STORK®

Materials Technology

Stork Twin City Testing Corporation

662 Cromwell Avenue
Saint Paul, MN 55114
USA

Telephone :(651) 645-3601
Toll Free :(888) 645-TEST
Telefax :(651) 659-7348
Website :www.twincitytesting.com

Investigative Chemistry
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NOISE EMISSION COMPARISON OF CORZAN® CPVC PIPE AND COPPER PIPE

Prepared for:
NOVEON INC.
Attn: Mr. David Ash
9921 Brecksville Road
Brecksville, OH 44141

Prepared By:

Mathew N. Botz
Project Manager
Product Testing Department
(651) 659-7353

Reviewed By:

Kyle T. Hall
Engineering Technician
Product Testing Department

The test results contained in this report pertain only to the samples submitted for testing and not necessarily to all similar products.

PROJECT NUMBER: 30160-07-85633

DATE: May 23, 2007

Noise Emission Testing

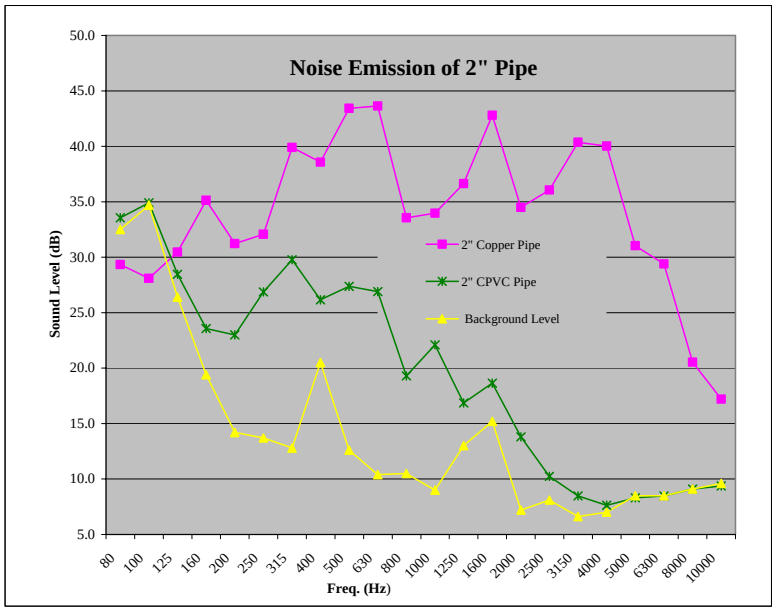
INTRODUCTION:

This report presents the results of Noise Emission testing conducted on two (2) pipe materials. The test specimens were submitted by Mr. David Ash of Noveon Inc. This work was completed on May 23, 2007.

TEST RESULTS SUMMARY:

	Average Sound Level, dB (re. 0.0002 µbar)	
1/3 Octave	2" Copper Pipe	2" CORZAN® CPVC Pipe
Freq (Hz)	L_{eq} (dB)	L_{eq} (dB)
80	29.3	33.6
100	28.1	34.9
125	30.5	28.5
160	35.1	23.6
200	31.2	23.0
250	32.1	26.9
315	39.9	29.8
400	38.6	26.2
500	43.4	27.4
630	43.6	26.9
800	33.6	19.3
1000	34.0	22.1
1250	36.6	16.9
1600	42.8	18.6
2000	34.5	13.8
2500	36.1	10.2
3150	40.4	8.5
4000	40.0	7.6
5000	31.0	8.3
6300	29.4	8.5
8000	20.5	9.1
10000	17.2	9.4

dBA	**49.9**	**31.7**
dB Lin	**50.9**	**39.6**



See 'TEST DATA' section for detailed results.

The Corzan® CPVC pipe had a sound level of **31.7dBA** and the copper pipe had a sound level of **49.9 dBA**. The Corzan® CPVC pipe was 18-dBA quieter than the copper pipe which represents an audible difference (as the human hear interprets sound) as being approximately 1/4 as loud.

