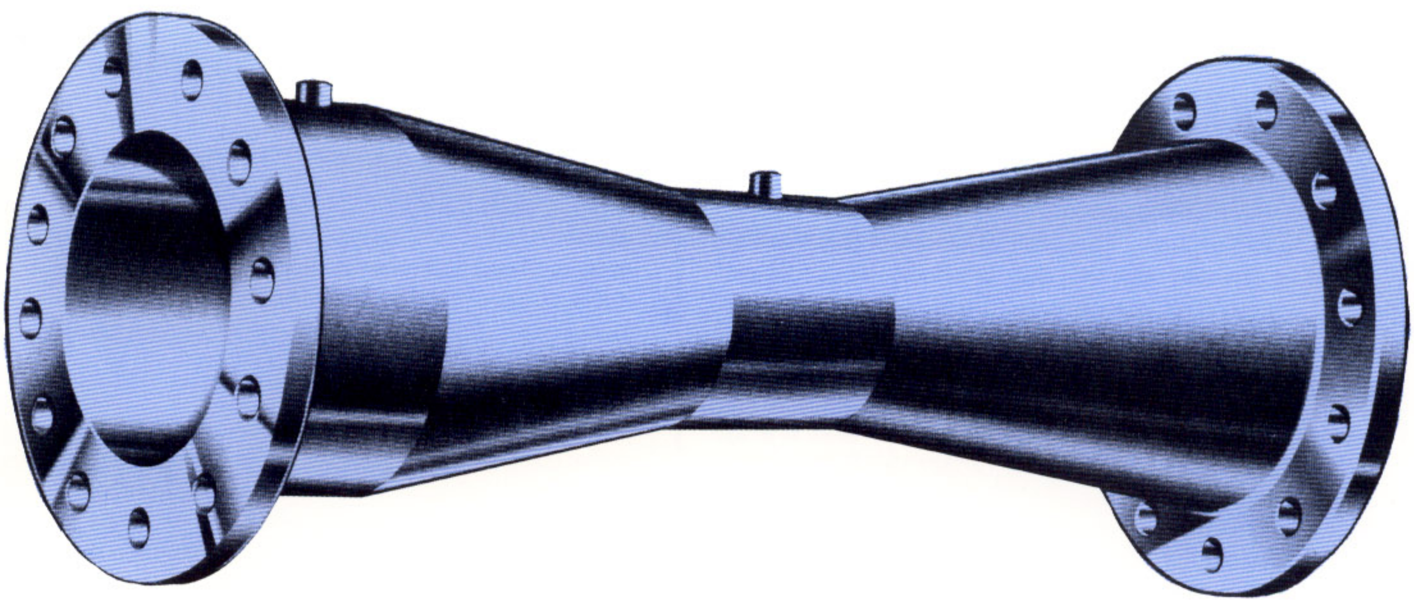
VENTURI TUBES

ASME types/low pressure loss designs

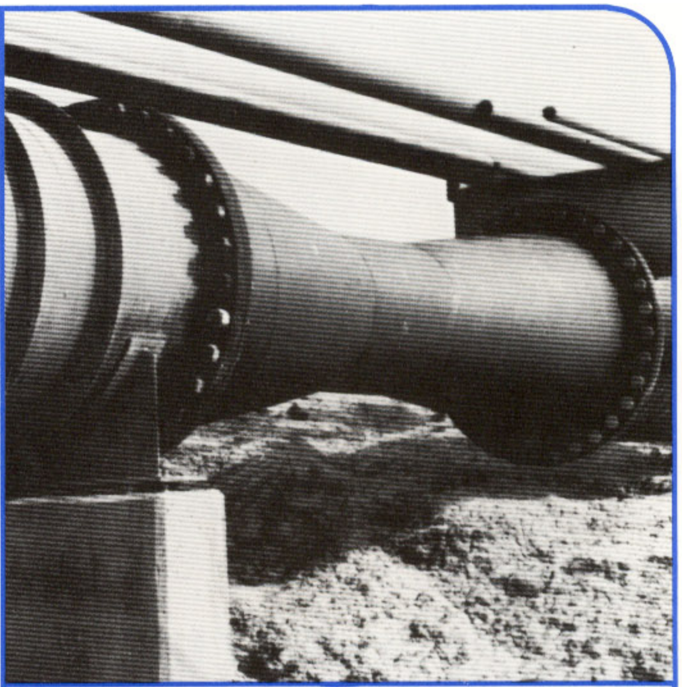


ENERGY FLOW SYSTEMS, INC.

ENERGY FLOW
ASME TYPE VENTURI

The present form of the ASME type venturi as manufactured by Energy Flow was first developed as a practical differential pressure producing device for flow measurement by Clemens Herschel in 1887. Since that time, it has been universally accepted as the most efficient primary device available. No other type of venturi or flow tube design has been more thoroughly researched, tested and proven than the ASME type.

Energy Flow Venturis have been in operation in petrochemical, refining, gas pipeline, metals, water, sewage and power plants since 1964. They are used wherever low pressure loss, high accuracy, piping restrictions or fluids containing solids are encountered.



Pictured above is a 36 inch Energy Flow Model VTF Venturi at a large secondary waste treatment facility.

ENERGY FLOW
LOW LOSS VENTURI

Many modified versions of the venturi, often referred to as flow tubes, have been developed in recent years. As pointed out in this brochure, these designs normally do not offer any significant improvement over the standard ASME type venturi except for somewhat higher pressure recovery.

