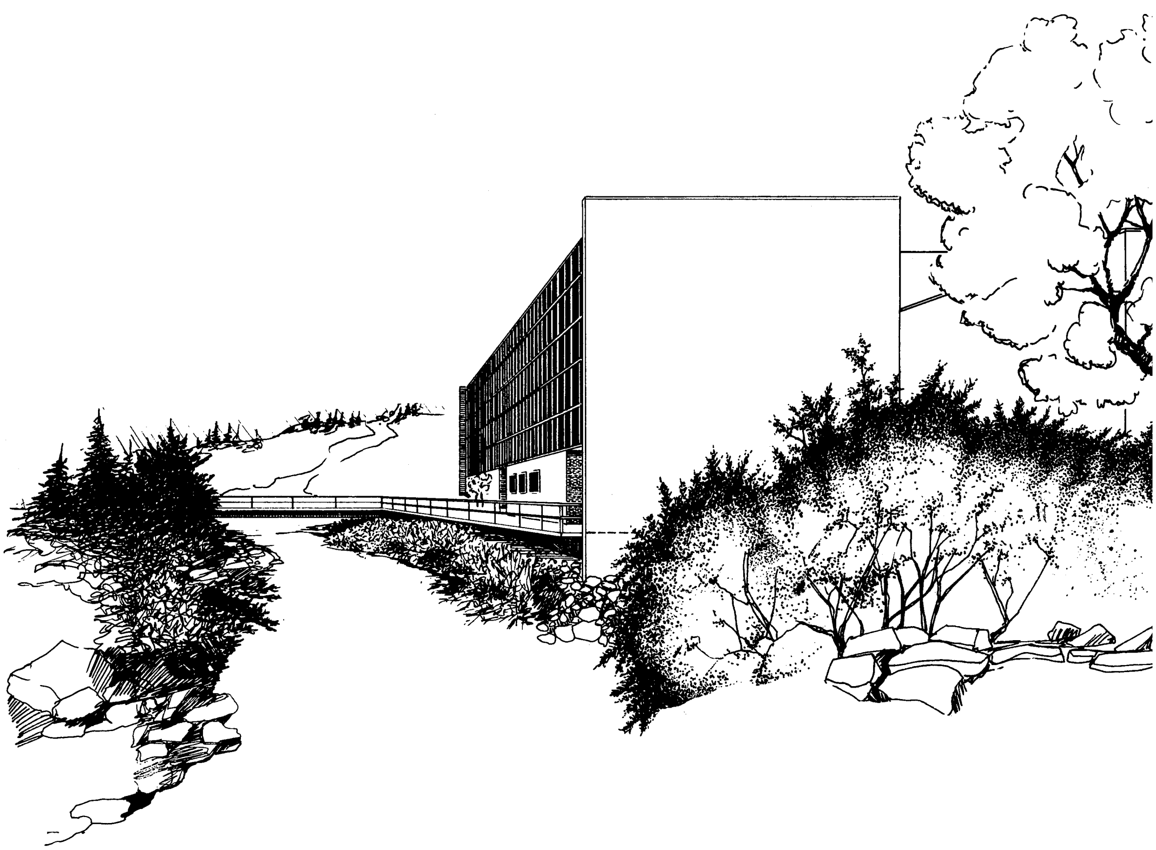
FLOW PERFORMANCE TESTING OF 4-INCH, AND 8-INCH STRAINERS

Prepared for

Metraflex

February 2017



UTAH WATER RESEARCH LABORATORY

Utah State University **Report No. 3732**
Logan, Utah

FLOW PERFORMANCE TESTING OF 4-INCH AND 8-INCH STRAINERS

Prepared for:

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INTRODUCTION

Flow performance tests were conducted at the Utah Water Research Laboratory (UWRL) on 4-inch, and 8-inch Mueller Steam basket strainers. The testing was developed to determine the flow versus pressure loss characteristics for each strainer and the flow coefficient of each strainer. Strainers 4-inch and larger strainers each had 0.125 inch perforations. The work was authorized under Metraflex Purchase Order No. 32338 and was done in accordance with the ANSI/ISA 75.02.01-2008 Control Valve Capacity Test Procedures standard with slight modifications in order to characterize each strainer's performance over a wide flow range.