Table #1:

A reference table for the apparent loudness* relating to a difference in sound level.

Change in Sound Pressure Level (+ or -)	Change in Apparent Loudness
3 dB	Just Perceptible
5 dB	Clearly Noticable
10 dB	Twice (or 1/2) as loud
15 dB	Three times (or 1/3) as loud
20dB	Four times (or 1/4) as loud

*-Apparent Loudness is defined as the sound level perceived by the human ear.

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SPECIMEN DESCRIPTIONS:

Two pipe materials were submitted for noise emission testing.

Pipe Type: Corzan® CPVC Pipe
Nominal Diameter: 2”
Outer Diameter: 2-3/8”
Inner Diameter: 1-7/8”
Printed Markings on Pipe:
“2” CORZAN CPVC 4120 SCH 80”

Bonding: The CPVC pipe joined to the fittings by solvent cement.

Pipe Type: Type “L” Copper
Nominal Diameter: 2”
Outer Diameter: 2-1/8”
Inner Diameter: 1-15/16”
Printed Markings on Pipe:
“IUSA CAMBRIDGE-LEE 2L USA 03/12/07-12:28 NSF-61”

Bonding: Solder Joints

Materials List:

Item:	Quantity
Corzan® Pipe	40-ft (approx.)
Union	2
90° Elbow	5
45° Elbow	2
Tee	2
Shutoff Valve	1
Adapter (2” to ¼”)	2
Adapter (2” to 1”)	2

Item:	Quantity .
Type “L” Cu Pipe	40-ft (approx.)
90° Elbow	5
45° Elbow	2
Tee	2
Shutoff Valve	1
Adapter (2” to ¼”)	2
Adapter (2” to 1”)	2

TEST PROCEDURE:

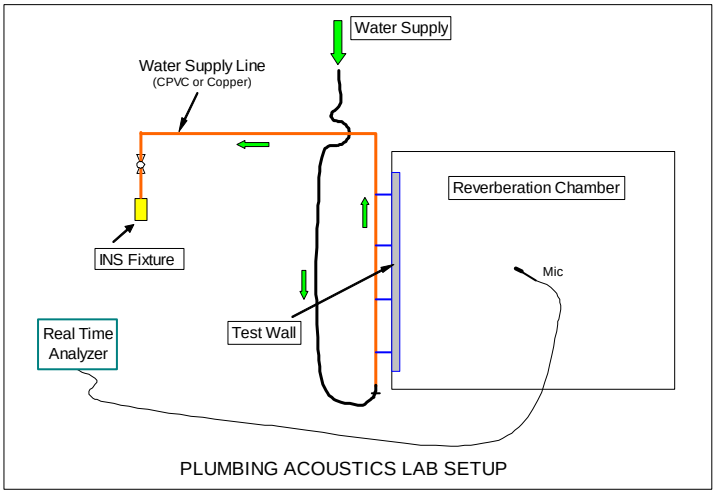
The tests were conducted using procedures outlined in ISO-3822 (99), "Laboratory Test on Noise Emission from Appliances and Equipment used in Water Supply Installations".

The testing was modified to allow noise level comparisons of CPVC and copper pipe of equal diameter (2"). The modification basically involved replacing the 1" diameter galvanized pipe, specified by the ISO Standard, with the CPVC or the copper pipe supply lines.

In both cases, an INS (Installation Noise Standard) reference fixture was used as a noise source. Three replications of each test set-up were conducted with air-venting procedures between each replication. The operating conditions were maintained at a nominal 43.5-psi with a flow rate of approximately 4.5 gallons per minute.

A rotating microphone was positioned in the center of the reverberant receiving room and was used to obtain the sound pressure levels emitted from the test wall. The noise level (dB) was recorded in 1/3 octave frequencies from 80 Hz to 10,000 Hz over a time interval of 1-minute.

