Evaluation of the Air Permeance of Concrete Masonry Wall Assemblies Coated with Air Barrier Coatings

For

Bautex Systems LLC
101 Thermon Dr., Suite 10
San Marcos, TX 78666

Conducted by:

NATIONAL CONCRETE MASONRY ASSOCIATION
RESEARCH & DEVELOPMENT LABORATORY

Project No. 09-109A Revised
Date: August 12, 2009
Revised: January 2, 2013

IAS ACCREDITED

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The measured and calculated values provided in this report are the official values resulting from this body of work. Values in parenthesis are mathematical conversions provided for reference only and may differ slightly from the official values due to conversion rounding.

This report was prepared for Bautex Systems, LLC by the National Concrete Masonry Association Research and Development Laboratory based upon testing, analyses, or observations performed by the National Concrete Masonry Association Research and Development Laboratory. Reference herein to any specific commercial product, process, or service by trade name, trademark, or manufacturer does not necessarily constitute or imply its endorsement or recommendation by the National Concrete Masonry Association or its staff. The contents of this report have been reviewed by the following individuals, who believe to the best of their ability that the observations, results, and conclusions presented in this report are an accurate and true representation of the services provided.

The NCMA Research and Development Laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to the joint ISO-ILAC-IAF Communiqué dated 18 June 2005). All test results presented here are within the scope of accreditation for the NCMA Research and Development Laboratory.

1/2/2013

Nicholas R. Lang, Manager, Research & Development Laboratory — Date

1/2/2013

Jason J. Thompson, Director of Engineering — Date

Statement of Revision

December 22, 2011 – Dry-film thickness measurements were removed.

January 2, 2013 – The client name and product trade names were revised from Report 09-109 per client request.

Table of Contents

Evaluation of the Air Permeance of Concrete Masonry Wall Assemblies with Air Barrier Coatings for Bautex Systems, LLC

1.0—INTRODUCTION

This report describes the construction and testing of two sets of concrete masonry wall assemblies each coated with a different proprietary product intended to reduce the infiltration of air through the assembly. The assemblies were evaluated for air permeance before and after the application of the two coatings in accordance with ASTM E2178-03, *Standard Test Method for Air Permeance of Building Materials* (Ref. 1). The relative performance of each set of assemblies with and without coatings is then compared.

2.0—MATERIALS

2.1 Concrete Masonry Units

The concrete masonry units used in this project were provided by the client and had nominal dimensions of 8 x 8 x 16 in. (203 x 203 x 406 mm). The units were sampled and tested for compressive strength, absorption, density, and dimensional tolerances following the procedures in ASTM C140-08a, *Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units* (Ref. 2). The evaluated properties of the units complied with the physical requirements contained in ASTM C90-08, *Standard Specification for Loadbearing Concrete Masonry Units* (Ref. 3). It is noted that the units had the density classification of "normal weight." A summary of the units' physical properties is provided in Table 1, with detailed results included in Appendix A.

Table 1 – Concrete Masonry Unit Test Results

Property	ASTM C90-08 Requirement	Average Test Results
Net Area Compressive Strength, psi (MPa)	1,900 (13.1 MPa) min	5,130 (35.4)
Density, lb/ft^3 (kg/m^3)	****	132.0 (2,114)
Absorption, lb/ft^3 (kg/m^3)	13 (208) max	9.9 (159)
Width, in. (mm)	****	7.64 (194.1)
Height, in. (mm)	****	7.63 (193.8)
Length, in. (mm)	****	15.60 (396.2)
Face Shell Thickness, in. (mm)	1.25 (32) min	1.28 (32.5)
Web Thickness, in. (mm)	1 (25) min	1.01 (25.7)
Percent Solid, %	****	51.4

2.2 Masonry Mortar

The masonry mortar used in this project consisted of Type S masonry cement mortar meeting the proportion requirements of ASTM C270-08a, *Standard Specification for Mortar for Unit Masonry* (Ref. 4). The proportions used were one part Type S masonry cement, conforming to ASTM C91-05, *Standard Specification for Masonry Cement* (Ref. 5), and three parts masonry sand conforming to ASTM C144-04, *Standard Specification for Aggregate for Masonry Mortar* (Ref. 6)

The mortar was sampled and tested for compressive strength using 2 in. (50.8 mm) cubes in accordance with ASTM C780-08a, *Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry* (Ref. 7). The average compressive strength of the mortar, after 28 days curing, was 2,080 psi (14.3 MPa). Detailed results from the mortar testing are provided in Appendix B.

2.3 Coatings

Two coatings were provided by the client; a water-born coating bearing the trade name "Bautex Air and Moisture Barrier 20-WP" and a solvent-born coating with the trade name "Bautex Air and Moisture Barrier 20-SN" Both coatings were applied following the same procedure using instructions provided by the client. For each coating, two coats of approximately 20 mils (0.5 mm) while wet were applied, for a total wet thickness application of approximately 40 mils (1.0 mm). Both coats were applied using a roller. The first coat was allowed to dry for at least 8 hours prior to application of the second coat. After the second coat dried, any pinholes seen on the coated area were touched-up by dabbing the coating material onto the area with a paint brush.

3.0—CONSTRUCTION AND TESTING PROCEDURES

3.1 Specimen Construction

All walls were constructed using good construction techniques in accordance with TMS 602-08/ACI 530.1-08/ASCE 6-08 *Specification for Masonry Structures* (Ref. 8).

A total of ten individual specimens were constructed. Each specimen had overall nominal dimensions of 64 in. (1,626 mm) in height, 56 in. (1,422 mm) in length, and a nominal thickness of 8 in. (203 mm). The specimens were laid in a running bond configuration using face shell mortar bedding except at the ends of the panels where the end webs were mortared. Mortar joint thickness was 3/8 ± 1/8 in. (9.5 ± 3.2 mm). Mortar joints at the faces of the specimens were struck and tooled with a concave jointer after they became thumbprint hard. Joints at the ends of the panel were struck flush.

The cells along top, bottom, and sides of each specimen outside of the test area were fully grouted to help isolating airflow through the test area of the assembly. In the grouted cells on each side, a vertical hook was embedded to facilitate moving specimens around the laboratory. The remainder of the specimen was left ungrouted.

3.2 Test Area Preparation

The test area as defined by ASTM E2178-03 is 1.0 m^2 (10.8 ft^2). For testing of concrete masonry wall assemblies, it is necessary to isolate the test area to eliminate extraneous airflow. To accomplish this, all non-incidental areas of the specimen were sealed, including the top and bottom of the specimen. For the bottom of the specimen, a self-adhesive rubber flashing membrane was attached to each specimen, and the joint between the flashing and the edge of the wall was caulked with silicon caulk. For all other areas, two coats of commercial block filler were applied using a roller, followed by two coats of one-part epoxy paint, typically used for concrete floors. The mortar joints immediately adjacent to the test area were filled with a silicon sealant, to create a consistent surface at the point of connection of the test apparatus. Each wall was further spot-checked during initial testing, and visible areas of leakage non-incidental to the test area were sealed using either silicon sealant or additional epoxy paint. The sealing of the non-incidental surfaces of each specimen as defined here is not required by ASTM E2178-03.

