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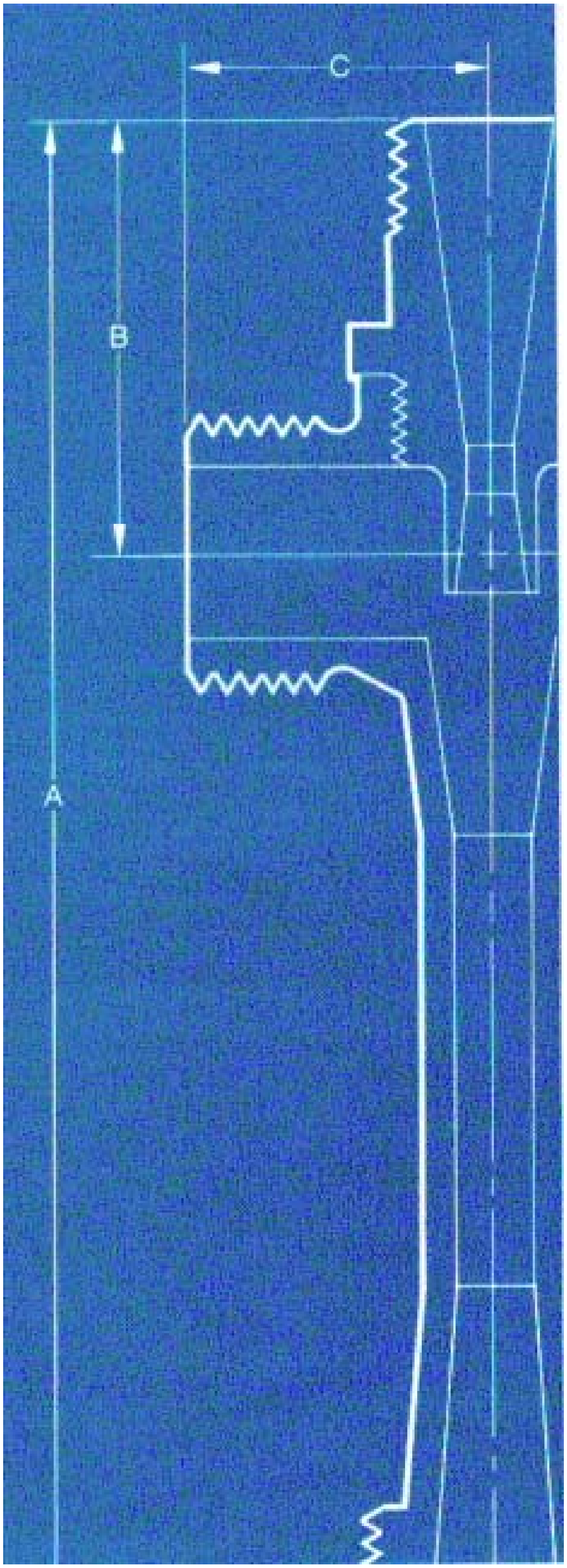


JET PUMP TECHNICAL DATA

pumping liquids

This technical bulletin includes general information about Penberthy Jet Pumps plus specific details for selecting the proper unit. The two basic series of Penberthy Jet Pumps covered in this bulletin are used for pumping liquids only.

introduction and selection

How jet pumps operate

All jet pumps operate on the principle of a fluid entraining a second fluid. Although design and construction may vary, this applies to all jet pumps.

All jet pumps have three common features: inlet, suction, and discharge. Here is how these function:

Inlet – The operating medium (liquid, gas, or steam) under pressure enters the inlet and travels through the nozzle into the suction chamber. The nozzle converts the pressure of the operating medium into a high velocity stream, which passes from the discharge side of the inlet nozzle.

Suction – Pumping action begins when vapor, gases, or liquid in the suction chamber are entrained by the high velocity stream emerging from the inlet nozzle, lowering the pressure in the suction chamber. The resulting action causes the liquid, gas, or vapor in the suction chamber to flow toward the discharge.

Discharge - The entrained material from the suction system mixes with the operating medium and acquires part of its energy in the parallel section. In the diffuser section part of the velocity of the mixture is converted to a pressure greater than the suction pressure, but lower than the operating medium pressure.

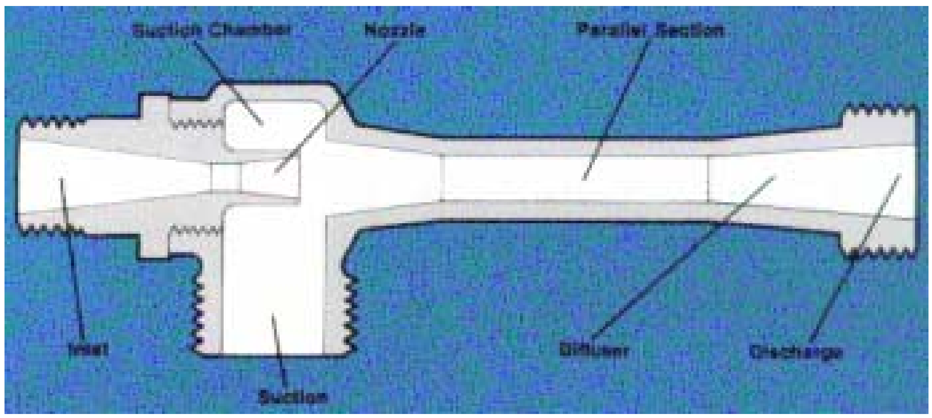
The advantages of using jet pumps for pumping liquids

Penberthy Liquid Jet Pumps offer many advantages:
They have no moving parts, nothing to break or wear.
There are no packing glands.
No lubrication is required.
They are practically noiseless in operation.
The initial cost is low.
Installation cost is low because they are compact and no foundation or wiring is necessary.
They provide reliable operation with low maintenance cost.

Jet pump applications

There are numerous possible applications for Penberthy Jet Pumps in handling liquids. Jet pumps are commonly found in these industries: chemical, textile, petroleum, power, mining, nuclear, fishing, wastewater, construction, distilling, potable water.

Specific applications include: handling condensate, pumping wells, circulating solutions, emptying cesspools, pumping brine solutions, extracting solvents, draining cellars, pumping out barges, acidifying, causticizing oils, producing emulsions, elevation water.

