PFS-FN

ASME FLOW NOZZLES

PRODUCT BULLETIN

PFS DOCUMENT NUMBER: 2006-1001-REV00

FEATURES:

* ASME & ISO RECOGNIZED *

* WIDELY ACCEPTED TEST STANDARD *

* RELIABLE PERFORMANCE HISTORY *

* ACCURATE METERING SOLUTION *

* FLEXIBLE DESIGN & MATERIALS *

Primary Flow Signal, Inc.- WORLD HEADQUARTERS
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Primary Flow Signal, Inc.
PFS
ISO 9001-2000 CERTIFIED
THE LEADER IN RELIABLE FLOW MEASUREMENT

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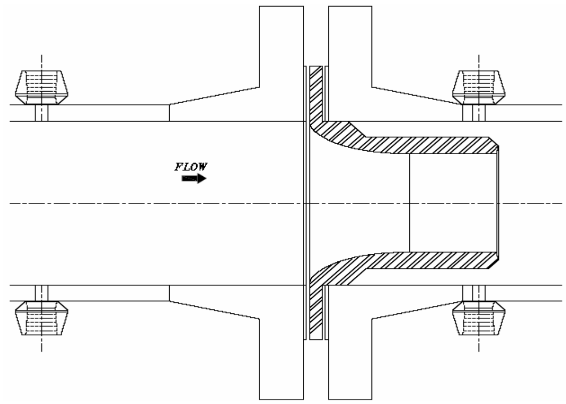
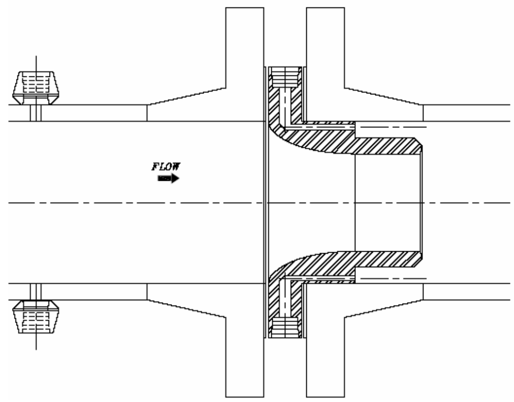
PFS FLOW NOZZLE TYPES

PFS-NZF



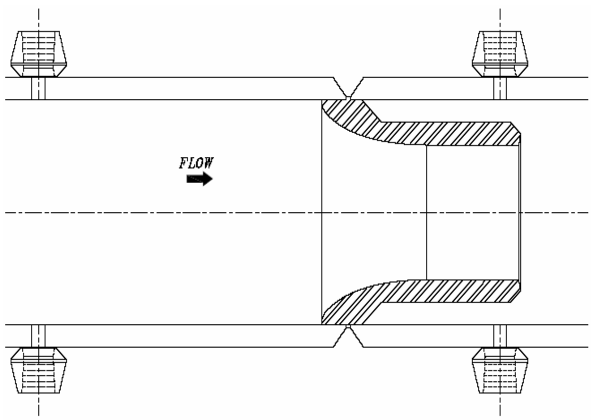
The **PFS-NZF** type nozzle is machined with a holding flange that is flush with the inlet contour of the element. This flange is typically of raised face or ring joint construction. The nozzle is mounted concentrically within the process flanges of the pipe section in which it is installed. Each nozzle is provided with a close tolerance shoulder downstream of the holding flange to insure its concentricity within the metering run.

