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Round-Robin Comparison of Heat Release Apparatus

Richard M. Johnson

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| 16. Abstract A series of 150 comparative tests were run by four currently operating laboratories using heat release apparatuses compliant with present FAA/JAR standards and the ATi-Russian Institute of Aviatric. Materials (VIAM) designed heat release apparatus. The evaluation of data showed little or no correlation between the subject apparatus and the four compliant apparatuses. | | | | | |
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EXECUTIVE SUMMARY

A comparison was made between data produced by heat release apparatus compliant with present FAA/JAA standards and data produced by a heat release apparatus designed and used by the All-Russian Institute of Aviation Materials (VIAM). Results show little or no correlation between the two.

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PURPOSE

The purpose of this test program was to compare heat release data obtained in an apparatus developed and used by the All-Russian Institute of Aviation Materials (VIAM) with results obtained from the modified Ohio State University (OSU) apparatus presently required by Federal Aviation Administration/Joint Aviation Authorities (FAA/JAA) standards.

BACKGROUND

The United States and Russia are presently evaluating each others Aircraft Certification System with the intent of implementing a Bilateral Airworthiness Agreement. As part of this evaluation, comparisons have been made between Russian and FAA/JAA flammability and smoke test methods. While in most areas the Russian test method is similar, using the same test apparatus as the FAA/JAA requirements, but that is not the case in heat release.

VIAM uses a heat release device designed and constructed locally. Although the apparatus operates similar to the Ohio State University (OSU) Heat Release Apparatus (the unit specified by the FAA/JAA) there are some major differences. Among them are (1) A smaller sample; (2) Different size and shape of the chamber; (3) No holding chamber; (4) Different thermopile pattern; and (5) Different airflow through the chamber.

DISCUSSION

In order to evaluate the reproducibility (the ability to obtain similar results as other laboratories) and repeatability (the ability to obtain consistent results) of the VIAM apparatus as compared to the OSU apparatus, as required by the FAA/JAA, a round-robin test series was undertaken. Four laboratories presently found acceptable for testing aircraft materials using an OSU apparatus in accordance with the Aircraft Material Fire Test Handbook (DOT/FAA/CT-89/15) participated in the program. These laboratories represent a cross section of those presently utilizing the OSU apparatus and are listed as Lab A, B, C, and D in this report. VIAM is listed as Lab E.

The materials utilized in the test program were selected to represent the wide range of materials used in aircraft interiors. Table 1 lists the ten materials tested. Each lab was sent four samples of each material, three for testing and a spare if needed. Tests were performed in accordance with the labs standard operating procedures. Results for both the total heat release at two minutes and the peak heat release rate were reported (both criteria are specified in the FAA/JAA requirements).

SUMMARY OF RESULTS

1. The correlation of data between the OSU and VIAM Heat Release apparatus was very poor.
2. The repeatability of the VIAM Heat Release Apparatus was two to three times worse than the OSU apparatus.
3. One lab, operating an OSU, produced low values of the total heat release at two minutes. (Problems are presently being corrected).

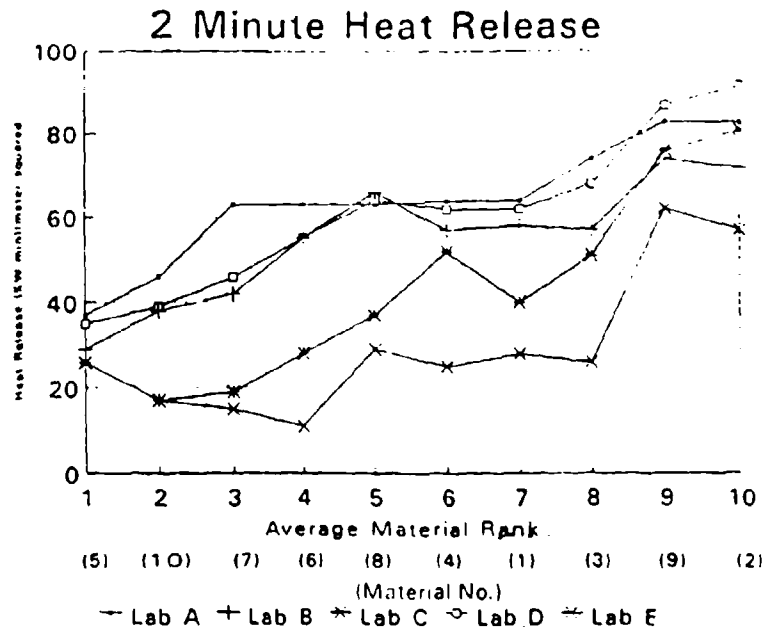
CONCLUSION

Results from the VIAM Heat Release Apparatus can not be used as a basis for judgement as to how a material will perform in the OSU Heat Release Rate Apparatus.

