

Engineering Report

ORIFLOW Engineering
2112 Sunnydale Blvd. Unit J
Clearwater, Florida 33765

Leakage of Spiral Seam Elbows

Client: Jinwwong Technology Ltd.
Date: December 27, 2011

Summary:

Five galvanized steel, spiral seam, elbows were tested for leakage at the following pressures -20 in.wg. (-5000 Pa), -10 in.wg. (-2500 Pa), +10 in.wg. (+2500 Pa), and +20 in.wg. (+5000 Pa). The elbows were fabricated by Jinwwong Technology Ltd., a Korean manufacturer of the equipment that fabricates spiral seam elbows. Three of the five elbows had no measureable leakage while the other two had minimal leakage. All five elbows have a SMACNA leakage class less than 0.025 at +/- 20 in.wg., which is exceptional considering ASHRAE 90.1 requires a maximum leakage class of 3 for round duct systems.

Test Specimens:

Five galvanized steel, spiral seam elbows were tested for leakage at pressures of -20 in.wg. (-5000 Pa), -10 in.wg. (-2500 Pa), +10 in.wg. (+2500 Pa), and +20 in.wg. (+5000 Pa). The elbows tested had diameters of 3.6 in. (92 mm), 5.7 in. (145 mm), 9.6 in. (245 mm), 15.6 in. (395 mm), and 19.3 in. (490 mm). All five elbows were fabricated from galvanized steel that was 0.020 inches (0.51 mm) thick.

Test Method:

Elbows were tested per the following:

- AMCA Publication 511-07 (Rev.8/08), *Certified Ratings Program – Product Rating Manual for Air Control Devices*.
- ANSI/ASHRAE Standard 126-2008, *Method of Testing HVAC Air Ducts and Fittings*.

See *Figure 1* for a picture of the typical test setup.



Figure 1

Typical Test Setup, 19.3 in. (490 mm) Elbow Shown

The equipment used for testing is shown in greater detail in *Figure 2* and *Figure 3*. In *Figure 2*, a picture is shown of the gas meter used to measure the volume of air leaking out of each elbow. In *Figure 3* a picture is shown of the Variac used to control the air supply.

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Test Method (continued):

