RTCA Development of a New Flammability Test for Electronic Boxes

Presented to: International Aircraft Materials Fire Test Forum
By: Steve Rehn
Date: 6/6/2018

Introduction

- **Working on new method to fire test electronic boxes whole, rather than test individual components in Bunsen burner**
- **Test method based on Telecom Industry test ANSI T1.319**
- **Will be added to RTCA-DO160H**
  - Draft due to committee in Spring 2020
- **Focused on refining test method**
- **Since the last meeting:**
  - Changes to draft test method
  - Another scenario for testing air flow limits
  - Proposed example drawings

Programmable Line Burner

- 3/8” stainless steel tube with (11) 5/16” holes places 1/2” apart
- Methane Fuel with variable flow rate controlled by computer program
- Burner holes can be covered for smaller box or lower flow rates

Changes to Draft Test Method

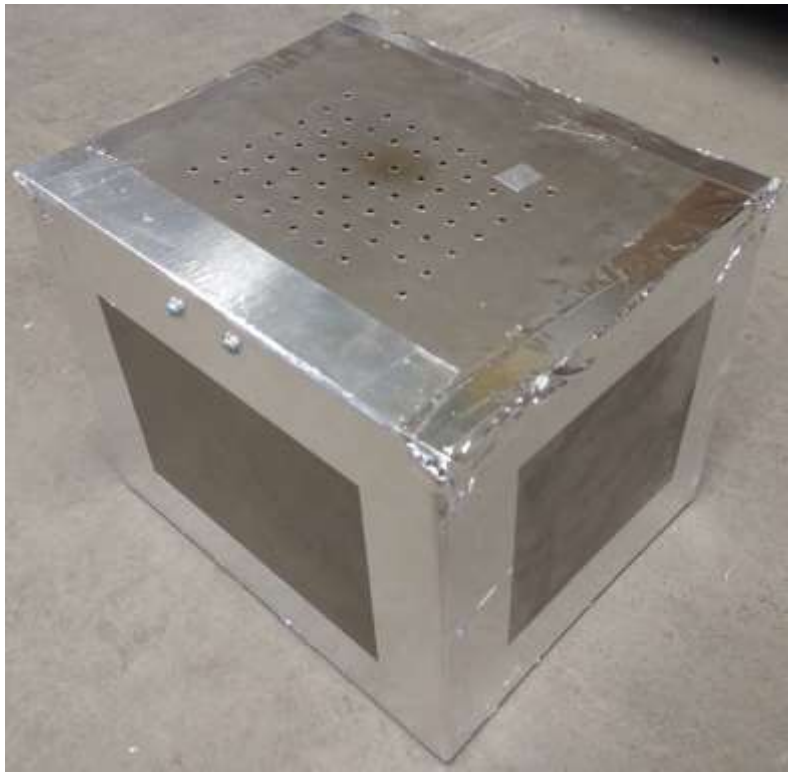
- **Added that boxes with small weep holes that are otherwise unvented would not need to be tested**
- **Added more details to the methane gas flow rate calculation that were previously missing**
- **Changed the methane flow rate for horizontal circuit boards to be the same as vertical**
- **Added that capacitors could be the highest concentration of fuel load in an enclosure**
- **Added that line burner must be placed within 0.375 inch of the vertical PCB or fuel load being tested**