EXPERIMENTAL PROGRAM

Each of the strainers was installed in a test line (standard steel diameters) with approximately 20 diameters of straight approach piping to provide uniform flow at the inlet of the strainer. There were approximately 10 diameters of straight pipe downstream from the strainer. Pressure taps were located two pipe diameters upstream from the strainer and six pipe diameters downstream from the strainer. Flow was supplied with laboratory pumps. Figures 1 and 2 show the typical test setups for the strainers for the 4-inch and 12-inch strainers. Each of the other sizes had similar installations however they were installed in pipe sizes corresponding to each strainer size.

Figure 1. 4-inch strainer installation (Mueller Steam strainer shown).

Figure 2. 12-inch strainer installation (Metraflex strainer shown).

The flow rate was measured using calibrated flow meters which were verified against certified weight tanks. The differential pressure across the strainer was measured using Rosemount differential transmitters. The upstream pressure was measured using a Rosemount transmitter. The water temperature was measured using a calibrated RTD.

Each strainer was tested over a range of flows sufficient to generate 1.5 ft/s to 15 ft/s average velocities in the approach pipe. Ten points were taken over the velocity range of each size.

To prevent screen plugging during testing, the laboratory used screens upstream of the various installations to capture any debris that entered the test system from water supplied from Logan River.

FLOW COEFFICIENT

The definition of the flow coefficient used in this report is:

$$C_v = \frac{Q}{\sqrt{\frac{\Delta P}{SG}}}$$

Where Q is the discharge of test fluid in U.S. gallons per minute flowing through the strainer, ΔP is the pressure drop across the strainer in psi, and SG is the specific gravity of the test fluid. C_v is calculated using the gross pressure drop (ISA standard) between taps that are two diameters upstream and six diameters downstream.

The net flow coefficient was also computed by subtracting the friction expected from steel pipe between the gross differential pressure measured between the pressure taps. This calculation was completed using the Swamee-Jain equation to determine the friction factor associated with the specific data point taken in the laboratory. The Swamee-Jain equation is given by:

$$f = \frac{1.325}{\left(ln\left(\frac{k}{3.7D} + \frac{5.74}{Re^{0.9}} \right) \right)^2}$$

Where f is the friction factor, k is the pipe roughness, D is the inside diameter of the pipe and Re is the Reynolds number of the flow in the pipe. The headloss in feet was then converted to psi and subtracted from the gross pressure loss measurement.

TEST PROCEDURE

The test procedure essentially followed ISA 75.02.01-2008 with slight modifications to account for the fact that a strainer is not a valve and it was desired to determine the strainer's performance characteristics over a wide flow range.

C_v Determination

1. Install the strainer in straight piping of nominal size and standard wall thickness. Ensure that at least 20 diameters of straight pipe are upstream from the strainer and at least 8 diameters are installed downstream from the strainer.
2. Flow test the strainer at several different flow rates and observe the relationship between flow and C_v.
3. The following data shall be recorded:
   a) Upstream pressure (measurement not to exceed 2 percent of actual value).
   b) Pressure differential across the strainer (measurement not to exceed 2 percent of actual value).
   c) Volumetric flow rate (measurement not to exceed 2 percent of actual value).
   d) Fluid temperature (measurement error not to exceed 2 degrees Fahrenheit).
   e) Strainer description and identifying numbers.
4. Calculate the gross and net flow coefficient C_v.

TEST RESULTS

The pressure loss and flow coefficient C_v data are given in Tables 1 through 6 and the net pressure loss and net flow coefficient data are shown graphically on Figures 3 through 8.

Table 2. Strainer Flow Performance Testing

4" Metraflex LPD 0.125 Perforations

Reference Data			
Pipe Dia. (I.D. in.) =	4.026	Water temp. (F) =	**47.4**
Inlet Pipe Area (ft^2) =	0.088	Unit weight H2O (pcf) =	62.42
Pipe roughness (ft) =	0.00015	Density (slug) =	1.940
Pipe Friction Length (ft) =	2.667	Specific Gravity H2O =	1.0008
		Vapor pressure (psia) =	0.16
		Viscosity (cP) =	1.3632
		Kinematic visc. (ft^2/s) =	1.47E-05

Tested by: E. Fisher 11-2-15
SS Prepared by: Michael C. Johnson 8/20/12
SS Checked by: Zac Sharp 8/27/12
Witnessed by: -