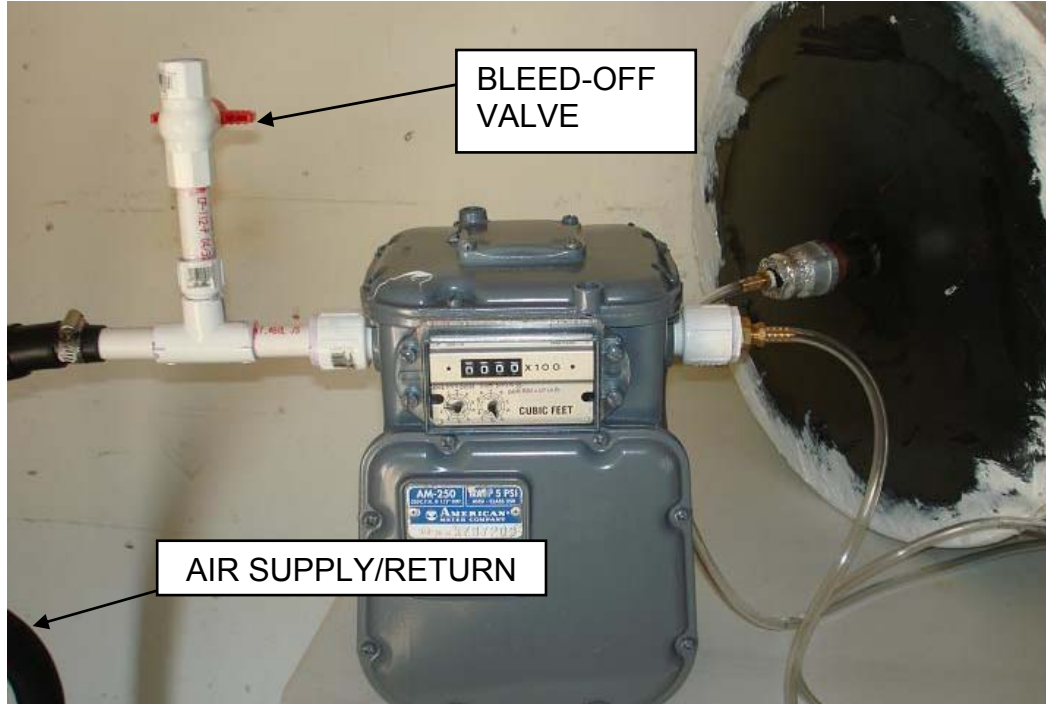


Figure 2

Gas Meter used to Measure Volume of Air Leaking Out from Each Elbow



Figure 3

Variac used to Vary Air Supply

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Test Results:

Test results are shown in *Table 1a* and *Table 1b*.

Since two of the elbows, the 395 mm and 490 mm elbows, had measureable leakage. These two elbows were covered with soapy water to see where leakage was occurring and verify that the leakage was not from the end caps or the supply line connections. In *Figure 4*, a picture is shown of the soap bubble test for the 15.6-inch (395 mm) elbow. In *Figure 5* a picture of the soap bubble test for the 19.3-inch (490 mm) elbow is shown. The end caps and the supply fittings did not show any soap bubbles and therefore all leakage was occurring from the spiral seams.

Table 1a – Total Leakage of Elbows Tested (cfm)

Elbow Size (inches)	Leakage (cfm)			
	- 20 in.wg.	- 10 in.wg.	+ 10 in.wg.	+ 20 in.wg.
3.6	0.000	0.000	0.000	0.000
5.7	0.000	0.000	0.000	0.000
9.6	0.000	0.000	0.000	0.000
15.6	0.021	0.009	0.010	0.020
19.3	0.011	0.004	0.004	0.011

Table 1b – Total Leakage of Elbows Tested (L/s)

Elbow Size (mm)	Leakage (L/s)			
	- 5000 Pa	- 2500 Pa.	+ 2500 Pa.	+ 5000 Pa
92	0.00000	0.00000	0.00000	0.00000
145	0.00000	0.00000	0.00000	0.00000
245	0.00000	0.00000	0.00000	0.00000
395	0.00982	0.00414	0.00482	0.00931
490	0.00536	0.00174	0.00169	0.00523

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Test Results (continued):



Figure 4
Picture of 15.6-inch (395 mm) Elbow during Soap Bubble Evaluation



Figure 5
Picture of 19.3-inch (490 mm) Elbow during Soap Bubble Evaluation

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Analysis:

After the elbows were tested for leakage, the seam length was measured so that the leakage per lineal seam foot (leakage per lineal seam meter) could be calculated. Those calculations are shown in *Tables 2a* and *2b*.

Table 2a – Seam Leakage (cfm per lineal foot)

Elbow Size (inches)	Leakage per lineal foot (cfm per foot)			
	- 20 in.wg.	- 10 in.wg.	+ 10 in.wg.	+ 20 in.wg.
3.6	0.000000	0.000000	0.000000	0.000000
5.7	0.000000	0.000000	0.000000	0.000000
9.6	0.000000	0.000000	0.000000	0.000000
15.6	0.000252	0.000106	0.000124	0.000239
19.3	0.000105	0.000034	0.000033	0.000103

Table 2b – Seam Leakage (L/s per lineal meter)

Elbow Size (mm)	Leakage per lineal meter (L/s per meter)			
	- 5000 Pa	- 2500 Pa.	+ 2500 Pa.	+ 5000 Pa
92	0.00000	0.00000	0.00000	0.00000
145	0.00000	0.00000	0.00000	0.00000
245	0.00000	0.00000	0.00000	0.00000
395	0.00469	0.00198	0.00230	0.00445
490	0.00196	0.00063	0.00062	0.00191

The surface area of each elbow was calculated using *Equation 1* so the leakage per unit area can be calculated to determine the Leakage Class of each elbow. Those results are summarized in *Tables 3a* and *3b*.

$$\text{Surface Area} = 12 \times (D/2)^2 \times \pi^2 / 4 \quad \text{in}^2 \quad \text{Equation 1}$$

where D = the elbow diameter, *inches*.