3.3 Test Apparatus

The test apparatus for measuring air permeance is a cabinet with a nominal test area of 1.0 m^2 (10.8 ft^2). This cabinet is attached to the wall specimen and sealed along the edges using closed cell foam. A thin layer of petroleum jelly was applied to the foam seal to facilitate sealing and subsequent removal of the cabinet from the specimen following testing.

Connected to the cabinet by way of plastic hoses are two air pumps, which create a negative pressure differential within the cabinet. The negative pressure differential is measured using a digital manometer

attached to the cabinet. The laboratory has the ability to test using either a high flow air pump, which accommodates larger volumes of air through the test specimens, or a low flow air pump, which offers better resolution of the air moving through the assembly. In this investigation, the low flow air pump was used.

3.4 Test Procedures

Each specimen was tested in accordance with ASTM E2178-03, as modified by standard laboratory procedure. The first step in the test procedure is to measure the extraneous airflow of the test assembly.

A piece of 0.006 in. (0.15 mm) thick polyethylene film was placed between the wall specimen and the apparatus frame on the exterior side of the wall specimen. Prior to performing the first test on each specimen, the air flow pump was turned on to its maximum speed, which, in conjunction with the polyethylene film, created a pressure differential much greater than 300 Pa (6.27 lb/ft2). The non-incidental areas of the test specimen were examined for air leakage, and any spots identified as not being sealed were treated either with additional epoxy paint or silicon sealant. In addition, the seal between the apparatus and the specimen were inspected to assure proper seal. Once any noticed imperfections were corrected, testing was continued. The specimen, with the polyethylene attached, was tested at each of the pressure differentials described below. After completing the testing for extraneous airflow, the polyethylene film was cut and removed from the test area, without removing the test apparatus. The airflow was measured at each pressure differential a second time. The final leakage values for each specimen were determined by subtracting the leakage obtained during calibration (with the polyethylene film) from the values obtained without the polyethylene.

As required by ASTM E2178-03, the air flow through the specimen was measured at six pressure differentials, at 25, 50, 75, 100, 150, and 300 Pa (0.52, 1.04, 1.57, 2.09, 3.13, and 6.27 lb/ft^2) in increasing order, and repeated at 100, 75, and 50 Pa (2.09, 1.57, and 1.04 lb/ft^2) while descending back to zero. The purpose of the descending measurements is to evaluate the repeatability of the results for each test. If the air flow results between the repeated measurements are greater than 10%, the test is repeated.

Each wall assembly was tested twice. The first test was without any coating on the test area to serve as the initial reading of the uncoated assembly. Each assembly was then coated and tested a second time to evaluate the airflow of the assembly with the test coating applied.

3.5 Coatings

As discussed above, two coatings were evaluated in this investigation. The ten wall assemblies were grouped into two sets of five. The first set, herein referred to as Set 1, was coated with the "Bautex Air and Moisture Barrier 20-WP" coating, and the second set, herein referred to as Set 2, was coated with the "Bautex Air and Moisture Barrier 20-SN". Each coating was applied using the client's instructions, as detailed in Section 2.3 of this report.

4.0—RESULTS

After completion of testing on each set of five uncoated and coated wall assemblies, a data analysis was performed on the obtained measurements. An analysis for outlying observations was performed in accordance with the "Dixon Criteria" method in ASTM E178-08, *Standard Practice for Dealing with Outlying Observations* (Ref. 9). There were no outlying observations for any of the tests in this investigation. The individual assembly values were then averaged, and these average values for each set were plotted. A power fit trend line was determined, and this trend line was used to calculate the air permeance at a pressure differential of 75 Pa (1.57 lb/ft^2). This value, in cubic feet per minute per square

foot (CFM/ft^2) or standard liters per minute per square meter (SLPM/m^2), is the final value determined for the test. Detailed results for Set 1 are provided in Appendix C and detailed results for Set 2 are provided in Appendix D. A summary of both the coated and uncoated results are provided here.

For Set 1, none of the uncoated walls were able to achieve the maximum required test pressure differential of 300 Pa (6.27 lb/ft^2). The interpolated value of the air permeance at a pressure differential of 75 Pa (1.57 lb/ft^2), therefore, is based on the results up to 150 Pa (3.13 lb/ft^2). Similarly, only three of the Set 2 uncoated walls were able to achieve the 300 Pa (6.27 lb/ft^2) differential, and the interpolated values for Set 2 uncoated are also based on results up to 150 Pa (3.13 lb/ft^2). Unlike the uncoated walls, all of the coated walls (both Set 1 and Set 2) were able to achieve 300 Pa (6.27 lb/ft^2). The interpolated values of air permeance at 75 Pa (1.57 lb/ft^2) for both sets with and without coating are reported in Table 2.

Table 2 – Air Permeance Testing Results

Set	Interpolated Air Permeance Value at 75 Pa (1.57 lb/ft^2), CFM/ft^2 (SLPM/m^2)	
	Uncoated[1]	Coated
Set 1	0.1068 (32.78)	0.0008 (0.23)
Set 2	0.0846 (25.98)	0.0004 (0.13)

[1]Interpolated values for the uncoated assemblies are based on test results up to 150 Pa (3.13 lb/ft^2)

As seen in Table 2, both coatings significantly reduced the air permeance of the concrete masonry wall assemblies. Prior to coating, both sets had air permeance values at 75 Pa (1.57 lb/ft^2) in excess of 0.08 CFM/ft^2 (24.56 SLPM/m^2), while after coating each set had air permeance values at 75 Pa (1.57 lb/ft^2) of less than 0.001 CFM/ft^2 (0.31 SLPM/m^2).

5.0—SUMMARY

Two sets of concrete masonry wall assemblies were constructed using normal weight concrete masonry units. Each set was prepared and tested for air permeance, both before and after coating with client-provided air barrier coatings. The first set of assemblies were coated with the coating "Bautex Air and Moisture Barrier 20-WP". The uncoated air permenace of this set at 75 Pa (1.57 lb/ft^2) was 0.1068 CFM/ft^2 (32.78 SLPM/m^2), while after coating the air permenace at 75 Pa (1.57 lb/ft^2) was 0.0008 CFM/ft^2 (0.23 SLPM/m^2). The second set of assemblies was coated with the coating "Bautex Air and Moisture Barrier 20-SN". The uncoated air permenace of this set at 75 Pa (1.57 lb/ft^2) was 0.0846 CFM/ft^2 (25.98 SLPM/m^2), while after coating the air permenace at 75 Pa (1.57 lb/ft^2) was 0.0004 CFM/ft^2 (0.13 SLPM/m^2).