PFS-NZFT



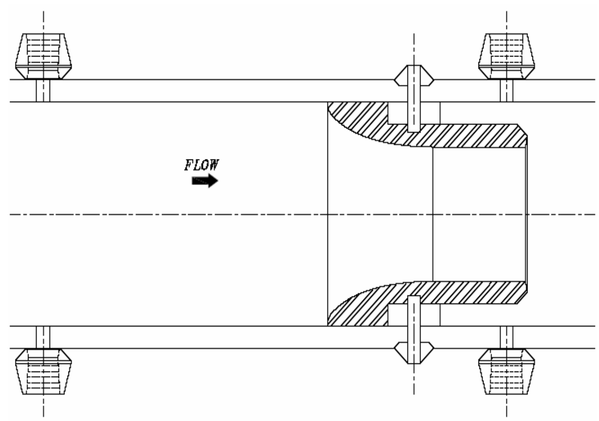
The **PFS-NZFT** is furnished with the downstream pressure tap machined integrally in the nozzle holding flange. It is a flanged nozzle used primarily in smaller line sizes where the downstream tap may cause interference with the pipe weld, mounting flange and/or assembly bolting. This nozzle is most commonly supplied in sizes of 4” and below and furnished with a 1/2” NPT-F as standard.

PFS-NZWI



The **PFS-NZWI** nozzle is designed for installation in the metering run by welding. The nozzle is furnished with a machined boss on the outside diameter of the shoulder which assists in its installation between the beveled ends of the up and downstream pipe sections. This nozzle is extensively used in applications that preclude the use of mounting flanges such as high pressure/temperature feedwater and steam measurements in power plants.

PFS-NZHR



The **PFS-NZHR** nozzle is supplied in a precision bored metering pipe where the welding of dissimilar metals is prohibited or not preferred. A holding ring is welded into the meter pipe with the nozzle subsequently pulled through and locked into place via pins that are installed through the pipe wall, holding ring and nozzle body. The pipe, ring and pins are all of compatible material designation. In line sizes below 4” please contact PFS.

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GENERAL FEATURES - PFS FLOW NOZZLES

LINE SIZE/BETA RATIO

ASME Nozzles manufactured in accord with ASME MFC-3M-2004 are supplied in 2.0” - 25.0” Line ID
Beta Ratio Range: 0.20-0.80

NOZZLE MATERIAL

Nozzles are furnished in 300 series Stainless Steel for most applications due to the high velocities and extreme environments to which they are exposed. Other materi als are available for extreme temperatures and corrosive service.

PRESSURE TAPS

For ASME Wall Tap Installation:
High Pressure: 1 Dia Upstream of Nozzle Inlet Face
Low Pressure: 0.5 Dia Downstream of Nozzle Inlet

PRESSURE TAPS (cont’d)

For ASME Throat Tap Installation:
High Pressure: 1 Dia Upstream of Nozzle Inlet Face
Low Pressure: Nozzle Throat-Code Specified Location

ACCURACY

Nozzle accuracy is dependent on several functions inclu sive of piping configuration, beta ratio and Reynolds number. The ASME MFC standard indicates a discharge coefficient uncertainty of +/- 2% for nozzles fabricated in accord with this specification. This may be improved through hydraulic Lab Calibration.

PIPING REQUIREMENTS

Table 3-3 below indicates up and downstream piping re quirements for these nozzles. These lengths may be re duced through the use of flow conditioners.

