RTCA Development of a New Flammability Test for Electronic Equipment

DO-160 Section 26, Category C

Task Group History & Decision Point

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Purpose

- **The purpose of this briefing is two-fold:**
  - provide an overview of the 10-year development of a *new, alternative* flammability test for electronic equipment;
  - then decide if this new test task is still worth pursuing

  (i.e., is the new alternate method better and/or needed than what is currently in use?)

RTCA DO-160G » DO-160H

- DO-160G contains the international standard for environmental testing of commercial avionics
- Section 26, Category C defines the flammability testing requirements for electronic housings and component parts
- In 2009, there was interest in developing alternative that would allow testing the enclosure whole to certify electronic equipment for flammability.

Current Standards (DO-160G)

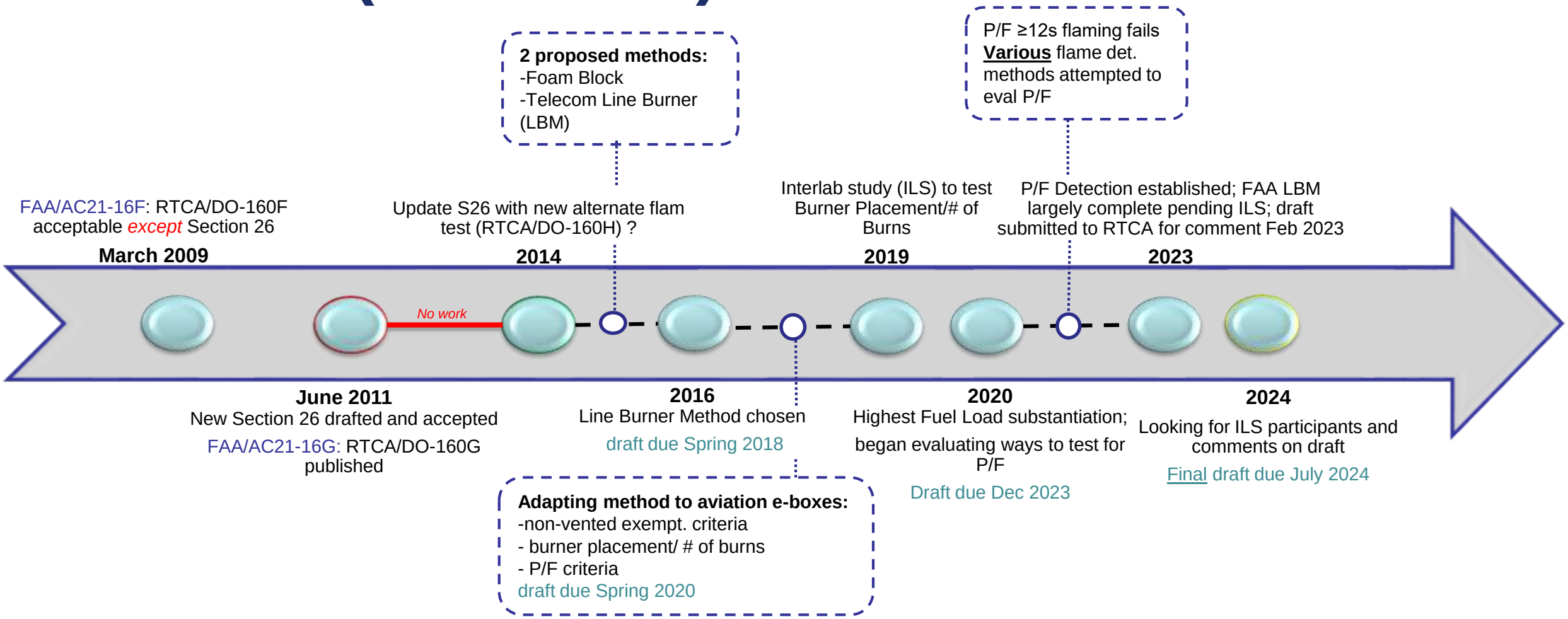
- Electronic equipment must be broken down into its individual parts and tested using the following FAA Fire Test Handbook procedures:

Table 26-2 Type of Test Determination

Components	Method	Paragraph
All materials other than rubber or elastomer parts, wire and cable	Vertical 12 second bunsen burner test	26.6.2
Rubber or elastomer parts	Horizontal bunsen burner test	26.6.3
Wire and cable	60 degree bunsen burner test	26.6.4

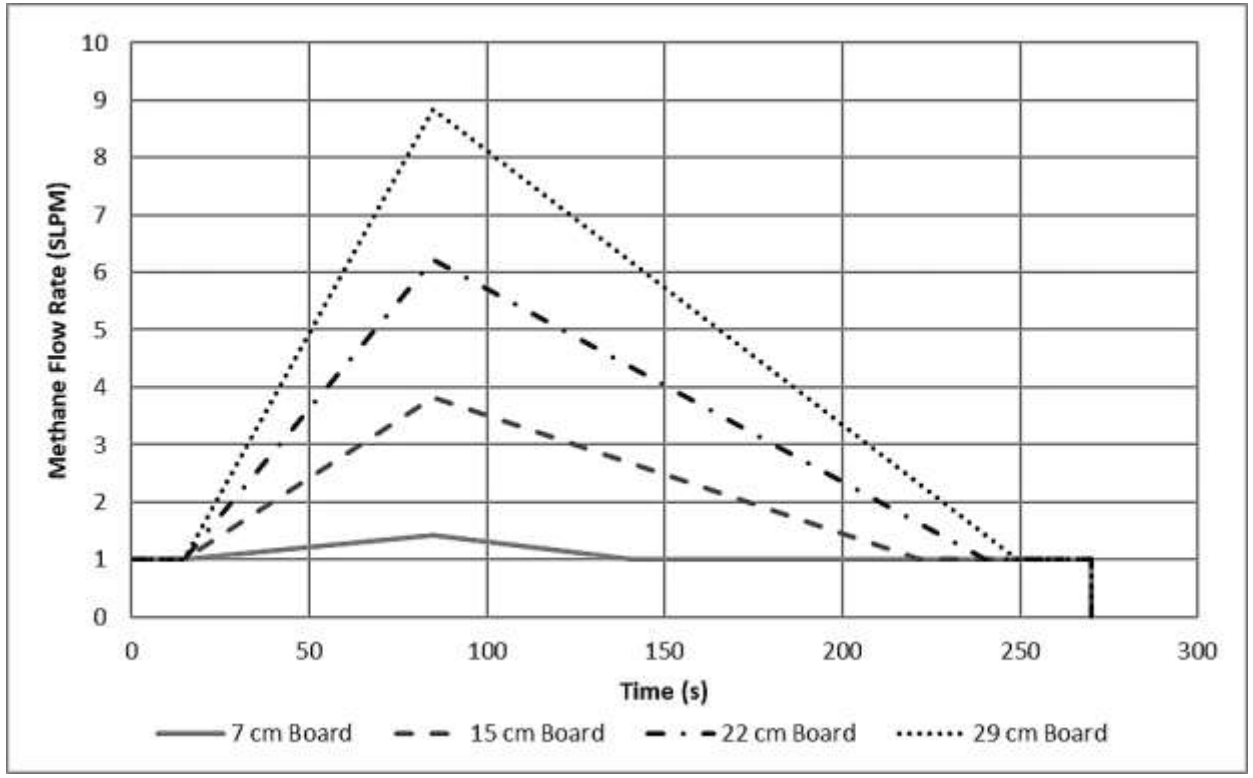
- Certain parts may be test-exempt via small part exemption

Timeline (2009-2024)