6.0—REFERENCES

1. ASTM Standard E2178, 2003, "Standard Test Method for Air Permeance of Building Materials", ASTM International, West Conshohocken, PA, www.astm.org.
2. ASTM Standard C140, 2008a, "Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units", ASTM International, West Conshohocken, PA, www.astm.org.
3. ASTM Standard C90, 2008, "Standard Specification for Loadbearing Concrete Masonry Units", ASTM International, West Conshohocken, PA, www.astm.org.

4. ASTM Standard C270, 2008a, "Standard Specification for Mortar for Unit Masonry", ASTM International, West Conshohocken, PA, www.astm.org.
5. ASTM Standard C91, 2005, "Standard Specification for Masonry Cement", ASTM International, West Conshohocken, PA, www.astm.org.
6. ASTM Standard C144, 2004, "Standard Specification for Aggregate for Masonry Mortar", ASTM International, West Conshohocken, PA, www.astm.org.
7. ASTM Standard C780, 2008a, "Standard Test Methods for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry", ASTM International, West Conshohocken, PA, www.astm.org.
8. TMS 602/ACI 530.1/ASCE 6, 2008, "Specification for Masonry Structures", Reported by the Masonry Standard Joint Committee, Boulder, CO, www.masonrysociety.org.
9. ASTM Standard E178, 2008, "Standard Practice for Dealing with Outlying Observations", ASTM International, West Conshohocken, PA, www.astm.org.

APPENDIX

In the appendix, the values presented are in inch-pound units. The following conversions to SI units can be used:

1 in = 25.4 mm

1 lb/ft^3 = 16.0 kg/m^3

1 lb (mass) = 0.4536 kg

1 lb (force) = 4.45 N

1 psi = 6.895 kPa

1 SLPM = 0.0353 CFM

1 Pa = 0.021 lb/ft^2

Appendix A – ASTM C140 Results

ASTM C 140-08 Test Report
Sampling and Testing Concrete Masonry Units and Related Units

Job No.: 09-109A-1
Report Date: 8/12/2009

Client: Bautex Systems, LLC
Address: 101 Thermon Dr., Suite 100
San Marcos, TX 78666

Testing Agency: National Concrete Masonry Association
Research and Development Laboratory
Address: 13750 Sunrise Valley Drive
Herndon, VA 20171-4662

Standard Specification: ASTM C90-08

Sampling Party: Bautex Systems, LLC

Unit Description:
8 x 8 x 16 Inch Concrete Masonry Unit

Date Samples Received: 7/14/2009

Summary of Test Results

Physical Property	Specified Values	Average Test Results		Physical Property	Specified Values	Average Test Results	
Net Compressive Strength	1900 min	5130	psi	Min. Faceshell Thickness (t_{fs})	1.25 min	1.28	in.
Gross Compressive Strength	****	2640	psi	Min. Web Thickness (t_w)	1.00 min	1.01	in.
Density	****	132.0	pcf	Equivalent Web Thickness	2.25 min	2.34	in.
Absorption	13 max	9.9	pcf	Equivalent Thickness	****	3.92	in.
Percent Solid	****	51.4	%	Max. Var. from Spec. Dimensions	.125 max	0.030	in.
				Net Cross-Sectional Area	****	61.21	in^2
				Gross Cross-Sectional Area	****	119.11	in^2

Individual Unit Test Results

		Received	Cross-Sectional Area *		Max.	Compressive Strength	
Compression	Specimen	Wt, W_R	Gross	Net	Load	Gross	Net
Units	No.	lb	in^2	in^2	lb	psi	psi
	#1	37.92	119.11	61.21	303850	2550	4960
	#2	37.45	119.11	61.21	307070	2580	5020
Date Tested:	#3	37.63	119.11	61.21	331280	2780	5410
7/23/2009	Average	37.67	119.11	61.21	314070	2640	5130

* Unit areas determined as the average of the three absorption units and are assumed to be the same as those units tested in compression.

		Avg	Avg	Avg	Avg./Min.	Min.
Absorption	Specimen	Width	Height	Length	t_{fs}**	t_w
Units	No.	in.	in.	in.	in.	in.
	#4	7.64	7.63	15.61	1.27	1.01
	#5	7.63	7.64	15.60	1.27	1.00
Date Tested:	#6	7.65	7.62	15.60	1.29	1.03
7/14/2009	Average	7.64	7.63	15.60	1.28	1.01

**Where the thinnest points of opposite face shells differ in thickness by less than 0.125 inches, their measurements are averaged.

	Specimen	Received Wt, W_R	Immersed Wt, W_I	Saturated Wt, W_S	Oven-Dry Wt, W_D	Absorp	Density	Net Volume	Percent Solid
Date Tested:	No.	lb	lb	lb	lb	pcf	pcf	ft^3	%
7/14/2009	#4	37.34	21.34	38.16	35.49	9.9	131.7	0.2696	51.3
to	#5	37.81	21.62	38.49	35.88	9.7	132.7	0.2704	51.4
7/20/2009	#6	37.47	21.43	38.31	35.60	10.0	131.6	0.2705	51.5
	Average	37.54	21.46	38.32	35.66	9.9	132.0	0.2701	51.4

Comments: These units meet or exceed the compressive strength, absorption and dimensional requirements of ASTM C 90-08.

Appendix B – ASTM C780 Results

ASTM C780-08a Test Report

Job No.: 09-109A-2
Report Date: 8/12/2009

Client:	Bautex Systems, LLC	Testing Agency:	National Concrete Masonry Association
Address:	101 Thermon Dr., Suite 10		Research and Development Laboratory
	San Marcos, TX 78666	Address:	13750 Sunrise Valley Drive
			Herndon, VA 20171-4662

Mortar Designation/Description:
Type S Masonry Cement Mortar

Batch Information (C 270)		Weight	Weight
Material	Type	Proportions	(lb)
Masonry Cement	Type S	1	15.6
Masonry Sand (OD)	C144	3	50.0

2-inch Cube Compressive Strength (C 109)

Date Tested: 7/30/2009

Cube Age: 1 day

Cube #	Cube Wt (g)	Load (lbs)	Cube Strength (psi)
1	253.8	8380	2100
2	259.2	8280	2070
3	254.4	8300	2080
Average	255.8	8320	**2080**

