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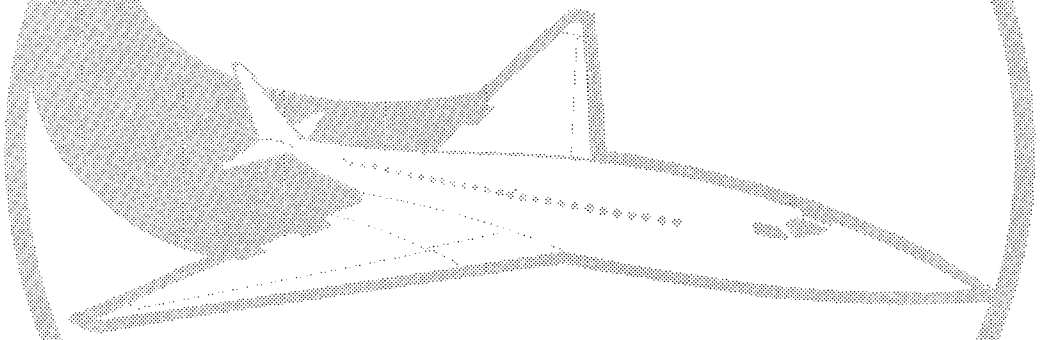
Round-Robin Comparison of Heat Release Apparatus

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

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).

RESULTS

A tabulation of all the data is presented in appendix I. The material numbers are those reported in table 1. The average result of the three samples tested as well as the spread (difference between high and low) in the data is also presented in appendix I.

In order to evaluate the reproducibility of the VIAM apparatus, the data generated by the four labs using the OSU apparatus were compared to the VIAM data for all ten materials. Figure 1 shows the results for the total heat release at 2 minutes. The materials are plotted in ascending order based on the average rank in the OSU apparatus. The average rank was obtained by ranking the materials from 1 (lowest) to 10 (highest) at each of the labs using the OSU apparatus, adding the ranks from each lab for a given material. Those numbers were used to obtain the material rank; e.g., the lowest number was rank number 1. This was done separately for the two-minute peak and peak data. The material number, as per table 1, are shown in parentheses below the material rank. Figure 1a shows good reproducibility between three labs (A,B and D) with lab C being much lower total heat release results, however, the repeatability and peak results were not affected. Reevaluation of lab C apparatus has uncovered some problems that are presently being fixed. Figure 1b shows a comparison of data without lab C. The VIAM apparatus produced data much lower than that of the OSU apparatus. For the two-minute average the VIAM results discriminate between the lowest and highest materials; however, the ranking of materials in the middle do not follow those of the OSU apparatus. Figure 2 is a comparison of the peak heat release rate data. It can easily be seen that there is no correlation between the OSU and the VIAM apparatus. For some materials the VIAM data are much higher than the OSU results, while for other materials the converse is true.

The repeatability of the VIAM apparatus was evaluated by comparing the spread in data for a given material at the labs using the OSU apparatus to that of VIAM. Tables 2a & b compare the spread in data for the total heat release at two minutes (table 2a) and the peak heat release rate (table 2b). The average spread for OSU labs was obtained by averaging the spreads for a given material of all four labs using the OSU apparatus. The high was obtained by using only the spread of the lab having the largest spread for a given material. For the total heat release at two minutes, the VIAM apparatus had an average spread almost twice as much as the average spread for labs using the OSU (6.15 to 11.8) and almost 20 percent higher than the average of the highest spread for each material (9.9 to 11.8). The comparison for the peak heat release rate shows VIAM to be almost three times the average of the OSU labs (6 to 17.6), and twice the average of the highest lab (9.8 to 17.6).

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).