New Test Method: Programmable Line Burner

- Based on telecom industry test ANSI T1.319
- 3/8” stainless steel tube with (11) 7/64” holes places 1/2” apart
- Methane Fuel with variable flow rate controlled by computer program
- Flow rate based on circuit board of certain size burning to completion
- Burner holes can be covered for smaller box or lower flow rates



Test Procedure

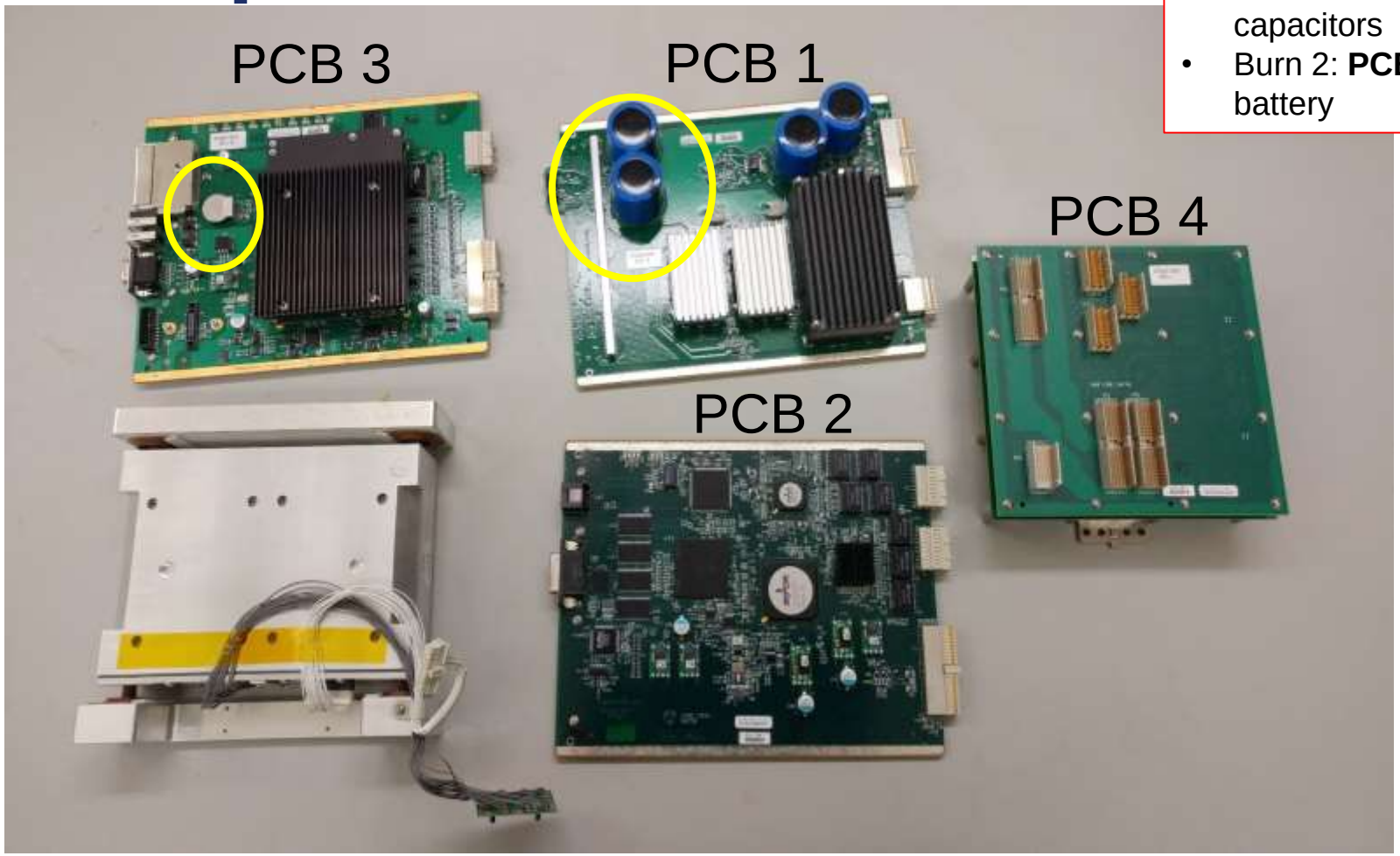
1. Identify printed circuit board (PCB) or other part with the highest fuel load (HFL)
2. Remove adjacent PCB and the burner is to be placed in the same general location aimed 45° towards HFL PCB to be tested
3. Drill 0.75” hole into enclosure to insert burner
4. Insert lit burner into enclosure and immediately start 270s burner program (flow rate based on circuit board of certain size burning to completion next to HFL)
5. Evaluate based on pass/fail criteria (pass if <12 seconds of cumulative flaming outside enclosure)