Appendix C – Set 1 E2178 Results

Uncoated

ASTM E 2178 - 03 - Standard Test Method for Air Permeance of Building Materials

Job No.: 09-109A-3A
Report Date: 8/12/2009

Client:	Bautex Systems, LLC	Testing Agency:	National Concrete Masonry Association
Address:	101 Thermon Dr., Suite 10		Research and Development Laboratory
	San Marcos, TX 78666	Address:	13750 Sunrise Valley Drive
			Herndon, VA 20171-4662

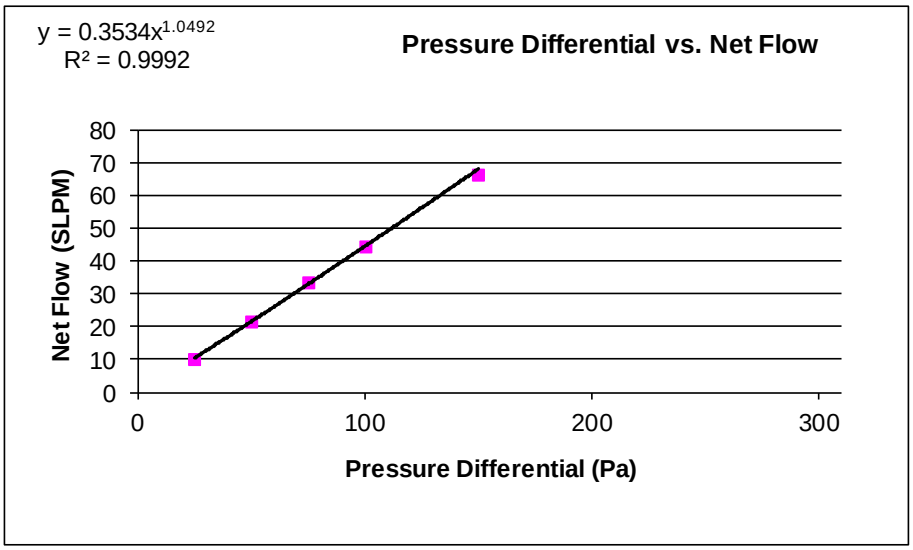
Results Summary

Sample set: Set 1 - Uncoated

Flow range: Low

Atmospheric Readings

Specimen	1A	1B	1C	1D	1E
Date Tested	7/21/09	7/21/09	7/21/09	7/22/09	7/22/09
Time	8:44 AM	10:58 AM	1:45 PM	9:03 AM	10:57 AM
Temperature (F)	79.6	80.4	81.8	80.4	81.4
Relative Humidity (%)	59.1	59	52.3	65.5	63.1



75 Pa Flow Calculation to Power Regression Fit

Regression equation: Net Flow = 0.3534 * Pressure Differential^ 1.0492

Interpolated 75 Pa Flow:	32.7779	SLPM	(Net Flow in 1 m x 1 m test area)
Conversion to CFM:	1.1571	CFM	(Net Flow in 1 m x 1 m test area)
Reported Value:	**0.1068**	**CFM / ft^2**	

Experimental results

Flow Readings were taken at : 25, 50, 75, 100, 150, 300, 100, 75, and 50 pa
Motor Speed is 60 Hz Maximum. Above that is untestable.

Specimen	Pressure (pa)	Motor (Hz)	Flow (SLPM)	% error	Measured Leakage (SLPM)	Net Flow (SLPM)
1A	0	0.0	0.00		0.00	0.00
	25	12.5	9.40		1.92	7.48
	50	14.9	24.85	**MUST**	2.47	22.38
	75	20.0	36.31	**Be less**	2.66	33.65
	100	25.4	47.40	**than 10%**	2.99	44.41
	150	36.4	68.85		3.68	65.17
	241	60.0	108.03		5.48	102.55
	100	25.8	47.51	-0.23	2.94	44.57
	75	20.7	37.33	-2.73	2.64	34.69
	50	15.4	26.21	-5.19	2.39	23.82
1B	0	0.0	0.00		0.00	0.00
	25	9.6	13.65		1.26	12.39
	50	15.0	26.18	**MUST**	1.76	24.42
	75	20.9	39.20	**Be less**	2.33	36.87
	100	26.6	50.96	**than 10%**	2.72	48.24
	150	39.2	76.16		3.62	72.54
	223	60.0	111.21		5.65	105.56
	100	26.9	51.27	-0.60	2.80	48.47
	75	21.0	39.90	-1.75	2.42	37.48
	50	15.2	26.60	-1.58	1.98	24.62
1C	0	0.0	0.00		0.00	0.00
	25	8.1	10.17		1.15	9.02
	50	12.2	19.51	**MUST**	1.60	17.91
	75	17.1	30.35	**Be less**	1.96	28.39
	100	21.7	40.42	**than 10%**	2.37	38.05
	150	31.5	60.52		3.04	57.48
	278	60.0	110.39		4.69	105.70
	100	21.5	39.76	1.66	2.47	37.29
	75	16.9	29.91	1.47	2.20	27.71
	50	12.5	20.24	-3.61	1.90	18.34
1D	0	0.0	0.00		0.00	0.00
	25	8.4	11.23		1.10	10.13
	50	13.0	21.86	**MUST**	1.50	20.36
	75	18.4	33.93	**Be less**	1.85	32.08
	100	23.7	45.20	**than 10%**	2.18	43.02
	150	34.6	67.28		2.75	64.53
	248	60.0	111.04		4.31	106.73
	100	24.0	45.40	-0.44	2.20	43.20
	75	18.7	34.24	-0.91	1.89	32.35
	50	13.9	23.66	-7.61	1.54	22.12
1E	0	0.0	0.00		0.00	0.00
	25	9.4	13.59		1.85	11.74
	50	15.0	26.41	**MUST**	2.42	23.99
	75	20.9	39.27	**Be less**	2.77	36.50
	100	26.6	51.02	**than 10%**	3.13	47.89
	150	39.7	76.54		3.90	72.64
	217	60.0	110.00		5.51	104.49
	100	26.8	50.36	1.31	3.22	47.14
	75	21.1	38.78	1.26	3.00	35.78
	50	15.4	26.66	-0.94	2.70	23.96

Statistical Outlier Check

This statistical check for outliers is from *Experimental Statistics* by M.G. Natrella
The method used follows ***The Dixon Criterion*** , which provides a statistical basis for rejection of a data point that

does not fit with the rest of the data set through calculation.

