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Testing of a Flame and Ember-Resistant Soffit Vent Construction

(Based on *Proposed* Draft California State Fire Marshall Interim Test Method for Evaluating the Ability of Vents to Resist Entry of Embers and Flame Impingement)

Report# 07059.08054.1

Conducted for: Vulcan Technologies/ Gunter Manufacturing

TESTING CONDUCTED: SEPTEMBER 20, 2007 AND AUGUST 4, 2008

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INTRODUCTION

This report documents the eave vent testing of vent samples performed by Western Fire Center, Inc. (WFCi) for Vulcan Technologies. This revision of the report updates information in the report originally issued November 11, 2008, and provides for an extension of data to vent sizes of larger dimensions that cannot be adequately tested in the equipment described in the draft procedure described herein.

Mike White of WFCi conducted the flame intrusion tests with the assistance of Wayne Beres on September 9, 2007. The ember penetration tests were performed by Howard Stacy and Wayne Beres on August 4, 2008.

The purpose of these tests was to evaluate the fire test performance characteristics of the client's exterior eave vent specimens when subjected to a specified fire exposure condition.

SUMMARY OF THE TEST METHOD

The test methodology employed for the evaluation of the Vulcan intumescent vent construction essentially followed the procedures described in a proposed draft interim test procedure entitled "Test Method for Evaluating the Ability of Vents to Resist Entry of Embers and Flame Impingement" submitted to the California State Marshall's Office for review on August 29, 2008.

NOTE: FOR THE PURPOSES OF THIS STUDY, THE FIRE EXPOSURE TO THE VENT DIFFERED FROM THAT DESCRIBED IN THE PROPOSED INTERIM TEST

METHOD IN THE FOLLOWING MANNER: THE FLAME EXPOSURE CONSISTED OF THE SFM 12-7A-1 BURNER OPERATED AT 150 KW, IMPINGING UPON A 4X8' WALL CLAD WITH HEAVY CEDAR SHAKES. THE CEDAR CLADDING IGNITED IMMEDIATELY WITH FLAMES IMPINGING ON THE SOFFIT CONSTRUCTION WITHIN 15 SECONDS. THE RESULTANT HEAT OUTPUT EXCEEDED 400 KW, AND WAS CONSIDERED BY WFCI TO BE AT LEAST EQUIVALENT TO THE EXPOSURE CONDITIONS DESCRIBED IN THE PROPOSED METHOD.

Excerpts of the test procedures from the draft interim flame and ember intrusion test are provided in the following:

4. PART A. Ember Intrusion Test

4.1 Apparatus. The ember intrusion apparatus is shown in Figures 1 and 2. It consists of an ember generation section (circular squirrel cage (tumbler) enclosed with wire) and a two-level cabinet. The vent to be tested shall be positioned on the upper level and the combustion (evaluation) material shall be positioned on the lower level. A 1-inch (25 mm) diameter pipe, with fifteen 1/8-inch (3 mm) holes, spaced at 1-inch (25 mm) intervals, shall be used as the gas diffusion burner (Figure 3). A 12-inch (300 mm) hole shall be cut into the back wall of the lower section so that air can be pulled through the chamber.

4.1.1 Pressure ports will be inserted above and below the horizontal vent separation panel (level). Pressure shall be measured in the sections above and below the vent.

4.1.2 One thermocouple (Type K, 18 ga.) shall be positioned at equal distances around the perimeter on the entering side of the vent. Temperature readings shall be taken at intervals not exceeding 1 per second.

4.2 Generation of Embers

4.2.1 Standard Class-C brands, as described in ASTM E-108 (Section 10.3.3), are used as the starting material. The squirrel cage will be loaded with eight C-brands prior to each test.

4.2.2 Prior to the test, the brands shall be conditioned in an oven at 40 to 49°C (105 to 120°F) for at least 24 hours.

4.2.3 Eight 7/8-inch diameter steel ball bearings shall be included in each charge of C-brands to aid in ember generation.

4.2.4 Ignition of Brands - The C-brands shall be ignited by subjecting them to the flame of a gas burner of such size that, during the process of ignition, the brands are enveloped in the burner flame for 3 minutes. The flame temperature of the igniting flame shall be 1630±50°F (888±28°C) measured 2 inches (51mm) inside the squirrel cage.