More Test Details

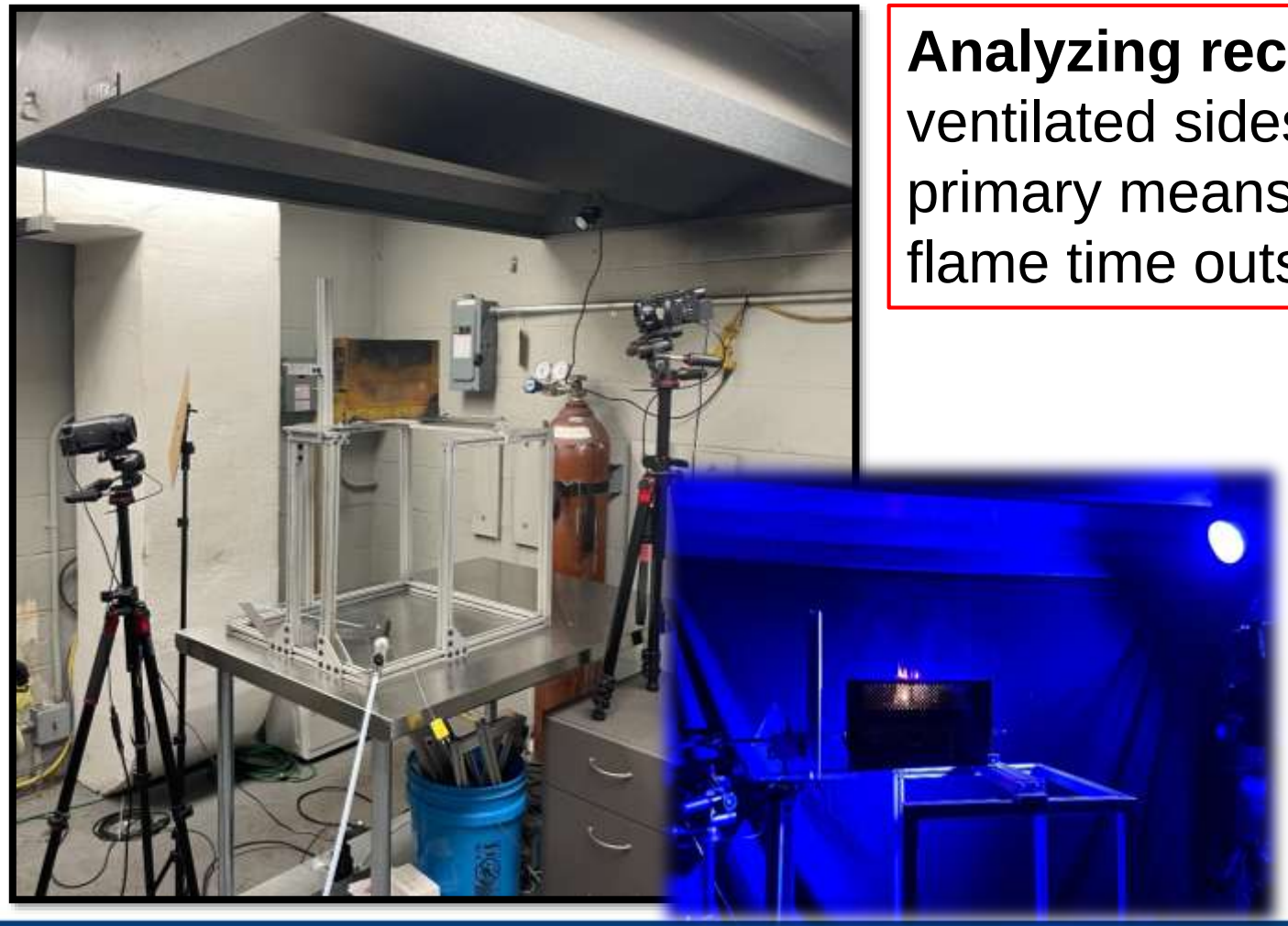
- **Test specimens** = representative of production units; powered on if assembly contains fans
- **Similarity/Substantiation:** the PCB/part with the highest fuel load can be used to substantiate PCB/part (w/in same enclosure design) with a lower fuel load.
- **Multiple burn tests** within the same unit may be required with the burner in different locations to help characterize the potential hazards.
- If ignition of the line **burner is not sustained** by procedure and following corrective action steps, the enclosure is a low flammability hazard (passes test).