Pressure level	Specimen	Net Flow (SLPM)	Range (SLPM)	Ordered Values (SLPM)	Sample	r_{ij}		95% confidence lim	Decision
	1A	7.48		7.48		0.314	<	0.642	retained
	1B	12.39		9.02					
25	1C	9.02	4.91	10.13					
	1D	10.13		11.74					
	1E	11.74		12.39		0.132	<	0.642	retained
	1A	22.38		17.91		0.376	<	0.642	retained
	1B	24.42		20.36					
50	1C	17.91	6.51	22.38					
	1D	20.36		23.99					
	1E	23.99		24.42		0.066	<	0.642	retained
	1A	33.65		28.39		0.435	<	0.642	retained
	1B	36.87		32.08					
75	1C	28.39	8.48	33.65					
	1D	32.08		36.50					
	1E	36.50		36.87		0.044	<	0.642	retained
	1A	44.41		38.05		0.488	<	0.642	retained
	1B	48.24		43.02					
100	1C	38.05	10.19	44.41					
	1D	43.02		47.89					
	1E	47.89		48.24		0.034	<	0.642	retained
	1A	65.17		57.48		0.465	<	0.642	retained
	1B	72.54		64.53					
150	1C	57.48	15.16	65.17					
	1D	64.53		72.54					
	1E	72.64		72.64		0.007	<	0.642	retained

A summary of its procedure is as follows:

The measurements for each pressure level are arranged in numerical order and the range is calculated.
A ratio of the (suspect value - its closest neighbor) / the entire range is calculated using

$$r_{ij} = (X_n - X_{n-1}) / (X_n - X_1)$$

where:
r_{ij} is the comparison ratio
X_n is the suspect value
X_{n-1} is the closest neighbor
X_1 is the smallest value in the data set

r_{ij} is then compared to the 95% confidence limit, r for rejection.
If $r_{ij} > r$, the suspect observation is to be rejected. If it $r_{ij} < r$, then it is to be retained.

Coated

ASTM E 2178 - 03 - Standard Test Method for Air Permeance of Building Materials

Job No.: 09-109A-3B
Report Date: 8/12/2009

Client:	Bautex Systems, LLC	Testing Agency:	National Concrete Masonry Association
Address:	101 Thermon Dr., Suite 10		Research and Development Laboratory
	San Marcos, TX 78666	Address:	13750 Sunrise Valley Drive
			Herndon, VA 20171-4662

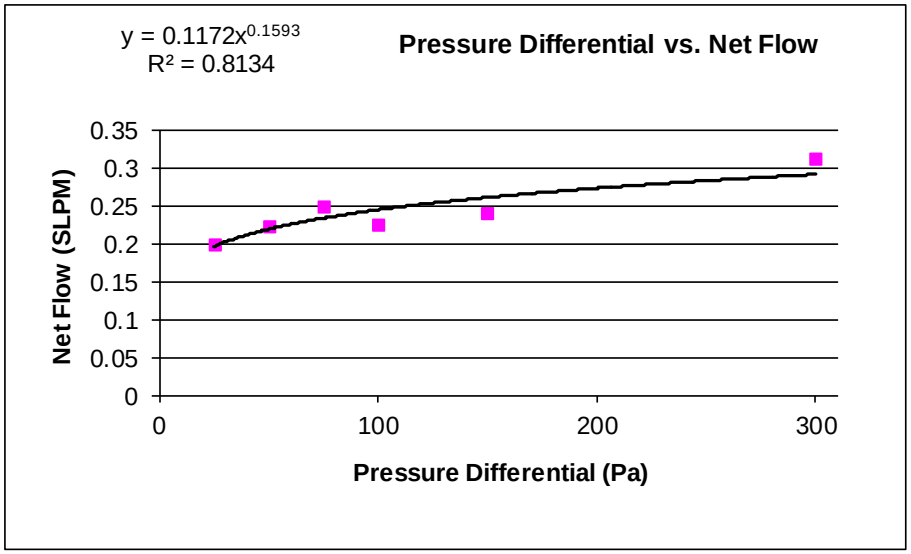
Results Summary

Sample set: Set 1 - Coated with "Bautex Air and Moisture Barrier 20-WP"

Flow range: Low

Atmospheric Readings

Specimen	1A	1B	1C	1D	1E
Date Tested	7/28/09	7/27/09	7/28/09	7/27/09	7/25/09
Time	8:56 AM	3:30 PM	10:52 AM	11:58 AM	10:45 AM
Temperature (F)	81.7	83.8	83	83.2	81.9
Relative Humidity (%)	67.6	54.7	62.8	61.2	54.3



75 Pa Flow Calculation to Power Regression Fit

Regression equation: Net Flow = 0.1172 * Pressure Differential^ 0.1593

Interpolated 75 Pa Flow:	0.2331	SLPM	(Net Flow in 1 m x 1 m test area)
Conversion to CFM:	0.0082	CFM	(Net Flow in 1 m x 1 m test area)
Reported Value:	**0.0008**	**CFM / ft^2**	

Experimental results

Flow Readings were taken at : 25, 50, 75, 100, 150, 300, 100, 75, and 50 pa
Motor Speed is 60 Hz Maximum. Above that is untestable.

Specimen	Pressure (pa)	Motor (Hz)	Flow (SLPM)	% error	Measured Leakage (SLPM)	Net Flow (SLPM)
1A	0	0.0	0.00		0.00	0.00
	25	4.9	0.61		0.39	0.22
	50	5.5	0.96	MUST	0.77	0.19
	75	6.2	1.33	Be less	1.03	0.30
	100	6.7	1.60	than 10%	1.38	0.22
	150	7.7	2.23		1.93	0.30
	300	9.9	3.74		3.46	0.28
	100	6.7	1.49	7.38	1.24	0.25
	75	6.2	1.29	3.10	0.92	0.37
	50	5.6	1.02	-5.88	0.63	0.39
1B	0	0.0	0.00		0.00	0.00
	25	4.9	0.61		0.42	0.19
	50	5.6	1.00	MUST	0.74	0.26
	75	6.2	1.27	Be less	1.05	0.22
	100	6.7	1.55	than 10%	1.33	0.22
	150	7.7	2.09		1.92	0.17
	300	9.9	3.82		3.38	0.44
	100	6.7	1.52	1.97	1.32	0.20
	75	6.2	1.22	4.10	1.07	0.15
	50	5.6	0.97	3.09	0.77	0.20
1C	0	0.0	0.00		0.00	0.00
	25	4.8	0.68		0.53	0.15
	50	5.5	1.02	MUST	0.86	0.16
	75	6.1	1.33	Be less	1.16	0.17
	100	5.7	1.68	than 10%	1.44	0.24
	150	7.7	2.28		2.07	0.21
	300	10.0	3.83		3.60	0.23
	100	6.7	1.57	7.01	1.38	0.19
	75	6.9	1.35	-1.48	1.11	0.24
	50	5.6	1.07	-4.67	0.78	0.29
1D	0	0.0	0.00		0.00	0.00
	25	5.0	0.50		0.48	0.02
	50	5.6	0.86	MUST	0.80	0.06
	75	6.2	1.19	Be less	1.11	0.08
	100	6.7	1.51	than 10%	1.44	0.07
	150	7.7	2.18		2.04	0.14
	300	9.9	3.84		3.62	0.22
	100	6.7	1.48	2.03	1.40	0.08
	75	6.2	1.19	0.00	1.07	0.12
	50	5.5	0.83	3.61	0.81	0.02
1E	0	0.0	0.00		0.00	0.00
	25	4.6	1.62		1.21	0.41
	50	5.4	2.03	MUST	1.59	0.44
	75	6.1	2.28	Be less	1.81	0.47
	100	6.6	2.52	than 10%	2.14	0.38
	150	7.6	3.05		2.67	0.38
	300	9.9	4.55		4.16	0.39
	100	6.7	2.64	-4.55	2.07	0.57
	75	6.1	2.26	0.88	1.78	0.48
	50	5.4	1.96	3.57	1.41	0.55