Table 3-3 Required Straight Lengths for Nozzles and Venturi Nozzles

Diameter Ratio, β [Note (1)]	Upstream (Inlet) Side of the Primary Device: Single 90 deg Bend or Tee (flow from one branch only)		Two or More 90 deg Bends in Same Plane		Two or More 90 deg Bends in Different Planes		Reducer 2D to D Over Length of 1.5D to 3D		Expander 0.5D to D Over Length of D to 2D		Globe Valve Fully Open		Full Bore Ball or Gate Valve Fully Open		Abrupt Symmetrical Reduction		Thermometer Pocket or Well of Diameter ≤ 0.03D [Note (2)]		Thermometer Pocket or Well of Diameter Between 0.03D and 0.13D [Note (2)]		Downstream (Outlet) Side of Primary Device: Fittings (Columns 2 to 8)	
1	2		3		4		5		6		7		8		9		10		11		12	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
0.20	10	6	14	7	34	17	5	Note (3)	16	8	18	9	12	6	30	15	5	3	20	10	4	2
0.25	10	6	14	7	34	17	5	Note (3)	16	8	18	9	12	6	30	15	5	3	20	10	4	2
0.30	10	6	16	8	34	17	5	Note (3)	16	8	18	9	12	6	30	15	5	3	20	10	5	2.5
0.35	12	6	16	8	36	18	5	Note (3)	16	8	18	9	12	6	30	15	5	3	20	10	5	2.5
0.40	14	7	18	9	36	18	5	Note (3)	16	8	20	10	12	6	30	15	5	3	20	10	6	3
0.45	14	7	18	9	38	19	5	Note (3)	17	9	20	10	12	6	30	15	5	3	20	10	6	3
0.50	14	7	20	10	40	20	6	5	18	9	22	11	12	6	30	15	5	3	20	10	6	3
0.55	16	8	22	11	44	22	8	5	20	10	24	12	14	7	30	15	5	3	20	10	6	3
0.60	18	9	26	13	48	24	9	5	22	11	26	13	14	7	30	15	5	3	20	10	7	3.5
0.65	22	11	32	16	54	27	11	6	25	13	28	14	16	8	30	15	5	3	20	10	7	3.5
0.70	28	14	36	18	62	31	14	7	30	15	32	16	20	10	30	15	5	3	20	10	7	3.5
0.75	36	18	42	21	70	35	22	11	38	19	36	18	24	12	30	15	5	3	20	10	8	4
0.80	46	23	50	25	80	40	30	15	54	27	44	22	30	15	30	15	5	3	20	10	8	4

DESIGN STANDARDS

All Flow Nozzles furnished by PFS are designed in accordance with the applicable sections of the following standards.

ASME MFC-3M-2004 ISO-5167 DIN ASHRAE
ASME PTC 19.5
ASME Research Committee Report on Fluid Meters

FABRICATION STANDARDS

ASME Section I
ASME B31.1 – Power Piping
ASME B31.3 – Process Piping

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TYPICAL CALIBRATION-ASME NOZZLE

DISCHARGE COEFFICIENT

ASME Nozzles manufactured in accord with ASME MFC-3M-2004 and supplied with pipe wall taps have a discharge coefficient that is characterized by the equation below:

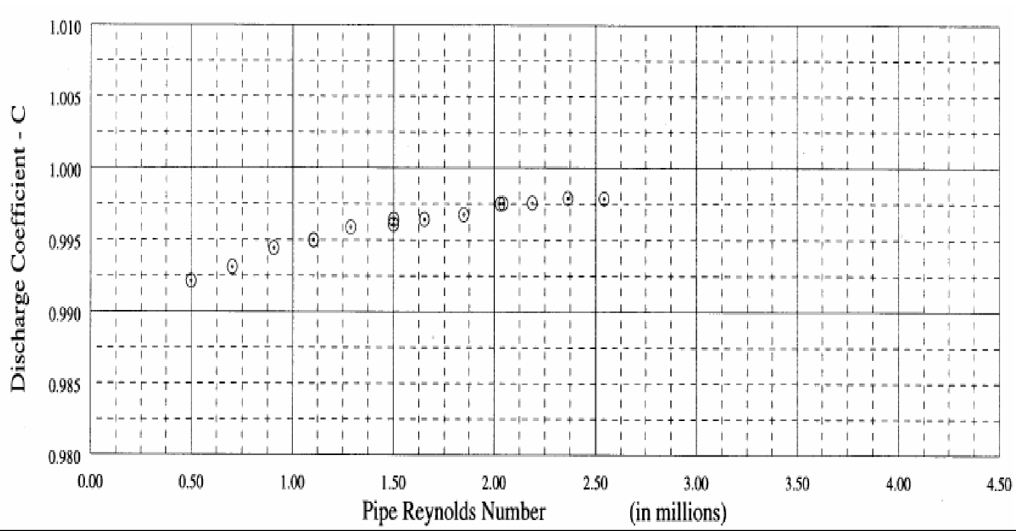
$$C = 0.9965 - 0.00653B^{0.5} \left(10^{6} / R_D \right)^{0.5}$$

The lab calibration report presented here is representative of a wall tap assembly.