A Norwegian Electronics Model 830 Real Time Spectrum Analyzer was used for the data acquisition and analysis. The equipment was calibrated with a Bruel & Kjaer Model 4228 calibrator before each test.



TEST EQUIPMENT:

Manufacturer	Description	Model	S/N
Norwegian Electronics	Spectrum Analyzer	NE830	10722
Larson Davis	½" Condenser Mic.	2560	1128
Brüel & Kjær	Rotating Microphone Boom	3923	1263439
Bruel & Kjaer	Sound Calibrator	4228	1681383

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DATE: May 23, 2007

ISO 3822 REVERBERATION CHAMBER DESCRIPTION:

Volume: 3710 ft^3 (105.1 $meters^3$)

Temperature: 70°F (± 5°)

Relative Humidity: 50% (± 3%)

Reverberation Times (seconds):

1/3 Octave Freq, Hz.	**80**	**100**	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**
Reverberation Time, sec.	1.77	1.56	1.65	1.99	2.01	3.06	2.96	3.04	3.24	3.36	3.10

1/3 Octave Freq, Hz.	**1000**	**1250**	**1600**	**2000**	**2500**	**3150**	**4000**	**5000**	**6300**	**8000**	**10000**
Reverberation Time, sec.	2.92	2.89	2.64	2.37	2.32	2.29	1.98	1.69	1.42	1.13	0.87

REMARKS:

The test sample will be retained for a period of **15-days** and then discarded unless notified by the client.

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PROJECT NUMBER: 30160-07-85633

DATE: May 23, 2007

TEST RESULTS:

Date of Test: May 21, 2007

Sample Description:
2" Copper Pipe, Type "L"

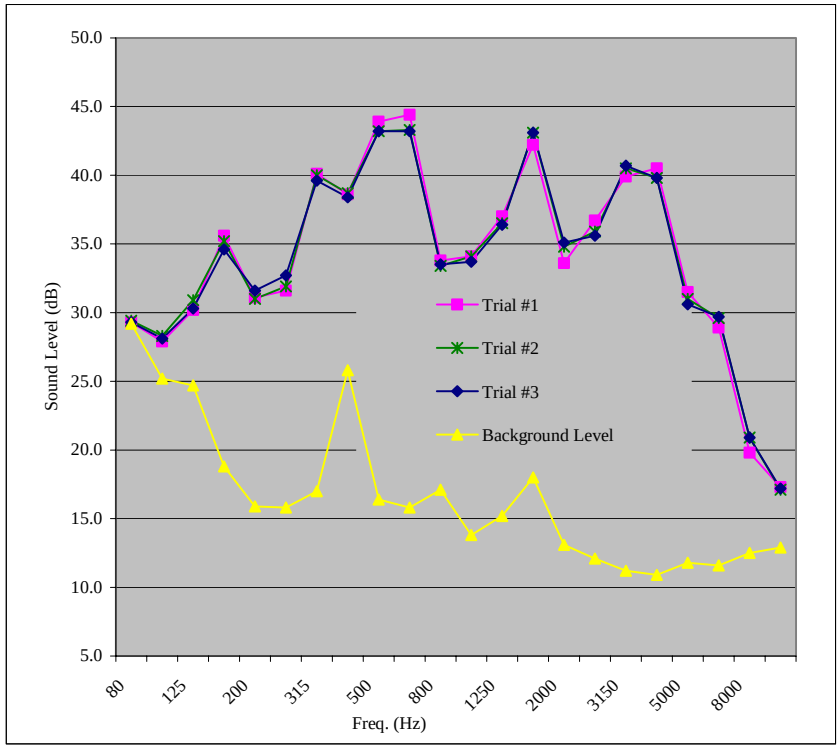
Pipe Markings:
"IUSA CAMBRIDGE-LEE 2L USA 03/12/07-12:28 NSF-61"