	Flow Measurement							Differential Measurement								Coef.	Coef.
Run No.	**Key**	**Mag. Hz**	**Weight lbs**	**Time s**	**Mag gpm**	**W. Tank gpm**	**V (pipe) ft/s**	**Pu Span psi**	**Pu V**	**DP Span psi**	**DP V**	**Pu (psi)**	**Pd (psi)**	**ΔP gross (psi)**	**ΔP net (psi)**	**Cv gross**	**Cv net**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
1	6M	237.20			59.30		1.49	35	4.790	4	1.0197	33.16	33.14	0.0197	0.0168	**422.7**	**457.3**
2	6M	476.60			119.15		3.00	35	4.754	4	1.0778	32.85	32.77	0.0778	0.0675	**427.3**	**458.7**
3	6M	713.90			178.48		4.50	35	4.714	4	1.1748	32.50	32.32	0.1748	0.1531	**427.1**	**456.4**
4	6M	948.70			237.18		5.98	35	4.665	4	1.3054	32.07	31.76	0.3054	0.2683	**429.3**	**458.0**
5	6M	1195.30			298.83		7.53	35	4.602	4	1.4844	31.52	31.03	0.4844	0.4270	**429.5**	**457.5**
6	6M	1431.80			357.95		9.02	35	4.531	4	1.6868	30.90	30.21	0.6868	0.6059	**432.1**	**460.0**
7	25K	1675.70	14000	240.48	418.93	418.63	10.56	35	4.506	4	1.9346	30.68	29.74	0.9346	0.8254	**433.5**	**461.3**
8	6M	1903.80			475.95		12.00	35	4.485	4	2.1970	30.49	29.30	1.1970	1.0575	**435.2**	**463.0**
9	6M	2141.00			535.25		13.49	35	4.454	4	2.5110	30.22	28.71	1.5110	1.3361	**435.6**	**463.2**
10	6M	2384.00			596.00		15.02	35	4.398	4	2.8640	29.73	27.87	1.8640	1.6489	**436.7**	**464.3**
															Average =	**430.9**	**460.0**

Table 3. Strainer Flow Performance Testing

4" Mueller Basket Strainer
Screen perforation: 0.125"

Reference Data			
Pipe Dia. (I.D. in.) =	4.026	Water temp. (F) =	**41.4**
Inlet Pipe Area (ft^2) =	0.088	Unit weight H2O (pcf) =	62.43
Pipe roughness (ft) =	0.00015	Density (slug) =	1.940
Pipe Friction Length (ft) =	2.667	Specific Gravity H2O =	1.0009
		Vapor pressure (psia) =	0.13
		Viscosity (cP) =	1.5078
		Kinematic visc. (ft^2/s) =	1.62E-05

Tested by: M. Cannor 11/3/2015
SS Prepared by: Michael C. Johnson 8/20/12
SS Checked by: Zac Sharp 8/27/12
Witnessed by: -

Run No.	Flow Measurement: Key	Mag. Hz	Weight lbs	Time s	Mag gpm	W. Tank gpm	V (pipe) ft/s	Differential Measurement: Pu Span psi	Pu V	DP Span psi	DP V	Pu (psi)	Pd (psi)	ΔP gross (psi)	ΔP net (psi)	Coef. Cv gross	Coef. Cv net
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	6M	235.40	1700	205.72	58.85	59.41	1.48	50	3.640	4	1.0355	33.00	32.96	0.0355	0.0326	**312.5**	**326.0**
2	6M	480.20			120.05		3.03	50	3.615	4	1.1486	32.69	32.54	0.1486	0.1380	**311.6**	**323.3**
3	6M	717.90			179.48		4.52	50	3.581	4	1.3295	32.26	31.93	0.3295	0.3072	**312.8**	**323.9**
4	6M	952.70	7000	210.97	238.18	238.56	6.00	50	3.544	4	1.5849	31.80	31.22	0.5849	0.5471	**311.6**	**322.2**
5	6M	1202.30			300.58		7.58	50	3.500	4	1.9348	31.25	30.32	0.9348	0.8762	**311.0**	**321.3**
6	6M	1438.20			359.55		9.06	50	3.444	4	2.3420	30.55	29.21	1.3420	1.2596	**310.5**	**320.5**
7	6M	1677.10	12000	205.63	419.28	419.58	10.57	50	3.412	4	2.8340	30.15	28.32	1.8340	1.7236	**309.7**	**319.5**
8	6M	1897.60			474.40		11.96	50	3.395	4	3.3660	29.94	27.57	2.3660	2.2262	**308.6**	**318.1**
9	6M	2147.00			536.75		13.53	50	3.377	4	4.0080	29.71	26.70	3.0080	2.8309	**309.6**	**319.2**
10	6M	2382.00	17000	205.12	595.50	595.88	15.01	50	3.335	4	4.6790	29.19	25.51	3.6790	3.4627	**310.6**	**320.2**
															Average =	**310.9**	**321.4**