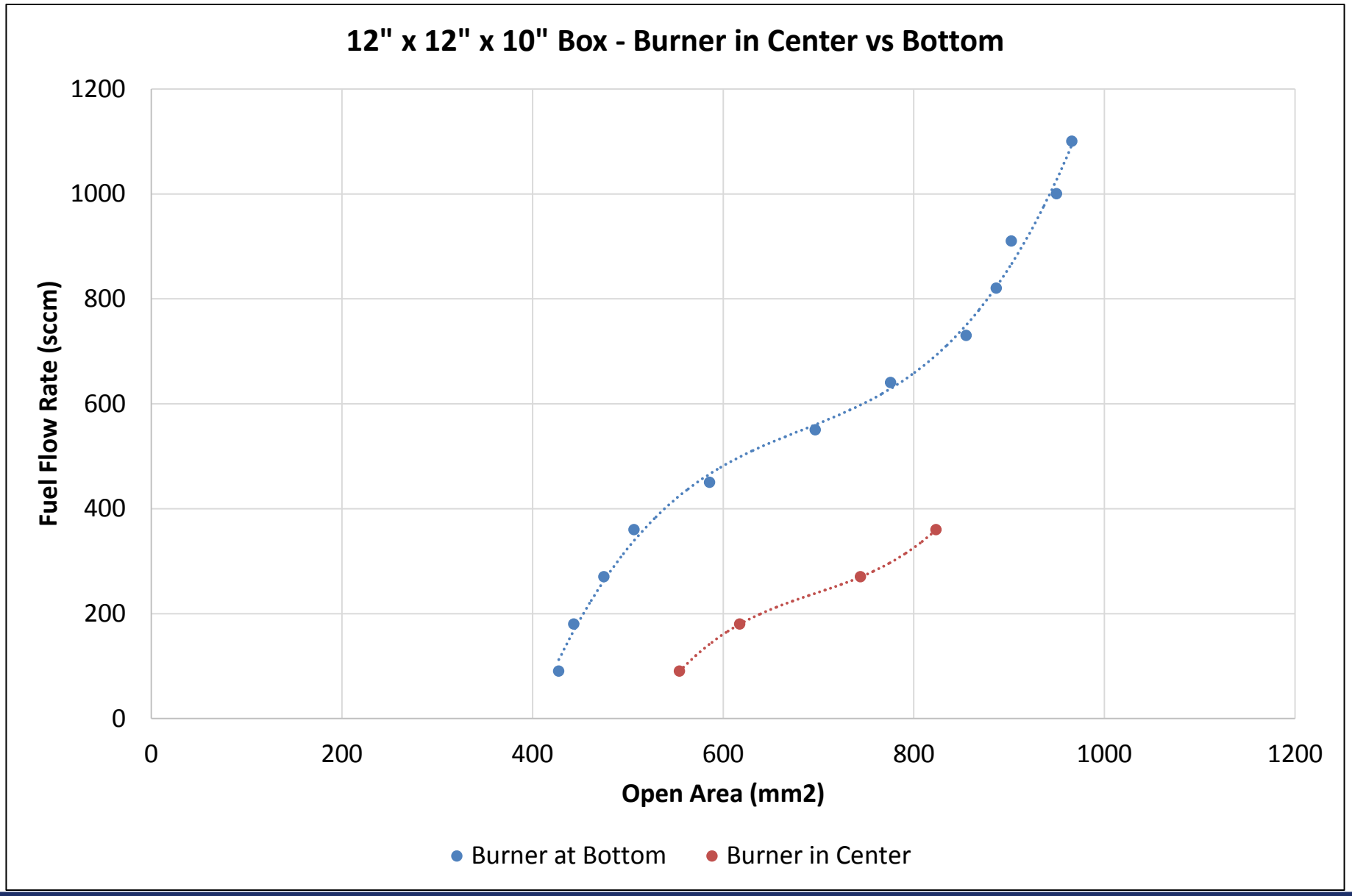
Airflow Limit Testing

- **Goal is to determine which box designs will not need to be tested because they don't allow enough airflow to sustain a flame**
- **Started with 90 sccm methane flame with one burner hole opened and increased up to 1000 sccm**
- **Started with air-tight box, drilled 1/8" holes until it could sustain a flame, then increase fuel flow rate and repeat**
- **Tested different box sizes, air hole patterns, and burner locations to be sure to find the absolute minimum**

Airflow Limit Testing

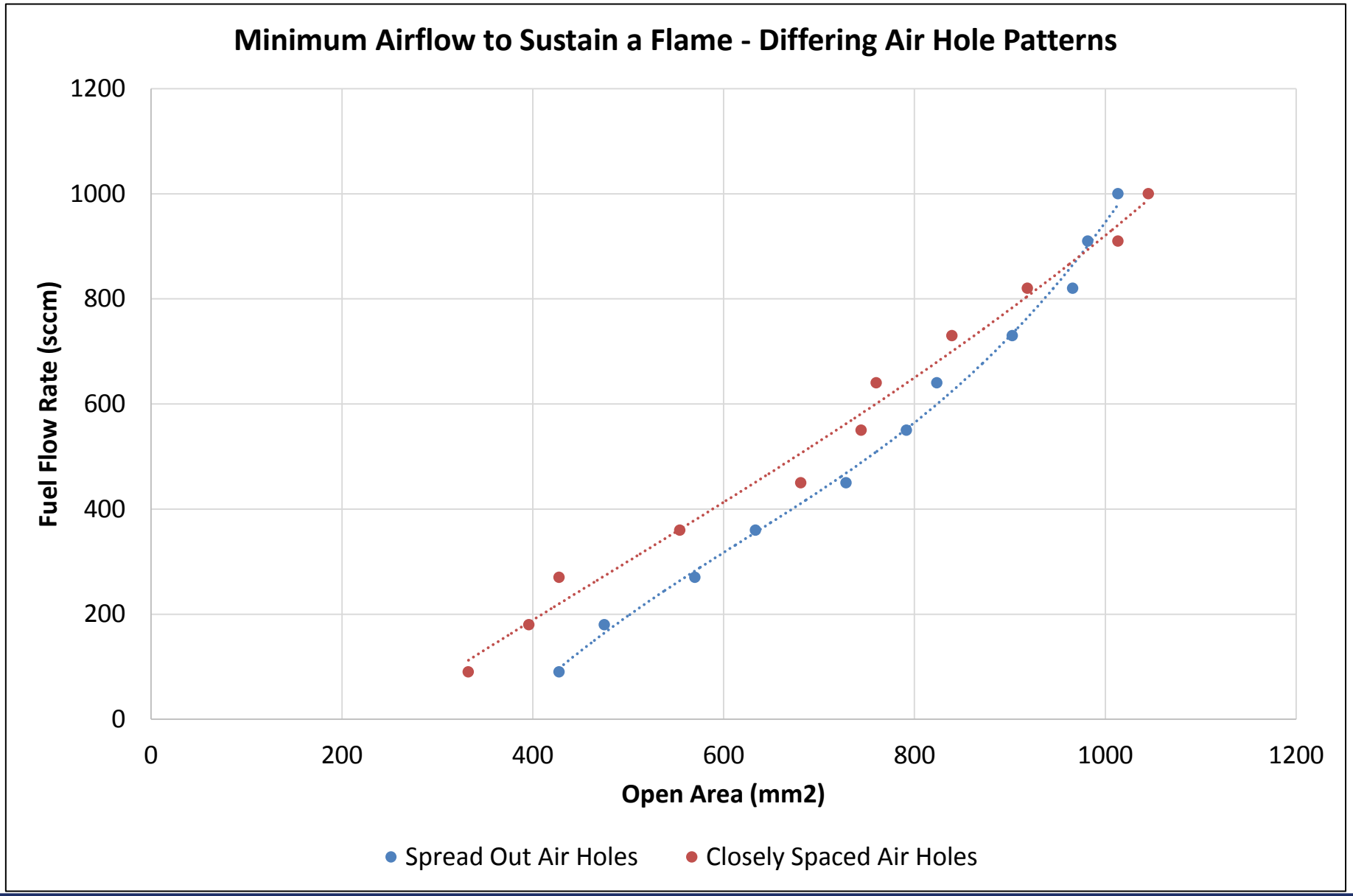
- 12” × 12” × 10” Box
- Tested with burner inserted into the center of the box
- Burner was previously placed at the bottom




