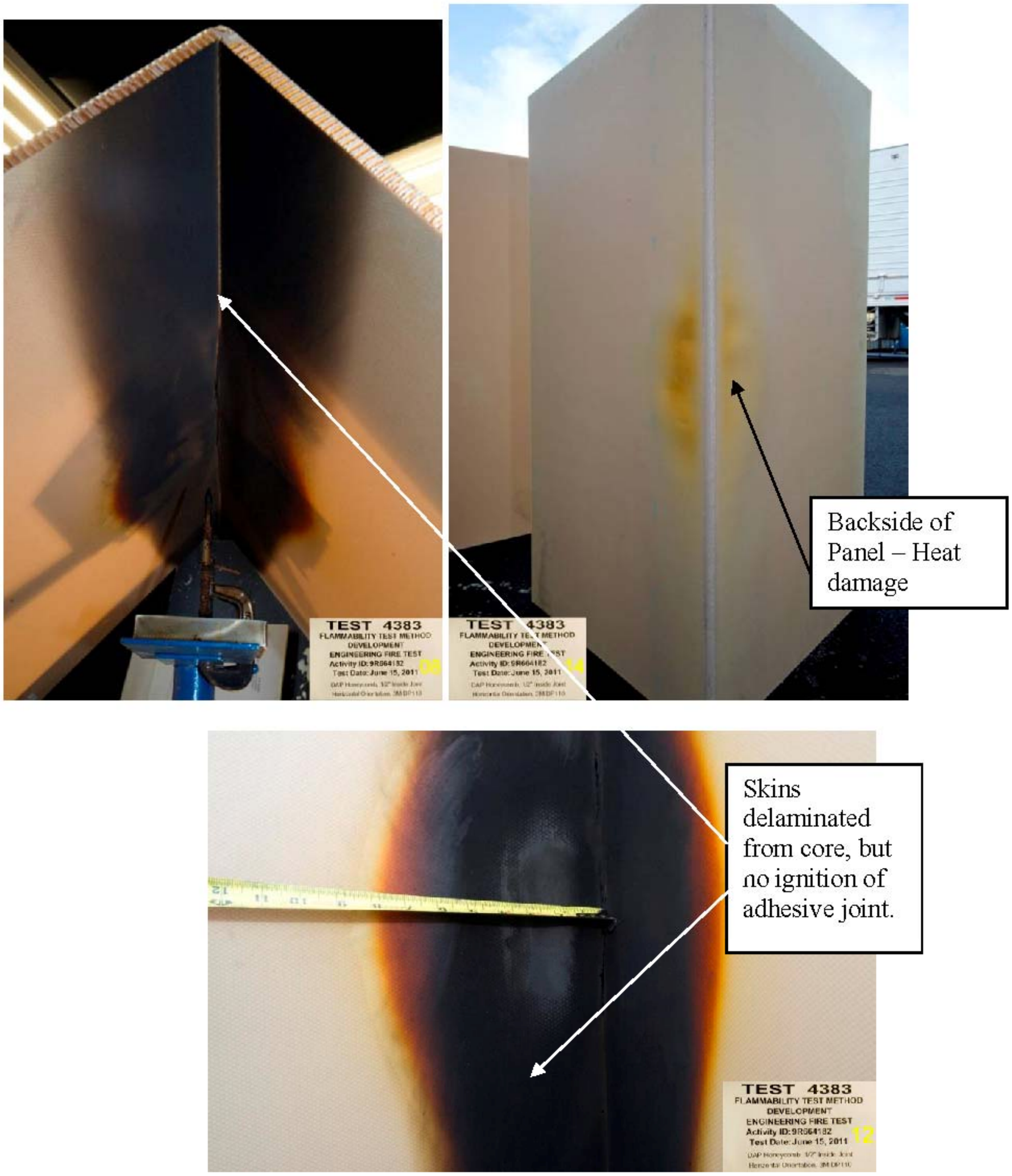
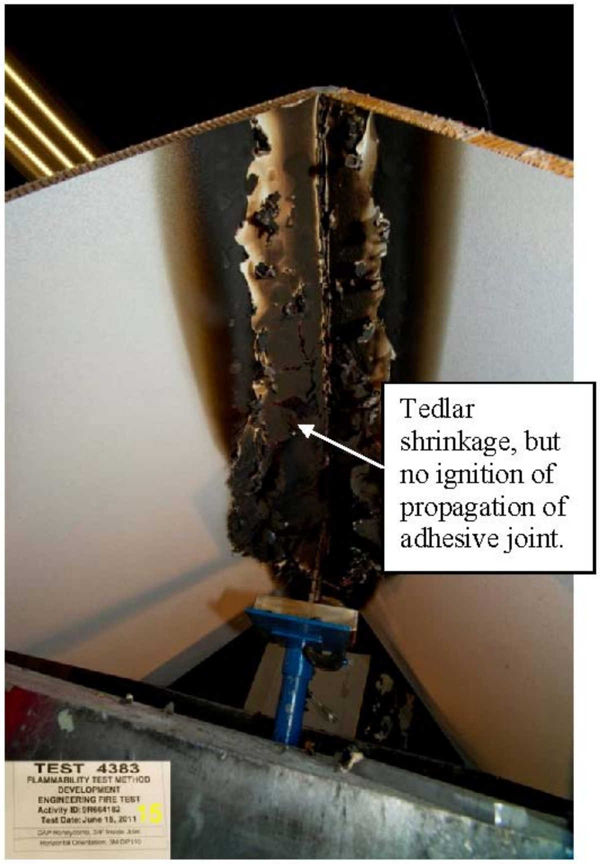
ANM-115-09-XXX "Policy Statement on Flammability Testing of Interior Materials"
Parts 1 and 2, Reference Items 43a to 43f
Test #2: 3MDP110 - Inside Joint, 1/4" panel, horizontal orientation



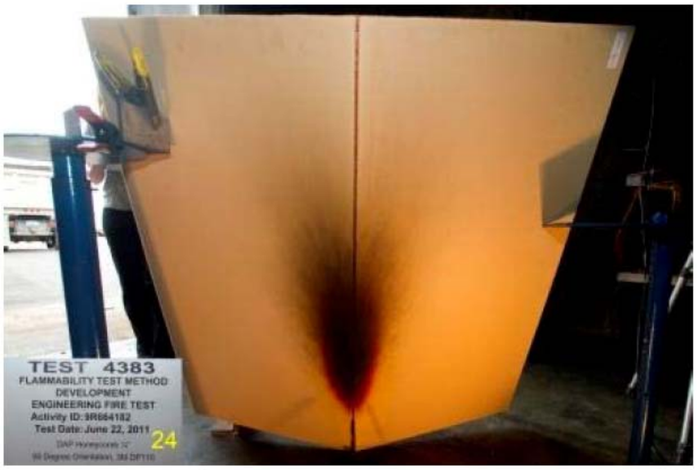
FAA Memorandum
ANM-115-09-XXX "Policy Statement on Flammability Testing of Interior Materials"
Parts 1 and 2, Reference Items 43a to 43f
Test #3: 3MDP110 - Inside Joint, 1/2" panel, horizontal orientation