4.3 Conduct of Test

4.3.1 Load the eight 7/8-inch steel ball bearings and eight C-brands in the bottom of the cage.

4.3.2 Insert cotton material on the second shelf.

4.3.2 Ignite the gas burner and direct the flame such that it extends approximately 2 inches into the squirrel cage and impinges on the C-brands. Continue the flame impingement exposure for a period of three minutes. The apparatus door shall remain open during ignition of C-brands.

4.3.3 At the end of the three minute period:

4.3.3.1 Turn off the gas burner.

4.3.3.2 Close apparatus door.

4.3.3.3 Turn on the squirrel cage tumbler.

4.3.3.4 Turn on the exhaust fan (the wiring can be set up such that the tumbler and fan are on the same switch).

4.3.3.5 Run the tumbler until it is devoid of all portions of the C-brands.

4.3.5 Tests shall be run in triplicate.

4.4 Acceptance Criteria

4.4.1 Sustained flaming on the cotton target shall not occur.

4.4.2 The test shall be run on three representative vents. All three vents must comply with the acceptance criteria.

Note: The average of the temperature measurements made during the test shall not exceed 55°C (130°F) at any time during the test. [The temperature at the entering side of the vent shall not exceed 55°C (130°F)]

5. PART B. Flame Intrusion Test

5.1 Burner. A 12 x 12 inch (300 x 300 mm) gas diffusion burner (propane or natural gas) shall be used.

5.2 Vent. Use the vent that has been selected for the test. If necessary, the vent will be reduced in size, while maintaining the same design features, to fit into the vent level in the apparatus.

5.3 Apparatus. The apparatus used to evaluate vents for flame intrusion shall be that described in SFM Standards 12-7A-1 (Exterior Wall Siding and Sheathing), and SFM 12-7A-3 (Under Eave). A diagram of the wall/eave test apparatus is shown in Figure 4. The wall opening of the holding fixture shall be enclosed with gypsum wallboard, fiber cement board, or equivalent. The 'interior' (attic side) of the roof vent assembly is to be open so that the flame plume from the burner will flow through the vent into the simulated attic space.

5.4 Vent Assembly. The vent shall be fitted into the noncombustible eave assembly described in 12-7A-3.7, Item 3, Test System Preparation. The horizontal soffit of the eave assembly shall be constructed of gypsum wallboard, fiber cement board, or equivalent.

The test vent shall be centered directly above the exterior wall vertical centerline. The distance between the top of burner and vent opening shall be 82 inches (2.1 m).

5.5 Sealing. All edges of the vent will be sealed with ceramic wool or comparable material to prevent flame penetration at the locations where the vent intersects with the noncombustible soffit material.

5.6 Video documentation. A video camera shall be positioned on the attic interior side of the vent test assembly so that any flame penetration through the vent can be viewed and documented. Another camera shall be placed to document the flame application to the vent entry opening.

5.7 Temperature measurements. Three type K (or equivalent) thermocouples (18 gauge or lighter) shall be mounted in the air space above the vent geometrical center and at its half points along the long dimension of the vent. The thermocouples shall be positioned 1.0 inch (25 mm) above the vent exit opening on the 'attic' side of the vent. The purpose of these thermocouples is to evaluate the effectiveness of the vent's sealing during testing.

5.8 Conduct of Tests

5.8.1 Airflow. The flame impingement test shall be conducted under conditions of ambient airflow. Care shall be taken to assure that the plume of flame issuing from the burner is as close to vertical as possible and impacts directly on the test vent.

5.8.2 Number of tests. Conduct the tests on three replicate vents of the same design and size.

5.8.3 Burner configuration. The burner will be centered with respect to the vent orientation in the soffit and 0.75 inches (20 mm) from the wall

5.8.4 Burner output verification. Without the vent in place, adjust the burner for 300 kW ± 15 kW. Extinguish the burner.

5.8.5 Procedure

5.8.5.1 Ignite the burner, controlling for a constant 300 ± 15 kW output.

5.8.5.2 Continue the exposure until flame penetration of the vent occurs, a maximum temperature of 325°C (617°F) is exceeded by any single thermocouple for a period of 6 seconds or more, or for a 10-minute period.