Table 4. Strainer Flow Performance Testing

8" Metraflex LPD 0.125 Perforations

Reference Data			
Pipe Dia. (I.D. in.) =	7.981	Water temp. (F) =	**47.4**
Inlet Pipe Area (ft^2) =	0.347	Unit weight H2O (pcf) =	62.42
Pipe roughness (ft) =	0.00015	Density (slug) =	1.940
Pipe Friction Length (ft) =	5.333	Specific Gravity H2O =	1.0008
		Vapor pressure (psia) =	0.16
		Viscosity (cP) =	1.3632
		Kinematic visc. (ft^2/s) =	1.47E-05

Tested by: M. Cannon 11-3-15
SS Prepared by: Michael C. Johnson 8/20/12
SS Checked by: Zac Sharp 8/27/12
Witnessed by: -

	Flow Measurement							Differential Measurement								Coef.	Coef.
Run No.	**Key**	**Mag. Hz**	**Weight lbs**	**Time s**	**Mag gpm**	**W. Tank gpm**	**V (pipe) ft/s**	**Pu Span psi**	**Pu V**	**DP Span psi**	**DP V**	**Pu (psi)**	**Pd (psi)**	**ΔP gross (psi)**	**ΔP net (psi)**	**Cv gross**	**Cv net**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
1	250K	14.57	4000	194.22	148.29	148.10	0.95	35	4.740	6	1.0064	32.73	32.72	0.0096	0.0085	**1514.0**	**1607.8**
2	250K	24.82			250.90		1.61	35	4.690	6	1.0187	32.29	32.26	0.0280	0.0252	**1498.6**	**1580.1**
3	250K	40.21			405.28		2.60	35	4.610	6	1.0481	31.59	31.52	0.0722	0.0654	**1509.4**	**1585.9**
4	250K	54.02	15100	200.00	543.98	542.92	3.49	35	4.640	6	1.0868	31.85	31.72	0.1302	0.1185	**1508.2**	**1581.0**
5	250K	66.67			669.94		4.30	35	4.610	6	1.1321	31.59	31.39	0.1982	0.1809	**1505.6**	**1575.9**
6	250K	80.60			808.15		5.18	35	4.550	6	1.1925	31.06	30.77	0.2888	0.2642	**1504.5**	**1573.0**
7	250K	93.98	26140	200.00	941.42	939.86	6.04	35	4.490	6	1.2604	30.54	30.15	0.3906	0.3578	**1506.9**	**1574.4**
8	250K	108.64			1088.33		6.98	35	4.410	6	1.3487	29.84	29.31	0.5231	0.4799	**1505.4**	**1571.6**
9	250K	119.31			1195.01		7.66	35	4.340	6	1.4201	29.23	28.59	0.6302	0.5786	**1506.0**	**1571.6**
10	250K	133.71	37180	200.00	1338.99	1336.79	8.59	35	4.250	6	1.5257	28.44	27.65	0.7886	0.7246	**1508.5**	**1573.7**
11	250K	171.72			1720.00		11.03	35	3.930	6	1.8597	25.64	24.35	1.2896	1.1863	**1515.2**	**1579.8**
12	250K	201.10			2015.00		12.92	35	3.610	6	2.1760	22.84	21.07	1.7640	1.6240	**1517.7**	**1581.8**
13	250K	234.90			2352.77		15.09	35	3.190	6	2.6060	19.16	16.75	2.4090	2.2201	**1516.5**	**1579.7**
															Average =	**1506.7**	**1579.5**

Table 5. Strainer Flow Performance Testing

8" Mueller Basket Strainer
Screen perforation: 0.125"

Reference Data			
Pipe Dia. (I.D. in.) =	7.981	Water temp. (F) =	**41.4**
Inlet Pipe Area (ft^2) =	0.347	Unit weight H2O (pcf) =	62.43
Pipe roughness (ft) =	0.00015	Density (slug) =	1.940
Pipe Friction Length (ft) =	5.333	Specific Gravity H2O =	1.0009
		Vapor pressure (psia) =	0.13
		Viscosity (cP) =	1.5078
		Kinematic visc. (ft^2/s) =	1.62E-05

Tested by: M. Cannon 2/17/17
SS Prepared by: Michael C. Johnson 8/20/12
SS Checked by: Zac Sharp 8/27/12
Witnessed by: -