Test Example

- Likely need **<u>two burns</u>** to substantiate this equipment
- Burn 1: **PCB 1** due to large capacitors
- Burn 2: **PCB 3** due to lithium battery



P/F: Camera/Blue LED System (Flame Detection)



Analyzing recorded test videos of all ventilated sides of the enclosure is the primary means of defining the cumulative flame time outside of the enclosure

Minimum Camera requirements:

- 1080-pixel resolution
- 30 frames per second (fps)
- field-of-view (FOV) of 90 degrees
- Color quality must closely match actual color condition seen by human eye (webcams not recommended for this reason)

Lighting Requirements:

- blue (450-495nm range) LED
- minimum of 2000 lumen (typically 27W LED)
- Test facility must otherwise be completely dark

Difficulties of Testing Aircraft Electronics

- **Various current methods used to certify flammability, not all approved by FAA.**
  - Foam block inserted in test unit
  - FAA VBB* test used but “creative” ways to make the 3”x12” sample. PCBs not tested as constructed within a production unit.
  - Major use of small parts exemption
- **FAA VBB does not describe** how to test electronic equipment samples
  - Sample face is non-uniform. No guidance on how to create 3”x12” sample.
- **Small Part Exemption:** No specific procedure given for small parts located close together; just “consideration must be given”.
- **Non-Vented Test Exemption:** “non-vented” is not fully defined.
- **No standard current method to accurately compare the cost-benefit of proposed alternate method.**