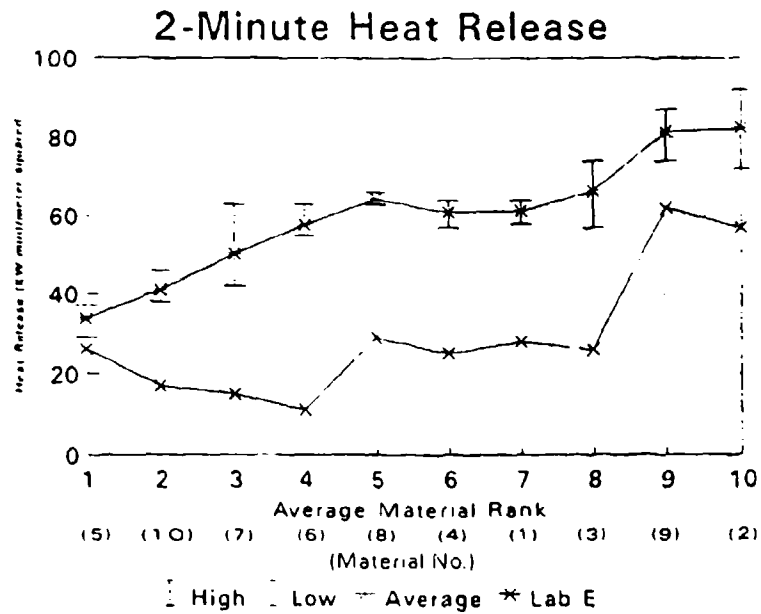
TABLE 1. MATERIAL DESCRIPTION

| <u>Material No.</u> | <u>Color</u> | <u>Description</u> | <u>Thickness</u> |
|---------------------|--------------|------------------------------------|------------------|
| 1 | Light Beige | Honeycomb, graphite back | 0.375" (9.53 mm) |
| 2 | Silver/white | Honeycomb | 0.250" (6.35 mm) |
| 3 | Tan | Glass/phenolic resin, sheet | 0.035" (0.89 mm) |
| 4 | Tan/black | Carbon/glass/phenolic resin, sheet | 0.035" (0.89 mm) |
| 5 | Light yellow | Pressed sheet | 0.025" (0.64 mm) |
| 6 | Dark blue | Textured thermoplastic | 0.066" (1.68 mm) |
| 7 | Cream | Textured thermoplastic | 0.087" (2.21 mm) |
| 8 | Light Tan | Finished honeycomb | 0.387" (9.83 mm) |
| 9 | White | Phenolic/Kevlar honeycomb | 0.250" (6.35 mm) |
| 10 | White | Epoxy/glass honeycomb | 0.250" (6.35 mm) |