Run No.	Flow Measurement							Differential Measurement								Coef.	Coef.
	Key	Mag. Hz	Weight lbs	Time s	Mag gpm	W. Tank gpm	V (pipe) ft/s	Pu Span psi	Pu V	DP Span psi	DP V	Pu (psi)	Pd (psi)	ΔP gross (psi)	ΔP net (psi)	Cv gross	Cv net
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	12M	23.80	7000	208.34	240.54	241.57	1.54	50	3.586	4	1.0480	32.33	32.28	0.0480	0.0453	**1098.4**	**1130.1**
2	12M	45.92			460.57		2.95	50	3.539	4	1.1760	31.74	31.56	0.1760	0.1673	**1098.4**	**1126.7**
3	12M	69.83			698.36		4.48	50	3.532	4	1.4064	31.65	31.24	0.4064	0.3875	**1096.0**	**1122.4**
4	12M	94.31	26200	200.00	941.65	941.87	6.04	50	3.470	4	1.7314	30.88	30.14	0.7314	0.6982	**1101.6**	**1127.4**
5	12M	117.30			1170.75		7.51	50	3.393	4	2.1280	29.91	28.78	1.1280	1.0779	**1102.8**	**1128.2**
6	12M	140.35			1400.70		8.98	50	3.309	4	2.6110	28.86	27.25	1.6110	1.5406	**1104.1**	**1129.0**
7	12M	165.51	45960	200.00	1652.36	1652.23	10.60	50	3.183	4	3.2350	27.29	25.05	2.2350	2.1385	**1105.8**	**1130.5**
8	12M	187.82			1875.90		12.03	50	3.051	4	3.8900	25.64	22.75	2.8900	2.7670	**1104.0**	**1128.3**
9	12M	211.50			2112.64		13.55	50	2.897	4	4.6540	23.71	20.06	3.6540	3.4994	**1105.7**	**1129.9**
10	12M	233.30	64800	200.00	2330.14	2329.52	14.94	50	2.738	5	4.5440	21.73	17.30	4.4300	4.2433	**1107.6**	**1131.7**
															Average =	**1102.4**	**1128.4**