5.8.5.3 Tests shall be run in triplicate.

5.9 Observations. Note the time and duration of flame penetration.

5.10 Conditions of Acceptance

5.10.1 The test shall be run on three representative vents. All three vents must comply with the acceptance criteria.

5.10.2 No flame shall be observed on the non-fire side of the vent for a period in excess of 10 seconds.

5.10.3 The maximum temperature of any single thermocouple shall not exceed 325°C (617°F) for 6 or more seconds.

SAMPLE DESCRIPTION

Six vents were delivered to WFCi by the client for testing. The vents measured 6.75" wide and 15" long overall. The opening of the vent measured 4.75" wide and 13.75" long. The vents consisted of 5/8" thick by nominal ¼" cell Hexcel aluminum honeycomb coated with FireFree Coatings intumescent material. The 'entry' side of the vent was covered with No. 4 mesh steel screen. The 'exit' side of the vent was covered on the face and wrapped on the sides with No. 20 mesh steel screen. The honeycomb/screen components were held in place in the steel vent body assembly with bent metal tabs.

The Vulcan Vent Specification Sheet detailing the client's representation of the vent construction is provided in Appendix A, along with information regarding product part numbers of associated production.

PART A - EMBER PENETRATION TEST.

TEST OBSERVATIONS AND RESULTS

Test #1:

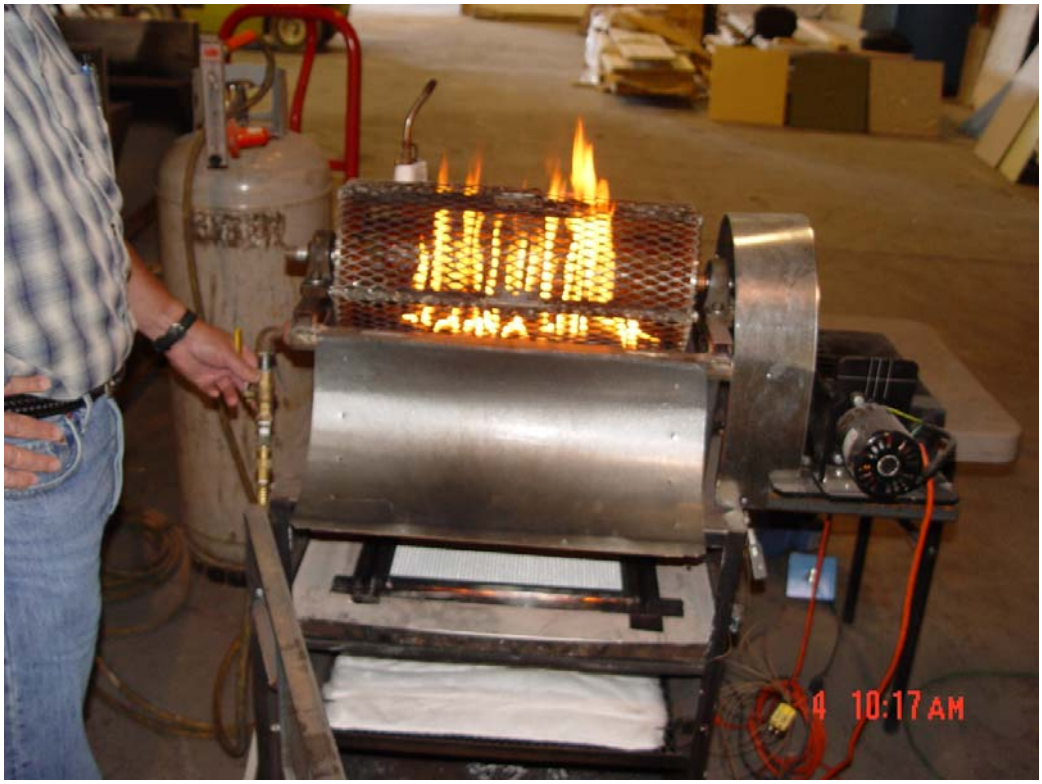
Time mm:ss	Observation
00:00	Ignite burner, expose brands to flame for 3 minutes
03:00	Terminate burner flame, activate blower, close cabinet door, inititate ember exposure,
03:00 to 08:00	Small embers pass through vent, some glow at points of ember contact with cotton target, no ignition
0:08:00	Ember generation complete, no ignition of cotton target, PASS
Post Fire Exposure:	Slight charring/discoloration at points of ember contact evenly distributed across cotton target
Date	8/4/08
Cabinet temperature - vent entry side	105°C
Laboratory Temp/Humidity	20°C/55%