12" x 12" x 10" Box - Burner in Center vs Bottom
Fuel Flow Rate (sccm)
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
Open Area (mm2)
Burner at Bottom
Burner in Center

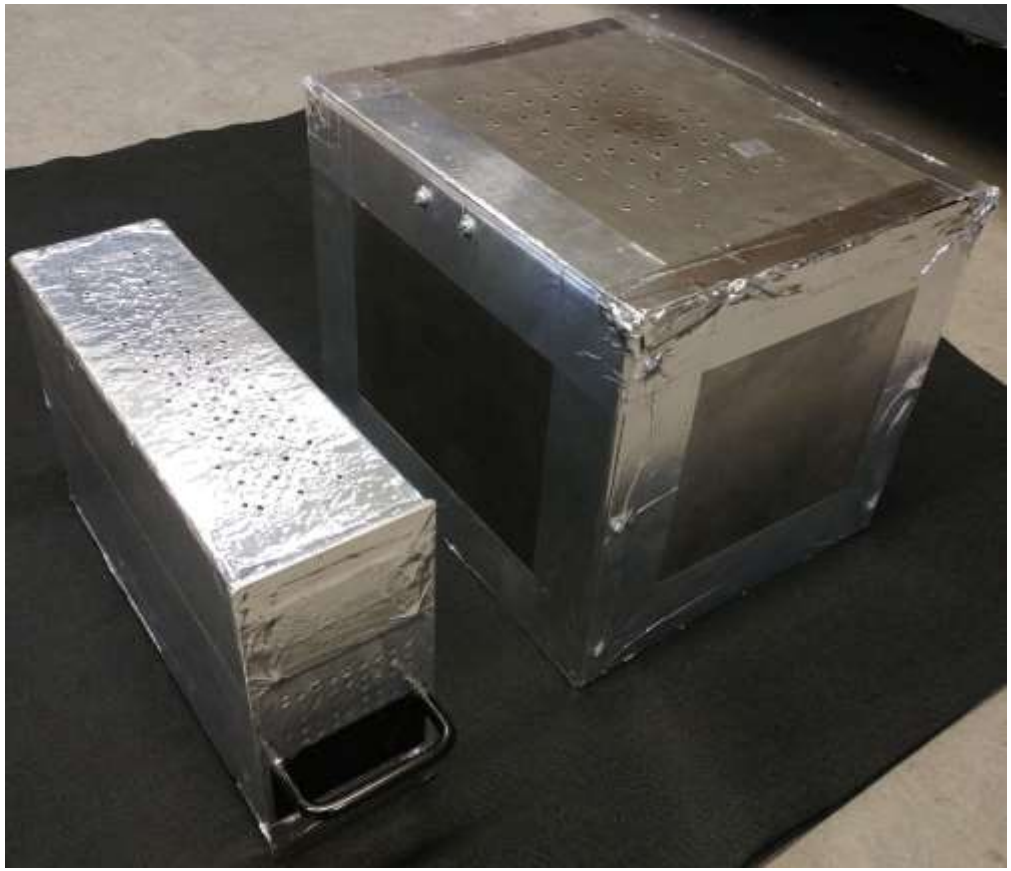
Airflow Limit Testing

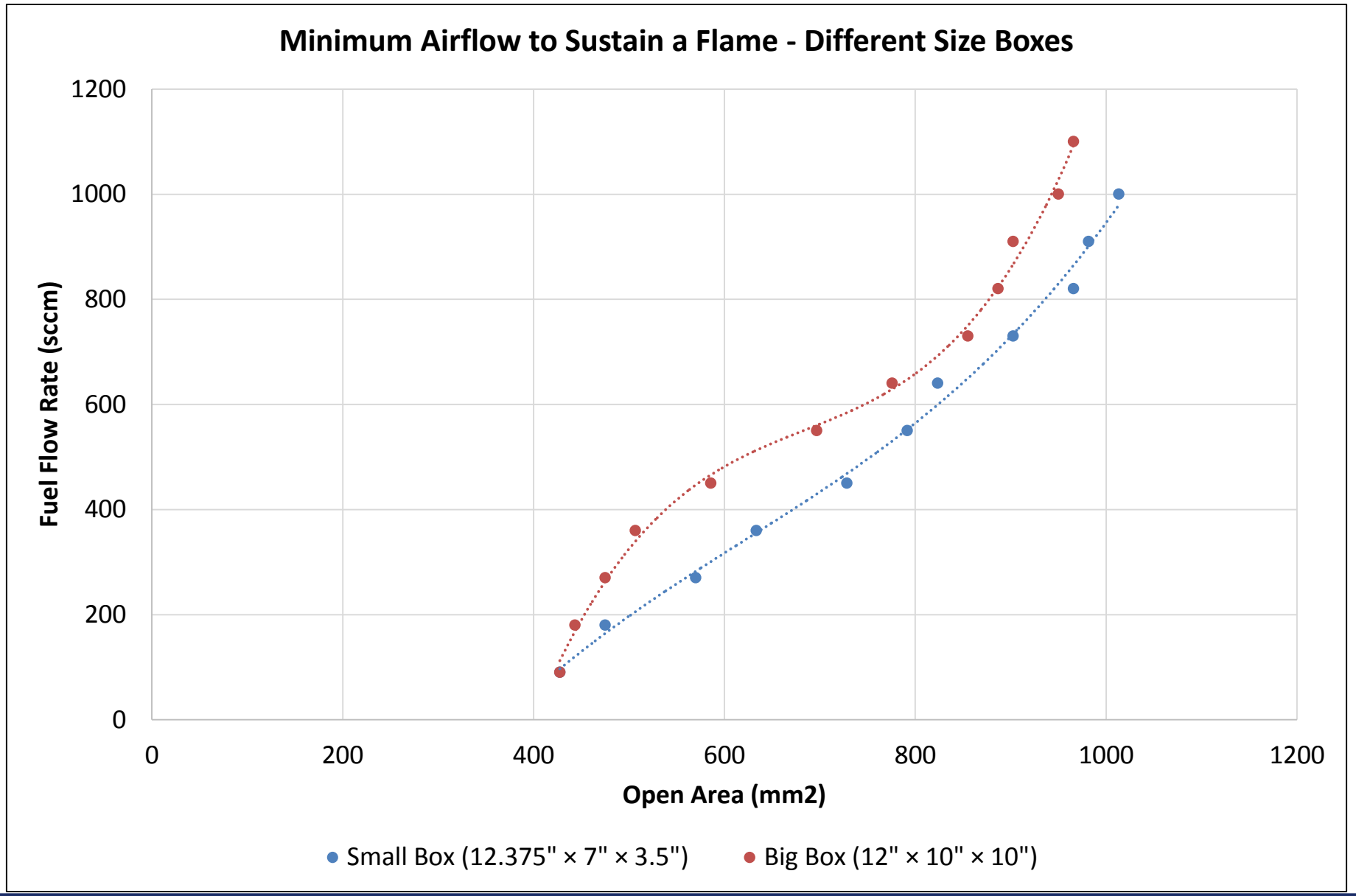
- **12.375” × 7” × 3.5” box**
