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WHI TEST REPORT #630-611300

REPORT

OF

TEST OF GASKETING FOR RESISTANCE TO
AIR FLOW AT ELEVATED TEMPERATURE
TO DETERMINE EFFECTIVENESS AS A SMOKE
CONTROL DOOR SEAL

FOR

SEALEZE CORPORATION
RICHMOND, VIRGINIA

BY

WARNOCK HERSEY INTERNATIONAL, INC.
MIDDLETON, WISCONSIN 53562

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The product described herein has met the performance requirement to be eligible for a Warnock Hersey International (WHI) certification program. This report does not automatically imply certification. Products must bear a WHI label in order to demonstrate WHI certification. Warnock Hersey authorizes the above named client to reproduce this report only in its entirety.

INTRODUCTION

Warnock Hersey International Inc. (WHI) conducted tests on March 8 and March 27, 1987 to determine the resistance to air leakage of Sealeze Corporation “THEM-L-BRUSH IT” brush type gasketing. Air leakage was measured at several differential pressures at room temperature and at an elevated temperature of over 400° F. These tests were designed to determine the effectiveness of the subject product as a smoke control barrier. The tests were designed to determine the gasketing’s performance as a component with respect to requirements and recommendations of NFPA 105, 1985 “INSTALLATION OF SMOKE AND DRAFT CONTROL DOOR ASSEMBLIES.

OVERVIEW

A center opening elevator door assembly was used for this test program. The opening measured 4 feet wide by 9 feet high. The door system, including frame and operators, was installed by a professional elevator installation contractor. The gasketing was applied per the manufacturer’s written instructions by a representative of Sealeze Corporation. The door system was cycled 652,720 times before the March 9, 1987 leakage test. A fault developed in the chamber heating system during the high temperature portion of this test resulting in a single set of readings being made after 3 minutes exposure to 400° F chamber temperatures. Since a minimum exposure time of 20 minutes was planned, it was decided that new gasketing be installed and the test rerun. The manufacturer of the gasket material recommends adjustment of the seals every 100,000 cycles. Therefore, it was decided to cycle the second gasket set 100,000 times and conduct the air leakage tests without adjustment of the gasket. A visual examination of the gasket used in the first test showed little wear and no significant degradation of the brush fibers as a result of the 652,720 cycles. For this and other reasons it is Warnock Hersey’s judgment that the results of the second test would not be significantly altered by additional cycling of the system up to the 500,000 – 700,000 range.

An oxidation resistance test was also conducted on small samples of the THERM-L-BRUSH II material in accordance with ASTM D-572-81.

APPARATUS

A chamber was constructed for this test in general conformance to the requirements of ASTM E-283. The chamber included insulation and heating equipment capable of heating the air in the chamber and make up air used to measure leakage rates to over 400° F.

The elevator doors were installed in a wall constructed in the open side of the chamber. All joints within the chamber and between the chamber wall and mask wall were sealed with silicone rubber caulk.

Make up air was introduced through a calibrated orifice plate metering system upstream of the heaters. The following is a list of instrumentation and measurements made during the tests.

	<u>MEASURED PARAMETER</u>	<u>INSTRUMENT</u>	<u>ACCURACY</u>
1.	Air Flow	Orifice Plate/manometer	$\pm 2\%$
2.	Chamber Pressure	Differential pressure gauge	$\pm .002''$ w.c.
3.	Chamber Temperature	Type K Thermocouples and Digital Readout	$\pm 1.5^\circ$ F
4.	Make-up Air Temperature	Type J Thermocouple and Digital Readout	$\pm 1.5^\circ$ F
5.	Barometric Pressure	Mercury in Glass Barometer	$\pm .01''$ Hg

TEST INSTALLATION

The elevator door and frame used were typical of normal construction and represented the shaft corridor opening (i.e. without car doors). The doors were U.L. listed 90 minute insulated steel doors 1-1/4" thick. As installed there was a 1/4 inch space between the edges of the door and the door frame. The Sealeze Corp. Therm-L Brush II was installed to span this gap and adjusted so that the end of the brush was in contact with the frame at the sides and the gib rail at the bottom. In these areas the gasket was attached to the doors. At the top the gasket was installed on the frame so that the brush was in contact with the top edge of the doors when in a closed position. Sealeze's 180° extrusions were used to mount the gasket on the sides and bottom of the doors so that the brush was perpendicular to the frame and gib rail surfaces. A 45° extrusion was used at the top and aligned so the contact of the brush was at the upper inside corner of the top edge of the doors. The gasketing used on the sides and bottom was 1/2 " wide brush. The top gasket was 3/4 inches wide.