Test #2:

Time mm:ss	Observation
00:00	Ignite burner, expose brands to flame for 3 minutes
03:00	Terminate burner flame, activate blower, close cabinet door, inititate ember exposure,
03:00 to 08:00	Small embers pass through vent, some glow at points of ember contact with cotton target, no ignition
0:08:00	Ember generation complete, no ignition cotton target, PASS
Post Fire Exposure:	Slight charring/discoloration at points of ember contact evenly distributed across cotton target
Date	8/4/08
Cabinet temperature - vent entry side	105°C
Laboratory Temp/Humidity	20°C/55%

Test #3:

Time mm:ss	Observation
00:00	Ignite burner, expose brands to flame for 3 minutes
03:00	Terminate burner flame, activate blower, close cabinet door, inititate ember exposure,
03:00 to 08:00	Small embers pass through vent, some glow at points of ember contact with cotton target, no ignition
0:08:00	Ember generation complete, no ignition cotton target, PASS
Post Fire Exposure:	Slight charring/discoloration at points of ember contact evenly distributed across cotton target
Date	8/4/08
Cabinet temperature - vent entry side	105°C
Laboratory Temp/Humidity	20°C/55%



Ignition of Brands

Immediately prior to ember exposure

Two cotton targets showing ember distribution post test

PART B – FLAME INTRUSION TEST (MODIFIED)

TEST OBSERVATIONS AND RESULTS

TEST #1:

Time	Observation
0:00:00	Ignite burner, start test
0:01:15	Vent closed off, no sign of flame penetration
0:10:00	No flame penetration of vent, Temperature rise meets limiting condition, PASS
Date	9/20/07
Burner Exposure	Burner = 150kW, Burner + burning wall cladding > 400 kW
Laboratory Temp/Humidity	19 C/ 57%

TEST #2:

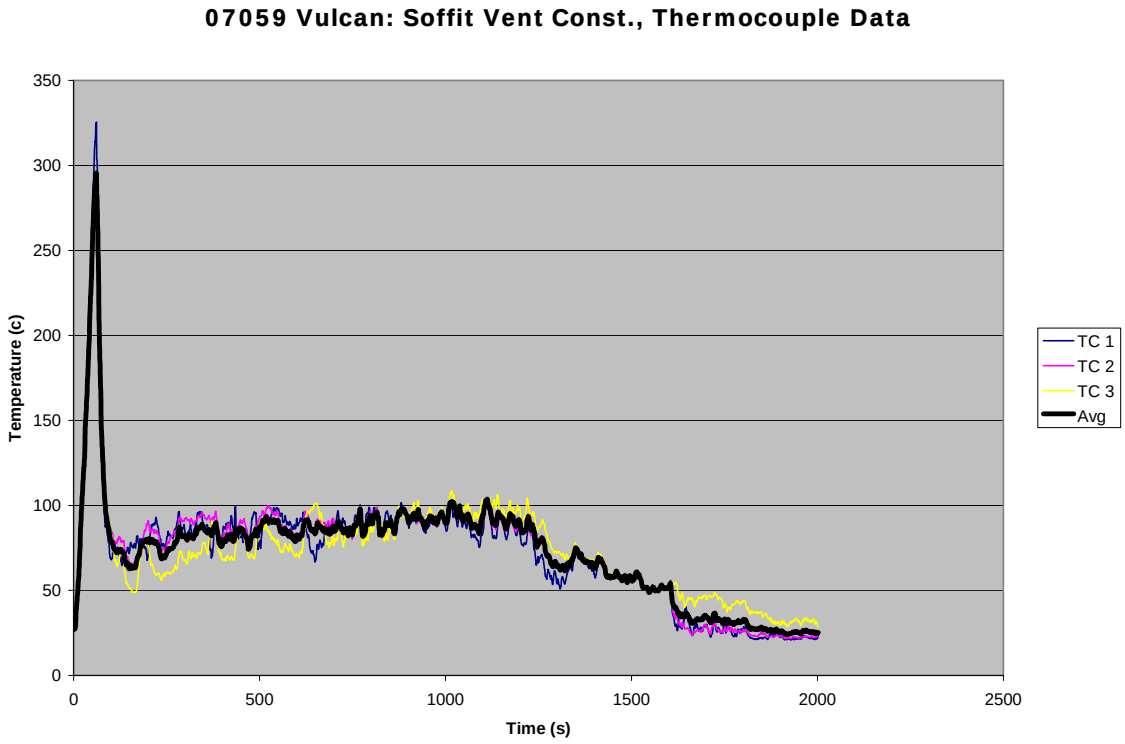
Time	Observation
0:00:00	Ignite burner, start test
0:01:10	Vent completely closed off, no sign of flame penetration
0:10:00	No flame penetration of vent, Temperature rise meets limiting condition, PASS
Date	9/20/07
Burner Exposure	Burner = 150kW, Burner + burning shake wall cladding > 400 kW
Laboratory Temp/Humidity	19 C/ 57%