- **Equal number of air holes on top and bottom**
- **Compared spread out vs bunched together**

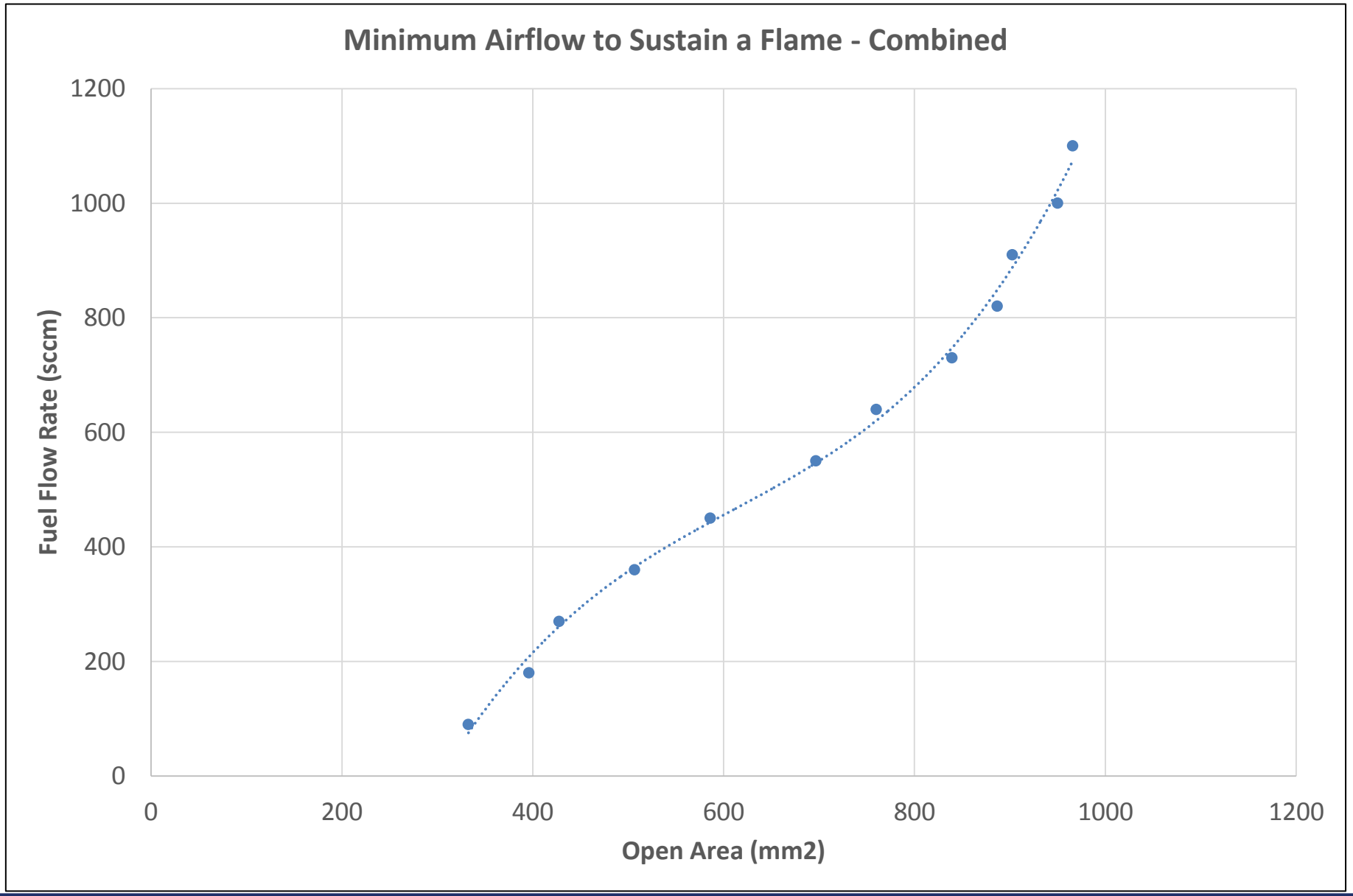

Minimum Airflow to Sustain a Flame - Differing Air Hole Patterns
Fuel Flow Rate (sccm)
0
200
400
600
800
1000
1200
Open Area (mm2)
0
200
400
600
800
1000
1200
Spread Out Air Holes
Closely Spaced Air Holes