Where minimum pressure loss is of concern, Energy Flow Model LL Low Loss Venturi should be considered. The Model LL utilizes the classic ASME venturi design with a modified (truncated) exit cone to provide the highest pressure recovery consistent with a time proven design and established flow coefficient data.

OPTIMIZED DESIGN

Optimum design is provided on each Energy Flow venturi since it is manufactured for a specific beta ratio or throat diameter necessary to produce the desired differential pressure consistent with minimum pressure loss, piping requirements and accuracy of measurement.

Cast venturis or flow tubes offer a limited selection of throat sizes which often forces the engineer to accept a compromise design. This frequently means utilizing a lower beta ratio than is necessary resulting in excessive permanent loss or a higher beta ratio thus requiring longer upstream straight runs of pipe.

SHORTEST LAYING LENGTH

A certain length of straight pipe is required upstream of all head type flow meters for proper operation. Some primary elements, such as the orifice plate and flow nozzle also require downstream straight runs of pipe.

When selecting a head type flow meter, the required straight run of pipe must be considered in the laying length. As shown in the graph below, the Energy Flow Model LL Low Loss Venturi and the Energy Flow ASME type standard form venturi offer the shortest overall laying lengths thereby providing maximum freedom of location in plant design.

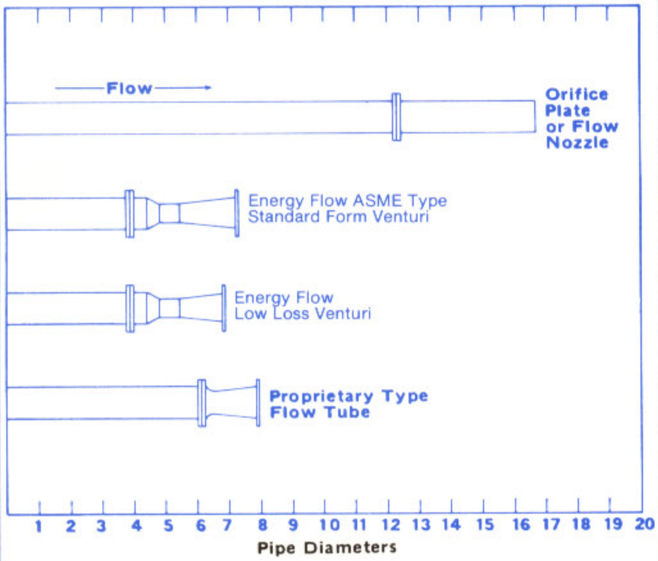


Figure 1.