Test #3:

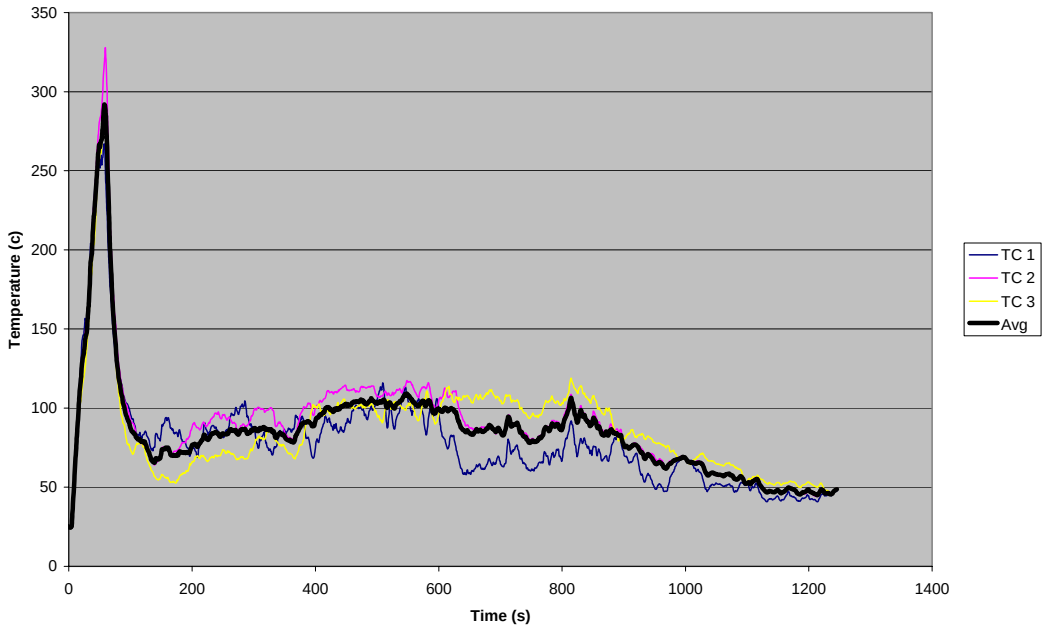
Time	Observation
0:00:00	Ignite burner, start test
0:01:10	Vent completely closed off, no sign of flame penetration
0:10:00	No flame penetration of vent, Temperature rise meets limiting condition, PASS

Date	9/20/07
Burner Exposure	Burner = 150kW, Burner + burning shake wall cladding > 400 kW
Laboratory Temp/Humidity	19 C/ 57%