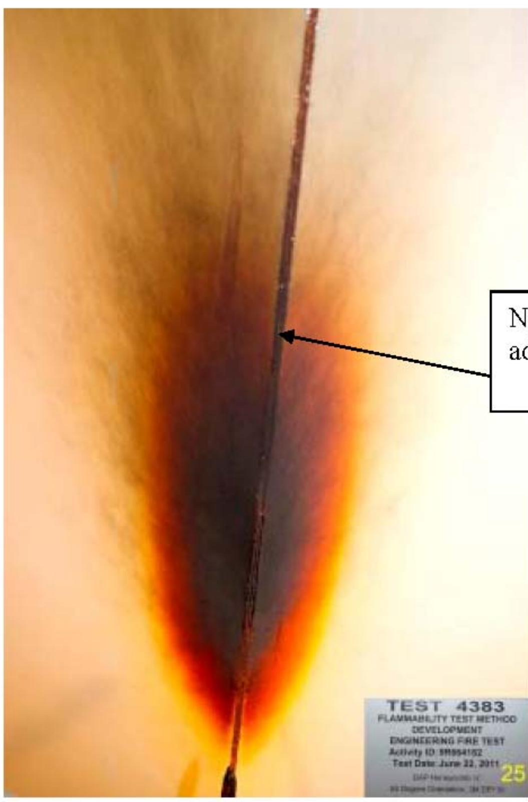


Test #4: 3MDP110 - Inside Joint, 3/4” panel, horizontal orientation



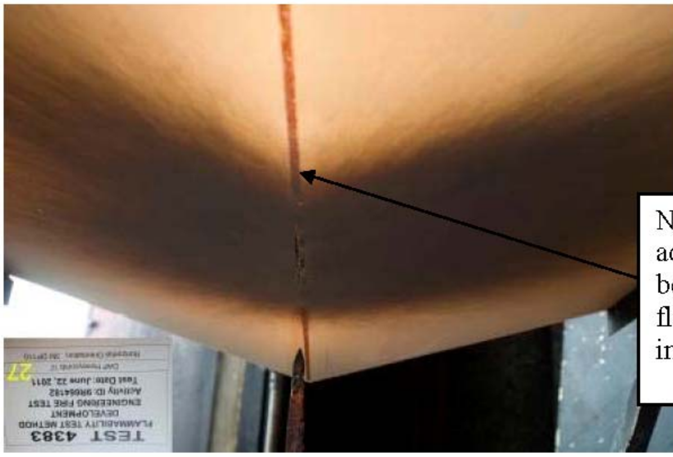
FAA Memorandum
ANM-115-09-XXX "Policy Statement on Flammability Testing of Interior Materials"
Parts 1 and 2, Reference Items 43a to 43f
Test #5: 3MDP110 - Outside Joint, 1/4" panel, 65 degree angle



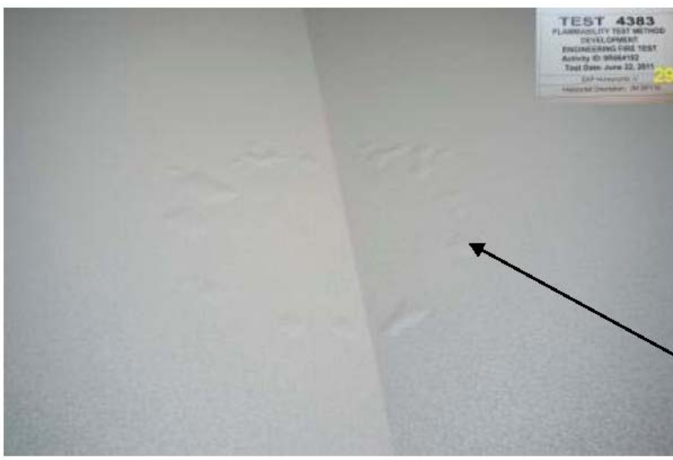


No ignition of adhesive

FAA Memorandum
ANM-115-09-XXX “Policy Statement on Flammability Testing of Interior Materials”
Parts 1 and 2, Reference Items 43a to 43f
Test #6: 3MDP110 - Outside Joint, 1/4” panel, horizontal orientation



No ignition of adhesive beyond direct flame impingement



Backside of Panel – Heat damage to decorative laminate

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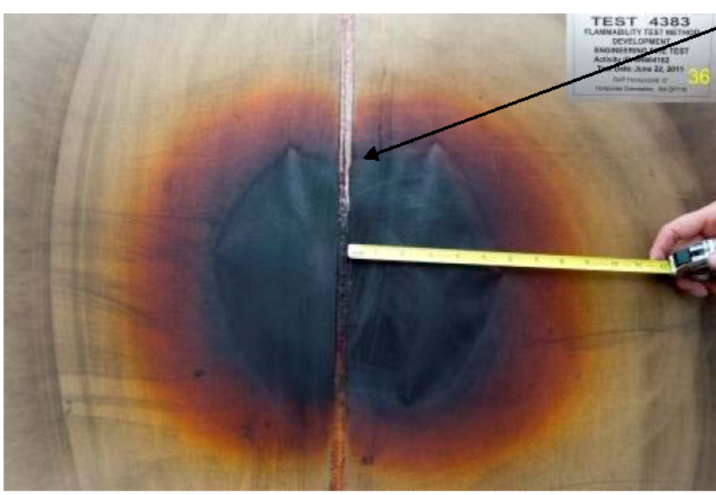
Test #7: 3MDP110 - Outside Joint, 1/2” panel, horizontal orientation

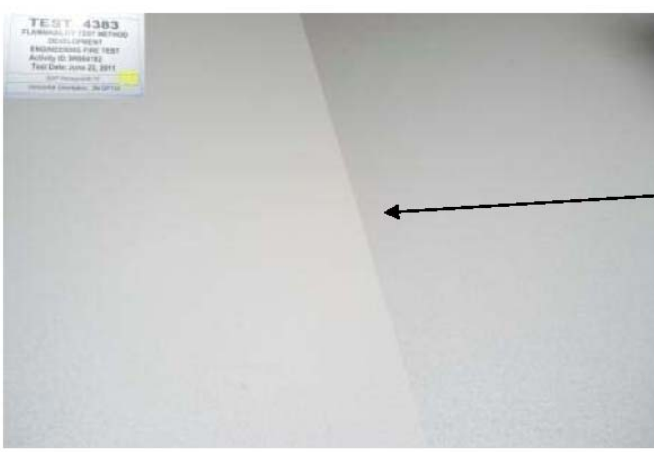
Backside of Panel – Heat damage



No ignition of adhesive.

FAA Memorandum
ANM-115-09-XXX "Policy Statement on Flammability Testing of Interior Materials"
Parts 1 and 2, Reference Items 43a to 43f
Test #8: 3MDP110 - Outside Joint, 3/4" panel, horizontal orientation

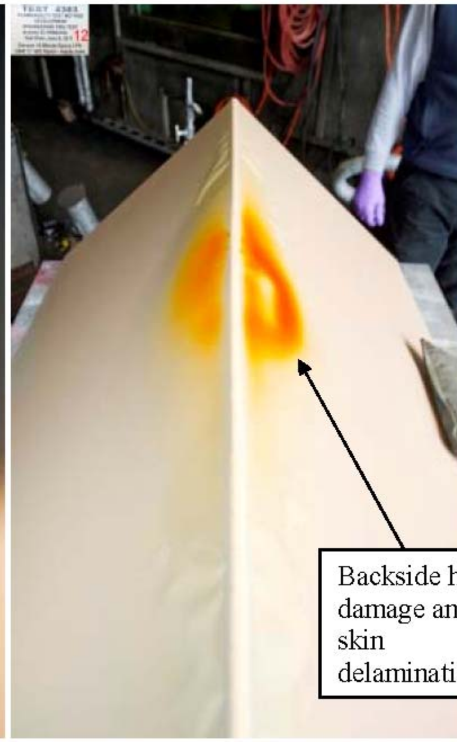
No ignition of adhesive.



No signs of backside heat damage.