The above example assumes a typical operating condition of one elbow upstream of the primary flow element with a beta ratio of 0.7. Information show above has been taken from the ASME Fluid Meters Handbook on the orifice plate, flow nozzle and standard form venturi, Information on the Energy Flow Model LL Low Loss Venturi and the proprietary flow tube has been taken from the manufacturers' specification sheets.

HIGHEST ACCURACY

The completeness of published research data permits Energy Flow to provide the classic ASME venturi design as well as the Model LL Low Loss Venturi with the highest accuracy of any differential producing flow element. In some applications accuracies of ± 0.5% can be assured without laboratory flow calibrations.

A variety of proprietary flow tubes on the market do not have the same recognition from the ASME. In fact, the latest ASME Research Report on Fluid Meters states in paragraph 11-111-48 Proprietary Flow Tubes, "If one of these flow tubes is to be used, it should be calibrated with the piping section in which it is to be used and over the full range of rates of flow to which it will be subjected when in use."

Unlike the orifice plate, the ASME type venturi has a constant coefficient over the normally used range of beta ratios and Reynolds Numbers. Also, the high accuracy of the venturi is sustained indefinitely, since there are no sharp edges or protrusions to wear.

REDUCED PIPING COST

Some plant piping configurations may require the engineer to run an extra loop of piping solely for the purpose of obtaining the long straight runs of pipe necessary for proper operation of orifice plates and flow nozzles. When such conditions exist, the use of a venturi with its' shorter piping requirements as shown in Figure 2 can eliminate the extra loop of piping resulting in a substantial savings in costs.

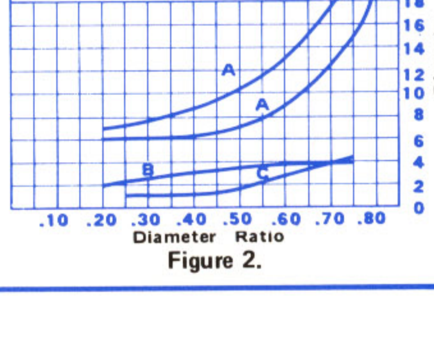


Figure 2.

LOW PERMANENT PRESSURE LOSS

Much is said about the low permanent loss of the proprietary flow tube when expressed as a percentage of the differential produced. However, little is said about the necessity in most cases of increasing initial differential pressures to meet operating range requirements with a corresponding increase in actual head loss.

To illustrate this fact let us assume a typical flow requirement of 4000 GPM of water in a 12" pipe. We would select a beta ratio of .75 which is considered to be the maximum ratio consistent with good engineering practice. As shown in the comparison below, the Energy Flow Model LL Low Loss Venturi has the lowest **actual** head loss even though the proprietary flow tube has the lowest head loss when expressed as a **percentage** of the differential.