Purchase Order Number: 889
10" METER TUBE
Tag Number: HAH50CF005

CALIBRATION
DATE: April 6, 2005
PIPE DIAMETER = 10.0410
THROAT DIAMETER = 5.9880

Run #	Line Temp Deg F	Air Temp Deg F	Net Weight lb.	Run Duration secs.	Output [see note]	Flow GPM	H Line FT H20	Pipe Rey. # x 10^6	Coef
1	91	69	95529	112.171	8.382~	6161.	67.157	2.5425	0.9979
2	91	69	95335	120.542	7.502~	5722.	57.915	2.3637	0.9979
3	91	69	95447	130.476	6.709~	5293.	49.583	2.1887	0.9976
4	91	69	95397	140.798	6.038~	4902.	42.541	2.0294	0.9975
5	91	69	95313	154.866	5.335~	4453.	35.156	1.8475	0.9968
6	91	69	95252	173.267	4.660~	3977.	28.070	1.6521	0.9964
7	91	69	95315	140.123	6.070~	4922.	42.881	2.0443	0.9975
8	91	69	95176	190.842	4.187~	3608.	23.102	1.5005	0.9964
9	91	69	95204	191.017	4.186~	3606.	23.088	1.4995	0.9961
10	91	69	95166	222.226	8.499~	3098.	17.053	1.2899	0.9959
11	91	69	95128	259.011	6.788~	2657.	12.565	1.1050	0.9950
12	91	69	95108	315.831	5.222~	2179.	8.457	0.9070	0.9944
13	92	69	68470	294.317	3.927~	1683.	5.061	0.7015	0.9931
14	92	69	87344	530.694	2.965~	1191.	2.538	0.4974	0.9921
15	91	69	95066	259.227	6.774~	2653.	12.529	1.1046	0.9950



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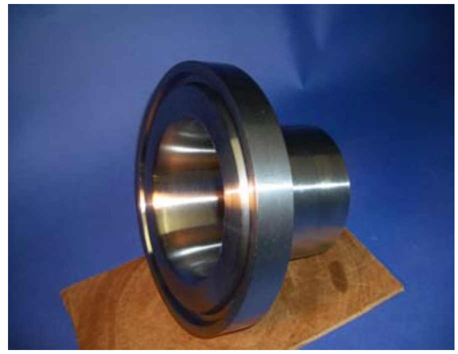
PRIMARY FLOW SECTIONS FOR ASME PTC-6 PERFORMANCE TEST

GENERAL DESCRIPTION

Primary Flow Sections by PFS are specifically designed and manufactured to meet the requirements of ASME PTC-6, 1996 , Performance Test Code for Steam Turbines. They are intended to be used as the primary flow measurement device during steam turbine acceptance tests. The test sections consist of a low-Beta series ASME throat-tap flow nozzle which is installed in a section of pipe approximately 30 pipe diameters long. The upstream section of pipe, which is approximately 20 diameters long , is carefully honed on the inside to insure cylindricality/finish for a minimum of 4 pipe diameters upstream of the nozzle. The downstream section of pipe is approximately 10 pipe diameters long. A flow conditioner is built into the upstream pipe section at a distance of approximately 16 pipe diameters upstream of the flow nozzle.



NOZZLE

The nozzle is available in one of two different styles. The flanged style is intended to be clamped between two mating flanges. Flanges may be flat faced, ring type joint, large groove, or tongue and grooved. **Fig-1** shows a typical flanged style nozzle.
The weld-in style is permanently welded in place between the upstream and downstream pipe sections. **Fig-2** shows a typical welded-in style nozzle.
Either style can be furnished with pipeshell ends beveled for butt-welding or with flanged ends.
Both styles are equipped with four, integrally machined, equally spaced, throat pressure taps. The interior surface of the nozzle is precision machined to insure roundness and cylindricality and then polished to achieve a hydraulically smooth surface.