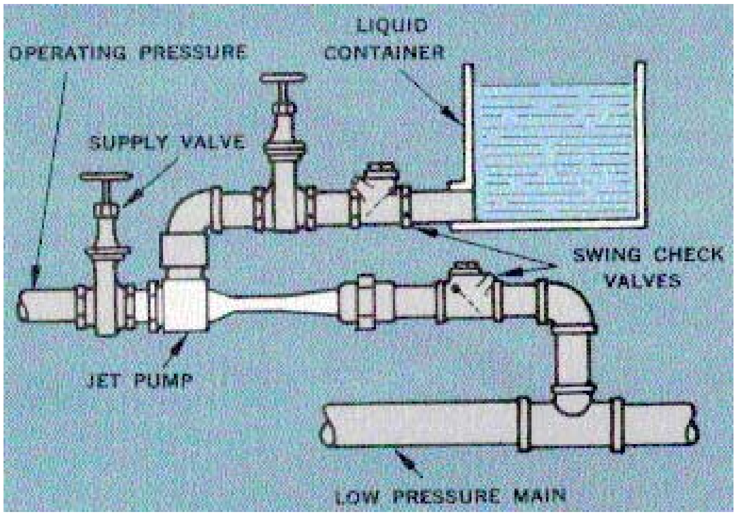


L SERIES and G SERIES

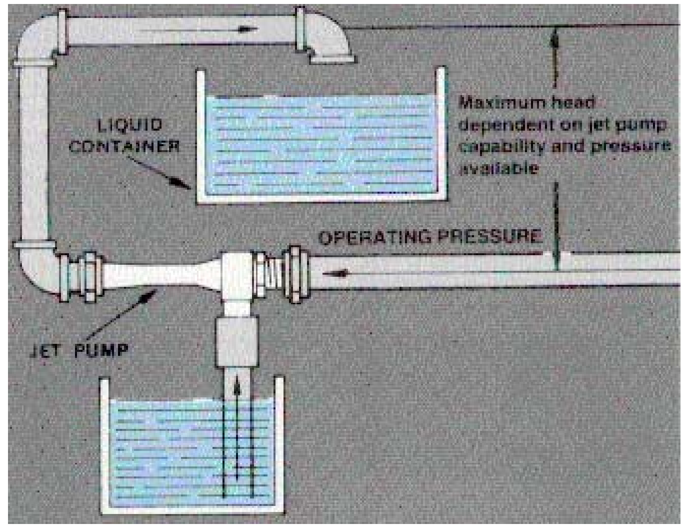
Jet Pump Selection
There are two basic series of Penberthy Jets available for pumping liquids. The L Series has three models, the LL, LM, and LH Models, using liquid as the operating medium. The G Series has two models, the GL and GH, using steam as the operating medium. Each of the five models is available in 15 different sizes, from 1/2 inch to 12 inches.

applications

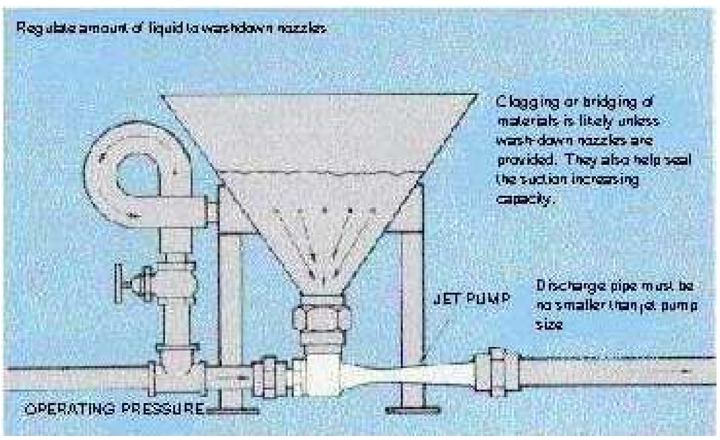
TYPICAL APPLICATIONS



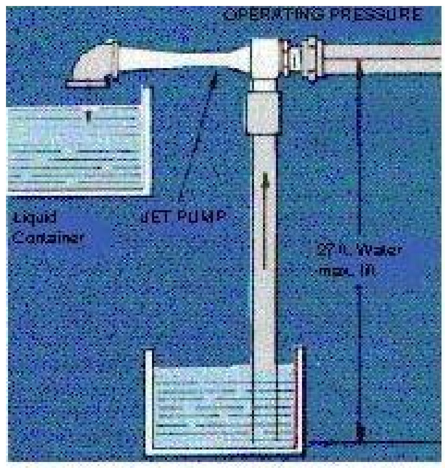
Blending



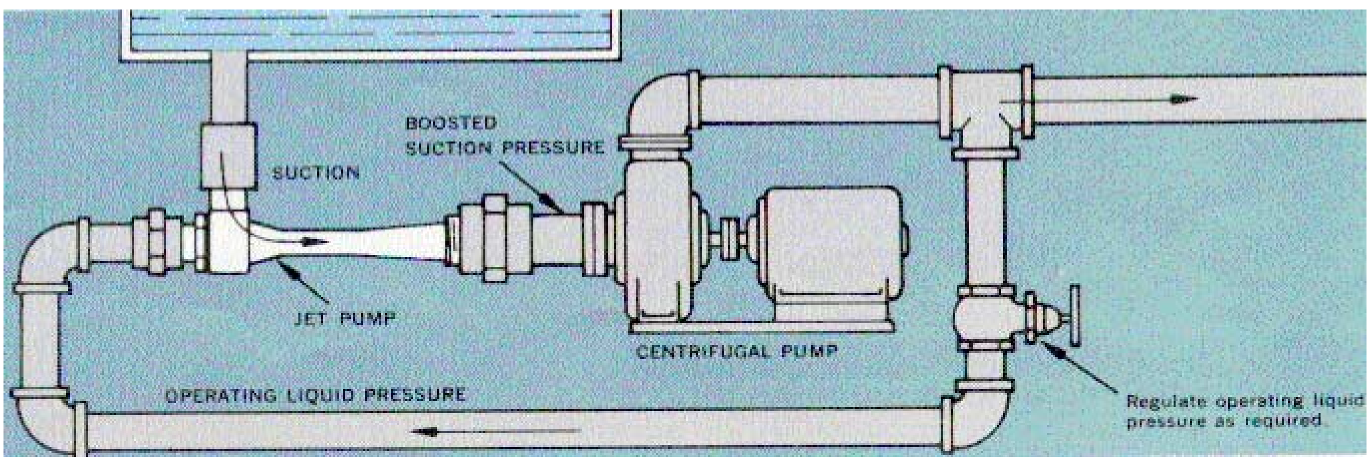
Lifting or elevating liquids



Handling granular solids with liquids



Lifting or elevating liquids



Boosting suction pressure to centrifugal pump

L series selection

Penberthy L Series liquid-operated jets are available for low, medium and high discharge pressures.

Sizes available

Each model is available in 15 sizes from 1/2 to 12 inches suction and discharge. Units are cast construction in sizes 1/2 through 4. Sizes 4 through 12 are available with fabricated construction. Certain sizes of units are also available in PVC or molded construction as shown in the charts on page 8.