Airflow Limit Testing

- **12.375” × 7” × 3.5” (303 in^3)**
- **12” × 10” × 10” (1200 in^3)**
- **Air holes spread out on both**




Minimum Airflow to Sustain a Flame - Different Size Boxes
Fuel Flow Rate (sccm)
0
200
400
600
800
1000
1200
Open Area (mm2)
0
200
400
600
800
1000
1200
Small Box (12.375" × 7" × 3.5")
Big Box (12" × 10" × 10")


Minimum Airflow to Sustain a Flame - Combined
Fuel Flow Rate (sccm)
0
200
400
600
800
1000
1200
Open Area (mm2)
0
200
400
600
800
1000
1200

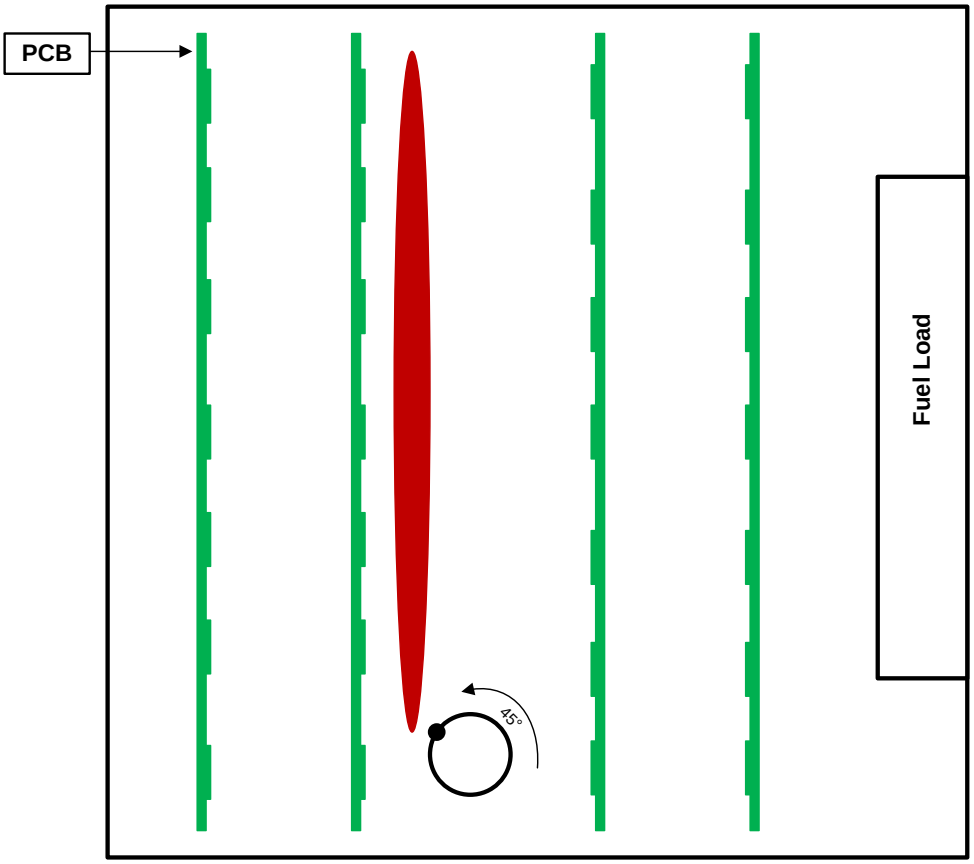
Airflow Limit Testing

- **Could add section to test method describing which boxes will not need to be tested**
- **Make a straight line just to the left of previous graph (to simplify and add a safety factor) to define minimum ventilation required in order for a test to go forward**
- **Smaller boxes that can not fit the entire burner will have lower limits because they use a lower fuel flow rate**
- **Any box with an open area less than the defined number for a given initial flow rate will not need to be tested**

