

**FAR 25.853 VERTICAL
FLAMMABILITY TESTING (12 SEC.)
FOR
FORMLABS
ON
2.5 MM
VTEC #100-7544-1
TESTED: MARCH 29, 2023**



VTEC Laboratories Inc.

March 29, 2023

Client: Formlabs
35 Medford Street
Somerville, MA 02143

I. SCOPE:

This report contains the reference to the test method, sample description, and test results.

II. TEST METHOD:

This test was conducted in accordance with the FAR 25.853, Appendix F, Part 25 Vertical Flammability (12 sec.) specification.

III. PASSING CRITERIA:

Fabrics, tested in both the weft and warp directions, must have an average burn length not exceeding 6 inches, an average after flame time not exceeding 15 seconds, and any dripping may not continue to flame for more than an average of 3 seconds after falling.

Disclaimer: This is a factual report of the results obtained from the laboratory test of sample products. The results may be applied only to the products tested and should not be construed as applicable to other similar products of the manufacturer. The report is not a recommendation or disapprobation by VTEC Laboratories, Inc. of the material tested. While this report may be used for obtaining product acceptance, it may not be used in advertising.

Notice: VTEC Laboratories Inc. will not be liable for any loss or damage resulting from the use of the data in this report, in excess of the invoice. This report pertains to the sample tested only. Such report shall not be interpreted to be a warranty, either expressed or implied as to the suitability or fitness of said sample for such uses or applications, as the party contracting for the report may apply such sample.

III. SAMPLE DESCRIPTION:

- 1) Manufacturer: Formlabs
- 2) Product Description: 2.5 mm
- 3) Color: Grey
- 4) Number of Specimens: 3
- 5) Specimen Dimensions: 3 x 13 inches
- 6) Material Description: By Manufacturer
- 7) Date of Selection: March 2023
- 8) Purpose of Test: Showing compliance with 25.853 Vertical (12 sec.) Flammability Test
- 9) Sample Mounting Method: Vertically in a metal frame with the two long edges and the upper edge secured
- 10) Conditioning: 70°F and 50% RH for 24 hours

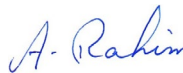
IV TEST RESULTS:

<i>Flame Application Time: 12 Seconds</i>				
	<u>Sample 1</u>	<u>Sample 2</u>	<u>Sample 3</u>	<u>Average</u>
After Flame Time (sec.)	2.00	0.00	0.00	0.67
Burn Length (in.)	0.19	0.13	0.18	0.17
Dripping Flaming Time (sec.)	0.00	0.00	0.00	0.00

Based upon the results shown above, the material met the passing criteria per the FAR 25.853 (12 sec.) vertical flammability specification.



Neil Schultz
Executive Director



Amirudin Rahim
Technical Director

**ASTM E662 TESTING
FOR
FORMLABS
ON
FR RESIN V1 3MM
VTEC #100-7571-2
TESTED: APRIL 12, 2023**



VTEC Laboratories Inc.

April 12, 2023

Client: Formlabs
35 Medford Street
Somerville, MA 02143

I. SCOPE:

This report contains the reference to the test method, purpose, limitations, description of materials, operating data, and test results.

II. TEST METHOD:

The test was conducted in accordance with ASTM Designation E-662, "Standard Test Method for Specific Optical Density of Smoke Generated by Solid Material".

III. PURPOSE:

The purpose of the test is to measure the smoke generated by solid materials and assemblies in thickness up to and including one inch. The test is based on the attenuation of a light beam by smoke accumulating within a closed chamber. Both non-flaming and flaming exposures are conducted. Results are expressed in terms of specific optical density, which is derived from measuring optical density (absorbance).