Statistical Outlier Check

This statistical check for outliers is from *Experimental Statistics* by M.G. Natrella
The method used follows ***The Dixon Criterion*** , which provides a statistical basis for rejection of a data point that

does not fit with the rest of the data set through calculation.

Pressure level	Specimen	Net Flow (SLPM)	Range (SLPM)	Ordered Values (SLPM)	Sample	r_{ij}		95% confidence lim	Decision
25	1A	0.22	0.39	0.02		0.333	<	0.642	retained
	1B	0.19		0.15					
	1C	0.15		0.19					
	1D	0.02		0.22					
	1E	0.41		0.41		0.487	<	0.642	retained
50	1A	0.19	0.38	0.06		0.263	<	0.642	retained
	1B	0.26		0.16					
	1C	0.16		0.19					
	1D	0.06		0.26					
	1E	0.44		0.44		0.474	<	0.642	retained
75	1A	0.30	0.39	0.08		0.231	<	0.642	retained
	1B	0.22		0.17					
	1C	0.17		0.22					
	1D	0.08		0.30					
	1E	0.47		0.47		0.436	<	0.642	retained
100	1A	0.22	0.31	0.07		0.484	<	0.642	retained
	1B	0.22		0.22					
	1C	0.24		0.22					
	1D	0.07		0.24					
	1E	0.38		0.38		0.452	<	0.642	retained
150	1A	0.30	0.24	0.14		0.125	<	0.642	retained
	1B	0.17		0.17					
	1C	0.21		0.21					
	1D	0.14		0.30					
	1E	0.38		0.38		0.333	<	0.642	retained
300	1A	0.28	0.22	0.22		0.045	<	0.642	retained
	1B	0.44		0.23					
	1C	0.23		0.28					
	1D	0.22		0.39					
	1E	0.39		0.44		0.227	<	0.642	retained

A summary of its procedure is as follows:

The measurements for each pressure level are arranged in numerical order and the range is calculated.
A ratio of the (suspect value - its closest neighbor) / the entire range is calculated using

$$r_{ij} = (X_n - X_{n-1}) / (X_n - X_1)$$

where:
r_{ij} is the comparison ratio
X_{n-1} is the closest neighbor
X_n is the suspect value
X_1 is the smallest value in the data set

r_{ij} is then compared to the 95% confidence limit, r for rejection.
If $r_{ij} > r$, the suspect observation is to be rejected. If it $r_{ij} < r$, then it is to be retained.

Appendix D – Set 2 E2178 Results

Uncoated

ASTM E 2178 - 03 - Standard Test Method for Air Permeance of Building Materials

Job No.: 09-109A-4A
Report Date: 8/12/2009
Page 1 of 3

Client: Bautex Systems, LLC
Address: 101 Thermon Dr., Suite 10
San Marcos, TX 78666

Testing Agency: National Concrete Masonry Association
Research and Development Laboratory
Address: 13750 Sunrise Valley Drive
Herndon, VA 20171-4662

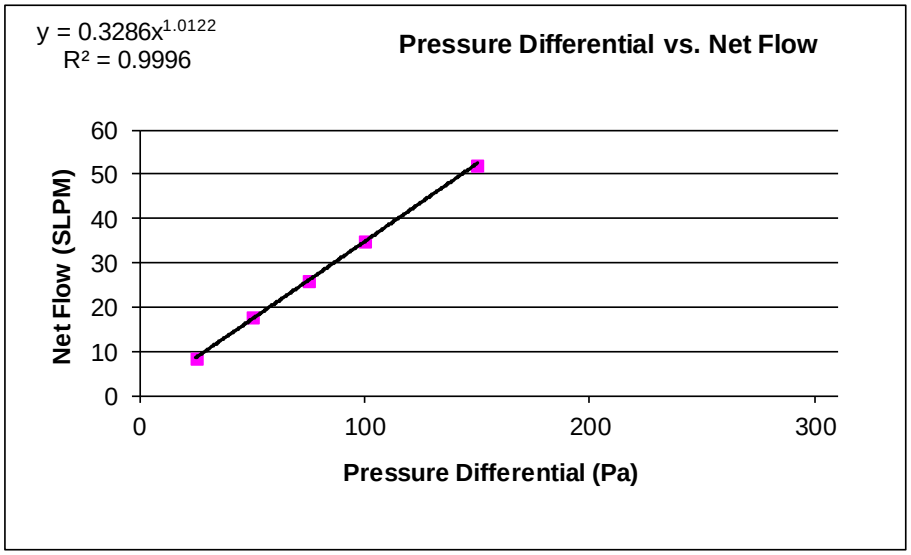
Results Summary

Sample set: Set 2 - Uncoated

Flow range: Low

Atmospheric Readings

Specimen	2A	2B	2C	2D	2E
Date Tested	7/23/09	7/22/09	7/24/09	7/23/09	7/23/09
Time	8:53 AM	4:05 AM	8:41 AM	11:09 AM	3:27 AM
Temperature (F)	81.6	82.9	79.7	82.3	83.5
Relative Humidity (%)	71	57.3	62.6	65.3	65.7



75 Pa Flow Calculation to Power Regression Fit

Regression equation: Net Flow = 0.3286 * Pressure Differential^ 1.0122

Interpolated 75 Pa Flow: 25.9779 SLPM (Net Flow in 1 m x 1 m test area)
Conversion to CFM: 0.9170 CFM (Net Flow in 1 m x 1 m test area)
Reported Value: 0.0846 CFM / ft^2

Experimental results

Flow Readings were taken at : 25, 50, 75, 100, 150, 300, 100, 75, and 50 pa
Motor Speed is 60 Hz Maximum. Above that is untestable.