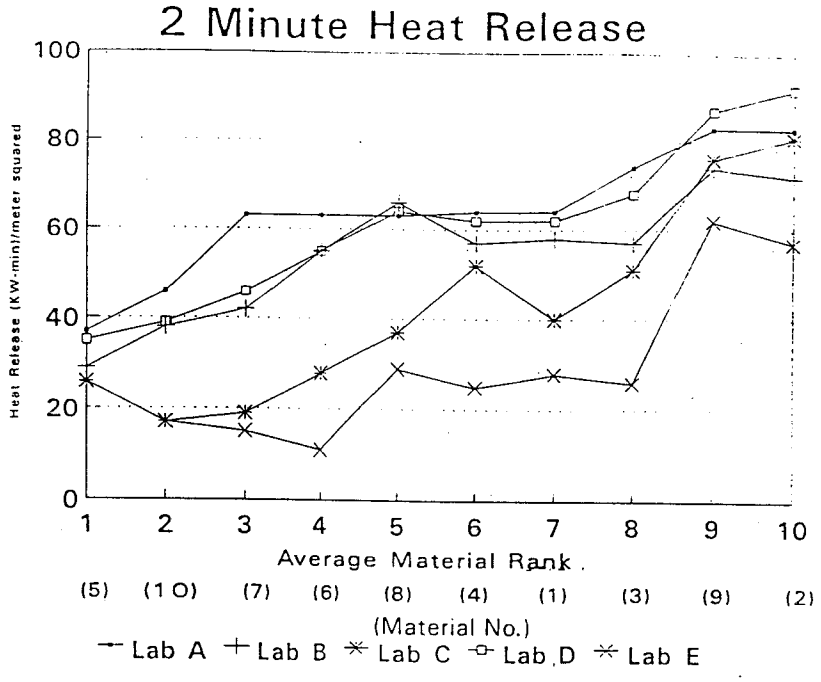
CONCLUSION

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.

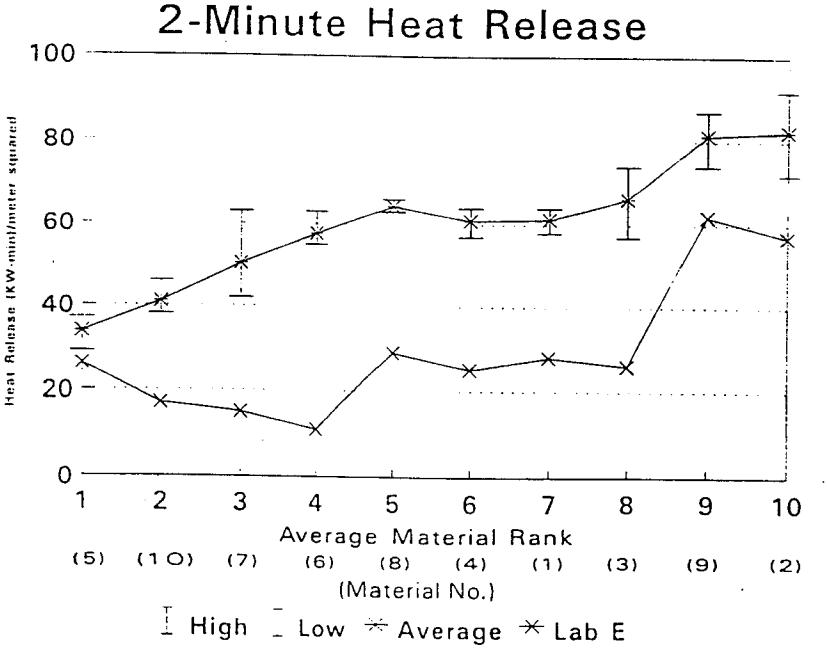
TABLE 1. MATERIAL DESCRIPTION

Material No.	Color	Description	Thickness
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