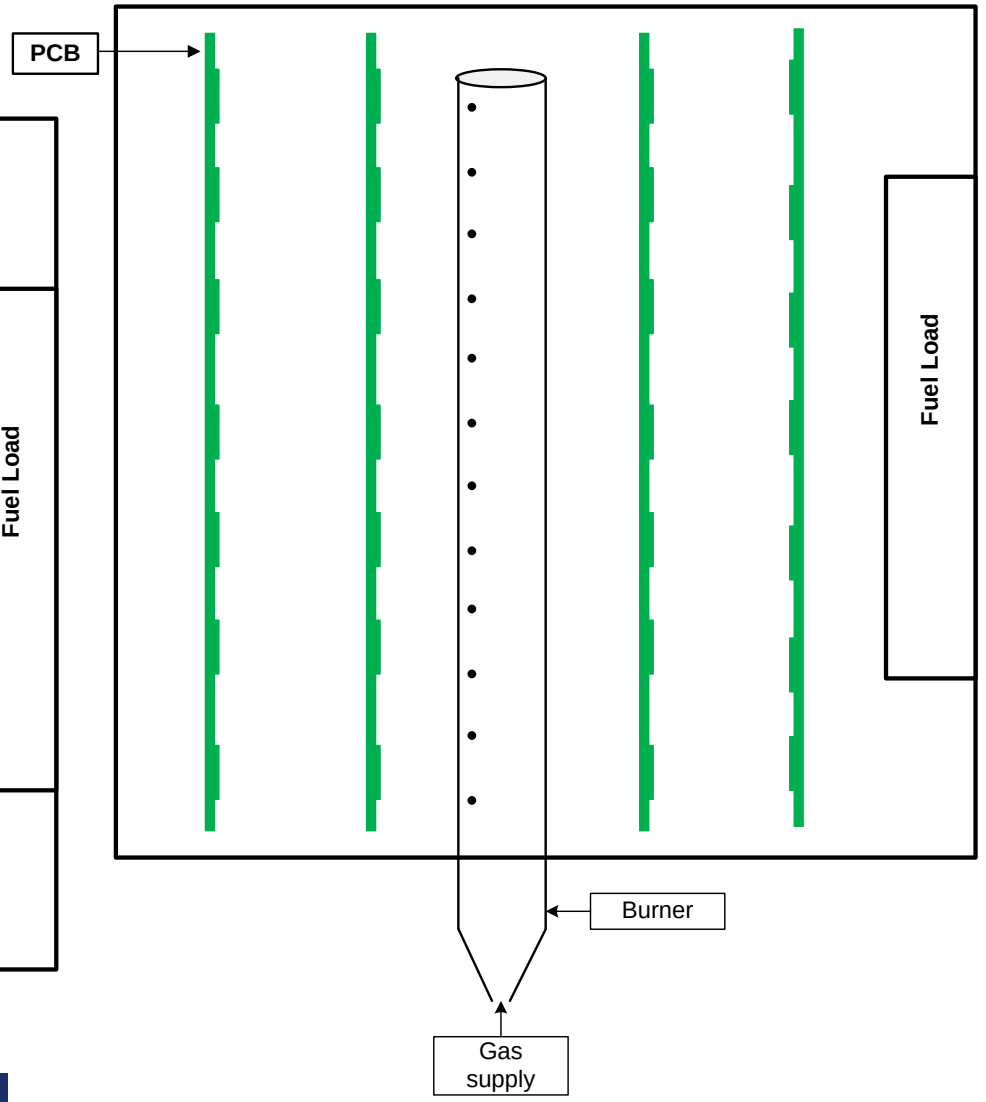
Proposed Drawings

- **Proposed by Alan Thompson from Element**
- **Thousands of possible configurations so we need basic guidance that can apply to many scenarios**