Specimen	Pressure (pa)	Motor (Hz)	Flow (SLPM)	% error	Measured Leakage (SLPM)	Net Flow (SLPM)
2A	0	0.0	0.00		0.00	0.00
	25	7.2	7.70		0.29	7.41
	50	10.8	15.86	**MUST**	0.39	15.47
	75	14.1	23.36	**Be less**	0.85	22.51
	100	17.9	31.03	**than 10%**	1.16	29.87
	150	25.1	47.11		1.76	45.35
	300	49.1	93.13		3.38	89.75
	100	17.9	31.58	-1.74	1.08	30.50
	75	14.6	24.36	-4.11	0.83	23.53
	50	11.1	16.50	-3.88	0.45	16.05
2B	0	0.0	0.00		0.00	0.00
	25	9.9	14.02		0.96	13.06
	50	15.2	26.24	**MUST**	1.48	24.76
	75	20.8	38.27	**Be less**	2.07	36.20
	100	26.3	49.70	**than 10%**	2.48	47.22
	150	38.1	73.06		3.38	69.68
	223	60.0	110.12		5.48	104.64
	100	38.1	72.47	-31.42	2.58	69.89
	75	20.7	37.50	2.05	2.14	35.36
	50	15.1	25.51	2.86	1.68	23.83
2C	0	0.0	0.00		0.00	0.00
	25	7.6	8.27		0.94	7.33
	50	11.5	17.01	**MUST**	1.35	15.66
	75	15.2	25.33	**Be less**	1.92	23.41
	100	19.0	33.56	**than 10%**	2.12	31.44
	150	27.0	49.70		2.67	47.03
	278	53.1	97.87		4.30	93.57
	100	19.0	32.98	1.76	2.04	30.94
	75	15.3	25.20	0.52	1.81	23.39
	50	11.5	16.87	0.83	1.51	15.36
2D	0	0.0	0.00		0.00	0.00
	25	8.3	10.06		1.40	8.66
	50	13.3	22.14	**MUST**	1.85	20.29
	75	18.2	32.86	**Be less**	2.31	30.55
	100	23.7	44.28	**than 10%**	2.67	41.61
	150	34.2	64.98		3.27	61.71
	248	60.0	108.42		4.82	103.60
	100	23.4	42.32	4.63	2.73	39.59
	75	18.3	31.86	3.14	2.49	29.37
	50	13.5	21.72	1.93	2.02	19.70
2E	0	0.0	0.00		0.00	0.00
	25	6.8	6.45		0.78	5.67
	50	9.9	12.85	**MUST**	1.19	11.66
	75	12.8	19.12	**Be less**	1.46	17.66
	100	15.8	25.58	**than 10%**	1.82	23.76
	150	21.7	37.76		2.39	35.37
	217	40.9	73.66		4.02	69.64
	100	15.8	25.40	0.71	1.79	23.61
	75	12.8	19.18	-0.31	1.48	17.70
	50	9.9	12.96	-0.85	1.18	11.78

Statistical Outlier Check

This statistical check for outliers is from *Experimental Statistics* by M.G. Natrella
The method used follows ***The Dixon Criterion*** , which provides a statistical basis for rejection of a data point that

does not fit with the rest of the data set through calculation.

Pressure level	Specimen	Net Flow (SLPM)	Range (SLPM)	Ordered Values (SLPM)	Sample	r_{ij}		95% confidence lim	Decision
	2A	7.41		5.67		0.225	<	0.642	retained
	2B	13.06		7.33					
25	2C	7.33	7.39	7.41					
	2D	8.66		8.66					
	2E	5.67		13.06		0.595	<	0.642	retained
	2A	15.47		11.66		0.291	<	0.642	retained
	2B	24.76		15.47					
50	2C	15.66	13.1	15.66					
	2D	20.29		20.29					
	2E	11.66		24.76		0.341	<	0.642	retained
	2A	22.51		17.66		0.262	<	0.642	retained
	2B	36.20		22.51					
75	2C	23.41	18.54	23.41					
	2D	30.55		30.55					
	2E	17.66		36.20		0.305	<	0.642	retained
	2A	29.87		23.76		0.260	<	0.642	retained
	2B	47.22		29.87					
100	2C	31.44	23.46	31.44					
	2D	41.61		41.61					
	2E	23.76		47.22		0.239	<	0.642	retained
	2A	45.35		35.37		0.291	<	0.642	retained
	2B	69.68		45.35					
150	2C	47.03	34.31	47.03					
	2D	61.71		61.71					
	2E	35.37		69.68		0.232	<	0.642	retained

A summary of its procedure is as follows:

The measurements for each pressure level are arranged in numerical order and the range is calculated.
A ratio of the (suspect value - its closest neighbor) / the entire range is calculated using

$$r_{ij} = (X_n - X_{n-1}) / (X_n - X_1)$$

where:
r_{ij} is the comparison ratio
X_n is the suspect value
X_{n-1} is the closest neighbor
X_1 is the smallest value in the data set

r_{ij} is then compared to the 95% confidence limit, r for rejection.
If $r_{ij} > r$, the suspect observation is to be rejected. If it $r_{ij} < r$, then it is to be retained.

Coated

ASTM E 2178 - 03 - Standard Test Method for Air Permeance of Building Materials

Job No.: 09-109A-4B
Report Date: 8/12/2009

Client:	Bautex Systems, LLC	Testing Agency:	National Concrete Masonry Association
Address:	101 Thermon Dr., Suite 10		Research and Development Laboratory
	San Marcos, TX 78666	Address:	13750 Sunrise Valley Drive
			Herndon, VA 20171-4662

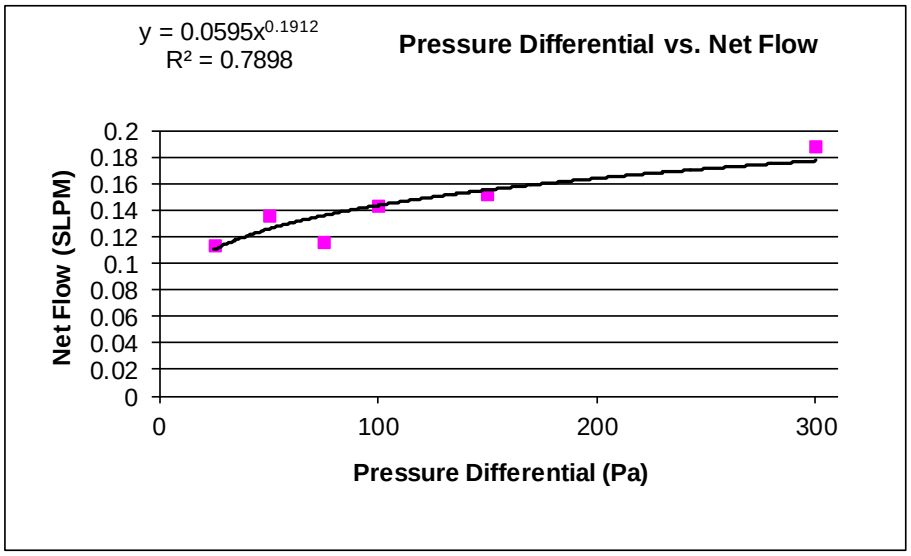
Results Summary

Sample set: Set 2 - Coated with "Bautex Air and Moisture Barrier 20-SN"