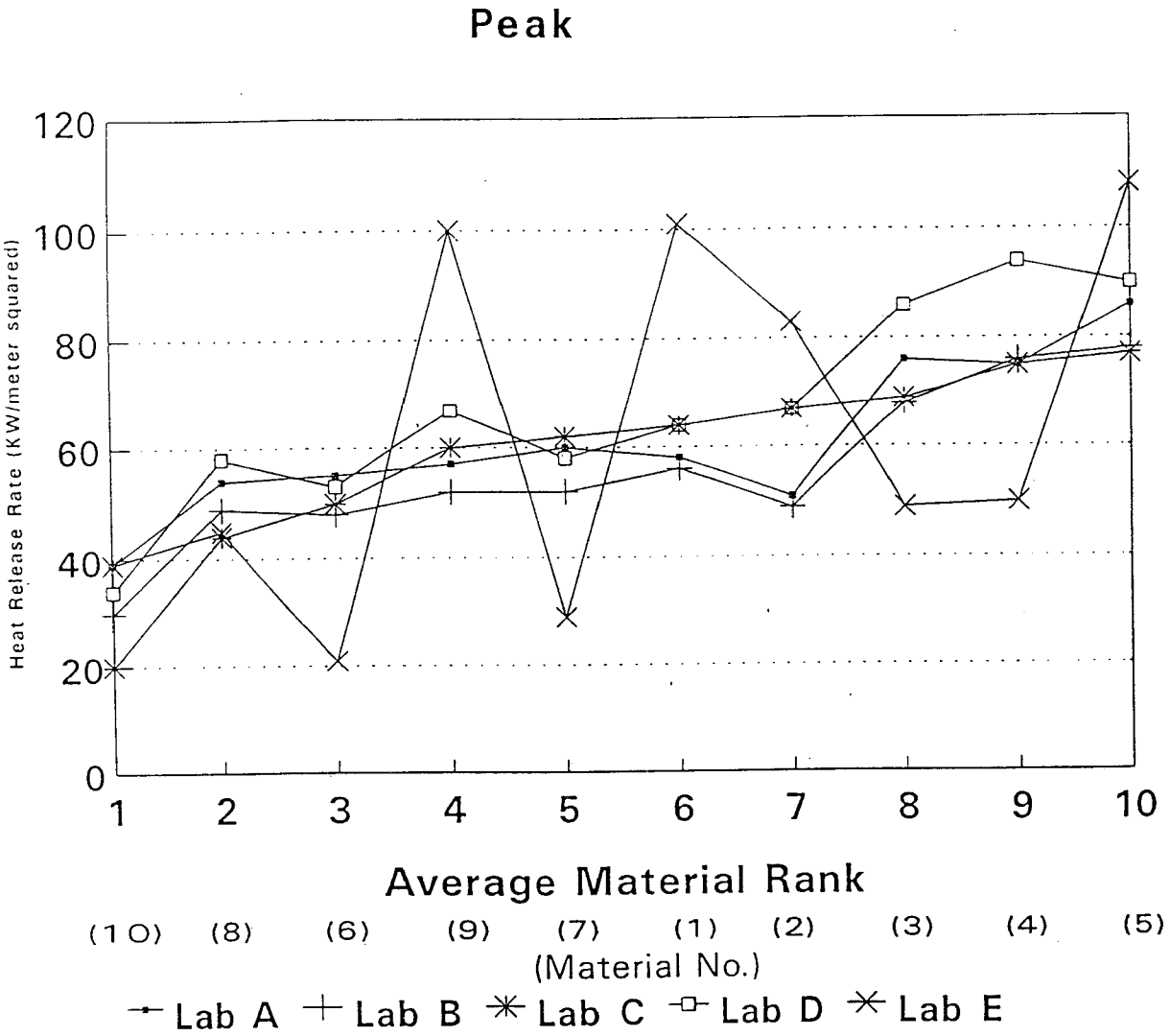


FIGURE 2. AVERAGE PEAK HEAT RELEASE RATE FOR TEN MATERIALS

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. 1	2	3	Avg	Spread
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. 1	2	3	Avg	Spread
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. 1	2	3	Avg	Spread
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. 1	2	3	Avg	Spread
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. 1	2	3	Avg	Spread
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