An initial test was run before gasketing was installed in an attempt to determine leakage rate through the ungasketed door. With the maximum air flow available from the equipment of 485 SCFM, the chamber pressure could not be brought to .05 inches w.c. The leakage rate of the ungasketed assembly could thus not be determined but was estimated at over 500 CFM for all test conditions.

PROCEDURE

The doors were operated after the gasketing was installed for 652,720 cycles prior to the first test. Gib rail shoes were replaced as recommended by the elevator door installer when wear was evident. At the end of the cycling the door opening was sealed with polyethylene plastic sheeting and tape and tests were run to measure back ground leakage. The plastic was then removed and a series of tests were run to determine ambient temperature leakage rates as followings:

1. Doors closed – no adjustments.
2. Meeting edge taped and gib rail ends sealed.
3. Meeting edge taped and gib rail track unsealed.
4. Meeting edge taped, track unsealed, Sealeze Gasket readjusted to manufacturer's specs.

These tests were run to determine the location and amounts of leakage through the Sealeze gasket system vs. other potential leakage paths. It was found that a substantial leakage was occurring through the meeting edge seal and through the gib rail track. Since the test was intended to measure the performance of the Sealeze gasket it was decided that sealing the meeting edge of the doors and plugging the track ends was appropriate so that the leakage rate measured would be a direct measurement of leakage through areas gasketed with the Sealeze product.

Following the ambient leakage tests described above, the air temperature in the chamber was raised to over 400°F and a set of leakage measurements made. A fault developed in the heating system shortly after the 400°F temperature was reached necessitating a shut down of the system.

RESULTS OF MARCH 9, 1987 TEST

Run #	Temp.	Conditions	Test		LEAKAGE RATES	
			Pressure	Totals*	SCFM/FT	SCFM/L.FT
1.	69°F	Background check Opening masked	0.05	2.98		
			0.10	6.61		
			0.20	12.19		
2.	71°F	Unmasked, No Additional Sealing	0.05	70.6	1.96	2.42
			0.10	107.4	2.98	3.84
			0.20	176.8	4.91	6.31
3.	72°F	Unmasked, Meeting Edge Taped, Track sealed	0.05	51.02	1.41	1.82
			0.10	80.59	2.24	2.88
			0.20	132.26	3.67	4.72
4.	73°F	Meeting edge, taped Track unsealed	0.05	54.11	1.50	1.93
			0.10	85.06	2.36	3.04
			0.20	137.39	3.81	4.91
5.	73°F	Meeting edge taped, Track sealed, Sealeze Gasket Adjusted	0.05	32.89	0.92	1.17
			0.10	54.87	1.52	1.96
			0.20	89.49	2.49	3.20
6.	403°F	Meeting edge taped Track sealed, Sealeze Gasket Adjusted	0.05	18.6	0.40	0.63
			0.10	22.7	0.63	0.81
			0.20	42.27	1.17	1.51

Since it was not possible to maintain the 400°F chamber temperature during this test, a second test was conducted. New gasketing was installed and adjusted and the doors were cycled 100,014

times before the air leakage tests were run. In this test the background leakage rates were measured as in the first test and the track and meeting edge of the doors were again sealed. No adjustment was made to the doors other gasketing after the 100,014 cycles. For this test series an additional pressure difference of 0.16 inches water column was used. Under the high chamber temperature conditions leakage readings were taken at 5, 10, 15, 20, 30, 45 and 60 minutes. Graphs I and II show the leakage rate vs. time at 400°F for each pressure and pressure vs. leakage rate at ambient and elevated temperatures.

*Leakage rate for runs 2-6 are net leakage calculated as follows:
 Net leakage = Metered leakage – background leakage.