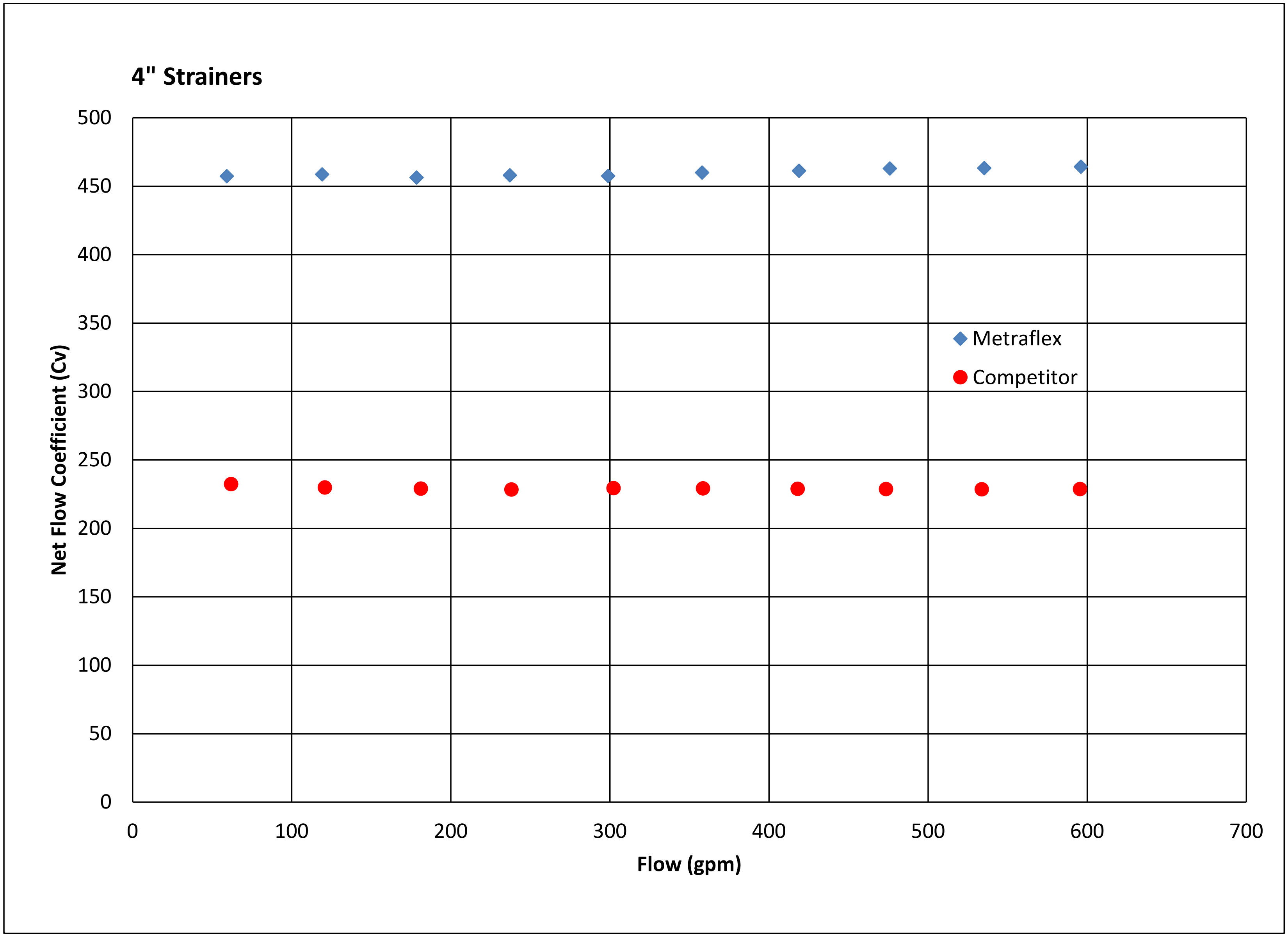

Figure 6. Flow rate versus flow coefficient.