The following information is needed for selection:

- Temperatures of operating and suction liquids.
- Available operating liquid pressure PSIG (h_m).
- Available volume of operating liquid GPM (Q_m).
- Suction lift in feet of water (h_s).
- Discharge head in feet of water (h_d).
- Required pumping capacity GPM (Q_s).
- Specific gravity of operating liquid.
- Specific gravity of suction liquid.
- Viscosity of operating liquid.
- Viscosity of suction liquid.

	Model		
	LL Low Head	**LM Medium Head**	**LH High Head**
Operating medium	Liquid	Liquid	Liquid
Operating medium pressure range	15-200 PSIG	15-200 PSIG	15-200 PSIG
Nominal operating medium pressure PSIG/ft of discharge head	2 PSIG (SG=1)	1.5 PSIG (SG=1)	1 PSIG (SG=1)
Discharge head pressure range	to 50 ft	40 to 80 ft	80 ft or more
Suction lift	to 27 ft	to 27 ft	to 27 ft
Minimum NPSH*	3 ft	3 ft	3 ft

***How to calculate NPSH**

In the selection chart above, the operating liquid is assumed to be at ambient temperature. When the operating liquid is at higher temperatures or when the vapor pressure is other than that of water, the liquid may vaporize within the jet pump and reduce pumping capacity.

For jet pumps, both motive and suction liquids must be considered for purposes of calculating net positive suction head (NPSH). Whichever liquid has the higher vapor pressure should be used as the basis of the calculation. Both liquids will be at the same temperature when they meet at the jet center line.

NPSH available is the dynamic pressure, in feet of liquid absolute, measured at the center line of the jet, less the vapor pressure. It must equal or exceed the NPSH that is required to achieve state performance.

To calculate NPSH for your application us the following formula:

$$NPSH = \frac{2.31(P_s - P_{vp})}{S_G} + h_s - H_f$$

where:

P_s = Pressure in the suction vessel in pounds per square inch absolute (PSIA).
P_{vp} = Vapor pressure of the pumped liquid in PSIA.
S_G = Specific gravity of pumped liquid at pumping temp.
h_s = Feet that the fluid is below or above the jet pump center line (negative if below, positive if above).
H_f = Friction loss in the suction line (feet of liquid).

NPSH EXAMPLE CALCULATION:
To pump water at 120°F with the surface of the water 12 feet below the jet pump center line:

Fluid Height (h_s)……………………………..-12
Vessel Pressure (P_s)………………………..14.7 PSIA
Vapor Pressure (P_{vp})………………………1.942 PSIA
Friction Loss (H_f)……………………………1 foot
Specific Gravity (S_G)………………………0.988

Using the formula given above:

$$NPSH = \frac{2.31(14.7 - 1.942)}{.988} + (-12) - 1$$

NPSH = 16.82 feet of water absolute

The feet of water supported by 14.7 PSIA minus NPSH equals Suction Lift in feet:
Suction Lift = (2.31x14.7)-16.82=17.1 feet of water

LL, LM, LH models

PUMPING LIOUIDS USING LIOUID OPERATING MEDIUM

L SERIES unit selection using performance charts

To determine the correct jet, refer to the performance charts on pages 6 and 7.

Step 1 - Locate the Suction Lift (h_s) nearest your application.
Step 2 - Locate Discharge Head (h_d).
Step 3 - The Operating Water Pressure shown (h_m) represents the amount of suction (water) flow (Q_s) for a 1 1/2 inch jet in each model (LL, LM, LH).
Step 4 - Determine the amount of Operating Water (Q_m) for a 1 1/2 inch jet in the three models.
Step 5 - Choose unit with Suction Flow GPM (Q_s) and Operating Water Used (Q_m) matching your requirements.

Ideally, the unit selected should have the greatest suction capacity (Q_s) and consume the least operating liquid (Q_m). Try all three models in other sizes as shown in the example on page 4. (The performance charts are based on 1½ inch units).

The effect of specific gravity and viscosity on Jet Pump performance

Fluid flow calculations indicate the effects of viscosity and specific gravity in fluid flow systems, as discussed below. The L Series performance data on pages 6 and 7 are based on water used as operating and suction liquids.

Specific gravity of water is 1 and viscosity is 1 centipoise (cP). Viscosity of a fluid is a measure of shearing stress within the fluid, and a factor in system flow rates and pressure drops. The effect of viscosity on the performance of Penberthy Jet Pumps is negligible for viscosity values as high as 100 cP. For higher viscosity values, consult the factory.

Specific gravity of a liquid is the ratio of its weight per unit volume to the weight per unit volume of water at standard conditions. Specific gravity values other than 1 will affect the performance of Penberthy Liquid Jet Pumps, and require the following adjustments:

1. **Operating medium flow rate -** rate shown in the performance charts must be adjusted by multiplying the table values by $\sqrt{(1 \div SG)}$ (the specific gravity of actual operating fluid).
2. **Suction flow rate -** Suction lift and Discharge Head are given in feet of fluid flowing and must be converted to equivalent lift or head in terms of feet of water. Multiply the given lift or head by the specific gravity of the fluid at that condition. For calculation purposes, the Suction Lift is multiplied by the specific gravity of the suction fluid. The equivalent Discharge Head is calculated by averaging the specific gravity of the operating liquid flow and the suction flow. Multiply that average by the Discharge Head in feet.

Temperature and vapor pressure properties of liquids also affect performance. Most applications fall in a range of 100°F inlet temperatures or less. For operating conditions outside these parameters, consult the factory.

How to size for transporting solids

Penberthy jet pumps may be used to mix and transport the slurry of dry solids and liquids with a minimal volume of wash-down fluid. The following steps are provided for sizing:

Step 1 -Determine Operating Flow in GPM by multiplying Solids Flow in ft^3/min by 15 for model LM (by 8.33 for model LL).
Step 2 - Determine Hopper Wash-Down Flow in GPM by multiplying Solids Flow in ft^3/min by 7.5.
Step 3 - Determine Operating Pressure in PSIG by multiplying Discharge Head in feet by 2 for model LM (by 4 for model LL),
Step 4 - Size the ejector using the performance chart on page 6, under 0' Suction Lift (h_s).

Maximum particle clearance

L Series jet pumps can handle liquids bearing particulate matter or slurries. Maximum particle size that can be passed in each is shown below.