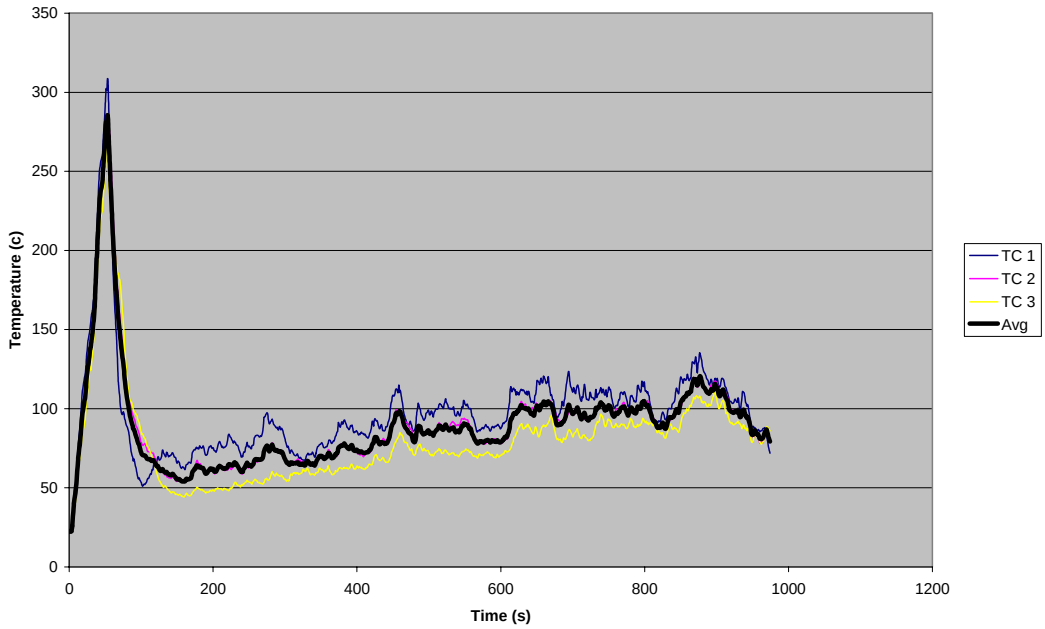
Thermocouple Data Test 1



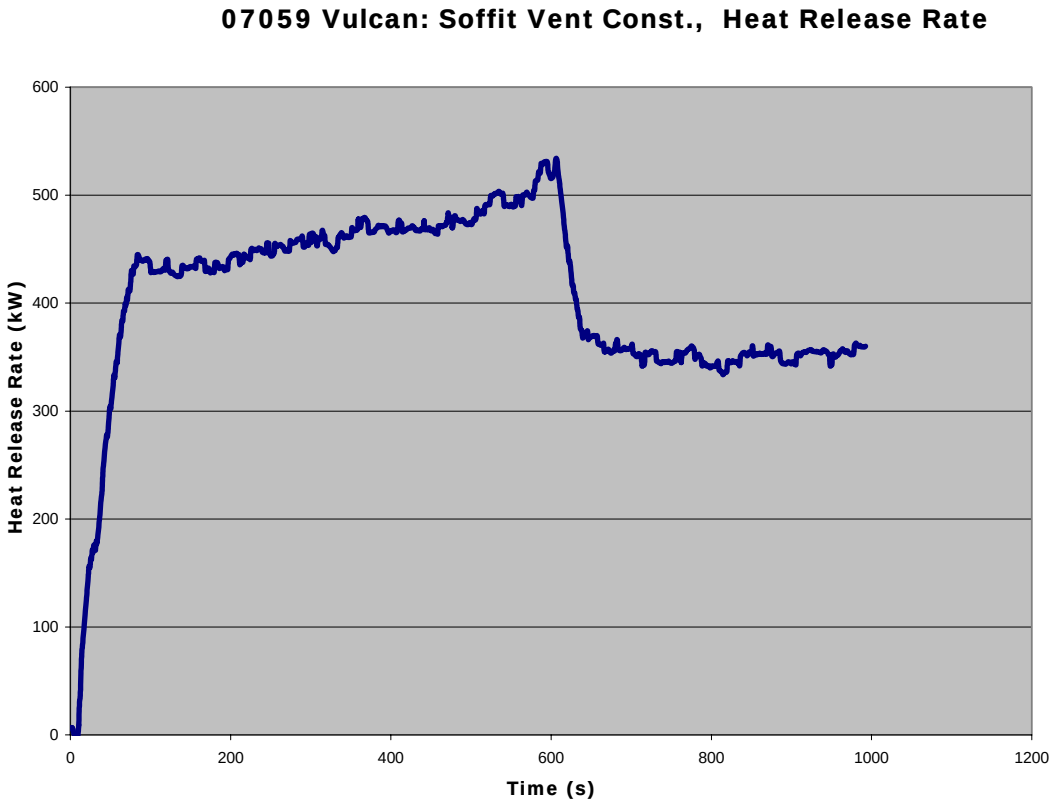
Thermocouple Data Test 2



Thermocouple Data Test 3