Foam Block Test Post-test photos – Devcon I-FR, 5 and 10 minute cure

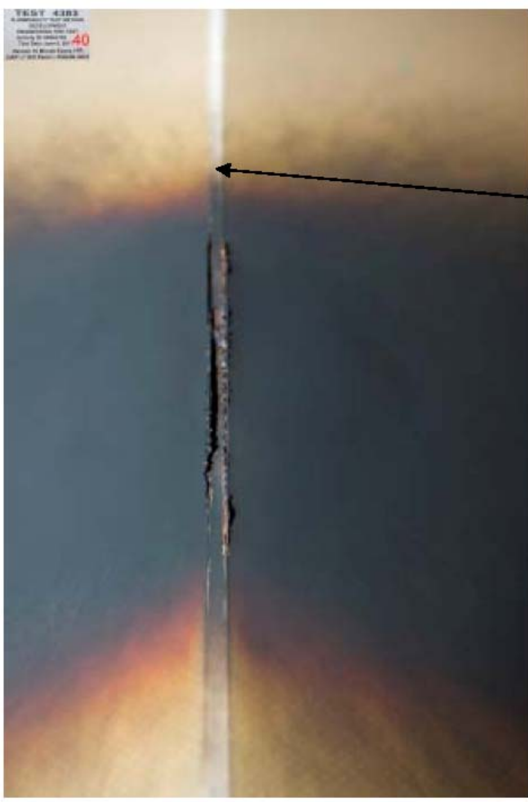
Test A: Devcon I-FR - Inside Joint, 1/4" panel, horizontal orientation



Backside heat damage and skin delamination

No ignition of adhesive.

FAA Memorandum
ANM-115-09-XXX "Policy Statement on Flammability Testing of Interior Materials"
Parts 1 and 2, Reference Items 43a to 43f
Test B: Devcon I-FR - Outside Joint, 1/4" panel, horizontal orientation



No ignition of adhesive.

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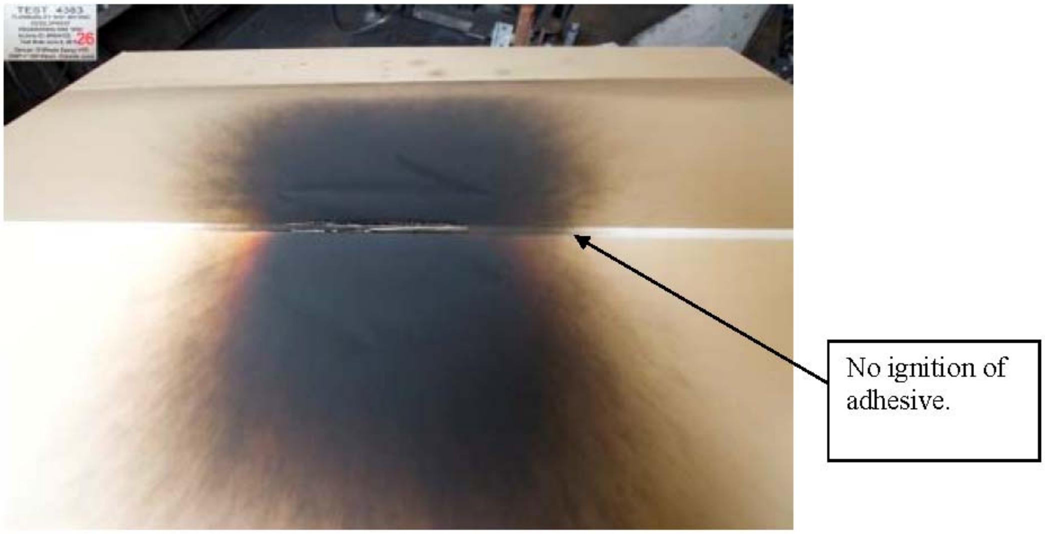
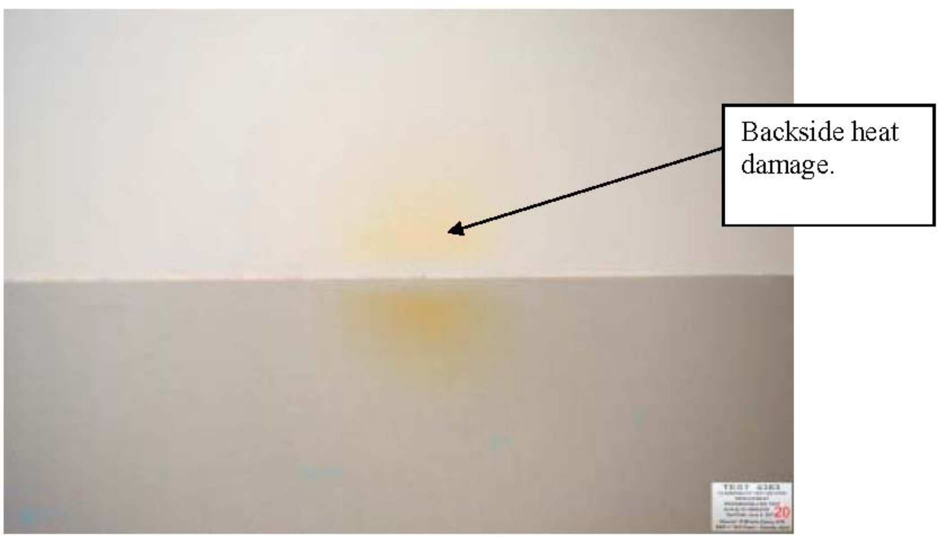
FAA Memorandum
ANM-115-09-XXX "Policy Statement on Flammability Testing of Interior Materials"
Parts 1 and 2, Reference Items 43a to 43f
Test C: Devcon I-FR - Outside Joint, 1/2" panel, horizontal orientation





Appendix D

Item 43 Testing of Plaques and Mortise & Tenon Joints.

Background:

3M evaluated Plaques of Epoxy Adhesives (12" x 3" x ¼") for standalone Vertical Bunsen Burner (VBB) fire resistance per 14 CFR25.853 a) (i) & (ii). Direct comparisons were made using those same adhesives in Mortise and Tenon Joints. A comparison was intended to test the proposed MoC. In both configurations, the intent of the VBB is to determine resistance of materials to fire propagation even though both length of burn and after burn time are the criteria.

The following configurations were tested:

1. Plaques (nominally 12" x 3" x 0.25") in both 12 sec & 60 sec Vertical Bunsen Burner (VBB) Test Configuration per Section 4.1 Figure III.
2. Mortise & Tenon Joints of the same adhesives in the 60 sec VBB. Test Configuration per Section 4.1 Figure IV.

Samples were tested in a 3M VBB chamber with a manual slide for moving the flame in and out of the sample edge and timed with a stop watch. This chamber is not FAA certified but operated in accordance with 14CFR 25.853.

Summary of results:

Plaque testing showed results which would be expected based on the type of adhesive. Adhesive materials without fire retardant (FR) formulations failed both the 12 and 60 second VBB plaque tests. Without fire suppressing materials the plaques burned and if allowed would have been totally consumed in 14CFR 25.853 (a) (i). The 60 second VBBs were stopped between 45 – 90 seconds, so as to not damage the test chamber. In 14CFR 25.853 (a) (ii), 12 second samples did self extinguish but with a longer burn time and less propagation but failed nonetheless. See Table AA.

Adhesives with an FR formulation passed both 12 and 60 second plaque testing, with one exception @ 60 seconds. This one adhesive failed in extinguish time (Average of 20 seconds) It did not fail from a fire propagation standpoint (2.1"). A small residual flame was observed @ the leading edge of the plaque which did self extinguished. Flame propagation was no different than those that passed and well below the requirement. Therefore, it did meet the non-propagation intent of the VBB test.