SIZING FOR LIQUIDS EXAMPLE

To pump 12 GPM (Q_s) with:
Suction Lift in feet (h_s)………………………………..-10
Discharge Head in feet (h_d)……………………….…..10
Operating Water Pressure PSIG (h_m)……………….50
Available operating Water Flow GPM (Q_m)………..14

From the Performance Chart

All the values for Q_s found in step 3 for models LL, LM and LH exceed the desired Q_s of 12 GPM and Q_m of 14 GPM. To find the size and model with the desired performance:
Find the Capacity Factor for LL:
Q_s (desired) ÷ Q_s (for LL) = 12 ÷ 21 = .571
Find this number or the next largest in the Capacity Factor chart on page 6.
For an LL 1 1/4:
Q_s = 21 x .613 = 12.87 GPM water pumped
Q_m = 17 x .613 = 10.42 GPM water used

Repeat this procedure for models LM and LH using the values of Q_s from step 3. Then choose the model and size that operates closest to the desired performance:
For this application use LL 1 1/4. It pumps the **most** suction liquid (Q_s = 12.87 GPM) with the **least** operating liquid (Q_m = 10.42 GPM).

SIZING FOR SOLIDS EXAMPLE: Consider the Model LM

To pump 5 ft^3/min of solids against 20 feet of Discharge Head:

Step 1 - Determine Operating Flow: 5 x 15 = 75 GPM
Step 2 - Determine Hopper Wash-Down Flow: 5 x 7.5 = 37.5 GPM
Step 3 - Determine Operating Pressure: 2 x 20 = 40 PSIG
Step 4 - All Q values shown in the performance chart for model LM are lower than the desired Operating Flow of 75 GPM. To find the size and model with the desired performance:
Find the Capacity Factor for LM:
Q_s (desired) ÷ Q_s (for LM) = 75 ÷ 24 = 3.125
Find this number or the next largest in the Capacity Factor chart on page 6.

Capacity Factor = 3.17 for an LM 2 1/2

For an LM 2 ½:
Q_s = 23 x 3.17 = 72.9 GPM
Q_m=24 x 3.17 = 76.0 GPM
For this application use model LM 2 1/2. It pumps the most suction slurry (Q_s=72.9 GPM) with the least operating liquid (Q_m = 76.0).

	Size (in inches)											
	1/2A	**1/2B**	**1/2**	**3/4**	**1**	**1 1/4**	**1 1/2**	**2**	**2 1/2**	**3**	**4**	**6**
LL	0.073	0.091	0.146	0.192	0.247	0.33	0.421	0.567	0.75	1.025	1.447	2.079
LM	0.065	0.081	0.129	0.17	0.218	0.291	0.372	0.501	0.663	0.906	1.276	1.834
LH	0.05	0.063	0.101	0.132	0.17	0.227	0.29	0.391	0.517	0.707	0.997	1.433

LL, LM, LH Capacity Factor

Size	½A	½B	½	¾	1	$1^1/_4$	1½	2	2 ½	3	4	6	8	10	12
Factor	.030	.047	.121	.208	.344	.613	1.00	1.82	3.17	5.92	11.8	24	49	71	123

1 ½ LL, LM, LH Performance (Suction Capacity GPM Q_s)

Suction Lift Ft (hs)	Disch. Hd. In Feet (hd)	Operating Water Pressure - PSIG (hm)																																										
		15			20			30			40			50			60			70			80			90			100			120			140			160			180			200		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
+10	0	51	39	41	51	43	41	51	46	40	51	46	39	51	45	39	51	45	38	51	45	38	50	44	37	49	44	37	48	44	37	48	44	37	48	44	37	48	44	37	48	44	37	48	44	37
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	140																																				20		1	31		15	31		28	31
	160																																				10			21			31		14	31
	180																																							12			24			31
OP. Water Used GPM (Qm)		9.2	14	25	11	17	29	13	20	36	15	24	41	17	26	46	18	29	51	20	31	55	21	33	58	23	35	62	24	37	65	26	41	71	28	44	77	30	47	83	32	50	88	34	53	92

1 ½ LL, LM, LH Performance (Suction Capacity GPM Q_s) [cont.]

Suction Lift Ft (hs)	Disch. Hd. In Feet (hd)	Operating Water Pressure - PSIG (hm)																																
		15			20			30			40			50			60			70			80			90			100			120			140			160			180			200		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
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	70																					10			19		3	26		11	28	4	28	28	11	32	28	22	32	28	33	32	28	36	32	28
	80																					3			12			19		1	28		19	28	1	32	28	12	32	28	23	32	28	32	32	28
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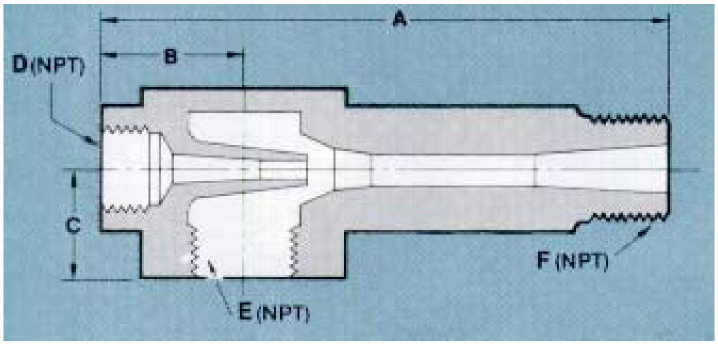
	120																														1			19			19		7	19		20	19		20	19
	140																																	16			17			19		5	19		18	19
	160																																	5			7			12			19		4	19
	180																																							2			19			19
OP. Water Used GPM (Qm)		9.2	14	25	11	17	29	13	20	36	15	24	41	17	26	46	18	29	51	20	31	55	21	33	58	23	35	62	24	37	65	26	41	71	28	44	77	30	47	83	32	50	88	34	53	92

LL, LM, LH models

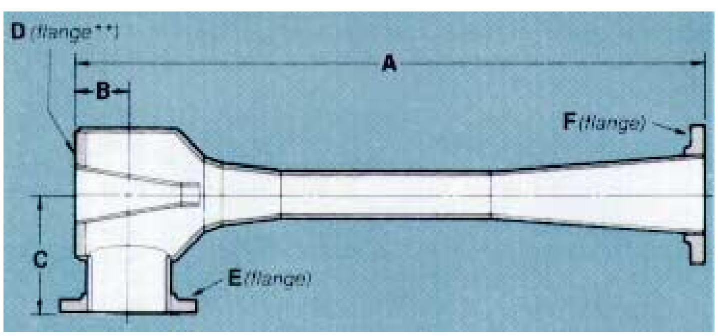
PVC – LL, LM, LH



PVC – LL, LM, LH (in inches)