(a) All Labs



(b) Without Lab C



High Low and Average for Labs A, B and D With Spread

FIGURE 1. AVERAGE TOTAL HEAT RELEASE AT TWO MINUTES FOR TEN MATERIALS

Peak

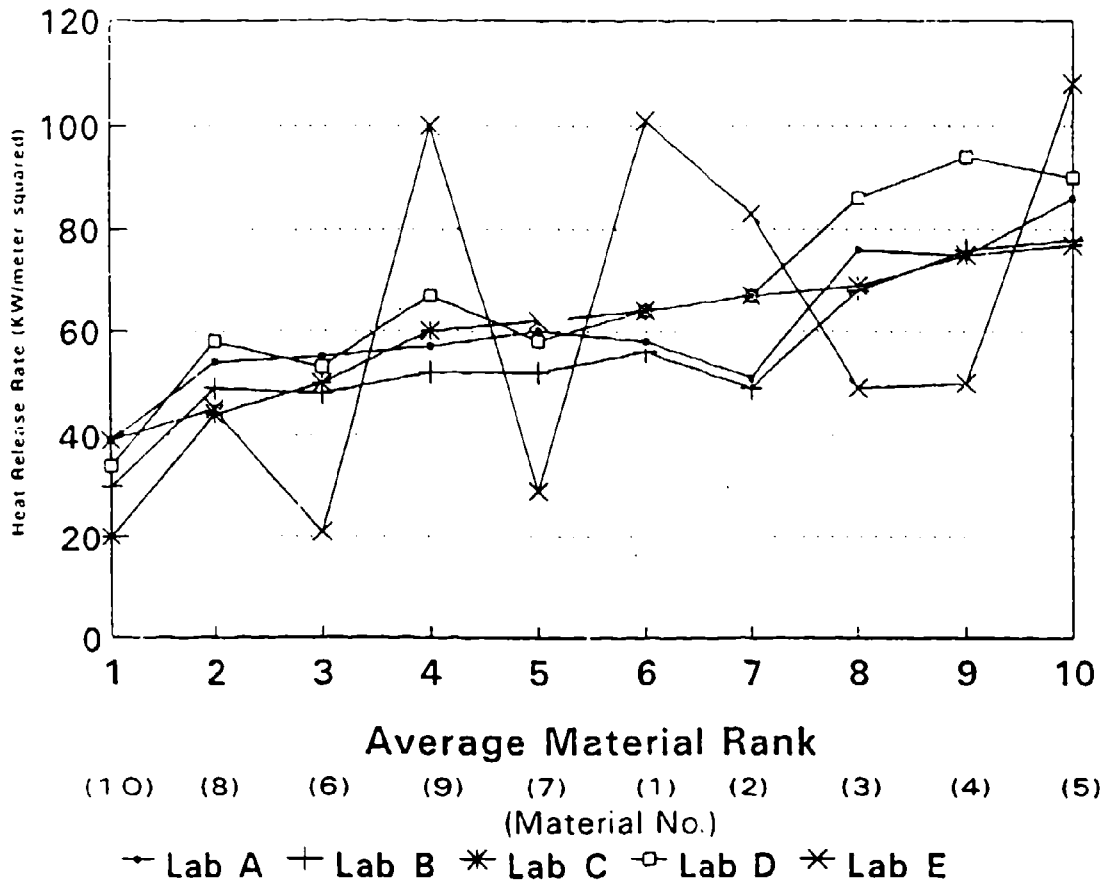


FIGURE 2. AVERAGE PEAK HEAT RELEASE RATE FOR TEN MATERIALS

TABLE 2. COMPARISON OF DATA SPREAD WITHIN LABS

(a) Total Heat Release at Two Minutes

Comparison of Spread
Labs A,B,C,D vs. Lab E Spreads
Labs A,B,C,D

| Material No. | Average | High | Lab E |
|--------------|-------------|------------|-------------|
| 1 | 10.25 | 15 | 10 |
| 2 | 5.5 | 10 | 15 |
| 3 | 4 | 7 | 12 |
| 4 | 3.75 | 8 | 5 |
| 5 | 6.5 | 8 | 6 |
| 6 | 6.25 | 10 | 11 |
| 7 | 7.75 | 14 | 13 |
| 8 | 6.5 | 9 | 27 |
| 9 | 5.5 | 9 | 16 |
| 10 | 5.5 | 9 | 3 |
| | 6.15 | 9.9 | 11.8 |

(b) Peak Heat Release Rate

Comparison of Spread
Labs A,B,C,D vs. Lab E Spreads
Labs A,B,C,D

| Material No. | Average | High | Lab E |
|--------------|----------|------------|-------------|
| 1 | 2.75 | 4 | 28 |
| 2 | 4.5 | 6 | 18 |
| 3 | 12.25 | 23 | 36 |
| 4 | 5.5 | 11 | 21 |
| 5 | 5 | 10 | 13 |
| 6 | 4.5 | 9 | 2 |
| 7 | 8.75 | 13 | 15 |
| 8 | 8 | 9 | 29 |
| 9 | 4.75 | 6 | 9 |
| 10 | 4 | 7 | 5 |
| | 6 | 9.8 | 17.6 |

TABLE 2. COMPARISON OF DATA SPREAD WITHIN LABS (CONTINUED)