Table AA

Plaques							
Adhesive	**VBB Test Time**	**After Burn Time**	**Burn Length**	**Drips**	**Drip Burn Time**	**Pass/Fail**	**Comment**
	Sec	Sec	inches	Y/N	sec		
EC2615 B/A	60	>60	>8	Y	>3	Fail	Extinguished @ 60 sec
EC2216 B/A	60	>80	>8	Y	>3	Fail	Extinguished @ 80 sec
DP100FR	60	0	0.94	NA	N	Pass	
SW7246-2 B/A FR	60	20	2.1	N	NA	Fail	Failed After Burn
SW9300 B/A FST	60	12	2.5	N	NA	Pass	Only One Sample Available
EC3550 B/A FST	60	1	1.8	N	NA	Pass	
EC2615 B/A	12	>48	2.5	N	NA	Fail	Extinguished @ 48 sec
EC2216 B/A	12	33	0.4	N	NA	Fail	Failed After Burn
DP100FR	12	0	0.1	N	NA	Pass	
SW7246-2 B/A FR	12	0.5	NA	N	NA	Pass	
SW9300 B/A FST	12	<1	NA	N	NA	Pass	
EC3550 B/A FST	12	<1	0.2	N	NA	Pass	

Mortise and Tenon Joints behaved similar to the failure modes observed in the 12 sec VBB plaques. 6 specimen were used for each sample. See Table AB. In all cases, the analysis of burn length was difficult to ascertain, as the honeycomb panels mitigated any external propagation during the burn. Although adhesive material was consumed in the joint itself, to measure the burn length would require a method of probing the depth of burn in the joint itself. Samples that were not FR formulated failed the test requirements by burning past the desired burn threshold in excess of 1 minute. Those samples which are FR formulated met the extinguish time. Again there was one FR formulation exception. That one exception was found to fail by exceeding the flame threshold by an average of 1.2 sec before self extinguishing. A mix of pass and fail was observed. This was well below the 1 minute or greater burn time. The type of failure was typically a small flame found at the leading edge of the test sample.

Table AB.

M&T Joints 4" wide Tested both ends						
Adhesive	**VBB Test Time**	**After Burn Time**	**Drips**	**Drip Burn Time**	**Pass/Fail**	**Comment**
	Sec	Sec	Y/N	sec		
EC2615 B/A	60	130.0	N	NA	Fail	Only 3 out of possible 6 ends were tested
EC2216 B/A	60	87.5	N	NA	Fail	Long Extinguish Time
DP100FR	60	16.2	N	NA	Fail	Mix of Pass and Fail Those that Failed, failed by exceeding Burn Time
SW7246-2 B/A FR	60	4.7	N	NA	Pass	
SW9300 B/A FST	60	6.0	N	NA	Pass	
EC3550 B/A FST	60	4.2	N	NA	Pass	

Conclusion:
The data validated two of the methods in the MoC, i.e. to determine the viability of an adhesive to meet Fire Retardancy VBB requirements; either to pass a 12 sec VBB as a plaque, or to be VBB 60 sec in a joint. Good correlation is found in either test method to the other, with one adhesive in each MoC exceeding the burn threshold slightly. In each case, the failure was a flame not extinguishing within the required time limit, but neither exceeding the burn length.

APPENDIX CC—ITEM 44: SEALANT AND FILLET SEALS

INDUSTRY FLAMMABILITY STANDARDIZATION TASK GROUP

ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials”

INDUSTRY TEAM PROPOSAL

Parts 1 and 2, Reference Item No. 44 “Sealant, Fillet Seals”

Revision C, 17-Aug-2011

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REVISION HISTORY

Rev	Description	Date	Issued By
NC	Initial release.	26-01-2011	HA
A	Corrected typo in Table II and added additional data	20-07-2011	HA
B	Editorial changes	17-08-2011	IL
C	Added test data from Embraer	22-08-2011	IL

1 INTRODUCTION

Interior fillet seals are employed at the juncture of two adjoining parts or surfaces, and along the edges of faying surfaces as a continuous bead of sealing material. A fillet seal can be applied over, along the edges of, and between installed parts. Fillet seals are typically used to fill voids in order to prevent liquids or gases from going through the gaps, or to provide a decorative transition between surfaces.

The quantities of sealing materials used relative to the size of the panels are generally small, but depend on the location, configuration and length of the joint being sealed.

Due to a lack of standardization across the industry flammability practices, the FAA has decided to publish a draft version of the FAA Memorandum ANM-115-09-XXX, “Policy Statement on Flammability Testing of Interior Materials” [1] (FAA draft policy memo). In this document, the FAA has tried to summarize acceptable methods of compliance (MOC) for various constructed parts, construction details, and materials used therein, based on the FAA’s technical judgement of what is acceptable and within the scope of current regulations. There are two categories to this guidance:

1. Acceptable methods without additional data (Attachment 2, Part 1)
2. Methods of compliance that require supporting data (Attachment 2, Part 2)

As part of the industry activities to provide validation of the Attachment 2, Part 2 items from the FAA draft policy memo, the industry team is also reviewing the Part 1 items to provide definitions, descriptions of terms to enable consistent interpretation and implementation across the aerospace industry.

The industry team has reviewed Item 44 “Fillet Seals” and is submitting the following concurrence, justification and proposal.

2. INDUSTRY TEAM LEADERS & SUPPORT TEAM

2.1 TEAM LEADERS

- Hector Alcorta (Bombardier)

2.2 SUPPORT TEAM

- Scott Campbell (C&D Zodiac)
- Pom Sattayatam (C&D Zodiac)
- Daniel Slaton (Boeing)
- Ingo Weichert (Airbus)
- Ian Lulham (Bombardier)
- Mary Pacher (Boeing)
- Jeff Smith (Gulfstream)
- Michael Jensen (Boeing)
- Daniel Boesser (Sell-Interiors)

3 PROJECT DEFINITION

3.1 CURRENT PROPOSAL

Currently, ANM-115-09-XXX is available as an undated draft. The current version is available from the FAA website as of 20 August 2009. Attachment 2, Part 1, reference item #44 reads as follows (see Figure I below):

Part 1 - Acceptable Methods without Additional Data

Reference Number	Feature/Construction	25.853(a) Bunsen Burner Test Requirements/Similarity	25.853(d) Heat Release Requirements/Similarity
44	Sealant, fillet seals	See part 2 of this attachment.	No test requirement. Industry has not traditionally tested fillet seals.

Figure I – Attachment 2, Part 2, Reference Item 44

Attachment 2, Part 2, reference item #44 reads as follows (see Figure II below):

Part 2 - Methods of Compliance that Require Supporting Data

Reference Number	Feature/Construction	25.853(a) Bunsen Burner Test Requirements/Similarity	25.853(d) Heat Release Requirements/Similarity
44	Sealant, fillet seals	No test requirement.	See part 1 of this attachment.

Figure II – Attachment 2, Part 2, Reference Item 44

3.2 DEFINITION OF TERMS

In the Interest of the overall stated goal of standardization of industry flammability practices, clear definitions of the terms ‘fillet seal’, ‘sealant’ and ‘same’ shall be provided so that confusion between different parties over their meaning shall be avoided. The industry group sees the definition of significant key terms and their consistent use throughout the policy as a joint effort between the FAA and industry. Once these key terms have been defined, they should be listed in the policy memo and used consistently throughout the document.

3.2.1 FILLET SEAL

The industry team agrees that the term ‘fillet seal’ in the context of this item refers to a seal applied after assembly at the juncture of two adjoining parts or surfaces, or along the edges of faying surfaces as a continuous bead of sealing material. It can be applied over, along the edges of, and between installed parts. Cleaning up of adhesive squeeze-out around bonded details is not considered a fillet seal and is covered as part of the bonded details items.