PRESSURE LOSS CURVES

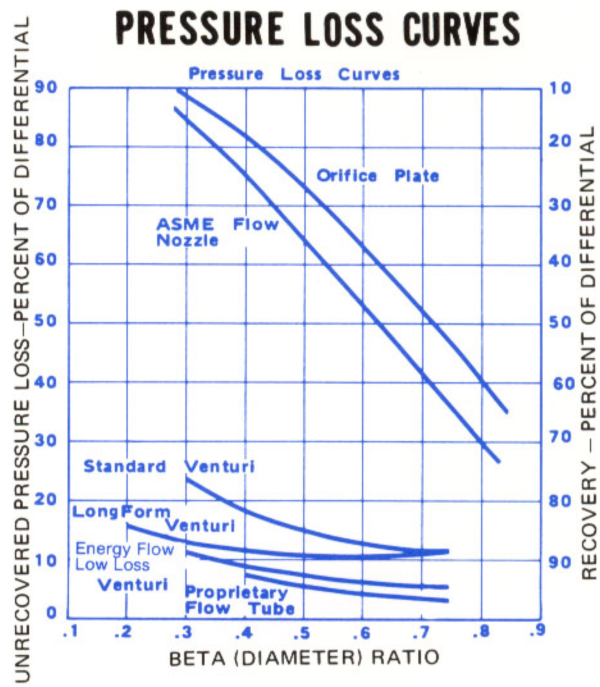


Figure 3.

	ENERGY FLOW ASME VENTURI	ENERGY FLOW LL VENTURI	**PROPRIETARY FLOW TUBE**	**ORIFICE PLATE**
Beta ratio selected	.75	.75	.75	.75
D. P. produced	54"	54"	95"	147"
Permanent pressure loss	11.2%	5.5%	3.5%	46%
Actual pressure loss - inches W.C.	6.0"	3.0"	3.3"	66.1"

NOTE: Values and charts for proprietary flow tubes and low loss tubes are approximate.

Figure 4.

REDUCED PUMPING COST

When evaluating the cost of various head meters, more than the initial purchase price should be considered. The higher initial cost of the venturi over an orifice plate can be an investment which will yield a large return where pumping costs are a factor. A comparison of the orifice plate and Energy Flow ASME type venturi is shown below utilizing the same flow conditions outlined in the previous paragraph and figure 4.

Orifice plate actual head loss	66.1"
Venturi actual head loss	-6.0"
Difference in actual head loss	**60.1" or 5.0'**

Therefore:

$$\text{Difference in pump horsepower} = \frac{\text{Lbs/min x ft of loss}}{\text{33,000 ft lbs/min}}$$

$$\text{Horsepower saved} = \frac{\text{4,000 GPM (8.33 lbs/gal) (5.0')}}{\text{33,000}} =$$

5.05 horsepower

Considering normal pump and motor efficiencies, it takes approximately 1 KW electric power to produce one horsepower.

At a power cost of \$.03/KWHR Savings per year =
5.05 hp (8760) hrs/yr (\$.03) = \$1237.00

FLUIDS WITH SUSPENDED SOLIDS

Liquid slurries such as sewage and plant waste streams; and gases with entrained liquids, such as steam, can be successfully metered with a venturi tube.

The venturi will often perform as well or better than a magnetic flow meter in many slurry applications at a fraction of the cost. Energy Flow Venturis can be constructed from special abrasion resistant materials when desirable for especially severe service.

Purge rotometers and regulators are available for keeping meters and lead lines free of solids buildup when required.

LIGHT WEIGHT

The fabricated venturi construction is more durable than cast primary elements yet weighs considerably less. As an example, a 12" fabricated venturi weighs approximately 275 lbs. with 150 lb. flanges as compared to 800 lbs. for a cast venturi and 500 lbs. for the typical proprietary flow tube. The lighter weight of the fabricated venturi results in a savings in shipping costs and installation costs.

SPECIAL VENTURI DESIGNS

Energy Flow can provide venturi designs to meet special requirements where the standard ASME type or the Model LL Low Loss Venturi cannot be used. Some of the typical special designs include:

A. Bi-directional flow measurement.
B. Measurement at extremely low Reynolds Numbers (small pipe size or high viscosity).
C. Control applications utilizing a control valve in the exit cone of the venturi.

MATERIALS OF CONSTRUCTION

Energy Flow Venturis are built of various carbon and stainless steels, Inconel, nickel, alloy 20 and other materials to suit specific applications. Energy Flow Venturis can also be internally plated, lined or coated with various materials for special purpose applications.