Flow range: Low

Atmospheric Readings

Specimen	2A	2B	2C	2D	2E
Date Tested	7/28/09	7/28/09	7/30/09	7/30/09	7/29/09
Time	2:28 PM	4:00 PM	3:00 PM	9:07 AM	10:35 AM
Temperature (F)	84.7	86.1	83.8	81.8	84.3
Relative Humidity (%)	55.4	55.7	58.4	61	66.4



75 Pa Flow Calculation to Power Regression Fit

Regression equation: Net Flow = 0.0595 * Pressure Differential^ 0.1912

Interpolated 75 Pa Flow:	0.1358	SLPM	(Net Flow in 1 m x 1 m test area)
Conversion to CFM:	0.0048	CFM	(Net Flow in 1 m x 1 m test area)
Reported Value:	**0.0004**	**CFM / ft^2**	

Experimental results

Flow Readings were taken at : 25, 50, 75, 100, 150, 300, 100, 75, and 50 pa
Motor Speed is 60 Hz Maximum. Above that is untestable.

Specimen	Pressure (pa)	Motor (Hz)	Flow (SLPM)	% error	Measured Leakage (SLPM)	Net Flow (SLPM)
2A	0	0.0	0.00		0.00	0.00
	25	4.7	0.75		0.56	0.19
	50	5.5	1.11	**MUST**	0.91	0.20
	75	6.1	1.43	**Be less**	1.19	0.24
	100	6.7	1.75	**than 10%**	1.48	0.27
	150	7.7	2.26		2.04	0.22
	300	9.9	3.78		3.56	0.22
	100	6.7	1.71	2.34	1.42	0.29
	75	6.1	1.41	1.42	1.22	0.19
	50	5.5	1.13	-1.77	0.88	0.25
2B	0	0.0	0.00		0.00	0.00
	25	4.6	0.78		0.69	0.09
	50	5.5	1.27	**MUST**	1.16	0.11
	75	6.2	1.63	**Be less**	1.55	0.08
	100	6.8	2.06	**than 10%**	1.95	0.11
	150	7.8	2.78		2.64	0.14
	223	10.2	4.78		4.56	0.22
	100	6.8	2.03	1.48	1.85	0.18
	75	6.2	1.55	5.16	1.51	0.04
	50	5.5	1.18	7.63	1.16	0.02
2C	0	0.0	0.00		0.00	0.00
	25	4.5	0.85		0.66	0.19
	50	5.3	1.18	**MUST**	0.94	0.24
	75	6.0	1.44	**Be less**	1.22	0.22
	100	6.7	1.80	**than 10%**	1.57	0.23
	150	7.7	2.34		2.06	0.28
	278	10.0	3.87		3.51	0.36
	100	6.7	1.76	2.27	1.50	0.26
	75	6.1	1.50	-4.00	1.26	0.24
	50	5.4	1.20	-1.67	0.96	0.24
2D	0	0.0	0.00		0.00	0.00
	25	4.7	0.83		0.78	0.05
	50	5.2	1.13	**MUST**	1.07	0.06
	75	6.1	1.41	**Be less**	1.40	0.01
	100	6.7	1.73	**than 10%**	1.70	0.03
	150	7.7	2.23		2.18	0.05
	248	9.9	3.79		3.71	0.08
	100	6.7	1.68	2.98	1.60	0.08
	75	6.2	1.43	-1.40	1.38	0.05
	50	5.6	1.21	-6.61	1.18	0.03
2E	0	0.0	0.00		0.00	0.00
	25	4.4	0.61		0.56	0.05
	50	5.3	1.02	**MUST**	0.95	0.07
	75	6.0	1.32	**Be less**	1.29	0.03
	100	6.7	1.70	**than 10%**	1.62	0.08
	150	7.7	2.32		2.25	0.07
	217	10.0	4.08		4.02	0.06
	100	6.7	1.60	6.25	1.44	0.16
	75	6.1	1.35	-2.22	1.26	0.09
	50	5.5	1.05	-2.86	0.96	0.09

Statistical Outlier Check

This statistical check for outliers is from *Experimental Statistics* by M.G. Natrella
The method used follows ***The Dixon Criterion*** , which provides a statistical basis for rejection of a data point that

does not fit with the rest of the data set through calculation.

Pressure level	Specimen	Net Flow (SLPM)	Range (SLPM)	Ordered Values (SLPM)	Sample	r_{ij}		95% confidence lim	Decision
	2A	0.19		0.05		0.000	<	0.642	retained
	2B	0.09		0.05					
25	2C	0.19	0.14	0.09					
	2D	0.05		0.19					
	2E	0.05		0.19		0.000	<	0.642	retained
	2A	0.20		0.06		0.056	<	0.642	retained
	2B	0.11		0.07					
50	2C	0.24	0.18	0.11					
	2D	0.06		0.20					
	2E	0.07		0.24		0.222	<	0.642	retained
	2A	0.24		0.01		0.087	<	0.642	retained
	2B	0.08		0.03					
75	2C	0.22	0.23	0.08					
	2D	0.01		0.22					
	2E	0.03		0.24		0.087	<	0.642	retained
	2A	0.27		0.03		0.208	<	0.642	retained
	2B	0.11		0.08					
100	2C	0.23	0.24	0.11					
	2D	0.03		0.23					
	2E	0.08		0.27		0.167	<	0.642	retained
	2A	0.22		0.05		0.087	<	0.642	retained
	2B	0.14		0.07					
150	2C	0.28	0.23	0.14					
	2D	0.05		0.22					
	2E	0.07		0.28		0.261	<	0.642	retained
	2A	0.22		0.06		0.067	<	0.642	retained
	2B	0.22		0.08					
300	2C	0.36	0.3	0.22					
	2D	0.08		0.22					
	2E	0.06		0.36		0.467	<	0.642	retained

A summary of its procedure is as follows:

The measurements for each pressure level are arranged in numerical order and the range is calculated.
A ratio of the (suspect value - its closest neighbor) / the entire range is calculated using

$$r_{ij} = (X_n - X_{n-1}) / (X_n - X_1)$$

where:
r_{ij} is the comparison ratio
X_{n-1} is the closest neighbor
X_n is the suspect value
X_1 is the smallest value in the data set

r_{ij} is then compared to the 95% confidence limit, r for rejection.
If $r_{ij} > r$, the suspect observation is to be rejected. If it $r_{ij} < r$, then it is to be retained.