3.2.2 SEALANT

The industry team agrees that the term ‘sealant’ in the context of this item refers to a viscous, elastomeric material which, once applied, changes state to become solid, and is used to fill voids and gaps of various sizes to prevent the passage of liquids or gaseous media, as well as to help meet health and safety requirements, and meeting aesthetics requirements.

Aerospace sealants are generally identified based on the main resin family used to produce them. The resin family most commonly used for fillet sealing of aircraft interiors is silicone. Within the silicone family, most of the materials used for fillet sealing aircraft interiors are RTV (Room Temperature Vulcanizing) silicones. Therefore, in the context of this item, the generic term ‘silicone’ refers to RTV silicones. Other resin families used are polyurethanes and polysulfides.

4 VALIDATION OF INDUSTRY PRACTICE

4.1 INDUSTRY PROPOSAL DISCUSSION

The use of this MOC has been grouped by the FAA into Part 2 for 14 CFR 25.853(a) and into Part 1 for 14 CFR 25.853(d). This means that the FAA will require additional supporting data to accept the “No test requirement” for 25.853(a) to validate this proposed MOC, but that the “No test requirement” for 25.853(d) is acceptable to the FAA and can be used without additional supporting data.

The use of fillet sealing in aircraft interiors is a well-established practice. The industry team has determined that industry and many regulatory agencies have not required fillet seals to be tested to the requirements of 14 CFR 25.853 (a) and (d) because they considered them “small parts” per 14 CFR 25.853(a), Appendix F, Part I, (a)(1)(v), and as such they do not require testing. Some industry participants have established internal requirements that the fillet sealing material must meet, such as the 15 second horizontal Bunsen burner (HBB) test requirements per 25.853(a)(1)(iv) or the 12 second vertical Bunsen burner (VBB) test requirements per 25.853(a)(1)(ii).

As fillet seals are formed using elastomeric materials (ie. silicones, polyurethanes, etc), the certification requirement if larger than a small part would be 14 CFR 25.853(a), Appendix F, Part I, (a)(1)(iv).

The collective experience of the industry team has been that RTV sealants presently used for fillet sealing aircraft interiors pass the 15 second HBB test. However, there are very few materials that can pass the 12 second VBB test. As of today, the industry team is not aware of any materials that will pass the 60 second VBB test while still meeting all the other requirements for fillet sealing aircraft interiors (eg. adhesion, colour, elongation, chemical resistance, fungus/bacteria resistance, etc).

4.1.1 BUNSEN BURNER TESTING

In order to validate the “No test requirement” for Bunsen burner testing in Part 2, the industry team would like to submit the existing data in Section 5.1 and perform the additional testing outlined in Section 5.2.

4.1.2 HEAT RELEASE RATE (HRR) AND SMOKE DENSITY (SD) TESTING

Attachment 2, Part 1, reference item 44 defines “No test requirement” for 25.853(d). This MOC is acceptable to the FAA and can be used without additional supporting data.

4.2 PROPOSED STANDARD TO MEET

Attachment 2, Part 2, reference item 44 defines "No test requirement" for 25.853(a). This is the MOC being validated by the industry team.

5 DATA / ANALYSIS

5.1 EXISTING TEST DATA

The industry has very little compliance data on fillet seals due to the industry practice that "small parts" are not tested. The industry team has called upon its members to submit any type of existing flammability data per 25.853(a) to support the "No test requirement" of sealants used for fillet sealing.

5.2 PROPOSAL OF TESTS TO BE PERFORMED

Data will be generated for multiple sealants currently used for fillet sealing of aircraft interiors using the 15 second HBB test, the 12 second VBB test, and the 60 second VBB test, and the tables below will be populated. At a minimum, two different types of aerospace sealant for each general chemistry (silicone, polyurethane, polysulfide, polythioether, and hybrids thereof), from two different manufacturers (except polythioether, as there is only one manufacturer) shall be tested.

Table I will contain data for each fillet seal material tested by itself. Table II will contain data for coupons made by applying each fillet seal material to an OSU-compliant panel. Table III will contain data for coupons made by applying each fillet seal material to an aluminum panel. These will be limited to sealants used in structure sealing, such as polyurethanes and polysulfides.

Product Designation	Manufacturer	Material By Itself						
		15 sec HBB	12 sec VBB			60 sec VBB		
			FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Product 1								
Product 2								
Product 3								
etc								

Table I – Fillet Seal Material By Itself

Product Designation	Manufacturer	Material Applied to a Non-Metallic Panel						
		15 sec HBB	12 sec VBB			60 sec VBB		
			FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Product 1								
Product 2								
Product 3								
etc								

Table II – Fillet Seal Material Applied to a Non-Metallic Panel

Product Designation	Manufacturer	Material applied to an Aluminum Panel						
		15 sec HBB	12 sec VBB			60 sec VBB		
			FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Product 1								
Product 2								
Product 3								
etc								

Table III – Fillet Seal Material Applied to an Aluminum Panel

The initial proposal is to test each sealant material as follows:

⇨ By itself using either:

- bead specimens of approximately 3/8” diameter x 12”
  or
- sheet specimens of 1/8” thick x 3” x 12”

(Specimens smaller than 3” x 12” may be used if testing shows that the burn length is less than the specimen size)

⇨ Applied to a 3” x 12” OSU-compliant panel either:

- as a bead of approximately 3/8” diameter x 12”
  or
- as a strip 1/8” thick and minimum 1/2” wide x 12”

⇨ For structure sealants, applied to a 3” x 12” x 0.020” to 0.040” aluminum panel either:

- as a bead of approximately 3/8” diameter x 12”
  or
- as a strip 1/8” thick and minimum 1/2” wide x 12”

Full definition of the specimen type(s), the resin families and the sealant materials will be included in the test report.

5.3 TEST RESULTS

The engineering data provided by industry to date is submitted below:

Product Designation	Manufacturer	Material By Itself						
		15 sec HBB	12 sec VBB			60 sec VBB		
			FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
RTV 736 Red [1], [2], [4]	Dow Corning	Pass [3]	0,225,0 (Avg 75)	0.4,0.8,0.3 (Avg 0.5)	ND,ND,ND	270,90,200 (Avg 187)	1.0,1.0,1.0 (Avg 1.0)	ND,ND,ND
RTV 3145 Clear [1], [2], [4]	Dow Corning	Pass [3]	60,7,6 (Avg 24)	0.5,0.5,0.5 (Avg 0.5)	ND,ND,ND	60,150,120 (Avg 110)	3.5,5.2,4.1 (Avg 4.3)	ND,ND,ND
RTV 739 White [1], [2], [4]	Dow Corning	Pass [3]	2,0,1 (Avg 1)	0.1,0.1,0.1 (Avg 0.1)	ND,ND,ND	115,8,11 (Avg 45)	2.0,2.0,2.0 (Avg 2.0)	ND,ND,ND
RTV 739 Black [1], [2], [4]	Dow Corning	Pass [3]	4,4,2 (Avg 3)	0.2,0.2,0.3 (Avg 0.2)	ND,ND,ND	17,200,28 (Avg 81)	1.0,1.0,1.0 (Avg 1.0)	ND,ND,ND
RTV 108 Translucent [1], [2], [4]	Momentive	Pass [3]	60,4,5 (Avg 23)	1.0,0.5,0.7 (Avg 0.7)	ND,ND,ND	20,34,150 (Avg 67)	3.3,1.4,2.5 (Avg 2.4)	ND,ND,ND
Polysulfide 1 [5], [6]	PRC-Desoto	0.6"/min						
Polysulfide 1 [5], [7]	PRC-Desoto	1.2"/min						
Polysulfide 1 [5], [8]	PRC-Desoto		46	6 (Full Burn)	ND			
Polysulfide 1 [5], [9]	PRC-Desoto					Not Tested	Not Tested	Not Tested
Pactan 7041 Grey [10]	Tremco Illbruck	0.0,0.0,0.0 (Avg 0.0 in/min)	60,60,60 (Avg 60)	12,12,12 (Avg 12.0)	0,0,0 (Avg 0)			
Pactan 7042 White [10]	Tremco Illbruck	0.0,0.0,0.0 (Avg 0.0 in/min)	60,60,60 (Avg 60)	12,12,12 (Avg 12.0)	0,0,0 (Avg 0)			
Pactan 7042 Transparent [10]	Tremco Illbruck	0.0,0.0,0.0 (Avg 0.0 in/min)	60,60,60 (Avg 60)	12,12,12 (Avg 12.0)	0,0,0 (Avg 0)			
Polysulphide Aerodynamic 11221 [11]	Desoto	Pass, 1.93"/min						
Polysulphide Aerodynamic 11221 [12]	Desoto		160.07	12.0	0.0			
Polysulphide Low Density 11214 [11]	Desoto	Pass 2.38"/min						
Polysulphide Low Density 11214 [12]	Desoto		172.47	12.0	0.0			
Silicone, Grey [13]		Pass [3]						