Proposed Drawings

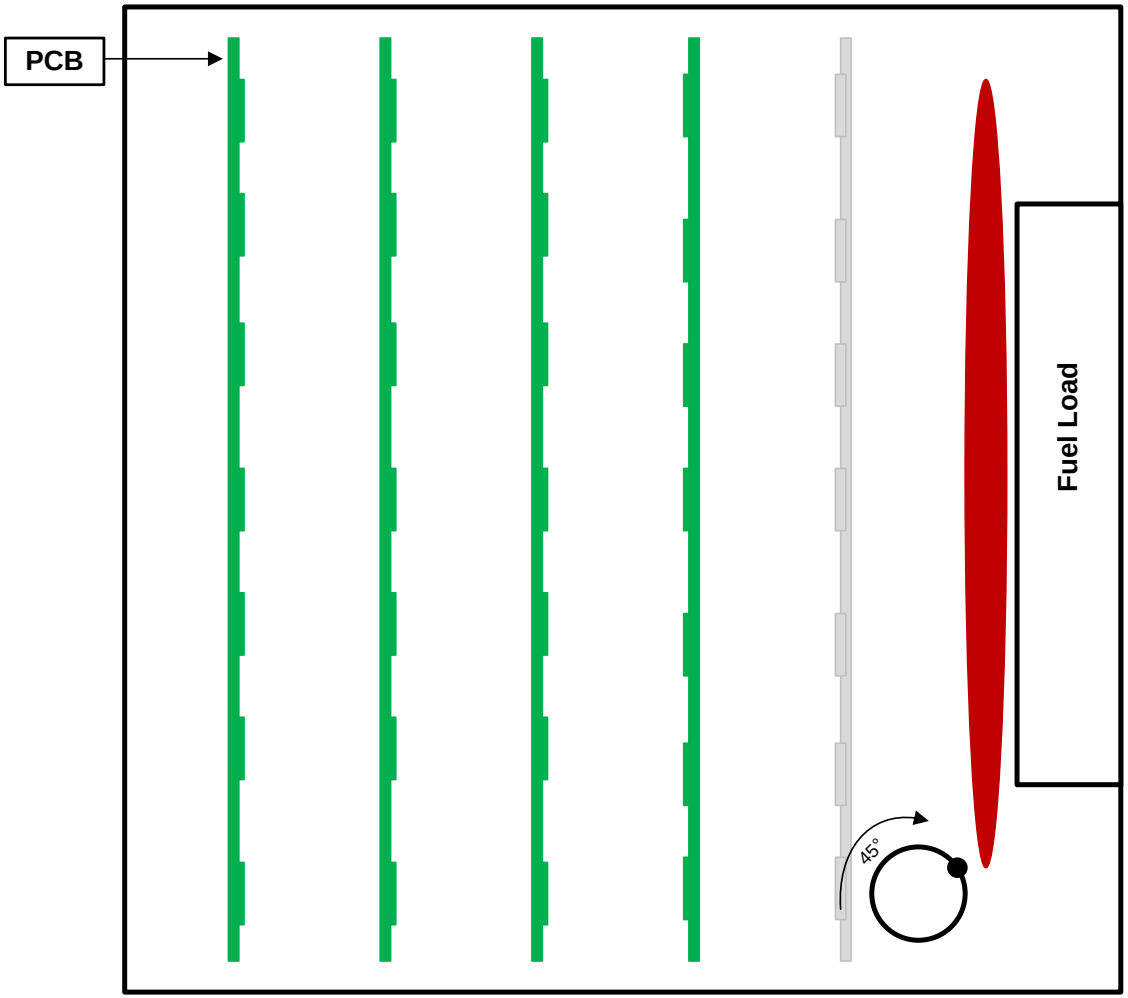


Front View
Position 1: Remove PCB near center of electronic box



Top View
Position 1: Remove PCB near center of electronic box

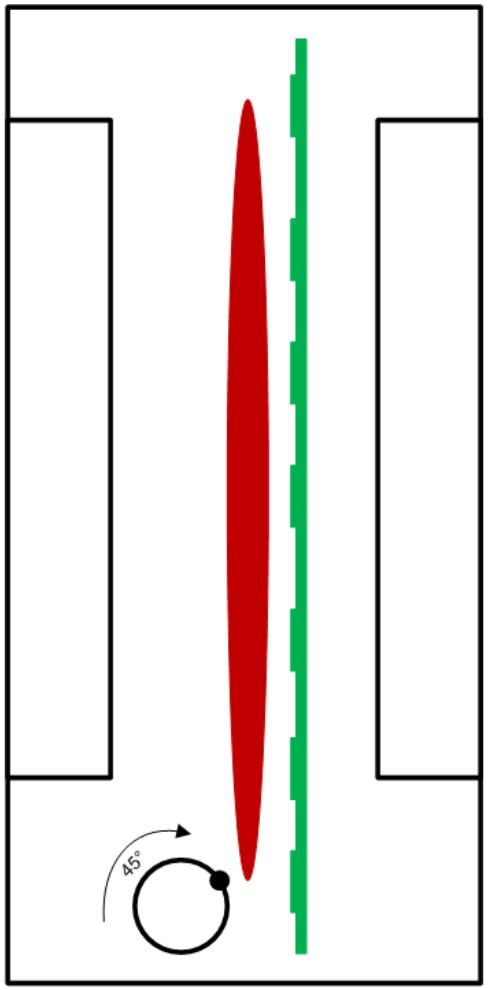
Proposed Drawings



Front View
Position 2: Remove PCB near fuel load (wire bundles, capacitors, etc.)