PIEZOMETER RING OR AVERAGING ANNULUS

To insure accurate flow measurement the fluid should enter the primary element with a fully developed velocity profile, free from swirls and vortices. Such a condition is achieved by the use of an adequate length of straight pipe preceding the venturi tube. This length, as recommended by the ASME, has been determined as necessary to hold the errors due to pipe configuration to less than 0.5%. Greater lengths of straight pipe should be included where possible. Energy Flow Venturis are normally supplied with a single high and low pressure tap whenever the above flow conditions can be met. If it is impossible to provide the recommended upstream length of pipe, even with the use of straightening vanes where they would be helpful, Energy Flow Venturis utilizing a piezometer ring with multiple taps (usually 2 or 4 at each tap location) can be supplied to reduce the error in flow measurement.

CLEANOUT RODS

Energy Flow Venturis may be equipped with cleanout rods on the pressure taps as shown in Figure 5 for periodic cleaning where required. Purge rotameters and regulators are also available for continuous purging.

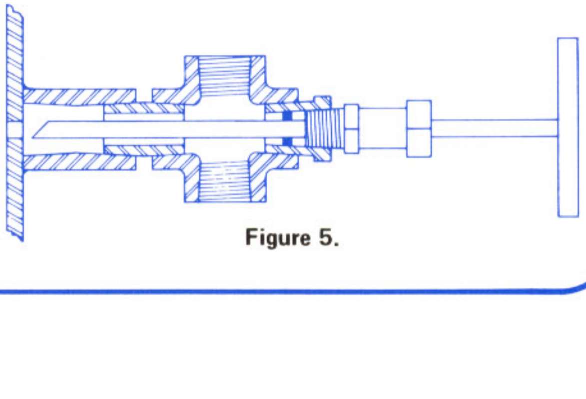
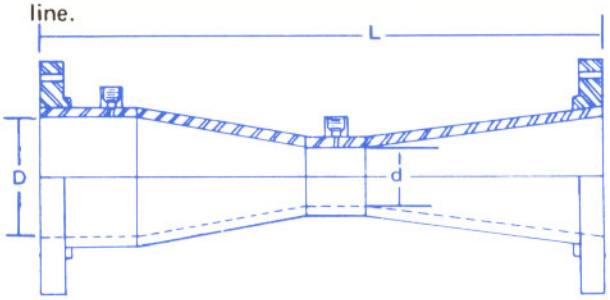


Figure 5.

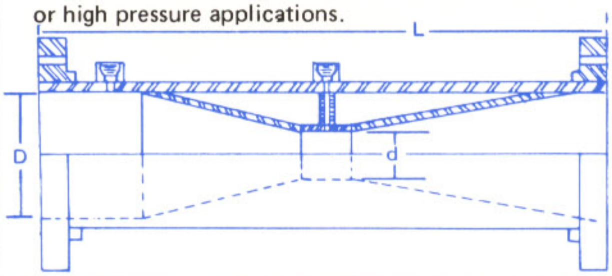
FLANGED ENDS, MODEL VTF. (1)

Durable, light weight construction for bolting into line.



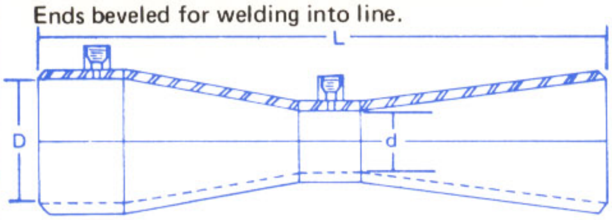
PIPE SHELL DESIGN, MODEL VTFS (1)

Light weight venturi welded inside pipe section. High structural strength. Often less expensive for large sizes or high pressure applications.