Size		A	B	C	D	E	F
½ A	LL,LM,LH	3 ¾	$1\,^{11}/_{16}$	$^{15}/_{16}$	¼	½	½
½ B	LL,LM,LH	3 ¾	$1\,^{11}/_{16}$	$^{15}/_{16}$	¼	½	½
½	LL,LM,LH	$4\,^{5}/_{8}$	$1\,^{11}/_{16}$	$^{15}/_{16}$	¼	½	½
¾	LL,LM,LH	5 ¾	$1\,^{7}/_{8}$	1	½	¾	¾
1	LL	$6\,^{7}/_{8}$	$2\,^{1}/_{8}$	$1\,^{5}/_{16}$	½	1	1
1	LM,LH	$6\,^{7}/_{8}$	$2\,^{1}/_{8}$	$1\,^{5}/_{16}$	¾	1	1
1 ¼	LL	$9\,^{1}/_{16}$	2 ¾	1 ½	¾	1 ¼	1 ¼
1 ¼	LM,LH	$9\,^{1}/_{16}$	2 ¾	1 ½	1	1 ¼	1 ¼
1 ½	LL,LM	$10\,^{15}/_{16}$	3	1 ¾	1	1 ½	1 ½
1 ½	LH	$10\,^{15}/_{16}$	3	1 ¾	1 ¼	1 ½	1 ½
2	LL,LM	$14\,^{3}/_{16}$	3 ½	$1\,^{15}/_{16}$	1 ¼	2	2
2	LH	$14\,^{3}/_{16}$	3 ½	$1\,^{15}/_{16}$	1 ½	2	2
2 ½	LL,LM	$18\,^{1}/_{2}$	4	2 ½	1 ½	2 ½	2 ½
2 ½	LH	$18\,^{1}/_{2}$	4	2 ½	2	2 ½	2 ½
3	LL,LM,LH	$24\,^{3}/_{16}$	4 ½	3	2	3	3

FABRICATED – LL, LM, LH

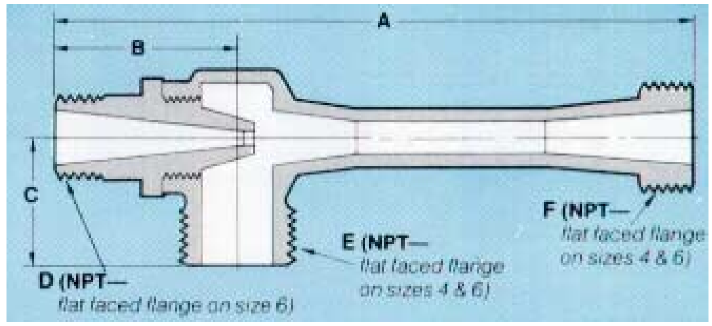


FABRICATED – LL, LM, LH (in inches)

Size		A	B	C	D**	E	F
4	LL,LM,LH	38 ¼	5 ¼	8	3	4	4
6	LL,LM,LH	$52\,^{7}/_{8}$	$5\,^{7}/_{8}$	9 ½	4	6	6
8	LL,LM,LH	$74\,^{7}/_{16}$	$8\,^{7}/_{16}$	13	6	8	8
10	LL,LM,LH	$87\,^{3}/_{8}$	$10\,^{3}/_{8}$	14	8	10	10
12	LL,LM,LH	110 ¾	11 ¾	18	10	12	12

**Bolting corresponds to ASA 150 lbs. Bolt holes in D flange of all sizes are blind tapped.

Cast – LL, LM, LH

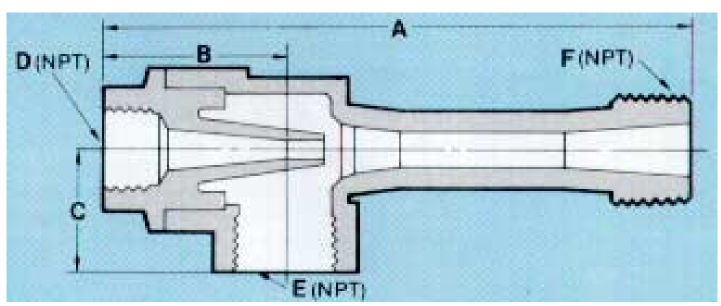


Cast – LL, LM, LH (in inches)

Size		A	B	C	D	E	F
½ A	LL,LM,LH	$4\,^{3}/_{8}$	1 ½	1 ¼	¼	½	½
½ B	LL,LM,LH	$4\,^{3}/_{8}$	1 ½	1 ¼	¼	½	½
½	LL	4 ½	$1\,^{5}/_{8}$	1 ¼	¼	½	½
	LM,LH	4 ½	$1\,^{5}/_{8}$	1 ¼	$^{3}/_{8}$	½	½
¾	LL	$5\,^{7}/_{8}$	2	1 ½	$^{3}/_{8}$	¾	¾
	LM,LH	$5\,^{7}/_{8}$	2	1 ½	½	¾	¾
1	LL	$7\,^{1}/_{8}$	2 ¼	1 ¾	½	1	1
	LM,LH	$7\,^{1}/_{8}$	2 ¼	1 ¾	¾	1	1
1 ¼	LL	9	2 ½	2 ¼	¾	1 ¼	1 ¼
	LM,LH	9	2 ½	2 ¼	1	1 ¼	1 ¼
1 ½	LL,LM	11	2 ¾	2 ½	1	1 ½	1 ½
	LH	11	2 ¾	2 ½	1 ¼	1 ½	1 ½
2	LL,LM	$14^{3}/_{8}$	$3\,^{1}/_{8}$	3	1 ¼	2	2
	LH	$14^{3}/_{8}$	$3\,^{1}/_{8}$	3	1 ½	2	2
2 ½	LL,LM	$18^{1}/_{8}$	3 ½	$4^{1}/_{8}$	1 ½	2 ½	2 ½
	LH	$18^{1}/_{8}$	3 ½	$4^{1}/_{8}$	2	2 ½	2 ½
3	LL,LM,LH	$23^{7}/_{8}$	4	5	2	3	3
4	LL,LM,LH	$32^{7}/_{8}$	5	6	3	4flange*	4flange*

*Bolting corresponds to ASA 150 lbs.

MOLDED – LL, LM, LH



MOLDED – LL, LM, LH (in inches)

Size		A	B	C	D	E	F
¾	LL,LM,LH	$5\,^{15}/_{16}$	2	1 ¼	½	¾	¾
1	LL,LM,LH	7 ¼	2 ¼	1 ½	¾	1	1
1 ¼	LL,LM,LH	$9\,^{3}/_{8}$	$2\,^{11}/_{16}$	$1\,^{7}/_{8}$	1	1 ¼	1 ¼
1 ½	LL,LM,LH	$11\,^{7}/_{16}$	3	$2\,^{1}/_{16}$	1 ¼	1 ½	1 ½

G series selection

PUMPING LIQUIDS USING STEAM OPERATING MEDIUM

Penberthy G Series steam operated jet pumps are designed for low head (Model GL) and high head (Model GH) conditions to assure optimum performance over a wide range of operating conditions.
The following are general operating limits used in selecting individual units.