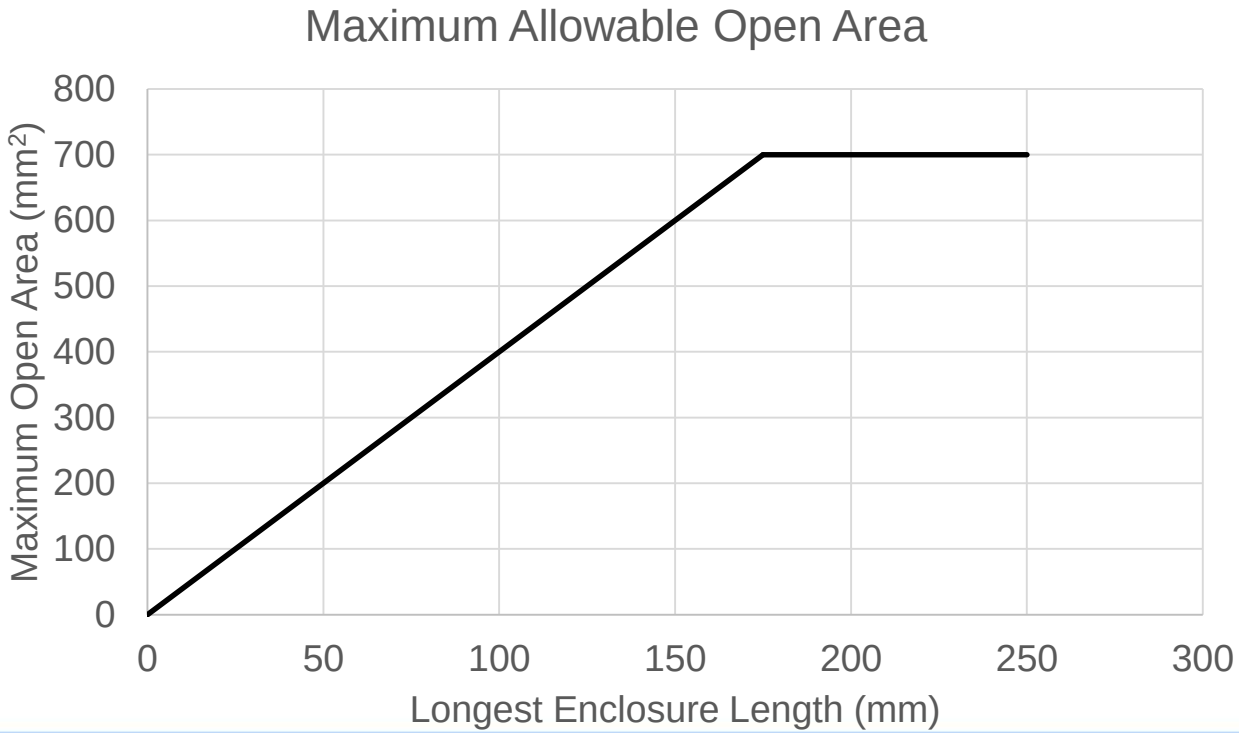
**FAA VBB = FAA Fire Test Handbook Vertical Bunsen Burner Test*

Shortfalls of Proposed New Test

- Burning an enclosure whole would potentially be **more costly** than individually testing stock components that go into an enclosure.
- Burning an enclosure whole offers **no traceability** to the problematic/flammable component.
- Most avionics PCBs are **already UL94-V0** rated/coated with fire retardant
  - Tested actual avionics PCBs and none of the boards caused flaming outside the enclosure.
- Need to **address** what to do if a component within an **enclosure changes** – retest?
- "Highest Fuel Load" PCB to test can be **highly subjective**.
  - New test allows for **multiple burns** if unsure of highest fuel load/threat
    - Issue: If more than one burn, the other components in the enclosure are subjected to heat/flame – **next sample(s) become tainted**.

“Non-Vented” Definition Added to Test Exemption Criteria (DO-160H)

Based on testing, an enclosure is considered to have no ventilation if **the total open area, A (in mm^2), is less than 4 times the longest outside dimension, L (in mm), ($A < 4 \times L$) up to a maximum of 700 mm^2**. Total open area is any open area on the enclosure that air can flow through, including but not limited to vent holes and worse-case scenario design tolerance gaps.



Only consider open area of the unit in its installed state.

(i.e., exclude screw holes/mounting slots/cable passthroughs, connections)

Summary & Decision Point

- There has been a severe lack of interest in developing a new test method for Section 26(C) over the last 10 years
- Current DO-160 referenced FAA fire test methods are not well-defined for aircraft electronic equipment (PCBs), causing variability of flammability certification techniques among aircraft electronics manufacturers.
- Proposed alternate test method still has gaps/uncertainties that can only be addressed with outside input/ILS participation.
- As of now the FAA will not be able to endorse the new method for inclusion into DO-160H Section 26 by the July 2024 deadline.

Where do we go from here?

If We Continue this Test Method:

- **Interlaboratory Study is ready for participants.**
- **FAA will supply identical LRU-type boxes and fuel sample materials.**

Thank you, Questions?

- **Contact Information:**

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