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TEST DATA: LIGHT TRANSMITTANCE

TEST:	NON-FLAMING			FLAMING		
Time (min.)	Test #1	Test #2	Test#3	Test#4	Test#5	Test#6
0.0	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
0.5	99.94%	99.94%	100.00%	100.00%	102.37%	97.45%
1.0	100.00%	102.43%	97.69%	100.00%	90.22%	87.73%
1.5	100.00%	99.94%	97.74%	95.63%	59.38%	63.49%
2.0	100.00%	102.43%	97.69%	73.33%	10.01%	24.70%
2.5	95.75%	100.24%	97.69%	37.25%	1.23%	5.38%
3.0	85.42%	95.14%	93.00%	8.04%	0.26%	1.48%
3.5	63.49%	80.90%	78.58%	0.98%	0.98%	0.26%
4.0	47.63%	64.41%	61.96%	0.26%	1.23%	1.04%
4.5	29.67%	49.09%	46.84%	0.98%	1.48%	0.98%
5.0	20.87%	37.08%	33.77%	0.95%	1.24%	1.23%
5.5	13.17%	25.48%	25.70%	1.23%	0.98%	0.98%
6.0	7.70%	18.07%	17.66%	0.98%	1.48%	0.75%
6.5	6.60%	12.54%	12.86%	1.48%	1.48%	0.98%
7.0	6.32%	9.80%	10.41%	1.48%	0.98%	1.06%
7.5	3.68%	7.85%	7.86%	1.48%	0.75%	0.32%
8.0	3.19%	5.96%	6.45%	0.98%	0.75%	0.98%
8.5	2.70%	4.76%	5.50%	1.78%	0.86%	0.78%
9.0	2.21%	4.06%	4.58%	0.75%	0.75%	0.98%
9.5	2.21%	3.48%	4.57%	1.47%	0.98%	0.26%
10.0	1.55%	3.01%	3.87%	0.98%	0.75%	0.75%
10.5	2.35%	2.87%	5.01%	0.98%	0.98%	0.73%
11.0	1.62%	2.64%	3.12%	0.75%	0.50%	0.50%
11.5	1.48%	2.55%	3.12%	0.75%	0.50%	0.26%
12.0	1.59%	1.69%	2.64%	0.75%	0.34%	0.26%
12.5	1.23%	2.18%	2.64%	0.98%	0.35%	0.26%
13.0	1.96%	2.15%	2.80%	0.98%	0.71%	0.11%
13.5	1.25%	1.83%	2.15%	0.75%	0.20%	0.26%
14.0	1.28%	1.91%	2.64%	0.75%	0.25%	0.26%
14.5	0.83%	2.39%	2.52%	0.50%	0.26%	0.26%
15.0	1.23%	2.41%	1.86%	0.26%	0.86%	0.49%
15.5	0.81%	2.16%	2.15%	0.74%	0.03%	0.75%
16.0	1.48%	2.64%	2.15%	0.24%	0.72%	0.75%
16.5	0.98%	2.83%	2.41%	0.27%	0.77%	0.98%
17.0	1.48%	3.17%	2.15%	0.27%	0.98%	0.98%
17.5	1.49%	2.17%	2.15%	0.27%	0.65%	0.98%
18.0	1.07%	3.11%	2.64%	0.26%	0.82%	2.21%
18.5	1.96%	3.26%	3.31%	0.24%	0.98%	1.15%
19.0	1.39%	3.14%	2.16%	0.21%	0.69%	1.62%
19.5	1.96%	3.81%	2.99%	0.29%	1.71%	1.96%
20.0	2.21%	3.35%	3.35%	0.26%	1.48%	2.35%

DATE: 4/12/2023
PROJECT #: 100-7571-2
SUPPLIER: Formlabs
CONDITIONING: 140°F for 24 hours.
TEST ROOM TEMP: 76 ± 5°F
RELATIVE HUMIDITY: 50 ± 10 %
CHAMBER WALL TEMP: 95 ± 4°F
SPECIMEN MOUNTING: Standard
SPECIAL PREPARATION: None
SPECIMEN COMPOSITION: Homogeneous
SPECIMEN COLOR: Grey
SPECIMEN DESCRIPTION: FR Resin v1 3mm