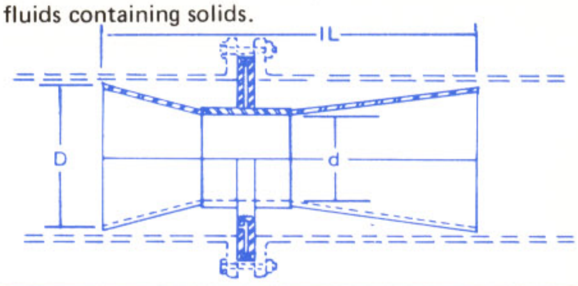
WELD-IN TYPE, MODEL VTW (1)

Ends beveled for welding into line.



INSERT TYPE, MODEL VTI (1)

Minimum weight and cost. Not recommended for fluids containing solids.



(1) To specify the Energy Flow Los Loss Venturi add -LL after the appropriate model number as listed in the above drawings.

ORDERING INFORMATION

After selecting the configuration best suited to your application, please fill in the appropriate model number as well as the following information on the flowing conditions.

For all fluids specify:

Model number ____

Type of end fittings and rating ____

____

Materials of construction:

Throat ____

Body ____

Flanges ____

Pipe I. D. ____ or

Line size ____ & Pipe Schedule ____

Fluid ____

Units of flow ____

Max flow ____ Normal flow ____

Specific gravity:

Operating ____ Base ____

Temperature:

Operating ____ Base ____

Pressure: Operating ____

If liquid specify:

Viscosity @ Operating temperature ____

____

If gas specify:

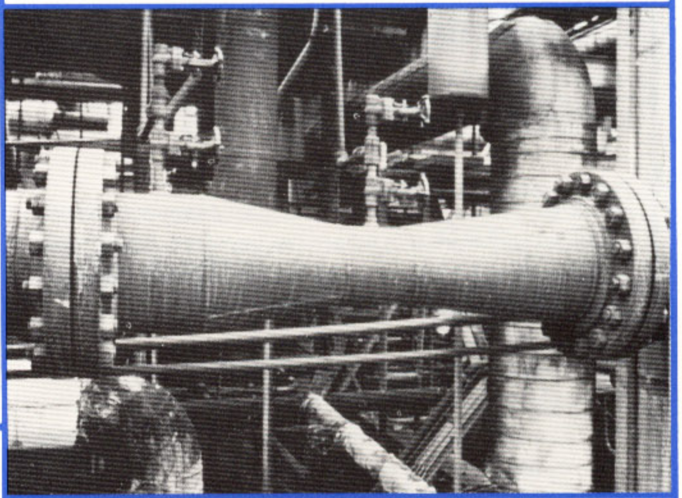
Molecular weight ____

Base pressure ____

Gas composition ____ or

Specific heat ratio ____ and

Compressibility ratio (Z_f) ____



Pictured above is a 12 inch Energy Flow Model VTF high pressure venturi in use at a large modern refinery.