FLOW CONDITIONER

The flow conditioner may be either the perforated plate or 50-tube bundle style at the purchaser's option. The code-preferred flow conditioner is the perforated plate with a non-uniform hole placement pattern. This style of plate has been shown to be able to remove both swirl and distortion from the upstream flow.

INSPECTION PORT

For weld-in type flow nozzle assemblies, a code-recommended inspection port with a removable, contoured, pin oriented plug can be furnished at the purchaser's option.

DIFFUSER CONE

Differential pressures for PTC-6 nozzles are typically high with ranges often exceeding 1,000 inches of water column. In order to reduce the permanent pressure loss of the Flow Section, a diffuser cone can be installed at the exit of the flow nozzle. The diffuser may be integral with the flow nozzle or may be supplied as a separate component coupled to the nozzle. Permanent pressure losses through the section can be reduced by as much as 70% through the use of diffuser cone attachments.

DESIGN STANDARDS

All Primary Flow Sections furnished by PFS are designed in accordance with the applicable sections of the following standards.

- ASME PTC-6 1996
- ASME PTC 19.5
- ASME Research Committee Report on Fluid Meters-6th Edition

FABRICATION STANDARDS

- ASME Section I
- ASME B31.1 – Power Piping
- ASME B31.3 – Process Piping

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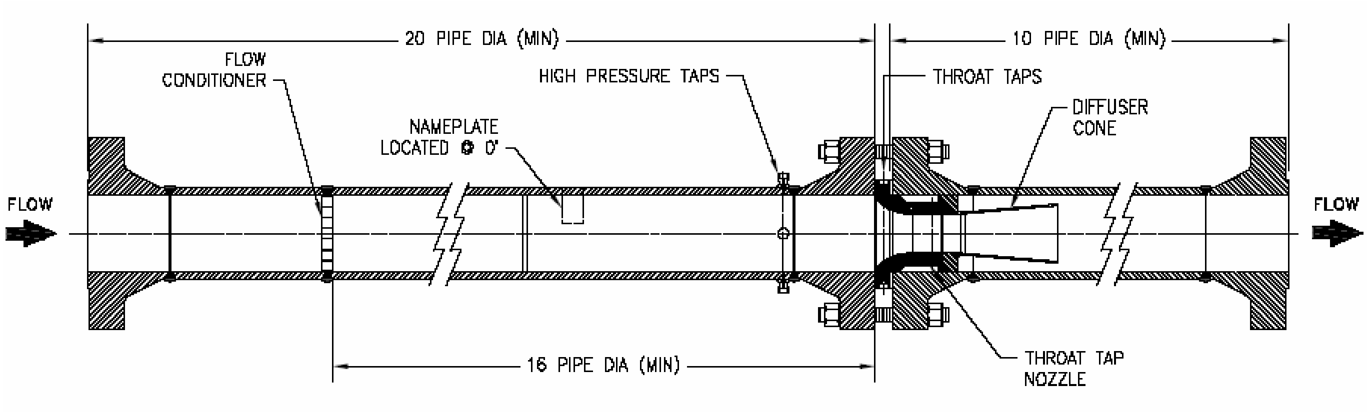
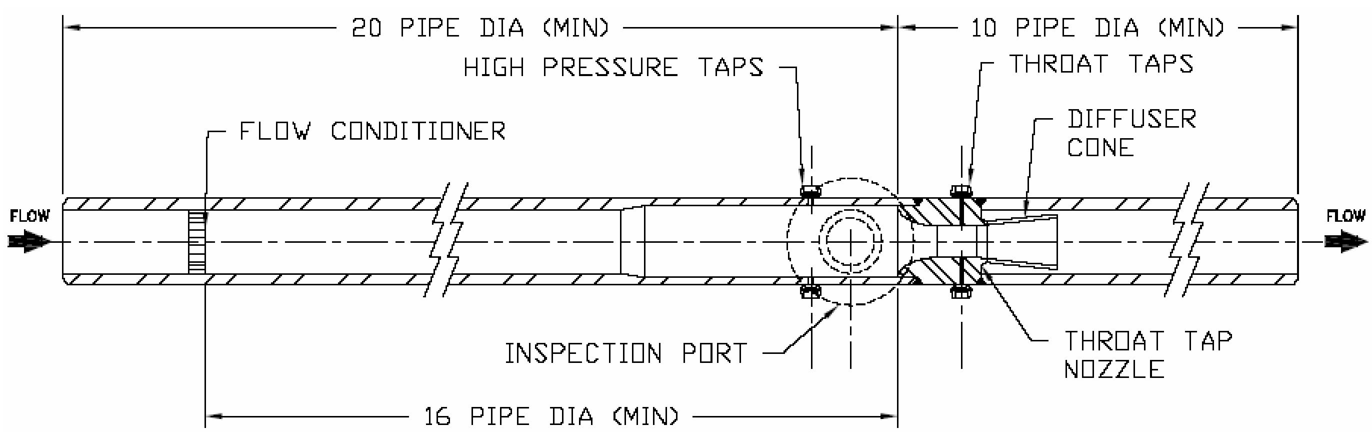
ASME PTC-6 FLOW NOZZLE TYPES