MODEL	GL Low Head	GH High Head
Operating steam pressure range	60 – 150 psig	35 – 150 psig
Operating Steam pressure to elevate liquid 50 ft.	150 PSIG	75 PSIG
Suction lift (with water temp. to 120° F.)	to 20 ft.	to 20 ft.
Minimum NPSH*	13 ft.	13 ft.

*The process of calculating NPSH is discussed on page 4.

Model GL

For use with operating steam from 60 to 150 PSIG. Pumps against heads of one foot for each 3 PSIG operating pressure up to 50 feet discharge head. Suitable for lifts up to 20 feet. The pump will handle water up to 170° F with gravity flow to suction and discharge heads less than six feet. Maximum suction lift is 23 feet with from 60 to 90° F water.

Model GH

For use with operating steam between 35 and 150 PSIG. Pumps against heads of one foot for 1½ PSIG operating pressure. Designed for discharge heads over 50 feet. The GH model is suitable for lifts up to 20 feet. The pump will handle water up to 160° F with gravity flow to suction and discharge heads less than six feet.

Sizes available

Each model is available in 15 sizes from ½ to 12 inches suction and discharge. Units are cast construction in sizes ½ through 4. Sizes 4 through 12 are available with fabricated construction. Certain sizes of units are also available in PVC or molded construction as shown in the charts on page 11.

NOTE: Always specify material, model and unit size when ordering. For available materials, check **Penberthy Material Specification Sheet**.

G SERIES unit selection using performance charts

The following information is needed in determining the correct unit.

- Available operating steam pressure PSIG (h_m)
- Available operating steam, lbs. / min. (Q_m)
- Suction water temperature in °F (T_s)
- Suction lift in feet of water (h_s)
- Discharge head in feet of water (h_d)
- Required pumping capacity GPM (Q_s)

Step 1 – Locate the Suction Lift (hs) nearest your application.

Step 2 – Opposite the appropriate Suction Lift (hs), locate Discharge Head (hd).

Step 3 – Read to the right to the column that most closely approaches your Suction Water Temperature (Ts) and Operating Steam Pressure (hm). **Note: contrary to what may be expected, reducing steam pressure often increases capacity. Maximum economy can frequently be gained by throttling the steam to its most efficient pressure.**

The figures in this column of the table represent the Suction Capacity (Qs), or amount of water that will be pumped by the 1½ size GL or GH unit respectively. The Steam Consumption Chart shows the Operating Steam (Qm) lbs./hr. for each model (GL,GH) at various pressures.

To find the size of unit appropriate for your application, refer to the example shown.

EXAMPLE

To pump 52 GPM (Qs) with:
Suction Lift in feet (hs) . . . . – 10
Operating Steam Pressure PSIG (hm) 120
Suction Water Temperature °F (Ts) 120
Discharge Head in feet (hd) 30
Available Motive Steam lbs. / min. (Qm) 13.5
(Converted to lbs. / hr.) 810

From Performance Chart:

Locate the values for Qs in the chart according to Steps 1, 2 and 3. In this case GL 1 ½ pumps 36 GPM (Qs), which is closest to the desired rate of 52 GPM. At 120 PSIG steam pressure, the GL 1 ½ uses 390 lbs. / hr. operating steam. This indicates low pumping capacity. To achieve correct pumping capacity within available operating steam supply:

Find the Capacity Factor:

Qs (desired) ÷ Qs (for GL) = 52 ÷ 36 = 1.44
Find this number or the next largest in the Capacity Factor chart on page 11.
Capacity Factor = 1.82 for GL 2
For GL 2:
Qs = 36 x 1.82 = 65 GPM water pumped
Qm = 390 x 1.82 = 710 lbs. / hr. steam consumed
Therefore, the GL 2 will exceed required capacity.

1 ½ GL, GH PERFORMANCE (SUCTION CAPACITY Qs in GPM)