DIMENSIONS & CAPACITY TABLES FOR ASME TYPE SHORT FORM VENTURIS

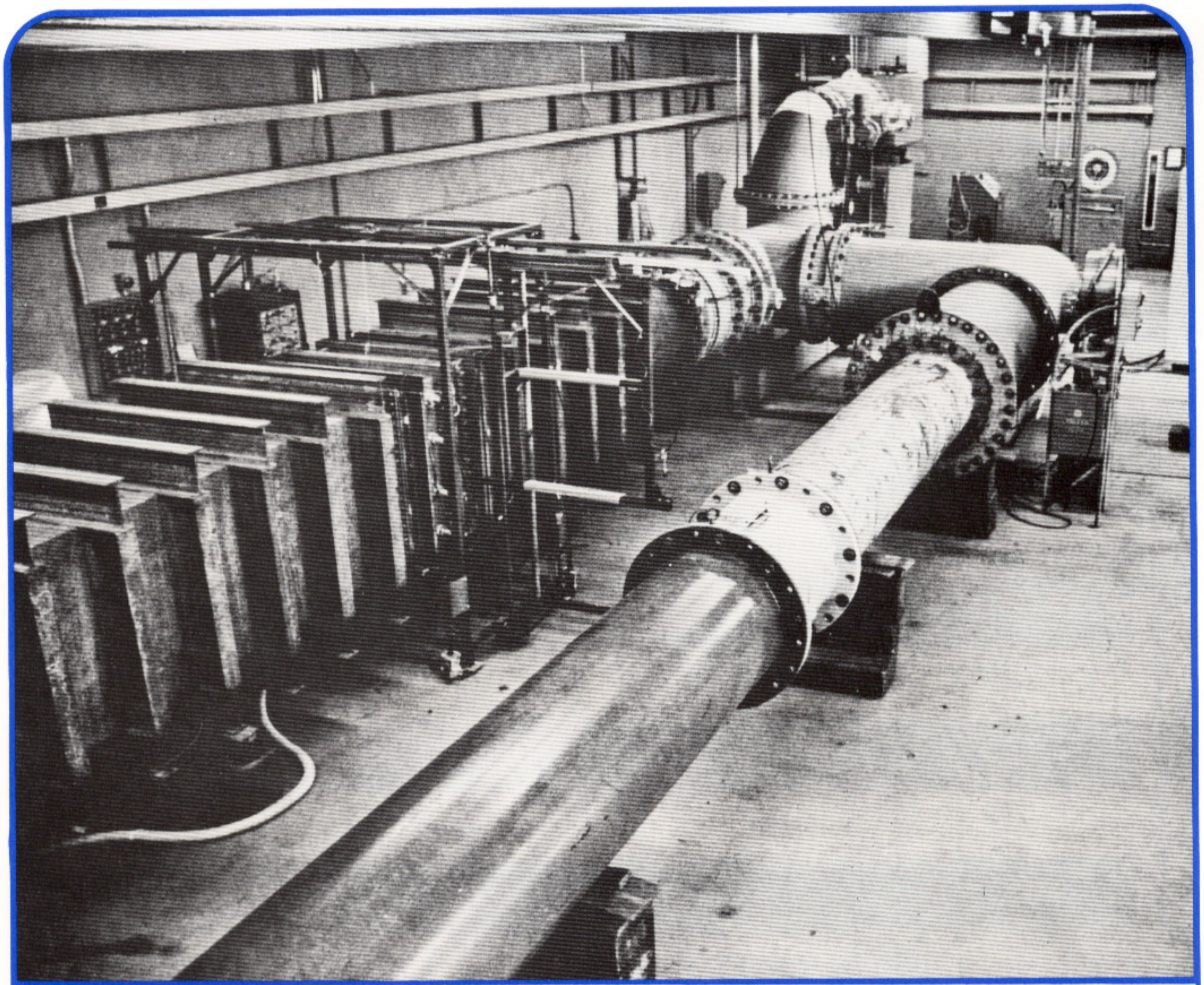
Note 1 Any beta ratio, pipe diameter or differential may be specified as required.
Any flange rating or type of end termination may be specified as required.
Venturis are available in line size larger & smaller than those listed below.

Note 2 Upstream straight pipe requirements for ASME type Venturis are less than those of Proprietary Flow Tubes providing a shorter overall "laying length".
See page 3 Figure 2 for piping requirements.

Note 3 Weld-in and Insert Venturis weigh approximately 30% less than Model VTF with 150 lb. flanges as listed

To obtain capacity for a design differential other than 100" multiply capacity at 100" by $\sqrt{\frac{\text{differential desired}}{100}}$