2-Minute Integration

Lab A

| Material No. | Run No. | | | Avg | Spread |
|----------------|---------|----|----|------|--------|
| | 1 | 2 | 3 | | |
| 1 | 65 | 68 | 59 | 64 | 9 |
| 2 | 84 | 82 | 82 | 82.7 | 2 |
| 3 | 75 | 75 | 72 | 74 | 3 |
| 4 | 66 | 64 | 62 | 64 | 4 |
| 5 | 40 | 39 | 33 | 37.3 | 7 |
| 6 | 59 | 66 | 64 | 63 | 7 |
| 7 | 61 | 61 | 65 | 62.3 | 4 |
| 8 | 67 | 63 | 58 | 62.7 | 9 |
| 9 | 88 | 79 | 83 | 83.3 | 9 |
| 10 | 45 | 51 | 42 | 46 | 9 |
| Average Spread | | | | | 6.3 |

Lab B

| Material No. | Run No. | | | Avg | Spread |
|----------------|---------|----|----|------|--------|
| | 1 | 2 | 3 | | |
| 1 | 55 | 65 | 55 | 58.3 | 10 |
| 2 | 78 | 69 | 68 | 71.7 | 10 |
| 3 | 56 | 57 | 57 | 56.7 | 1 |
| 4 | 58 | 52 | 60 | 56.7 | 8 |
| 5 | 34 | 26 | 26 | 28.7 | 8 |
| 6 | 60 | 50 | 55 | 55 | 10 |
| 7 | 42 | 35 | 49 | 42 | 14 |
| 8 | 63 | 65 | 68 | 65.3 | 5 |
| 9 | 67 | 77 | 78 | 74 | 5 |
| 10 | 41 | 35 | 38 | 38 | 6 |
| Average Spread | | | | | 7.7 |

Lab C

| Material No. | Run No. | | | Avg | Spread |
|----------------|---------|----|----|------|--------|
| | 1 | 2 | 3 | | |
| 1 | 43 | 36 | 41 | 40 | 7 |
| 2 | 71 | 64 | 66 | 67 | 7 |
| 3 | 54 | 50 | 47 | 50.3 | 7 |
| 4 | 51 | 52 | 52 | 51.7 | 1 |
| 5 | 27 | 27 | 23 | 25.7 | 4 |
| 6 | 27 | 29 | 28 | 28 | 2 |
| 7 | 13 | 25 | 18 | 18.7 | 12 |
| 8 | 35 | 37 | 39 | 37 | 4 |
| 9 | 75 | 76 | 76 | 75.7 | 1 |
| 10 | 18 | 17 | 16 | 17 | 2 |
| Average Spread | | | | | 4.7 |

Lab D

| Material No. | Run No. | | | Avg | Spread |
|----------------|---------|----|----|------|--------|
| | 1 | 2 | 3 | | |
| 1 | 68 | 64 | 53 | 61.7 | 15 |
| 2 | 93 | 92 | 90 | 91.7 | 3 |
| 3 | 68 | 65 | 70 | 67.7 | 5 |
| 4 | 61 | 63 | 62 | 62 | 2 |
| 5 | 37 | 30 | 37 | 34.7 | 7 |
| 6 | 57 | 51 | 56 | 54.7 | 6 |
| 7 | 46 | 47 | 46 | 46.3 | 1 |
| 8 | 66 | 59 | 67 | 64 | 8 |
| 9 | 89 | 83 | 90 | 87.3 | 7 |
| 10 | 41 | 41 | 36 | 39.3 | 5 |
| Average Spread | | | | | 5.9 |

Lab E

| Material No. | Run No. | | | Avg | Spread |
|----------------|---------|----|----|------|--------|
| | 1 | 2 | 3 | | |
| 1 | 22 | 30 | 32 | 28 | 10 |
| 2 | 66 | 54 | 51 | 57 | 15 |
| 3 | 27 | 20 | 32 | 26.3 | 12 |
| 4 | 28 | 23 | | 25.5 | 5 |
| 5 | 26 | 29 | 23 | 26 | 6 |
| 6 | 16 | 5 | | 10.5 | 11 |
| 7 | 8 | 21 | | 14.5 | 13 |
| 8 | 44 | 17 | 26 | 29 | 27 |
| 9 | 69 | 64 | 53 | 62 | 16 |
| 10 | 18 | 15 | 17 | 16.7 | 3 |
| Average Spread | | | | | 11.8 |

Shaded Area Highest Spread for OSU Apparatus

TABLE 2. COMPARISON OF DATA SPREAD WITHIN LABS (CONTINUED)