Suction Lift Ft (hs)	Disch. Hd. In Feet (hd)	SUCTION WATER TEMPERATURE 80° F (Ts) OPERATING STEAM PRESSURE, PSIG (hm)												SUCTION WATER TEMPERATURE 120° F (Ts) OPERATING STEAM PRESSURE, PSIG (hm)												SUCTION WATER TEMPERATURE 150° F (Ts) OPERATING STEAM PRESSURE, PSIG (hm)											
		35		60		80		100		120		150		35		60		80		100		120		150		35		60		80		100		120		150	
		GL	GH	GL	GH	GL	GH	GL	GH	GL	GH	GL	GH	GL	GH	GL	GH	GL	GH	GL	GH	GL	GH	GL	GH	GL	GH	GL	GH	GL	GH	GL	GH	GL	GH	GL	GH
+5	0		58	56	63	56	61	61	56	62	55	64	53		54	56	50	58	48	58	45	55	45	53	43		30	47	35	42	34	41	33	41	33	41	
	5		54	47	63	56	61	61	56	62	55	64	53		54	56	50	58	48	58	45	55	45	53	43		30	47	35	42	34	41	33	41		41	
	10		39	36	63	50	61	61	56	62	55	64	53		54	42	50	58	48	58	45	55	45	53	43		30	47	35	42	34	41	33	41		41	
	15		23	24	63	42	61	56	56	62	55	64	53		54	29	50	48	48	58	45	55	45	53	43		30	32	35	42	34	41	33	41		41	
	20			13	63	33	61	48	56	62	55	64	53			16	50	36	48	58	45	55	45	53	43		30		35	42	34	41	33	41		41	
	25				57	25	61	40	56	54	55	64	53				50	24	48	47	45	55	45	53	43				35	28	34	41	33	41		41	
	30				47	17	61	29	56	46	55	64	53				50	12	48	37	45	53	45	53	43				35		34	41	33	41		41	
	40				27		51	17	56	32	55	52	53				25		48	15	45	27	45	53	43				35		34		33	35		41	
	50						41		56		55	38	53						48		45		45	53	43						34		33			41	
	60								56		55	24	53								45		45		43								33				
	70								40		55		53								40		45		43								33				
	80										55		53										45		43												
	100												53												43												
-5	0		52	47	51	54	51	55	48	57	44	57	39		42	48	37	47	37	44	36	42	34	42	30		23	30	24	29	24	29	24	29	24	30	21
	5		52	36	51	54	51	55	48	57	44	57	39		42	42	37	47	37	44	36	42	34	42	30		23	30	24	29	24	29	24	29		30	
	10		39	26	51	43	51	55	48	57	44	57	39		42	29	37	47	37	44	36	42	34	42	30		23	30	24	29	24	29	24	29		30	
	15		23	16	51	33	51	48	48	57	44	57	39		42	16	37	37	37	44	36	42	34	42	30		23		24	29	24	29	24	29		30	
	20				51	23	51	40	48	52	44	57	39				37	24	37	44	36	42	34	42	30				24	26	24	29	24	29		30	
	25				51		51	34	48	44	44	57	39				37		37	35	36	42	34	42	30				24		24	29	24	29		30	
	30				47		51	21	48	37	44	57	39				37		37	25	36	42	34	42	30				24		24	24	24	29		30	
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	60								48		44		39								36		34		30								24				
	70								40		44		39								36		34		30								24				
	80										44		39												30												
	100												39												30												
-10	0		48	42	45	50	44	51	40	52	35	52	31		35	39	32	38	32	37	31	36	26	36	23		16	23	17	22	18	24	19	23	16	23	
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	20				45	16	44	34	40	50	35	52	31				32	16	32	37	31	36	26	36	23				17		18	24	19	23		23	
	25				45		44	25	40	41	35	52	31				32		32	28	31	36	26	36	23				17		18	24	19	23		23	
	30				45		44	21	40	33	35	52	31				32		32		31	36	26	36	23				17		18		19	23		23	
	40				27		44		40		35	41	31				25		32		31		26	36	23				17		18		19			23	
	50						41		40		35	23	31						32		31		26		23						18		19				
	60								40		35		31								31		26		23								19				
	70								40		35		31								31		26		23								19				
	80										35		31										26		23												
	100												31												23												
-15	0		40	36	37	45	36	46	31	45	26	43	23		26	31	26	30	26	30	21	30	17	30	15			16		14		16		16		15	
	5		40	23	37	43	36	46	31	45	26	43	23		26	27	26	30	26	30	21	30	17	30	15			16		14		16		16		15	
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	15		25		37	17	36	39	31	45	26	43	23		26		26	23	26	30	21	30	17	30	15					14		16		16		15	
	20				37		36	29	31	45	26	43	23				26		26	30	21	30	17	30	15							16		16		15	
	25				37		36	20	31	37	26	43	23				26		26	18	21	30	17	30	15									16		15	
	30				37		36		31	27	26	43	23				26		26		21	27	17	30	15									16		15	
	40				27		36		31		26	30	23				26		26		21		17	30	15											15	
	50						36		31		26		23				26		26		21		17		15												
	60								31		26		23								21		17		15												
	70								31		26		23								21		17		15												
	80										26		23										17		15												
	100												23												15												
-20	0		31	31	26	35	25	32	21	32	17	29	15		18	22	16	24	14	22		20		19													
	5		31		26	35	25	32	21	32	17	29	15		18	12	16	24	14	22		20		19													
	10		23		26	30	25	32	21	32	17	29	15		18		16	24	14	22		20		19													
	15				26	17	25	32	21	32	17	29	15		18		16	24	14	22		20		19													
	20				26		25	29	21	32	17	29	15		18		16		14	22		20		19													
	25				26		25		21	32	17	29	15				16		14			20		19													
	30				26		25		21		17	29	15				16		14			20		19													
	40						25		21		17		15											19													
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	60								21		17		15																								
	70								21		17		15																								
	80										17		15																								
	100												15																								

GL, GH models

1 ½ GL,GH STEAM CONSUMPTION (lbs. / hr. Q_m)

Steam Pres.	35	60	80	100	120	150
GL		221	277	333	390	474
GH	335	497	623	750	878	1067

GL, GH CAPACITY FACTOR

SIZE	½ A	½ B	½	¾	1	1¼	1½	2	2½	3	4	6	8	10	12
FACTOR	.030	.047	.121	.208	.344	.613	1.00	1.82	3.17	5.92	11.8	24	49	71	123

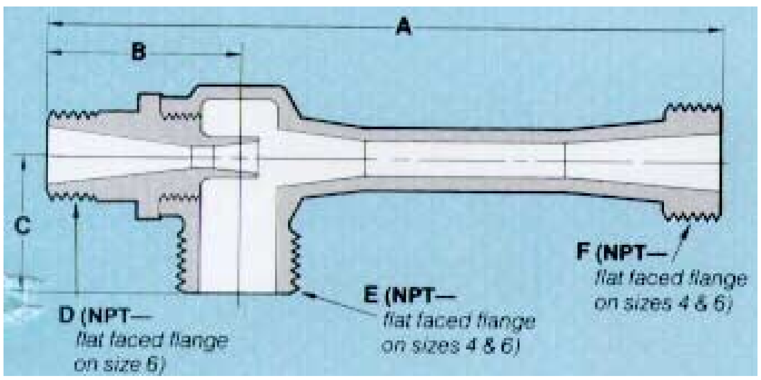
Maximum particle clearance

The GL and GH Models can handle liquids bearing particulate matter or slurries. The following table shows maximum particle size that can be passed in each.

MAXIMUM PARTICLE CLEARANCE (in inches)

SIZE	½ A	½ B	½	¾	1	1¼	1½	2	2½	3	4	6
GL	.097	.122	.195	.256	.329	.439	.561	.756	.999	1.365	1.926	2.767
GH	.057	.071	.114	.150	.193	.258	.329	.444	.587	.801	1.131	1.625

CAST – GL, GH

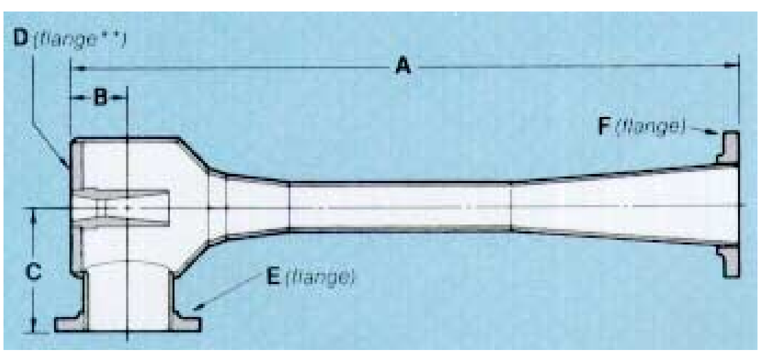


CAST – GL, GH DIMENSIONS (in inches)

SIZE	A	B	C	D*	E*	F*
½ A	4 3/8	1 ½	1 ¼	¼	½	½
½ B	4 3/8	1 ½	1 ¼	¼	½	½
½	4 ½	1 5/8	1 ¼	3/8	½	½
¾	5 7/8	2	1 ½	½	¾	¾
1	7 1/8	2 ¼	1 ¾	¾	1	1
1¼	9	2 ½	2 ¼	1	1 ¼	1 ¼
1½	11	2 ¾	2 ½	1	1 ½	1 ½
2	14 3/8	3 1/8	3	1 ¼	2	2
2½	18 1/8	3 ½	4 1/8	1 ½	2 ½	2 ½
3	23 7/8	4	5	2	3	3
4	32 7/8	5	6	3	4flange*	4flange*

*Bolting corresponds to ASA 150 lbs.