NOM. LINE SIZE	BETA RATIO Note 1	THROAT DIA. d Note 1	STD. PIPE DIA. D Note 1	LENGTH Note 2		APPROX. WT. LB: Note 3	FLOW RATES IN GPM OF WATER @ 60° F. ΔP IN INCHES OF W.C.			
				L (VTF)	IL (VTI)		20"	50"	100"	200"
2	0.50	1.034	2.067	10		21	27.4	43.3	61.3	86.7
	0.60	1.240		9		19	40.9	64.8	91.6	130
	0.75	1.550		8		18	72	113	160	226
3	0.50	1.534	3.068	14		48	60	95	135	190
	0.60	1.841		12		42	90	143	202	286
	0.75	2.301		10		37	160	250	355	500
4	0.50	2.013	4.026	17		88	105	165	232	330
	0.60	2.416		15		79	156	245	347	491
	0.75	3.020		12		66	274	433	612	865
6	0.50	3.033	6.065	24	19	221	235	370	525	740
	0.60	3.639		21	16	192	351	553	785	1110
	0.75	4.549		17	12	155	620	985	1390	1970
8	0.50	3.991	7.981	40	22	132	410	645	915	1290
	0.60	4.789		35	18	127	613	964	1370	1930
	0.75	5.986		30	13	123	1075	1700	2405	3400
10	0.50	5.010	10.020	50	28	213	645	1020	1440	2040
	0.60	6.012		45	24	208	964	1525	2155	3050
	0.75	7.515		35	17	189	1695	2680	3790	5360
12	0.50	6.000	12.000	60	34	315	925	1460	2065	2920
	0.60	7.200		50	29	290	1385	2185	3085	4365
	0.75	9.000		40	20	271	2435	3845	5440	7690
14	0.50	6.625	13.250	65	38	401	1125	1780	2520	3560
	0.60	7.950		55	32	376	1680	2660	3766	5320
	0.75	9.938		45	23	358	2965	4690	6630	9380
16	0.50	7.625	15.250	70	44	461	1490	2360	3335	4720
	0.60	9.150		65	37	464	2230	3530	4984	7055
	0.75	11.440		50	27	421	3930	6215	8790	12430
18	0.50	8.625	17.250	80	50	603	1910	3020	4270	6040
	0.60	10.350		70	42	580	2855	4515	6380	9030
	0.75	12.940		55	30	537	5025	7950	11240	15900
20	0.50	9.625	19.250	90	56	701	2375	3755	5310	7510
	0.60	11.550		75	47	705	3550	5615	7940	11220
	0.75	14.440		60	34	665	6260	9900	14000	19800
24	0.50	11.625	23.250	105	69	1035	3465	5480	7750	10960
	0.60	13.950		90	58	980	5180	8190	11580	16380
	0.75	17.550		70	42	906	9125	14470	20420	28940
30	.050	14.625	29.250	130	87	1546	5485	8675	12270	17350
	0.60	17.550		110	73	1448	8200	12965	18330	25920
	0.75	21.940		85	53	1333	14455	22860	32320	45720
36	0.50	17.625	35.250	150	105	2203	7970	12600	17820	25200
	0.60	21.150		130	89	2113	11910	18830	26620	37660
	0.75	26.440		100	65	1948	20995	33200	46950	66390
42	0.50	20.625	41.250	175	123	3050	10910	17265	24400	34510
	0.60	24.750		150	104	2905	16305	25790	36460	51570
	0.75	30.940		115	76	2680	28750	45465	64290	90930
48	0.50	23.625	47.250	200	142	3907	14315	22640	32010	45260
	0.60	28.350		170	120	3690	21400	33830	47840	67650
	0.75	35.440		130	87	3400	37720	59650	84350	119,300



Flow calibration, testing, research and development are all a part of the continuing efforts of Energy Flow to provide the finest primary flow elements available. Photo compliments of Alden Laboratories.

SOME OF THE APPLICATIONS IN WHICH ENERGY FLOW VENTURIS HAVE BEEN WIDELY USED ARE —

- **SLURRY FLOWS IN MINING, METALS AND CHEMICAL PLANTS**
- **WATER AND SEWAGE PLANT FLOWS**
- **FAN AND COMPRESSOR SUCTION GAS IN PIPELINE AND PROCESS**
- **FLARE GAS IN OIL REFINERIES AND GAS PLANTS**

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