Table IV – Industry Data for Fillet Seal Material By Itself

[1] Bead, 3/8" diameter x 12" long.

[2] For the 15-sec HBB tests the specimen was supported by four thin wires spaced at ~ 3". For the 12-sec VBB and 60-sec VBB tests the specimen was supported with a metallic clip at the top end, and with a U-shaped wire about 2"-3" above the flame to keep it aligned with the flame (See Figure III below).
[3] Self-extinguished before reaching timing mark
[4] FET failures were due to very small flame (< 3/16") flickering on and off before it extinguished
[5] Square rod, 0.125" x 0.125" x 6.0" long.
[6] Single specimen. Specimen supported by three steel wires spaced at 1.5" (See Figure IV below). Flame slowed at first wire and then slowed at 2nd wire. Test stopped at 240 seconds after passing 1.5" mark.
[7] Single specimen. Specimen supported by three steel wires pierced through the sample (See Figure IV below).
[8] Single specimen. Specimen supported by wrapping it with wire (See Figure IV below). Specimen ignited and slowly stretched ~3" then fell out of holding wire. Specimen was extinguished.
[9] Did not test material by itself to 60 sec, since all other data showed consistent properties.
[10] Flat specimens, 3" x 12" x 0.080".
[11] Sheet approximate thickness - 3.2mm, 1specimen tested, both ends
[12] Sheet approximate thickness - 3.2mm, 1specimen tested
[13] Sheet approximate thickness - 3.2mm, 3 specimens tested, both ends

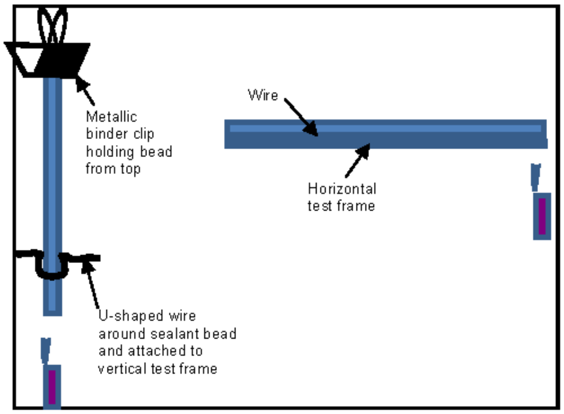

Figure III – Test Setup for Round Bead of Fillet Seal Material Tested By Itself

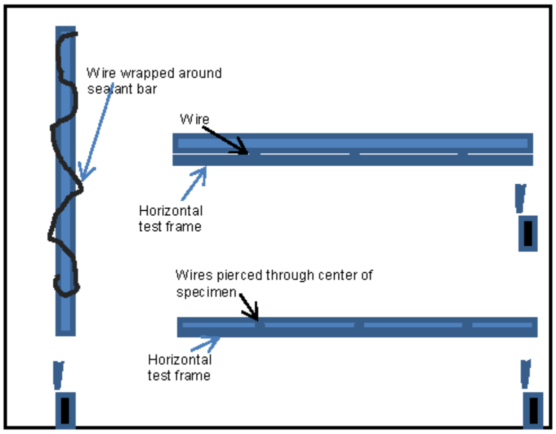

Figure IV – Test Setup for Square Rod of Fillet Seal Material Tested By Itself

Product Designation	Manufacturer	Material Applied to a Non-Metallic Panel						
		15 sec HBB	12 sec VBB			60 sec VBB		
			FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
RTV 102 [1]	Momentive		0,0,29.3 (Avg 9.8)	0.5,0.7,0.8 (Avg 0.7)	ND,ND,ND	0,0,0 (Avg 0)	1.9,2.1,2.3 (Avg 2.1)	3.5,5.0,ND (Avg 2.8)
RTV 102 [2]	Momentive		0,0 (Avg 0)	0.5,0.5 (Avg 0.5)	ND,ND	0,0 (Avg 0)	1.9,2.3 (Avg 2.1)	ND,ND
RTV 739 White [3]	Dow Corning		0,0,0 (Avg 0)	0.1,0.1,0.1 (Avg 0.1)	0,0,0 (Avg 0)	9,18,5 (Avg 10.6)	1.0,1.0,1.0 (Avg 1.0)	0,0,0 (Avg 0)
RTV 739 Black [3]	Dow Corning		0,0,0 (Avg 0)	0.2,0.2,0.2 (Avg 0.2)	0,0,0 (Avg 0)	0,1,10 (Avg 3.6)	1.5,1.3,1.5 (Avg 1.4)	0,0,0 (Avg 0)
RTV 3145 Clear [3]	Dow Corning		9,5,5 (Avg 6.3)	0.5,0.5,0.5 (Avg 0.5)	0,0,0 (Avg 0)	120,131,120 (Avg 123.6)	2.1,2.1,2.0 (Avg 2.1)	0,0,0 (Avg 0)
Pactan 7041 Grey [4]	Tremco Illbruck		0,0,0 (Avg 0)	0.0,0.2,0.0 (Avg 0.1)	0,0,0 (Avg 0)			
Pactan 7042 White [4]	Tremco Illbruck		0,0,0 (Avg 0)	0.0,0.0,0.1 (Avg 0.0)	0,0,0 (Avg 0)			

Table V – Industry Data for Fillet Seal Material Applied to a Non-Metallic Panel

[1] Flat bead, ¼ " wide x 12" long on CDM050-50 flat panel 0.5" thick (2-ply/2-ply phenolic glass with 3 lb density Nomex core, white bondable Tedlar both sides)
[2] Fillet seal in internal corner of CDM050-50 L-joint panel 0.5" thick (2-ply/2-ply phenolic glass with 3 lb density Nomex core, white bondable Tedlar both sides) and tested as shown in Figure V below.
[3] Bead, 3/8" diameter on 3-ply Phenolic laminate 2 ¾" x 10 ½" long.
[4] Fillet seal in internal corner of L-joint panel and tested as shown in Figure VI below.