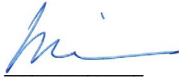
SAMPLE #:	NON-FLAMING			FLAMING		
	1	2	3	4	5	6
Thickness (in):	0.1165	0.1165	0.1165	0.1165	0.1165	0.1165
Weight (g):	21.86	21.71	22.09	21.79	21.52	21.82
Tmin (%):	0.81%	1.69%	1.86%	0.21%	0.03%	0.11%
Dm (20.0 min.):	276.22	233.91	228.50	354.41	464.30	390.87
T (clear):	91.80%	79.54%	76.97%	54.45%	54.50%	58.63%
Dc (clear):	4.91	13.12	15.00	34.84	34.79	30.61
Dm (corr):	271.31	220.78	213.50	319.57	429.51	360.27
Ds (1.5 min.):	0.00	0.03	1.31	2.56	29.88	26.05
Ds (4.0 min.):	42.52	25.22	27.44	342.30	251.98	261.81
Color of smoke:	Grey	Grey	Grey	Grey	Grey	Grey

OBSERVATIONS:

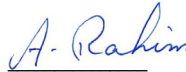
During the flaming mode, the samples ignited at 0m06s and burned until 8m57s.

OPTICAL DENSITY TEST RESULT SUMMARY

	<u>NON-FLAMING</u>	<u>FLAMING</u>
Ds @ 1.5 min. (average):	0.4	19.5
Ds @ 4.0 min. (average):	31.7	285.4
Dm (average):	246.2	403.2
Dm(corr) (average):	235.2	369.8



Neil Schultz
Executive Director



Amirudin Rahim
Technical Director

**ASTM E662 TESTING
FOR
FORMLABS
ON
FR RESIN V1 5MM
VTEC #100-7571-1
TESTED: APRIL 12, 2023**



VTEC Laboratories Inc.

April 12, 2023

Client: Formlabs
35 Medford Street
Somerville, MA 02143

I. SCOPE:

This report contains the reference to the test method, purpose, limitations, description of materials, operating data, and test results.

II. TEST METHOD:

The test was conducted in accordance with ASTM Designation E-662, "Standard Test Method for Specific Optical Density of Smoke Generated by Solid Material".

III. PURPOSE:

The purpose of the test is to measure the smoke generated by solid materials and assemblies in thickness up to and including one inch. The test is based on the attenuation of a light beam by smoke accumulating within a closed chamber. Both non-flaming and flaming exposures are conducted. Results are expressed in terms of specific optical density, which is derived from measuring optical density (absorbance).

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TEST DATA: LIGHT TRANSMITTANCE