Temperature: 73° F
Relative Humidity: 50%
Barometric Pressure: 985 mbar

Water Pressure: 43.5-psi
Input Water Flow: 4.5 gpm

	Sound Level, dB (re. 0.0002 µbar)				
1/3 Octave	**Background Level**	**Trial #1**	**Trial #2**	**Trial #3**	**Average**
Freq (Hz)	L_{eq} (dB)	L_{eq} (dB)	L_{eq} (dB)	L_{eq} (dB)	L_{eq} (dB)
80	29.2	29.3	29.4	29.3	29.3
100	25.2	27.9	28.3	28.1	28.1
125	24.7	30.2	30.9	30.3	30.5
160	18.8	35.6	35.2	34.6	35.1
200	15.9	31.1	31.0	31.6	31.2
250	15.8	31.6	31.9	32.7	32.1
315	17.0	40.1	40.0	39.6	39.9
400	25.8	38.6	38.7	38.4	38.6
500	16.4	43.9	43.2	43.2	43.4
630	15.8	44.4	43.3	43.2	43.6
800	17.1	33.8	33.4	33.5	33.6
1000	13.8	34.1	34.1	33.7	34.0
1250	15.2	37.0	36.5	36.4	36.6
1600	18.0	42.2	43.1	43.1	42.8
2000	13.1	33.6	34.8	35.1	34.5
2500	12.1	36.7	35.9	35.6	36.1
3150	11.2	39.9	40.5	40.7	40.4
4000	10.9	40.5	39.8	39.8	40.0
5000	11.8	31.5	31.0	30.6	31.0
6300	11.6	28.9	29.6	29.7	29.4
8000	12.5	19.8	20.9	20.9	20.5
10000	12.9	17.3	17.1	17.2	17.2

dBA	**27.0**	**50.0**	**49.9**	**49.9**	**49.9**
dB Lin	**33.7**	**51.1**	**50.9**	**50.8**	**50.9**



PROJECT NUMBER: 30160-07-85633

DATE: May 23, 2007

TEST RESULTS:

Date of Test: May 23, 2007

Sample Description:
2" CORZAN® CPVC

Pipe Markings:
"2" CORZAN® CPVC 4120 SCH 80"

Temperature: 70° F
Relative Humidity: 54%
Barometric Pressure: 980 mbar

Water Pressure: 43.5-psi
Input Water Flow: 4.5 gpm

	Sound Level, dB (re. 0.0002 µbar)				
1/3 Octave	**Background Level**	**Trial #1**	**Trial #2**	**Trial #3**	**Average**
Freq (Hz)	L_{eq} (dB)	L_{eq} (dB)	L_{eq} (dB)	L_{eq} (dB)	L_{eq} (dB)
80	32.5	33.4	34.4	32.9	33.6
100	34.7	34.8	35.3	34.6	34.9
125	26.4	27.3	30.2	27.9	28.5
160	19.4	23.2	24.2	23.3	23.6
200	14.2	23.0	23.1	22.9	23.0
250	13.7	26.8	27.0	26.8	26.9
315	12.8	29.6	30.5	29.2	29.8
400	20.5	25.5	26.2	26.8	26.2
500	12.6	27.2	26.9	28.0	27.4
630	10.4	27.1	26.6	27.0	26.9
800	10.5	18.9	19.2	19.8	19.3
1000	9.0	22.1	22.3	21.9	22.1
1250	13.0	16.6	16.5	17.5	16.9
1600	15.2	18.5	18.7	18.7	18.6
2000	7.2	16.6	12.5	12.3	13.8
2500	8.1	9.3	11.1	10.3	10.2
3150	6.6	6.9	8.5	10.0	8.5
4000	7.0	7.4	7.6	7.9	7.6
5000	8.5	8.4	8.4	8.1	8.3
6300	8.5	8.5	8.5	8.4	8.5
8000	9.1	9.1	9.1	9.1	9.1
10000	9.6	9.4	9.4	9.3	9.4

dBA	**23.9**	**31.6**	**31.7**	**31.8**	**31.7**
dB Lin	**37.3**	**39.0**	**40.3**	**39.5**	**39.6**