Table 3a –Leakage per Surface Area (cfm per ft²)

Elbow Size (inches)	Leakage per lineal foot (cfm per ft ²)			
	- 20 in.wg.	- 10 in.wg.	+ 10 in.wg.	+ 20 in.wg.
3.6	0.000000	0.000000	0.000000	0.000000
5.7	0.000000	0.000000	0.000000	0.000000
9.6	0.000000	0.000000	0.000000	0.000000
15.6	0.001684	0.000710	0.000826	0.001598
19.3	0.000597	0.000193	0.000188	0.000582

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Analysis (continued):

Table 3b –Leakage per Surface Area (L/s per m²)

Elbow Size (mm)	Leakage per lineal meter (L/s per m ²)			
	- 5000 Pa	- 2500 Pa.	+ 2500 Pa.	+ 5000 Pa
92	0.00000	0.00000	0.00000	0.00000
145	0.00000	0.00000	0.00000	0.00000
245	0.00000	0.00000	0.00000	0.00000
395	0.00856	0.00361	0.00420	0.00812
490	0.00303	0.00098	0.00096	0.00296

The Leakage Class of each elbow was calculated using *Equation 2* since the current edition of ASHRAE Standard 90.1 requires that round duct systems have a maximum leakage class of 3. The resulting calculations are summarized in *Table 4*.

$$\text{Leakage Class} = \frac{F}{P^{0.65}}$$

Equation 2

where F = leakage in units of *cfm/100 sq.ft.*
P = pressure in units of *in.wg.*

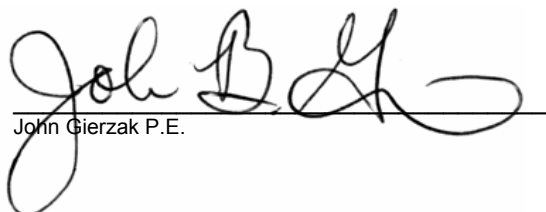
Table 4 – Leakage Class of each Elbow

Elbow Size (inches)	Leakage Class			
	- 20 in.wg.	- 10 in.wg.	+ 10 in.wg.	+ 20 in.wg.
3.6	0.000	0.000	0.000	0.000
5.7	0.000	0.000	0.000	0.000
9.6	0.000	0.000	0.000	0.000
15.6	0.024	0.016	0.018	0.023
19.3	0.001	0.000	0.000	0.001

Conclusions:

The soap bubbles in the pictures should not be a cause for alarm. All five elbows evaluated have zero to negligible leakage at exceptionally high static pressures. In a typical HVAC system, the resulting leakage would be even less. There should not be any concern for the leakage out of the elbow lockseams.

Report Written and Submitted by:


John Gierzak P.E.

Mr. Gierzak's vitae is attached to this report.

John Gierzak, P.E.

Mr. Gierzak is owner of Oriflow, a manufacturer of air leakage test equipment. He has over 20 years of R&D experience in the HVAC industry, running both laboratories at United McGill Corp. and Metal Industries Inc. John is an active member of ASHRAE, currently serving as Vice Chair of ASHRAE TC 2.6, Sound and Vibration Control. Throughout the years, he has actively participated in developing Test Standards for ASTM, AMCA, and ASHRAE. Mr. Gierzak holds a BSME from University of Dayton, and an MBA from The Ohio State University.

- Twenty years of experience designing duct leakage testing equipment.
- Current active member of ASHRAE.
- Former Chair of technical committees in ASHRAE, ASTM, AMCA and AHRI.
- has given numerous presentations to engineers and sales people on various subjects:
 - HVAC system acoustics
 - Air terminal unit fundamentals
 - Duct system design
 - Duct leakage
 - Air distribution fundamentals
- Technical writer for SMACNA, authoring two manuals:
 - *Building Systems Analysis and Retrofit*
 - *Energy Systems Analysis and Management*
- Author of articles and papers including:
 - ASHRAE paper, *Predicting Performance of Reinforced, Circular Spiral Lockseam Ducts Under Negative Pressure.*
 - SNIPS article, *The Great Duct Debate - Another View on Equivalent Sizing.*
- Bachelors of Science in Mechanical Engineering at University of Dayton.
- Master of Business Administration from Ohio State University.
- Registered Professional Engineer in Ohio.