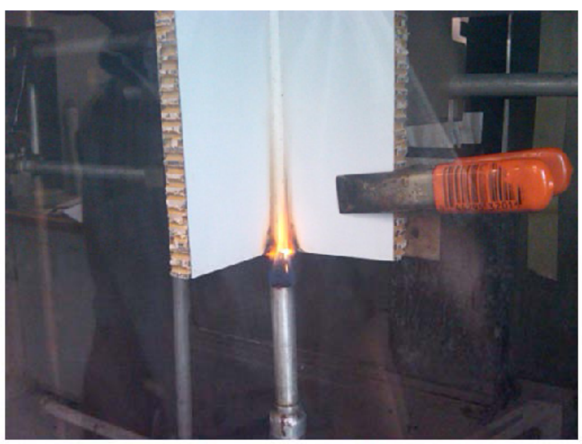

Figure V – Test Setup for Fillet Seal Material Applied to Inside Corner of L-Shaped Non-Metallic Panel

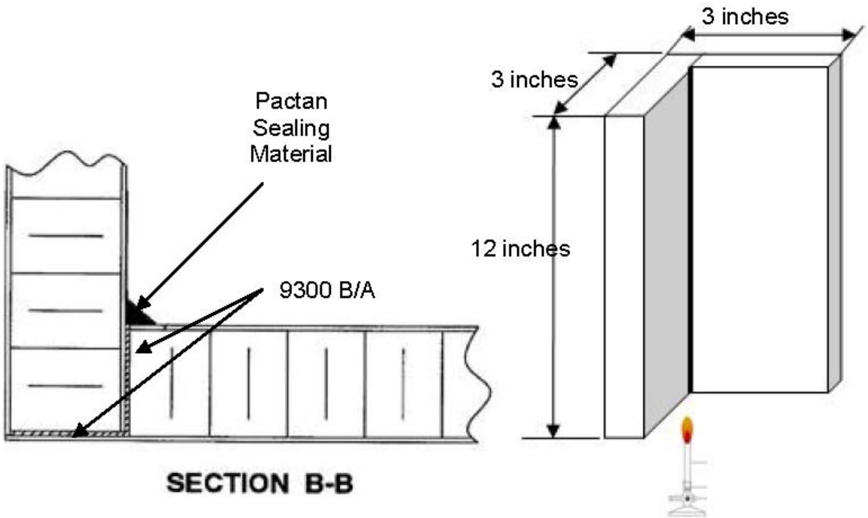

Figure VI – Test Setup for Fillet Seal of Pactan Materials Applied to Inside Corner of L-Shaped Non-Metallic Panel

Product Designation	Manufacturer	Material Applied to an Aluminum Panel						
		15 sec HBB	12 sec VBB			60 sec VBB		
			FET (s)	BL (in)	Drips ET (s)	FET (s)	BL (in)	Drips ET (s)
Polysulfide 1 [1], [2]	PRC-Desoto	1.4"/min [3]						
Polysulfide 1 [1], [2]	PRC-Desoto	1.7"/min [4]						
Polysulfide 1 [1], [2]	PRC-Desoto		86	6.75	ND			
Polysulfide 1 [1], [2]	PRC-Desoto		68	5.0	ND			
Polysulfide 1 [1], [2], [5]	PRC-Desoto		165	10 (Full Burn)	ND			
Polysulfide 1 [1], [2]	PRC-Desoto					74	10 (Full Burn)	ND
Polysulfide 1 [1], [2]	PRC-Desoto					121	10 (Full Burn)	ND
RTV 739 White [6]	Dow Corning		0,0,0 (Avg 0)	0.1,0.1,0.1 (Avg 0.1)	0,0,0 (Avg 0)	5,13,0 (Avg 6)	0.5,0.9,0.5 (Avg 0.6)	0,0,0 (Avg 0)
RTV 739 Black [6]	Dow Corning		0,0,0 (Avg 0)	0.1,0.1,0.1 (Avg 0.1)	0,0,0 (Avg 0)	4,0,0 (Avg 1.3)	1.5,1.5,1.3 (Avg 1.4)	0,0,0 (Avg 0)
RTV 3145 Clear [6]	Dow Corning		7,4,9 (Avg 6.6)	0.5,0.3,0.3 (Avg 0.4)	0,0,0 (Avg 0)	0,23,16 (Avg 13)	2.0,1.8,0.9 (Avg 1.6)	0,0,0 (Avg 0)
Pactan 7041 Grey [7]	Tremco Illbruck		0,8,0 (Avg 2.7)	0.1,0.3,0.1 (Avg 0.2)	0,0,0 (Avg 0)			
Pactan 7042 White [7]	Tremco Illbruck		11,12,13 (Avg 11.6)	0.2,0.2,0.2 (Avg 0.2)	0,0,0 (Avg 0)			
Pactan 7042 Transparent [7]	Tremco Illbruck		10,3,13 (Avg 8.7)	0.2,0.1,0.2 (Avg 0.2)	0,0,0 (Avg 0)			

Table VI – Industry Data for Fillet Seal Material Applied to an Aluminum Panel

[1] Big blob, ~0.5" wide x 0.125" thick applied on 0.060" Aluminum using a duck-billed nozzle (See Figure VII below)
[2] Single specimen recorded.
[3] Single specimen. Flame reached 1.5" mark at 76 seconds. Test stopped after 240 seconds after flame reached 1.5" mark. Burned a total of 7.1" inches.
[4] Single specimen. Test stopped after 240 seconds after flame reached 1.5" mark. Burned a total of 8.3" inches.
[5] Specimen had a smaller bead, ~0.25" x 0.125"
[6] Bead, 3/8" diameter on bare Aluminum panel 3" x 12" x 0.040".
[7] Flat specimen, 3" x 12" x 0.080" applied to Aluminum panel 3" x 12" x 0.080".

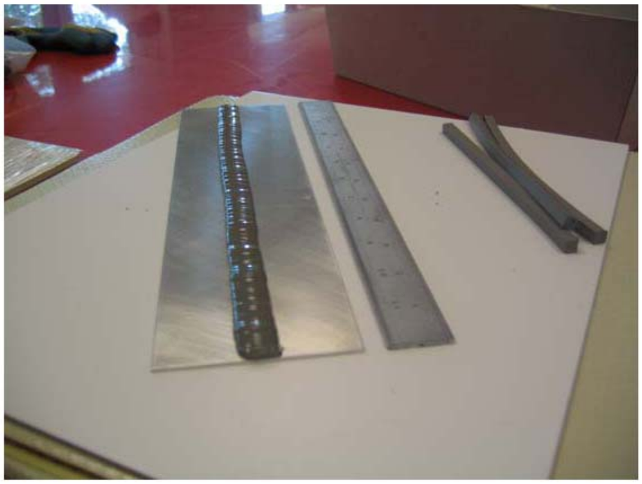

Figure VII – Fillet Seal Material Applied to an Aluminum Panel

5.4 ANALYSIS OF TEST RESULTS

5.4.1 MATERIALS TESTED BY THEMSELVES

Eight RTV silicones and one polysulfide were tested by themselves. Five of those RTV silicones were tested to 15-sec HBB, 12-sec VBB and 60-sec VBB. The other three RTV silicones and the polysulfide were tested to 15-sec HBB and 12-sec VBB. The results showed that:

- All materials met the requirements of the 15-sec HBB test per 14 CFR 25.853(a), Appendix F, Part I, (a)(1)(iv).
- Only two RTV silicones met the requirements of the 12-sec VBB test per 14 CFR 25.853(a), Appendix F, Part I, (a)(1)(ii).
- None of the five RTV silicones tested to 60-sec VBB met the requirements of 14 CFR 25.853(a), Appendix F, Part I, (a)(1)(i).