TEST:	NON-FLAMING			FLAMING		
Time (min.)	Test #1	Test #2	Test#3	Test#4	Test#5	Test#6
0.0	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
0.5	100.00%	97.73%	99.28%	97.79%	97.69%	100.00%
1.0	100.00%	97.73%	97.73%	95.36%	97.69%	98.84%
1.5	100.00%	97.68%	97.68%	88.73%	95.07%	91.14%
2.0	100.00%	97.68%	97.68%	72.65%	77.81%	78.98%
2.5	100.00%	97.68%	95.57%	51.09%	60.19%	62.88%
3.0	98.17%	97.68%	95.57%	36.53%	36.75%	41.75%
3.5	97.68%	95.57%	93.30%	23.51%	21.10%	26.86%
4.0	95.57%	93.30%	93.25%	13.43%	12.26%	15.78%
4.5	88.99%	86.72%	86.72%	9.99%	7.03%	7.90%
5.0	78.03%	75.54%	75.48%	6.20%	4.00%	5.00%
5.5	64.53%	62.26%	60.54%	3.20%	3.27%	2.80%
6.0	47.70%	49.06%	47.92%	2.29%	1.27%	0.94%
6.5	37.04%	37.48%	38.14%	1.04%	1.01%	0.24%
7.0	26.07%	27.52%	29.95%	0.70%	0.55%	0.51%
7.5	18.42%	19.17%	23.77%	0.24%	0.71%	0.24%
8.0	13.55%	13.76%	18.42%	0.67%	0.26%	0.19%
8.5	10.45%	11.10%	14.39%	0.24%	0.27%	0.16%
9.0	7.26%	8.67%	11.54%	0.92%	0.77%	0.24%
9.5	6.45%	7.33%	9.77%	1.10%	0.26%	0.47%
10.0	5.78%	6.85%	7.82%	0.96%	0.26%	0.72%
10.5	5.12%	5.79%	6.67%	1.38%	0.46%	0.94%
11.0	4.72%	6.45%	6.12%	1.38%	0.26%	0.94%
11.5	4.79%	5.33%	4.45%	1.38%	0.51%	0.94%
12.0	4.23%	4.83%	4.23%	1.25%	0.77%	0.94%
12.5	4.23%	5.12%	4.00%	1.38%	0.33%	0.93%
13.0	4.57%	5.03%	3.55%	1.38%	0.91%	0.93%
13.5	4.23%	4.23%	3.60%	1.38%	0.74%	0.94%
14.0	4.32%	4.23%	3.12%	0.92%	0.77%	0.71%
14.5	3.62%	4.01%	2.91%	1.37%	0.51%	0.71%
15.0	3.79%	3.53%	3.00%	1.15%	0.73%	0.90%
15.5	4.01%	3.55%	2.71%	1.15%	0.50%	1.13%
16.0	3.79%	3.13%	2.00%	0.91%	0.75%	0.47%
16.5	4.23%	2.91%	2.47%	1.00%	0.26%	0.71%
17.0	3.97%	2.46%	2.65%	1.15%	0.26%	0.71%
17.5	3.88%	2.46%	2.91%	1.15%	0.77%	0.38%
18.0	3.77%	3.55%	3.13%	1.19%	0.16%	0.24%
18.5	4.01%	2.99%	3.55%	1.13%	0.26%	0.31%
19.0	4.01%	2.09%	2.87%	1.16%	0.96%	0.40%
19.5	3.55%	2.46%	3.35%	1.38%	0.77%	0.21%
20.0	3.60%	2.23%	3.12%	0.92%	0.26%	0.50%

DATE: 4/12/2023
PROJECT #: 100-7571-1
SUPPLIER: Formlabs
CONDITIONING: 140°F for 24 hours.
TEST ROOM TEMP: 76 ± 5°F
RELATIVE HUMIDITY: 50 ± 10 %
CHAMBER WALL TEMP: 95 ± 4°F
SPECIMEN MOUNTING: Standard
SPECIAL PREPARATION: None
SPECIMEN COMPOSITION: Homogeneous
SPECIMEN COLOR: Grey
SPECIMEN DESCRIPTION: FR Resin v1 5mm

SAMPLE #:	NON-FLAMING			FLAMING		
	1	2	3	4	5	6
Thickness (in):	0.1970	0.1970	0.1970	0.1950	0.1965	0.1965
Weight (g):	36.43	36.44	36.30	36.34	36.19	36.71
Tmin (%):	3.55%	2.09%	2.00%	0.24%	0.16%	0.16%
Dm (20.0 min.):	191.32	221.69	224.33	346.33	368.31	370.38
T (clear):	88.77%	93.25%	88.77%	74.97%	84.48%	78.92%
Dc (clear):	6.83	4.01	6.83	16.51	9.67	13.57
Dm (corr):	184.49	217.68	217.50	329.82	358.64	356.81
Ds (1.5 min.):	0.00	1.35	1.35	6.85	2.90	5.32
Ds (4.0 min.):	2.60	3.97	4.01	115.11	120.33	105.85
Color of smoke:	Grey	Grey	Grey	Grey	Grey	Grey

OBSERVATIONS:

During the flaming mode, the samples ignited at 0m33s and burned until 11m44s.

