

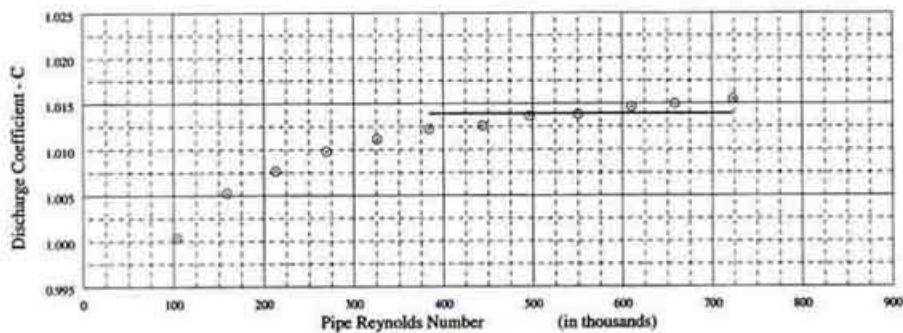
ALDEN RESEARCH LABORATORY, INC.

Solving Flow Problems Since 1894

CALIBRATION OF ONE 6" AND ONE 12" FLOW NOZZLE METER RUN

PURCHASE ORDER NUMBER 26841-ALS

OCTOBER 2002 - ARL NO. 323-02/C853



$q_a = C F_a K_M \sqrt{\Delta h}$	
q_a = Actual Flow (ft ³ /sec)	
C = Discharge Coefficient (Dimensionless)	
Δh = Pressure Differential (Feet of Water at Room Temperature)	
K_M Meter Constant = $\frac{K \sqrt{2g}}{\sqrt{1 - \beta^4}}$	= 0.3350
F_a = Average Thermal Expansion Factor	= 0.9996
a = Throat Area (in ²)	= 0.0409
g = Local Acceleration of Gravity (ft/sec ²)	= 32.1625
β = Ratio of Throat to Pipe Diameter (Dimensionless)	= 0.4514
Pipe Diameter (Inches)	= 6.0650
Throat Diameter (Inches)	= 2.7380
For Pipe Reynolds Number > 380.00 \pm 10% avg coefficient	= 1.0139

Purchase Order Number: 26841-ALS
6" FLOW NOZZLE CS SCH STD
Serial Number: P & ID: M-10301
Tag Number: FE-B0302
October 23, 2002

Certified By: *James D. Hight*



Purchase Order Number: 26841-ALS
 6" FLOW NOZZLE CS SCH STD
 Serial Number: P & ID: M-10301
 Tag Number: FE-B0302

CALIBRATION
 DATE: October 23, 2002
 PIPE DIAMETER = 6.0650
 THROAT DIAMETER = 2.7380

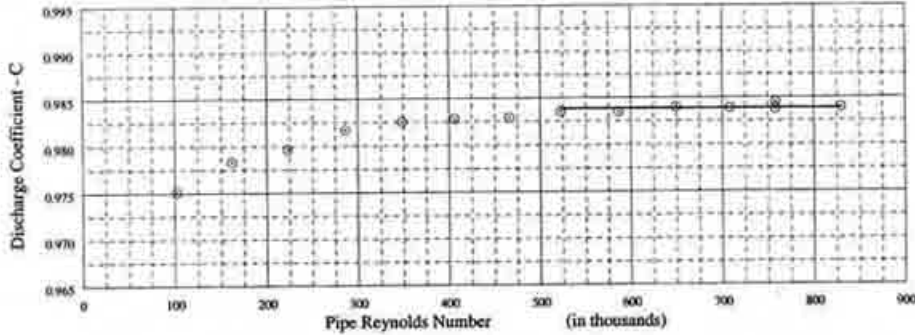
Run #	Line Temp Deg F	Air Temp Deg F	Net Weight lb	Run Duration secs	Output [see note]	Flow GPM	H Line FT H2O	Pipe Rey. # x 10 ⁵	Coef
1	48	66	45412	175.722	7.147-	1860.	148.650	7.2338	1.0155
2	48	66	45442	191.605	6.539-	1707.	125.309	6.5841	1.0150
3	48	66	40364	183.668	5.728-	1582.	107.673	6.1011	1.0146
4	48	66	35380	178.430	5.040-	1427.	87.789	5.5048	1.0139
5	48	66	31095	173.911	4.873-	1287.	71.410	4.9638	1.0137
6	48	66	35301	222.637	7.417-	1141.	56.278	4.4383	1.0126
7	48	66	36510	266.107	6.060-	987.8	42.165	3.8405	1.0123
8	48	66	25216	216.557	4.932-	838.3	30.437	3.2593	1.0112
9	48	66	20160	209.246	4.014-	693.6	20.895	2.6969	1.0098
10	48	66	21068	276.574	7.053-	548.4	13.115	2.1322	1.0077
11	48	66	20135	354.935	4.818-	408.4	7.309	1.5879	1.0053
12	48	66	20632	555.779	3.221-	267.2	3.161	1.0391	1.0004