FABRICATED – GL, GH



FABRICATED – GL, GH DIMENSIONS (in inches)

Size	A	B	C	D**	E	F
4	38 ¼	5 ¼	8	3	4	4
6	52 7/8	5 7/8	9 ½	4	6	6
8	74 7/16	8 7/16	13	6	8	8
10	87 3/8	10 3/8	14	8	10	10
12	110 ¾	11 ¾	18	10	12	12

**Bolting corresponds to ASA 150 lbs. Bolt holes in D flange of all sizes are blind tapped.

installation and operation

CONSIDERATIONS WHEN INSTALLING OR OPERATING JET PUMPS

Installation
Penberthy Jet Pumps will operate in any position. They should be installed with minimum length of piping and with as few elbows and valves as possible to limit friction losses.

Inlet piping
Piping must be large enough to supply jet pump at maximum flow. Inlet pressure should be as specified in the performance data for the application.

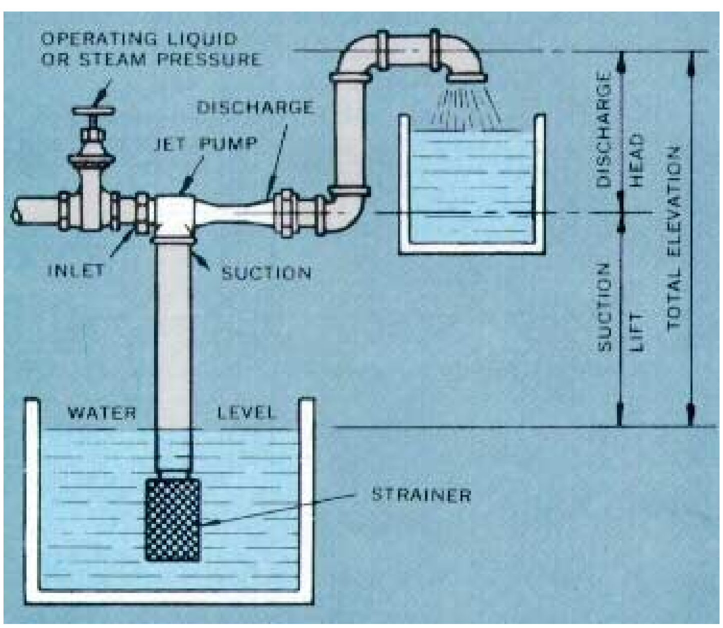
Suction piping
To insure maximum capacity and highest possible vacuum, all suction piping must be airtight.

When lifting liquids by suction, locate the jet as close to the liquid level as practical, with the remainder of the elevation on the discharge side. Design pressure loss should not exceed two feet, including strainer, foot valve and other piping at design suction flow rate.

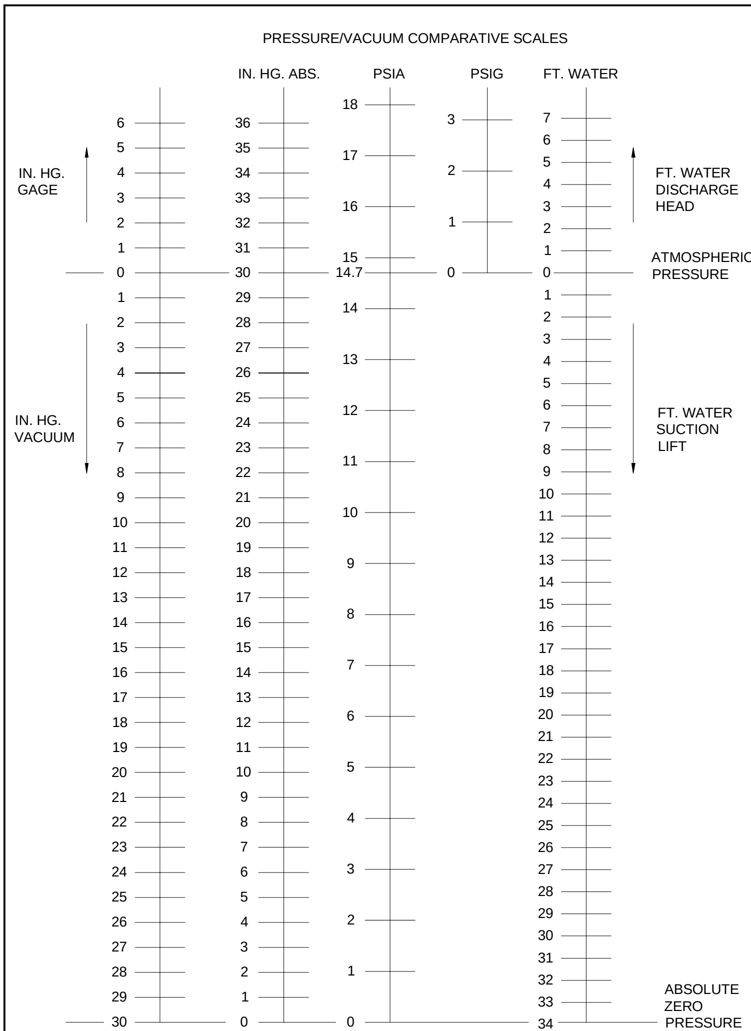
Discharge piping
Piping should be equal in size to that of the pump. If discharge line is long, piping size should be increased to minimize the discharge head.

Start-up of steam jet pumps
When starting steam jet pumps, the steam valve should be opened slowly to enable the unit to start smoothly. All valves should then be adjusted to permit operation according to design conditions.

Maintenance
If properly selected, Penberthy Jet Pumps will operate for extended periods without maintenance or parts replacement. Faulty operation, or reduced performance, particularly on small units, may be caused by scale or foreign matter in the lines. Install suitable strainers in the inlet lines to eliminate this problem. Scale can be removed mechanically by disassembly or by chemical treatment.



Typical jet pump installation



1" Hg = 0.49 PSI = 1.13' Water
2.04" Hg = 1.0 PSI = 2.31' Water
0.88" Hg = 0.73 PSI = 1.0' Water

Unit Conversions

1 kPa	=	0.145 PSIG
	=	0.335 ft water (20° C)
	=	0.295 in Hg (20° C)
1 cm	=	0.394 in
1 m	=	3.28 ft
1 L/s	=	15.85 GPM
1 mPa * s	=	1 cP
1 kg / h	=	2.205 lb / hr (steam)

tyco Flow Control / Tyco Valves & Controls
Penberthy
320 Locust St., Prophetstown, IL 61277 USA
TEL: (815) 537-2311 FAX (815) 537-5764