Fig. 1 - PTC6-NZFT



The **PTC6-NZFT** type nozzle assembly is typically provided for the measurement of condensate return flow where line pressures are low to moderate. The construction of this assembly allows for easy removal and inspection of the nozzle, pressure taps and piping during performance testing. The assembly is most commonly supplied with carbon steel process piping, 304 stainless steel flow nozzle and flow conditioner. Other material combinations and grades can be supplied as required.

Fig. 2 - PTC6-NZWI



The **PTC6-NZWI** type nozzle assembly typically provided for the measurement of final feedwater flow where line pressures are high. The nozzle can be furnished with the diffuser cone integral to the flow nozzle or as an attachment. Inspection ports are supplied as standard to allow for code recommended nozzle inspection during performance testing. The assembly is most commonly supplied with carbon steel process piping, carbon steel inspection port, 304 stainless steel nozzle and flow conditioner. Other material combinations and grades can be supplied as process conditions dictate.

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ASME PTC-6 FLOW NOZZLE-ACCURACY & CALIBRATION

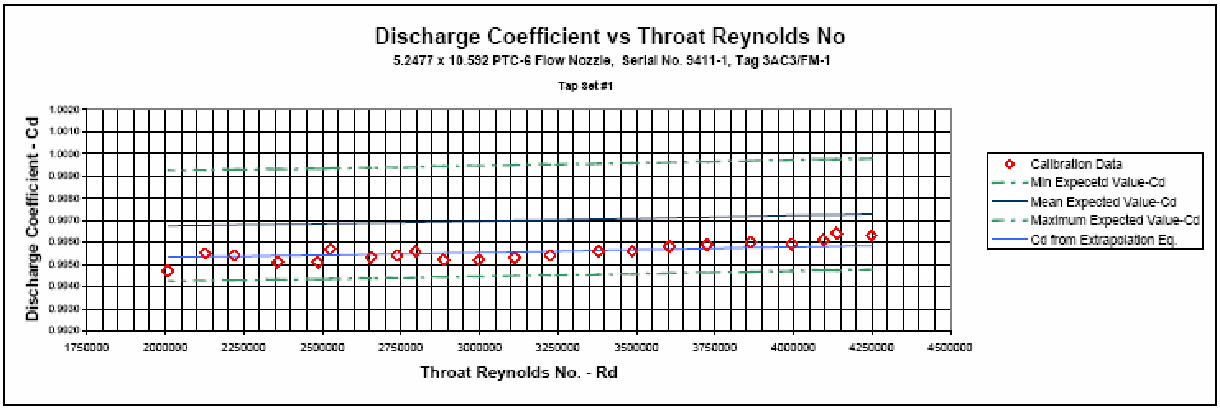
FLOW MEASUREMENT ACCURACY

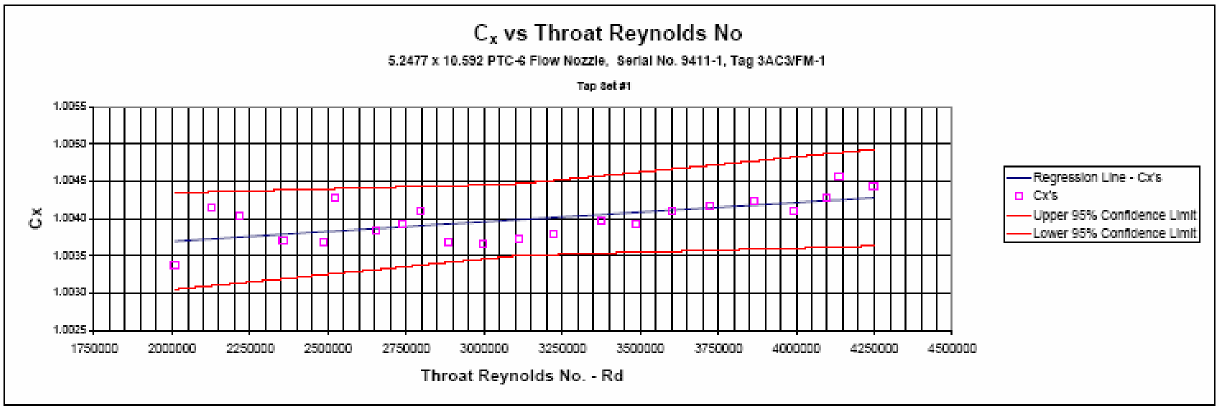
All Primary Flow Sections furnished by PFS are guaranteed to meet the requirements for fabrication and the laboratory calibration acceptance criteria as set forth in ASME PTC-6, 1996. The PTC-6 Code Committee's further explanation of those criteria as published in "Mechanical Engineering", Feb 1999, pp81-83. Specifically, these acceptance criteria are:

1. The average value of Cx must be within the range, 1.0029<= Cx <=1.0079
2. The confidence interval of the slope of the Cx's must include 0 (zero) or the absolute value of the slope must be less than 2.72 x 10-7.
3. The confidence interval of the Cx's must not exceed 0.0006.