Heat Release Data for Representative Vulcan Vent Exposures



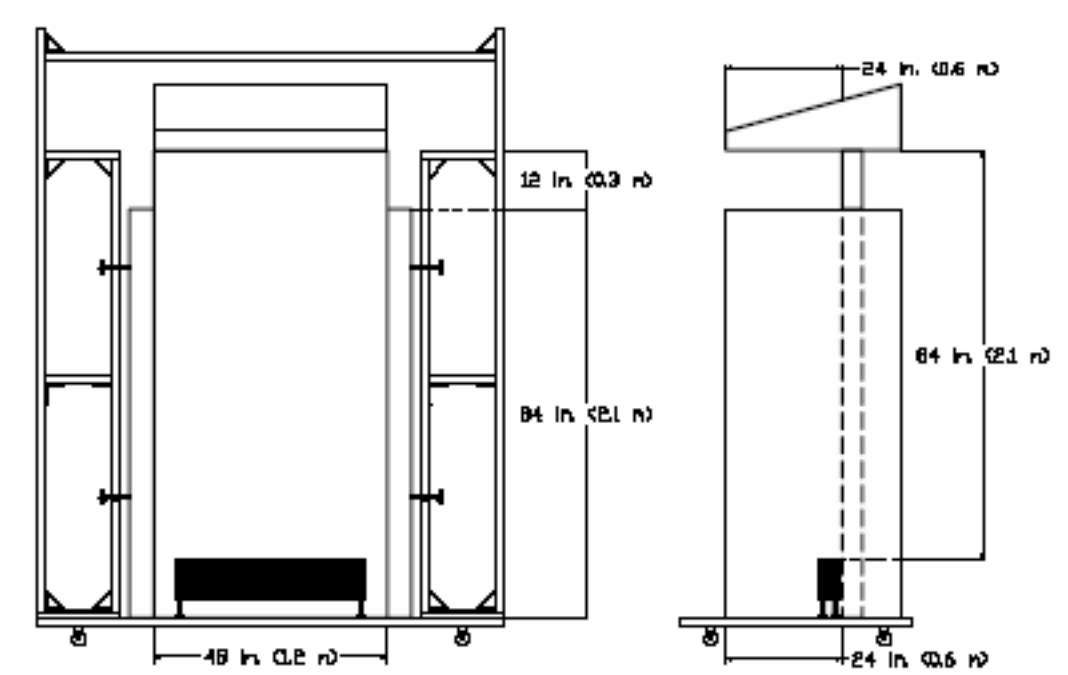
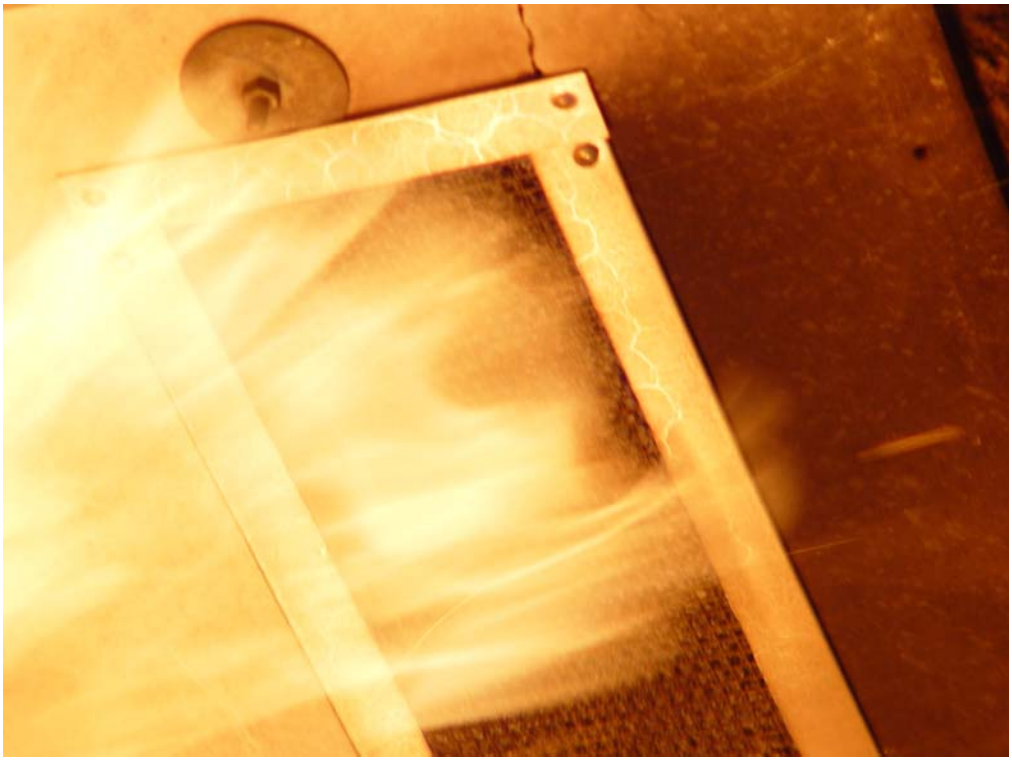