RESULTS				LEAKAGE RATES		
Test Description	Temp.	Press.	SCFM	SCFM/FT	SCFM/L.FT	
Background Leakage	74	.05	7.1			
		.10	9.18			
		.16	12.27			
		.20	13.89			
Ambient leakage - Meeting edge & track sealed	74	.05	33.5	0.93	1.29	
		.10	63.5	1.76	2.44	
		.16	99.05	2.75	3.81	
		.20	124.1	3.45	4.77	
Door Seals at Meeting edge & track	5 Min.	400	.05	20.66	.57	.79
			.10	41.79	1.16	1.61
			.16	60.82	1.69	2.34
			.20	72.52	2.01	2.79
	10 Min.	401	.05	15.69	.44	.60
			.10	40.59	1.13	1.56
			.16	61.53	1.71	2.37
			.20	73.97	2.05	2.84
	15 Min.	398	.05	19.92	0.55	0.77
			.10	45.63	1.27	1.75
			.16	63.16	1.75	2.43
			.20	74.24	2.06	2.86
	20 Min.	414	.05	19.34	0.54	0.74
			.10	44.19	1.23	1.7
			.16	69.11	1.92	2.66
			.20	77.66	2.16	2.99
	30 Min.	406	.05	18.46	0.51	0.71
			.10	44.16	1.23	1.7
			.16	63.98	1.78	2.46
			.20	74.89	2.08	2.88
45 Min.	407	.05	16.91	0.47	0.65	
		.10	42.17	1.17	1.62	
		.16	63.98	1.82	2.41	
		.20	75.13	2.08	2.89	
60 Min.	406	.05	16.96	0.47	0.65	
		.10	43.85	1.22	1.69	
		.16	63.69	1.77	2.45	
		.20	76.02	2.11	2.92	

The ASTM D-572-81 test for deterioration by exposure to heat and oxygen showed no affect on the Sealeze product.

DISCUSSION

In both tests, leakage under the elevated temperature conditions was considerable reduced compared to Ambient temperature leakage rates. This was due to a bowing inward of the doors resulting from heating the inner surface. As this surface was heated it expanded more than the outer, cooler surface. This resulted in a bowing of the door which pressed the door tight to the frame along the center area and pulled the pressed the door tight to the frame along the center area and pulled the door away from the frame at the top and bottom. As a result, the gap being sealed became smaller in total area as the chamber heated up.

The data shows relatively constant performance throughout the 60 minute period during which the chamber temperature was maintained above 400°F. This indicates that there was no thermal degradation of the seals during the exposure period.

The application of the Sealeze Gasket showed at least a 95% decrease in leakage rates based on ambient temperature tests and estimated ungasketed leakage rates.

CONCLUSIONS

The Sealeze Corporation Therm-L-Brush II material evaluated in this program is eligible for Warnock Hersey listing and labeling service. The following information will be contained on the label.

1. Manufacture's Name and Locations.
2. The WHI trademark logo.
3. The words "listed Smoke Control Gasketing."

The following information will be included in the listing Performance Table as follows:

<u>Pressure Difference Inch W.C.</u>	<u>Leakage Per Foot (SCFM) Ambient Temp.</u>	<u>Leakage Per Foot (SCFM) 400 F</u>
.05	1.29	.74
.10	2.44	1.70
.16	3.81	2.66
.20	4.77	2.99

ADDEMDUM TO REPORT #630-61130
SEALEZE CORPORATION – RICHMOND, VIRGINIA

INTRODUCTION

On April 1, and April 10, 1987, Warnock Hersey International, Inc. conducted additional tests on Sealeze Therm-L-Brush II gasketing to determine the extent of effects of cycling the elevator doors 100,000 times and to determine air leakage rates through areas other than those to which the gasket was applied.

PROCEDURE

Following the tests reported on in report #630-611300 new gasketing was applied to the door by WHI personnel. Leakage rates for the gasketed area were measured with all alternate leakage paths sealed. The assembly was then cycled 100,000 times and new measurements made without any readjustment of the door or gasketing. Tests were run under the following conditions.

1. No additional sealing. I.e. gib rail track, meeting edge gasket and openings at the top of the doors unsealed.
2. Track plugged.
3. Track and meeting edge gasket sealed.
4. Track unplugged, meeting edge sealed.
5. Track, meeting edge, and top and bottom of door sealed.

From the results of these measurements leakage rates through each identifiable opening were calculated.