- dp transmitter volts

For Pipe Rey. # above 3.80 x 10⁵ Avg Coef = 1.0139 With Standard Deviation = 0.0012
 The data reported on herein was obtained by measuring equipment the calibration of which is traceable to NIST, following the installation and use procedures referenced in this report, resulting in a flow measurement uncertainty of +/- 0.25% or less.

CALIBRATED BY: THE

CERTIFIED BY: *[Signature]*



$q_a = C F_a K_M \sqrt{\Delta h}$	
q_a = Actual Flow (ft ³ /sec)	
C = Discharge Coefficient (Dimensionless)	
Δh = Pressure Differential (Feet of Water at Run Temperature)	
K_M = Meter Constant = $\frac{e\sqrt{2g}}{\sqrt{1-\beta^4}}$	= 1.9470
F_a = Average Thermal Expansion Factor	= 0.9996
e = Throat Area (ft ²)	= 0.2319
g = Local Acceleration of Gravity (ft/sec ²)	= 32.1625
β = Ratio of Throat to Pipe Diameter (Dimensionless)	= 0.5434
Pipe Diameter (Inches)	= 12.0000
Throat Diameter (Inches)	= 6.5210
For Pipe Reynolds Number > 500.00 x 10 ³ avg coefficient	= 0.9839

Purchase Order Number: 26841-ALS
 12" FLOW NOZZLE CS SCH STD
 Serial Number: P & ID: M-107-01
 Tag Number: FE-B0701
 October 22, 2002

Certified By: *[Signature]*



Purchase Order Number: 26841-AJ5
 12" FLOW NOZZLE CS 9CH STD
 Serial Number: P & ID: M-107-01
 Tag Number: FF-8070)

CALIBRATION
 DATE: October 22, 2002
 PIPE DIAMETER = 12.0000
 THROAT DIAMETER = 6.5216

Run #	Line Temp Deg F	Air Temp Deg F	Net Weight lb.	Run Duration secs.	Output [see note]	Flow GPM	H Line FT H2O	Pipe Key # x 10 ⁵	Coef
1	48	63	45567	77.687	4.325-	4223	24.141	4.2981	0.9840
2	48	63	45258	84.421	3.943-	3859	20.174	7.5847	0.9838
3	48	63	45313	84.511	9.763-	3860	20.152	7.5835	0.9845
4	48	63	45628	91.138	8.777-	3654	17.590	7.0829	0.9839
5	48	63	45380	98.829	7.701-	3305	14.794	6.4951	0.9840
6	48	63	45448	109.679	6.648-	2983	12.000	5.8623	0.9835
7	48	63	46650	125.227	5.758-	2682	9.745	5.2270	0.9836
8	48	63	45374	136.621	4.992-	2391	7.755	4.6601	0.9830
9	48	63	45992	150.472	4.275-	2084	5.893	4.0615	0.9828
10	48	63	45598	183.561	3.678-	1788	4.342	3.4835	0.9825
11	48	63	40650	199.101	3.138-	1469	2.938	2.8647	0.9817
12	48	63	30200	180.979	8.835-	1144	1.789	2.2325	0.9797
13	48	63	30344	262.221	5.636-	830.4	0.944	1.6184	0.9784
14	48	63	21156	290.860	3.457-	523.6	0.378	1.0206	0.9751

- dp transmitter valve

CALIBRATED BY: THL

For Pipe Key #s above 5.00 x 10⁵, Avg Coef = 0.9830 With Standard Deviation = 0.0001
 The data reported on herein was obtained by measuring equipment from the calibration of which is traceable to NIST, following the justification and test procedures referenced in this report, resulting in a flow measurement uncertainty of +/- 0.25% or less.

CERTIFIED BY: 