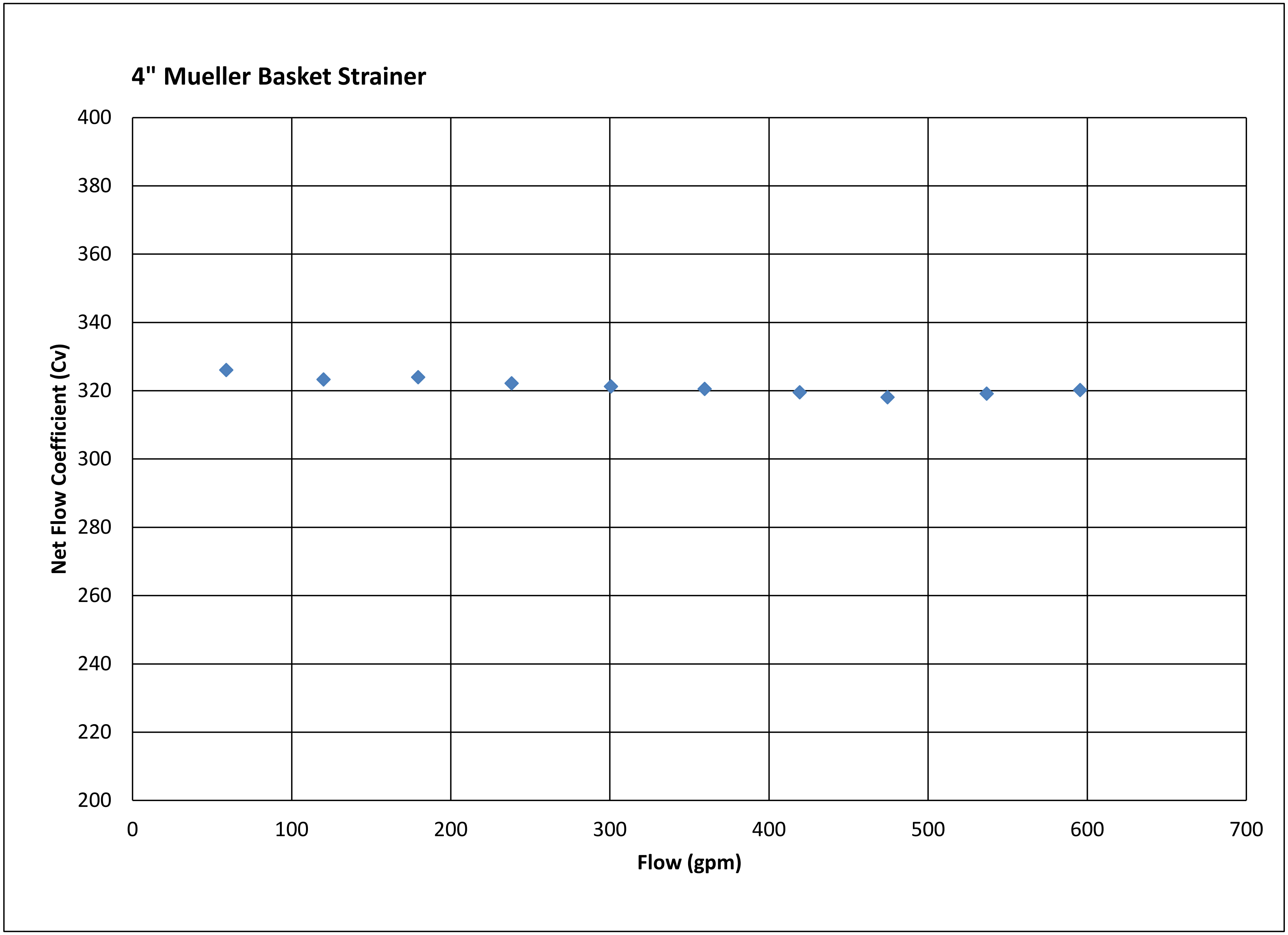

Figure 5. Flow rate versus flow coefficient.

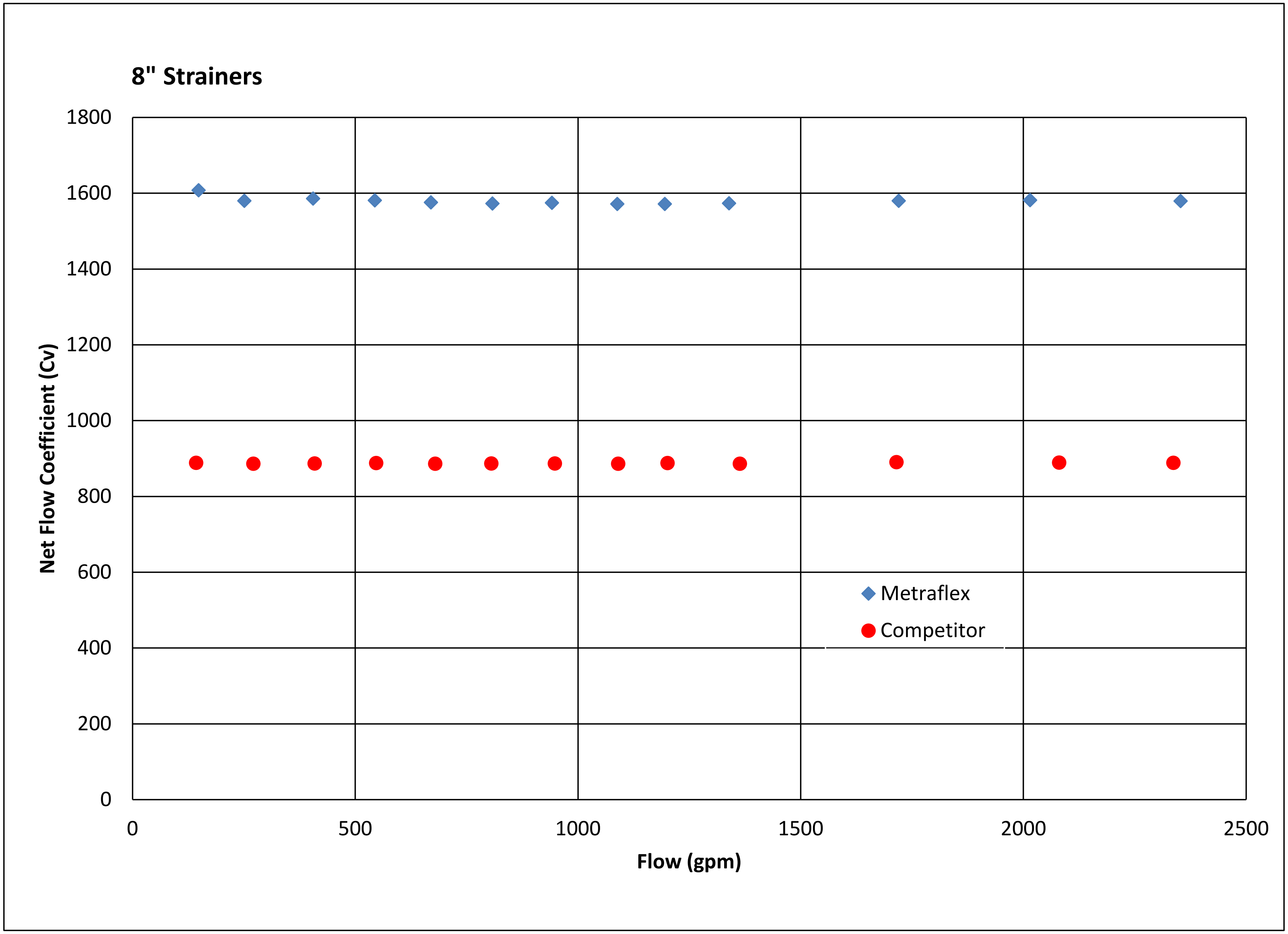

Figure 8. Flow rate versus flow coefficient.