Peak

Lab A

| Material No. | Run No | | | Avg | Spread |
|----------------|--------|----|----|------|-----------|
| | 1 | 2 | 3 | | |
| 1 | 59 | 60 | 57 | 58.7 | 3 |
| 2 | 52 | 51 | 50 | 51 | 2 |
| 3 | 84 | 82 | 61 | 75.7 | 23 |
| 4 | 73 | 76 | 76 | 75 | 3 |
| 5 | 87 | 87 | 83 | 85.7 | 4 |
| 6 | 55 | 55 | 55 | 55 | 0 |
| 7 | 57 | 61 | 62 | 60 | 5 |
| 8 | 59 | 53 | 51 | 54.3 | 8 |
| 9 | 60 | 56 | 56 | 57.3 | 4 |
| 10 | 42 | 42 | 35 | 39.7 | 7 |
| Average Spread | | | | | 5.9 |

Lab B

| Material No. | Run No | | | Avg | Spread |
|----------------|--------|----|----|------|-----------|
| | 1 | 2 | 3 | | |
| 1 | 57 | 55 | 56 | 56 | 2 |
| 2 | 50 | 46 | 49 | 48.3 | 4 |
| 3 | 70 | 71 | 64 | 68.3 | 7 |
| 4 | 76 | 74 | 77 | 75.7 | 3 |
| 5 | 81 | 81 | 71 | 77.7 | 10 |
| 6 | 48 | 49 | 47 | 48 | 2 |
| 7 | 46 | 52 | 58 | 52 | 12 |
| 8 | 46 | 53 | 47 | 48.7 | 7 |
| 9 | 51 | 55 | 51 | 52.3 | 4 |
| 10 | 31 | 28 | 31 | 30 | 3 |
| Average Spread | | | | | 6.4 |

Lab C

| Material No. | Run No | | | Avg | Spread |
|----------------|--------|----|----|------|-----------|
| | 1 | 2 | 3 | | |
| 1 | 63 | 64 | 65 | 64 | 2 |
| 2 | 82 | 77 | 83 | 80.7 | 6 |
| 3 | 70 | 73 | 64 | 69 | 9 |
| 4 | 77 | 72 | 75 | 74.7 | 5 |
| 5 | 78 | 78 | 76 | 77.3 | 2 |
| 6 | 48 | 54 | 47 | 49.7 | 7 |
| 7 | 70 | 60 | 57 | 62.3 | 13 |
| 8 | 43 | 48 | 40 | 43.7 | 8 |
| 9 | 63 | 57 | 60 | 60 | 6 |
| 10 | 20 | 20 | 21 | 20.3 | 1 |
| Average Spread | | | | | 5.9 |

Lab D

| Material No. | Run No | | | Avg | Spread |
|----------------|--------|----|----|------|-----------|
| | 1 | 2 | 3 | | |
| 1 | 66 | 65 | 62 | 64.3 | 4 |
| 2 | 71 | 66 | 65 | 67.3 | 6 |
| 3 | 88 | 80 | 90 | 86 | 10 |
| 4 | 87 | 98 | 97 | 94 | 11 |
| 5 | 92 | 89 | 88 | 89.7 | 4 |
| 6 | 58 | 49 | 51 | 52.7 | 9 |
| 7 | 57 | 61 | 56 | 58 | 5 |
| 8 | 57 | 63 | 54 | 58 | 9 |
| 9 | 67 | 64 | 69 | 66.7 | 5 |
| 10 | 32 | 33 | 37 | 34 | 5 |
| Average Spread | | | | | 6.8 |

Lab E

| Material No. | Run No | | | Avg | Spread |
|----------------|--------|-----|-----|------|--------|
| | 1 | 2 | 3 | | |
| 1 | 98 | 88 | 116 | 101 | 28 |
| 2 | 75 | 80 | 93 | 82.7 | 18 |
| 3 | 51 | 30 | 66 | 49 | 36 |
| 4 | 51 | 30 | | 40.5 | 21 |
| 5 | 114 | 101 | 109 | 108 | 13 |
| 6 | 22 | 20 | | 21 | 2 |
| 7 | 21 | 36 | | 28.5 | 15 |
| 8 | 62 | 41 | 33 | 45.3 | 29 |
| 9 | 100 | 105 | 96 | 100 | 9 |
| 10 | 39 | 36 | 41 | 38.7 | 5 |
| Average Spread | | | | | 17.6 |

Shaded Area - Highest Spread for OSU Apparatus