5.4.2 MATERIALS TESTED ON NON-METALLIC, OSU-COMPLIANT SUBSTRATES

Six RTV silicones were tested on non-metallic, OSU-compliant substrates. Four were tested to both 12-sec VBB and 60-sec VBB. The other two were only tested to 12-sec VBB. The results showed that:

- ⇨ All RTVs met the requirements of the 12-sec VBB test per 14 CFR 25.853(a), Appendix F, Part I, (a)(1)(ii) when tested on an OSU-compliant substrate.
- ⇨ Three of the four RTVs tested to the 60-sec VBB test per 14 CFR 25.853(a), Appendix F, Part I, (a)(1)(i) met the requirements when tested on an OSU-compliant substrate.

5.4.3 MATERIALS TESTED ON ALUMINUM SUBSTRATES

Six RTV silicones and one polysulfide were tested on Aluminum substrates. Three RTV silicones were tested to both 12-sec VBB and 60-sec VBB. The other three were only tested to 12-sec VBB. The polysulfide was tested to 15-sec HBB, 12-sec VBB and 60-sec VBB. Results showed that:

- ⇨ All six RTV silicones met the requirements of the 12-sec VBB test per 14 CFR 25.853(a), Appendix F, Part I, (a)(1)(ii) when tested on an Aluminum substrate.
- ⇨ The three RTV silicones tested to the 60-sec VBB test per 14 CFR 25.853(a), Appendix F, Part I, (a)(1)(i) met the requirements when tested on an Aluminum substrate.
- ⇨ When tested on an Aluminum substrate, the polysulfide met the requirements of the 15-sec HBB test per 14 CFR 25.853(a), Appendix F, Part I, (a)(1)(iv), but did not meet the requirements of the 12-sec VBB test per 14 CFR 25.853(a), Appendix F, Part I, (a)(1)(ii), or of the 60-sec VBB test per 14 CFR 25.853(a), Appendix F, Part I, (a)(1)(i).

5.4.4 SUMMARY

All materials met the requirements of the 15-sec HBB test by themselves. The two RTVs that met the requirements of the 12-sec VBB test by themselves also met the requirements of the 12-sec VBB test and of the 60-sec VBB test, both on OSU-compliant substrates and on Aluminum substrates. However, from the six RTVs that failed the 12-sec VBB test by themselves, three of them met the requirements of the 12-sec VBB test on OSU-compliant substrates, and four of them met the same requirements on Aluminum substrates. In addition, one of the six RTVs that failed the 12-sec VBB test by themselves easily met the requirements of both the 12-sec and 60-sec VBB tests on an Aluminum substrate, but failed the 60-sec VBB test on an OSU-compliant substrate. Table VII below presents the summary of the results:

		Material by Itself			Material on Non-Metallic Panel			Material on Aluminum Panel		
Product Designation	**Manufacturer**	**15 sec HBB**	**12 sec VBB**	**60 sec VBB**	**15 sec HBB**	**12 sec VBB**	**60 sec VBB**	**15 sec HBB**	**12 sec VBB**	**60 sec VBB**
RTV 736 Red	Dow Corning	Pass	Fail	Fail						
RTV 3145 Clear	Dow Corning	Pass	Fail	Fail		Pass	Fail		Pass	Pass
RTV 739 White	Dow Corning	Pass	Pass	Fail		Pass	Pass		Pass	Pass
RTV 739 Black	Dow Corning	Pass	Pass	Fail		Pass	Pass		Pass	Pass
RTV 108 Translucent	Momentive	Pass	Fail	Fail						
Polysulfide 1	PRC-Desoto	Pass	Fail					Pass	Fail	Fail
Pactan 7041 Grey	Tremco Illbruck	Pass	Fail			Pass			Pass	
Pactan 7042 White	Tremco Illbruck	Pass	Fail			Pass			Pass	
Pactan 7042 Transparent	Tremco Illbruck	Pass	Fail						Pass	
RTV 102	Momentive					Pass	Pass			

Table VII – Summary of Results as “Pass/Fail”

6 CONCLUSION

The use of fillet sealing in aircraft interiors is a well-established industry practice. The resin family most commonly used for fillet sealing of aircraft interiors is silicone. Within the silicone family, the material most commonly used for fillet sealing aircraft interiors is RTV (Room Temperature Vulcanizing) silicone. Industry has typically evaluated parts constructed in whole or in part of elastomeric materials using the15-sec HBB - 2.5 in /min burn rate requirements of Appendix F Part 1(a)(1)(iv).

With that in mind, the industry team proposed to validate the MOC of “No test requirement” for 25.853(a) for any silicone material that could be used for fillet sealing aircraft interiors. The team intended to produce 15-sec HBB and 12 and 60-sec VBB data for RTV silicones. The RTV silicones selected for this evaluation are currently being used by the industry and are considered to be ‘state-of-the-art’ materials.

At the same time, a few other types of sealant materials were also evaluated that are used in the airframe structure for corrosion and environmental sealing. It was decided to test one polysulfide sealant on an aluminum panel for comparison purposes, but not to test materials from the other resin families.

Test results confirmed the collective experience of the industry team. The RTVs most commonly used today for fillet sealing aircraft interiors consistently pass the 15-sec HBB test by themselves, and a few of those can also pass the 12-sec VBB test by themselves. As of today, there are no known RTV silicones that will pass the 60-sec VBB test by themselves while still meeting all the other requirements for fillet sealing aircraft interiors (eg. adhesion, colour, elongation, chemical resistance, fungus/bacteria resistance, etc).

The data also showed that RTVs that met the requirements of the 12-sec VBB test by themselves also met the requirements of the 12-sec VBB test and of the 60-sec VBB test, both on OSU-compliant substrates and on Aluminum substrates. The reverse, however, could not be shown. Some RTVs passed the 12-sec VBB test on OSU-compliant substrates and/or on Aluminum substrates, but could not pass it by themselves. And in at least one case, an RTV passed the 60-sec VBB test on an Aluminum substrate, but could not pass it on an OSU-compliant substrate.

Based on the above, and the fact that the fire impact of these materials in their small quantity does not adversely impact the fire safety of the aircraft, the industry team proposes a “ No Test Requirement” MOC in Table VIII below for 25.853(a) for sealants to be used for fillet sealing of aircraft interiors.

Reference Number	Feature/ Construction	25.853(a) Bunsen Burner Test Requirements/Similarity	25.853(d) Heat Release Requirements/ Similarity
44	Sealant used for fillet sealing of aircraft interiors	No Test Requirement	No test requirement.

Figure VIII – Reference Item 44 - MOC

The industry team believes that the data presented substantiates this MOC for 14 CFR 25.853(a) for sealants to be used for fillet sealing of aircraft interiors, and requests that it be moved to Part 1.

7 ABBREVIATIONS

FAA	=	Federal Aviation Administration
MOC	=	Method of Compliance
CFR	=	Code of Federal Regulations
TBD	=	To Be Determined
AC	=	Advisory Circular
MCC	=	Microscale Combustion Calorimetry
HBB	=	Horizontal Bunsen Burner Test per FAR 25.853(a) and App F, Part I
VBB	=	Vertical Bunsen Burner Test per FAR 25.853(a) and App F, Part I
HRR	=	Heat Release Rate Test per FAR 25.853(d), App F, Part IV
SD	=	Smoke Density Test per FAR 25.853(d), App F, Part V
FET	=	Flame Extinguishing Time
BL	=	Burn Length
ET	=	Extinguishing Time
ND	=	No Drips

8 REFERENCES

[1] Gardlin, Jeff, FAA Memorandum, ANM-115-09-XXX, Policy Statement on Flammability Testing of interior Materials, Department of Transportation, Federal Aviation Administration, August 2009

[2] FAA Handbook, FAA Technical Center, Report DOT/FAA/AR-00/42, Aircraft Materials Fire Test Handbook, April 2000