OPTICAL DENSITY TEST RESULT SUMMARY

	<u>NON-FLAMING</u>	<u>FLAMING</u>
Ds @ 1.5 min. (average):	0.9	5.0
Ds @ 4.0 min. (average):	3.5	113.8
Dm (average):	212.4	361.7
Dm(corr) (average):	206.6	348.4



Neil Schultz
Executive Director



Amirudin Rahim
Technical Director

**BSS 7239
TOXIC GAS TESTING
FOR
FORMLABS
ON
FR RESIN V1 3MM
VTEC #100-7571-3
TESTED: APRIL 12, 2023**



VTEC Laboratories Inc.

April 12, 2023

Client: Formlabs
35 Medford Street
Somerville, MA 02143

Subject:

Measure amount of toxic gas generation per BSS 7239 specification.

Test Description:

The gas analysis was made after 4 minutes of exposure to 2.5 w/cm² in the flaming mode. Toxic gas was analyzed in accordance to BSS 7239 specification.

Disclaimer:

This test result alone does not assess the fire hazard of the material, or a product made from this material, under actual fire conditions. Consequently, the results of this test alone are not to be quoted in support of claims with respect to the fire hazard of the material or product under actual fire conditions. The results when used alone are only to be used for research and development, quality control and material specifications.

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Material Tested:

DATE: 4/12/2023
 VTEC #: 100-7571-3
 PRODUCT DESCRIPTION: FR Resin v1 3mm
 SUPPLIER: Formlabs
 COLOR: Grey
 SPECIMEN COMPOSITION: Homogeneous
 AVERAGE THICKNESS: 0.1165 in.

Results:

	SPECIMEN #1	SPECIMEN #2		
Weight (g)	21.5	21.8		
	CORRECTED	CORRECTED	AVERAGE	STD. DEVIATION
GAS	PPM	PPM	PPM	PPM
CO	50	63	56	9
HCN	6	8	7	2
SO ₂	<1	<1	<1	<1
HCl	<1	<1	<1	<1
HF	<1	<1	<1	<1
(NO+NO ₂) NO _x	<1	<1	<1	<1



Neil Schultz
 Executive Director



Amirudin Rahim
 Technical Director



TEST REPORT

In Account With Formlabs Inc. 35 Medford St. Suite 201 Somerville, MA 02143	Date March 31, 2023	Page 1 of 2 Pages
	W.O. Number 76078	Test Report Number TR76078
		Received 03/13/2023

IDENTIFICATION: One (1) 3D printed plastic sample material was submitted for Outgas Testing in accordance with ASTM E595. The test sample was identified as follows:

1) FR Resin

SPECIFICATION : ASTM E595.

TESTING : Outgas Testing.

SUMMARY : The test results, reported herein, are submitted for customer evaluation.

Respectfully submitted,
PACIFIC TESTING LABORATORIES, INC.

Hans Shin
Laboratory Director

OUTGAS TESTING

REFERENCE:

ASTM E595.

REQUIREMENT:

ASTM E595, paragraph 1.5: The criteria used for the acceptance and rejection of materials shall be determined by the user and based upon specific component and system requirements. Historically, a total mass loss (TML) of 1.00% and collected volatile condensable material (CVCM) of 0.10% have been used as screening levels for rejection of spacecraft materials.

TEST METHOD:

The Outgas Test was performed in a vacuum environment of less than 5×10^{-5} torr according to ASTM E595, for a duration of 24 hours, at 125°C on three specimens per sample (unless otherwise noted). The TML, CVCM, and the amount of Water Vapor Recovered (WVR) were measured after the test and the average values reported.

RESULTS:

The following tables list the results of the testing:

Table 1. Average Outgas test results.

Sample	TML (%)	CVCM (%)	WVR (%)
FR Resin	0.87	<0.01	0.20

Table 2. Testing observation results (for information/reference only).

Sample	Visible Condensate (CVCM)	Percent Covered (CVCM)	Thin / Heavy (CVCM)	Opaque / Transparent (CVCM)	Interference Fringes (CVCM)	Colored Fringes (CVCM)	Appearance After Test (Sample)
FR Resin	No	0%	N/A	N/A	N/A	N/A	No change

REMARKS:

The test results, reported herein, are submitted for customer evaluation.