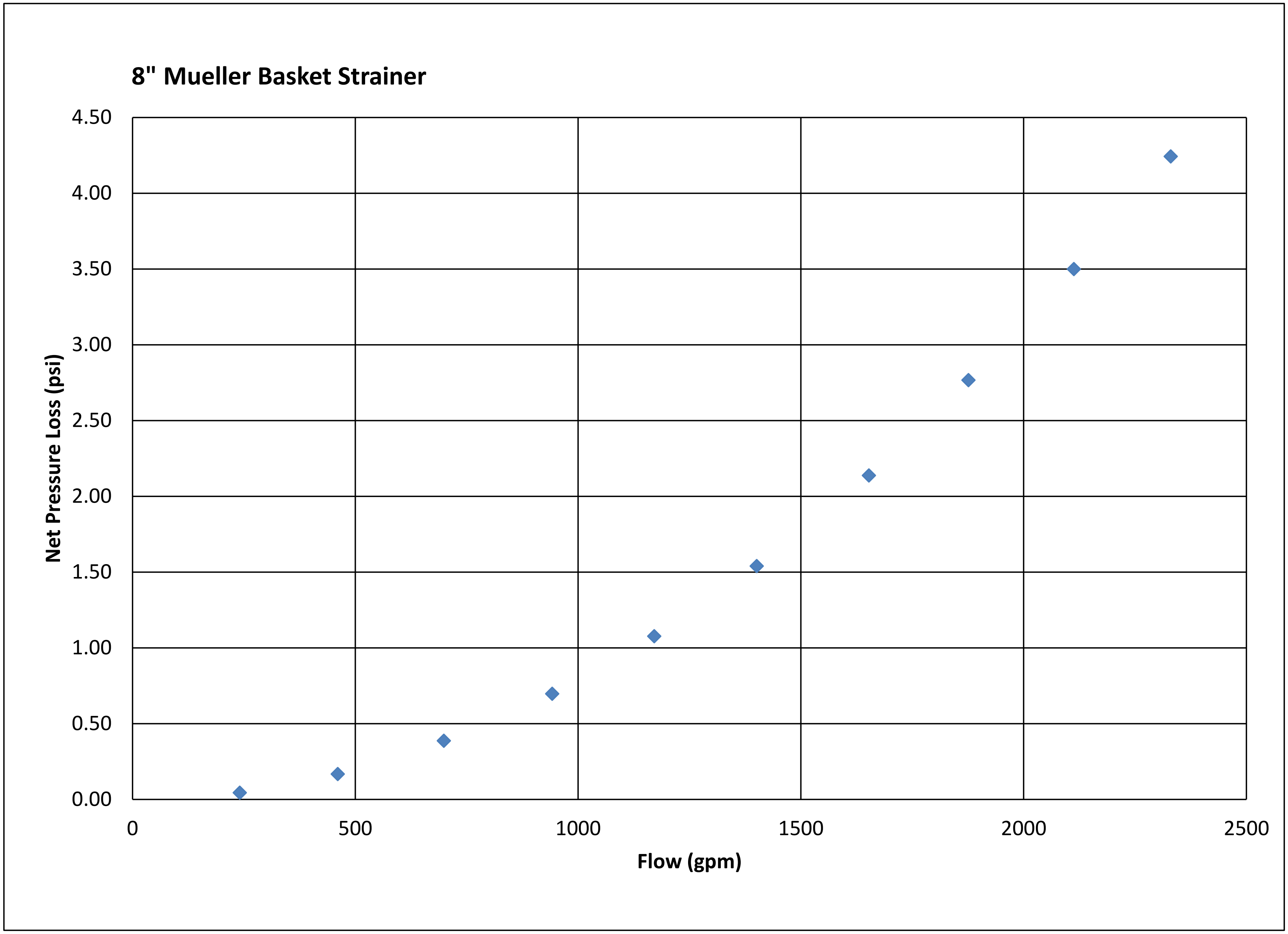

Figure 13. Flow rate versus differential pressure.