- 2nd burn in same box

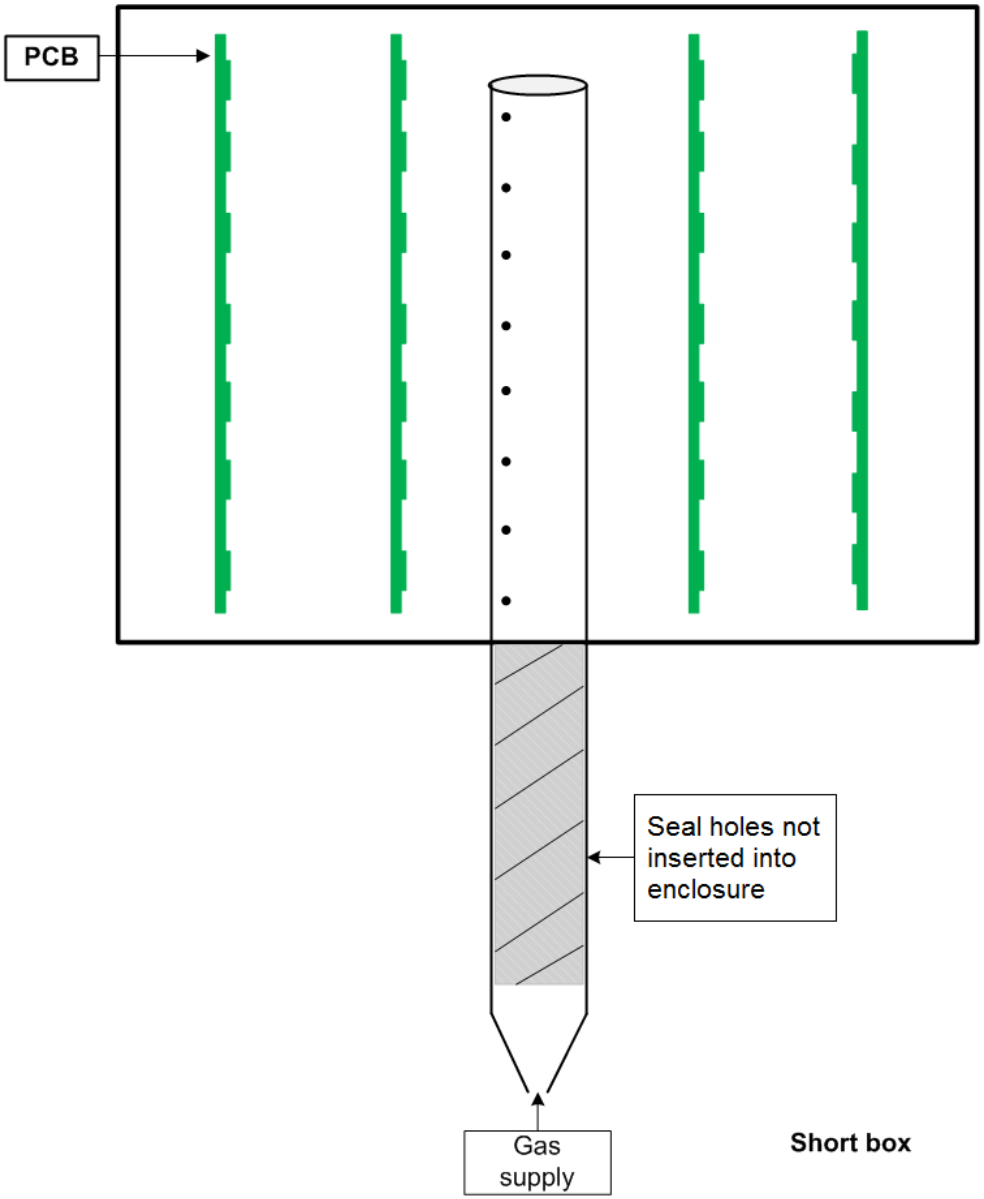
Proposed Drawings



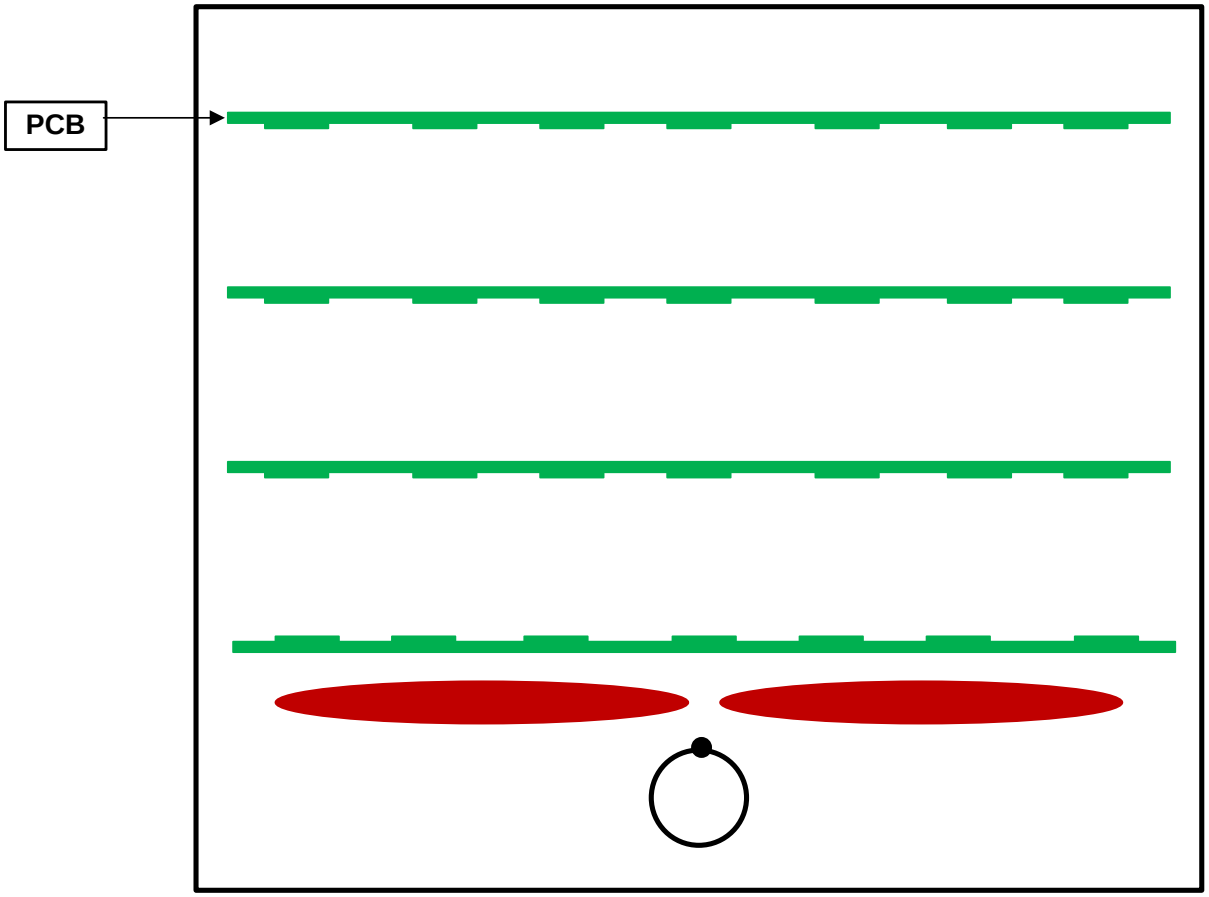
Single PCB

- Do not remove PCB when testing box with single PCB
- If burner can't fit, must be tested using current Bunsen Burner method

Proposed Drawings



Proposed Drawings



- Box with horizontal PCBs

Remove lowest PCB and insert burner centrally in electrical box

Pass/Fail Criteria

- **Discussion at last meeting to place material above the box being tested, and if that material ignites, it is a failure**
- **The problem is finding a material that will always be the same and obtaining it years into the future**
- **It also can't be too difficult or easy to ignite**
- **Another idea is to place a heat flux gauge above the box and define a value that would be considered a failure**
  - Lots of testing would need to be done to validate

Future Work and Discussions

- **Pass/Fail criteria**
  - Can we find a reliable material?
  - Use heat flux gauge?
- **Discuss limits on boxes that do not need to be tested**
  - Does more testing need to be done?
- **Example drawings**
  - Changes/Additions

Questions?

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