In the special case when the range of Reynolds numbers achieved during the calibration matches or exceeds the range of Reynolds numbers that will be encountered during the acceptance test, the above criteria are modified as follows:

1. The average value of Cx need not be within the range, 1.0029<= Cx <=1.0079
2. The confidence interval of the slope of the Cx's need not include 0(zero) nor must the absolute value of the slope be less than 2.72 x 10-7.
3. The confidence interval of the Cx's must not exceed 0.0006.
4. The calibration data must be repeatable. This can be verified by a minimum of three repeat points in the calibration. The repeat points must agree to within 0.05% in order to satisfy this criterion.
5. The calibration must be reliable. This requirement is considered to have been met if the calibration is done at a facility with an established reputation for performing this type of calibration correctly. One such laboratory is ARL, Inc of Holden, MA.





Regression of Cx's to [a + b x Rd]	
Slope (b) =	2.60621E-10
Intercept (a) =	1.003174135
S.E.E. =	0.00023083
Student's t =	2.086022413
Conf Int w.r.t. Reg line =	0.00010256

Standard deviation of Slope of Cx's	
Sb =	7.19396E-11

Confidence limits of the Slope of Cx's	
95% conf int +/- =	1.50068E-10
Upper limit	4.10689E-10
Lower limit	1.10553E-10

Is the average value of Cx in the range 1.0029 <= Cx <= 1.0079?	YES
Is ZERO within the range of confidence limits or is ABS(Slope) LT 2.72E-10?	YES
Is the 95% confidence interval of the Cx's less than or equal to +/- 0.0003?	YES
Is the lowest value of Rd attained during the calibration <= Min Operating Reynolds No.?	YES
Is the highest value of Rd attained during the calibration => Max Operating Reynolds No.?	NO

Based on all of the above, this tap set **MEETS** the acceptance criteria of PTC-6, 1996 and it is therefore **ACCEPTABLE**

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