RESULTS

	TEST	LEAKAGE RATES IN SCFM (INCHES WATER COLUMN)		
		PRESS.		
Test conditions	0.05	0.1	0.16	.20
New Gasket, all alternated leakage paths sealed	19.01	29.9	41.9	50.8
After 100,000 cycles, all alternate leakage paths sealed	21.4	32.5	46.3	53.8
% CHANGE	12.6%	8.7%	10.5%	5.9%
Unit Unsealed Total Leakage	37.0	55.0	76.7	88.3
Leakage through Track	5.2	6.0	8.3	10.1
% of TOTAL	14.1%	10.9%	10.8%	11.4%
Leakage through Meeting edge Seal	7.3	11.4	15.8	16.4
% of TOTAL	19.7	20.7	20.6	18.6
Leakage through openings at Top & Bottom or Doors at meeting edge	3.1	5.1	0	6.3
% of TOTAL	8.4%	9.3%		8.2%
Leakage through Sealeze Gasketed Cracks	21.4	32.5	46.3	53.8
% of TOTAL	57.8%	59.1%	60.4%	60.9%

DISCUSSION

These tests were conducted in an attempt to determine the relationship between leakage rates through gasketed areas vs. other leakage paths. Since NEPA 105 is presented in terms of leakage through the total opening, it is necessary to either test total systems for compliance or determine the effects of various typed of leakage paths to determine an overall effectiveness of opening protection. Since the gasket which was the subject of this investigation is applied typically to perimeter cracks, it is appropriated to give it a rating based on its ability to seal these cracks. If, in a real installation, other leakage paths exist which are unaffected by the installation of gasketing, the total opening will leak at a higher rate than determined from the gasket ratings alone. The existence of alternate leakage paths, their size and effect is likely to be a highly variable portion of the total leakage contribution picture.

The results of this investigation showed that nearly 40% of the leakage through the door system, once gasketing was applied, occurred through areas other than the gasketed perimeter cracks. This implies that the total leakage rate will in general be higher than that calculated from gasket ratings alone. It also implies that even a 100% seal of the edge cracks would still allow significant leakage through other areas.

One approach to determining opening compliance with NFPA 105 draft a smoke control criteria is based on component contribution. In this method the designer must evaluate the system and determine where leakage may occur and estimate its extent. In the case of a 4-0 by 9-0 center opening elevator door as described in these tests, there are 4 basic leakage paths. 1) the door perimeter to frame crack, 2) the meeting edge, 3) the gib rail track, and 4) small opening between the doors at the bottom and top where the center gasket ends.

The Sealeze Therm-L-Brush II test data provides information regarding expected leakage at ambient and elevated temperatures through the perimeter crack. This addendum provides some additional information regarding the other three leakage paths at room temperature. It is expected that leakage through the gib rail track would not be significantly affected temperature or door movement at elevated temperatures. The other leakage paths, however, may be affected by temperature and door deflection. Thus there is currently not enough information to make supportable estimates of total high temperature leakage rates through this type of system.

If on the other hand one considers using the Sealeze gasket on a single opening 3.0 by 8.0 door, the problem is simplified. In this case there are only the perimeter and track end areas for leakage paths. Based on the test results reported on here one could estimate the 400°F leakage rate of the assembly at .05 inches w.c. as follows:

$$\begin{aligned} \text{Perimeter Leakage} &= (8+8+3+3) \times 1.29 = 28.38 \text{ SCFM} \\ \text{Track ends} &= 5.2 \text{ SCFM} \\ \text{TOTAL} &= 33.58 \text{ SCFM} \end{aligned}$$

Leakage rate per square foot of opening =

$$\frac{33.58 \text{ SCFM}}{24 \text{ ft}^2} = 1.40 \text{ SCFM/ft}^2$$

CONCLUSIONS

1. Significant leakage was measured in areas other than those to which gasketing was applied. Approximately 40% of the total assembly leakage occurred in these areas.
2. 100,000 cycles decreased the Sealeze gaskets effectiveness by about 10%. Earlier tests showed adjustment of door and gasket restored effectiveness.
3. The component approach to estimating total assembly leakage rates is feasible but requires more information on the effects of high temperatures on alternate leakage paths.
4. Leakage rates through each path as a percentage of total leakage were nearly constant and nearly linear with pressure change.