Figure 1. Eaves-Wall Test Assembly

Vent in position prior to flame exposure

Flame intrusion exposure



Vent during flame intrusion exposure

CONCLUSION

The Vulcan vent construction as described in this report meets the limiting criteria established in Parts A and B of the **Draft California State Fire Marshal Interim Test Method for Evaluating the Ability of Vents to Resist Entry of Embers and Flame Impingement**.

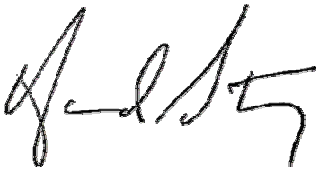
EXTENSION OF DATA

It is our opinion that the test results presented in this report for the vent size and construction described herein can be applicable to larger eave and soffit vent sizes described in Appendix A for the following reasons:

- The No. 20 steel mesh screen appeared to limit the number and size of embers to a level that was insufficient to ignite the cotton waste target in our test. It is our judgement that this mesh size would produce a similar result if larger vent openings/constructions were to be tested in a larger scale.
- The intumescent coating of the ¼" aluminum honeycomb vent component reacted and completely closed off the vent from passage of flame in our test. It is our judgement that vents of larger sizes would respond comparably to the specified test conditions.

SIGNATURE PAGE

Reviewed and approved,



Howard Stacy
Director, Testing Services

The test specimen identification is as provided by the client and WFCi accepts no responsibilities for any inaccuracies therein. WFCi did not select the specimen and has not verified the composition, manufacturing techniques or quality assurance procedures.

Appendix A

Product Specifications and Associated Model Nos.

Exclusive Manufacturer of the Vulcan Vent®
The Fire & Ember Safe Vent
PO Box 1126 • Loomis, CA 95650
916-652-7424 • FJ 916-647-0477

Vulcan Vent Specification Sheet

Vulcan Vents shall be constructed according to the following specifications, consisting of:

1) A corrosion resistant, industry standard vent frame (i.e. Gable, Eave, Foundation/Soffit, Roof mount).
2) .002" (min) Aluminum 1/4" cell expanded hexagonal honeycomb 5/8" thick, coated with FireFree88 intumescent coating. Each cell requires a minimum average coating thickness of .005" at thickest point.
3) 20 mesh-.009", stainless steel wire.

The coated honeycomb and mesh shall be secured in the frame in such a way as to require all air flow through the vent frame to pass through the coated honeycomb and the wire mesh.

	GMFG #	Size	Part
1	VE3522(S)	3.5 X 22	Eave
2	VE5522(S)	5.5 X 22	Eave
3	VE3514(S)	3.5 X 14	Eave
4	VE5514(S)	5.5 X 14	Eave
5	VER2	2" RND	Eave
6	VER3	3" RND	Eave
7	VFS414(S,FF,FB)	4 X 14	Foundation/Soffit
8	VFS614(S,FF,FB)	6 X 14	Foundation/Soffit
9	VFS814(S,FF,FB)	8 X 14	Foundation/Soffit
10	VG148(S,FF,FB,R)	14 X 8	GableEnd
11	VG1412(S,FF,FB,R)	14 X 12	GableEnd
12	VG1418(S,FF,FB,R)	14 X 18	GableEnd
13	VG1424(S,FF,FB,R)	14 X 24	GableEnd
14	VSB1212	20x20	Sub-Base
15	VSB8585	16.5X16.5	Sub-Base
16	VSC2120	2 X 120	Soffit
17	VM1424	13.5 x 24	Matrix/Mesh Only

All models are comprised of the following:

1) Industry Standard vent frame
2) 5/8" thick by nominal 1/4" cell Hexcel aluminum honeycomb coated with FireFree intumescent material
3) No. 20 mesh steel screen.

S = Stucco, FF = Flat Front (wood), FB = Flat Back (1 ½" for Foam)