SECTION III
DESUPERHEATERS & NOISE REDUCTION

NOTES:

DESUPER-HEATERS

STEAM ATOMIZING DESUPERHEATER

DESUPERHEATERS

PRESSURES to 600 PSIG at 750°F

- **Reduces the temperature of superheated steam by controlled direct injection of cooling water**
- **Mechanical atomizing 2.5:1 turndown**
- **Steam atomizing 20:1 turndown**
- **Line Sizes 3" to 24" (larger sizes available upon request)**
- **Velocities to 8000 feet per minute**
- **Air operated only**

Canadian Registration # OH6267.51

APPLICATION DATA

- Reduce Temperature of Superheated Steam

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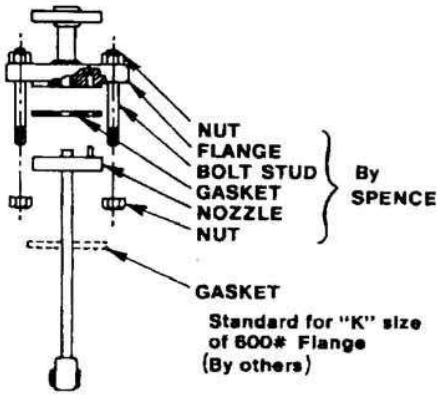
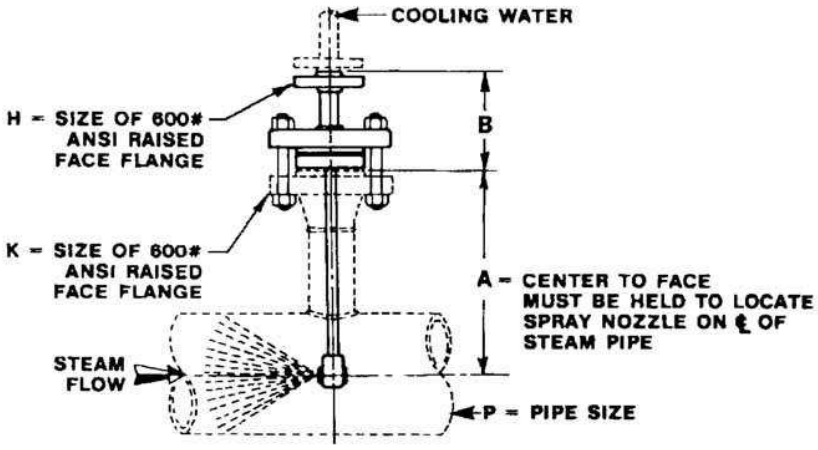
MECHANICAL ATOMIZING DIMENSIONS, inches (mm) **AND WEIGHTS**, pounds (kg)

Size	B	H	K	A — P = MAIN STEAM PIPE 3	3½	4	5	6	8	10	12	14	16	18	20	24	Weight
#1	5 (127)	¼ (6)	2 (51)	7 (178)	7½ (191)	8½ (216)	10 (254)	11 (280)	13 (330)	— —	— —	— —	— —	— —	— —	— —	15 (6.8)
#3	4½ (113)	½ (13)	2 (51)	— —	— —	8½ (216)	10 (254)	11 (280)	13 (330)	15½ (394)	16½ (419)	— —	— —	— —	— —	— —	22 (10)
#5	5⅞ (149)	1 (25)	4 (102)	— —	— —	— —	— —	11 (280)	13 (330)	15½ (394)	16½ (419)	17½ (445)	19½ (495)	— —	— —	— —	40 (18)
#6	7½ (190)	1¼ (32)	4 (102)	— —	— —	— —	— —	— —	13 (330)	15½ (394)	16½ (419)	17½ (445)	19½ (495)	21½ (546)	— —	— —	75 (34)
#8	9 3/16 (233)	2 (51)	6 (152)	— —	— —	— —	— —	— —	— —	15½ (394)	16½ (419)	17½ (445)	18½ (470)	19½ (495)	20½ (521)	22¼ (565)	135 (61)





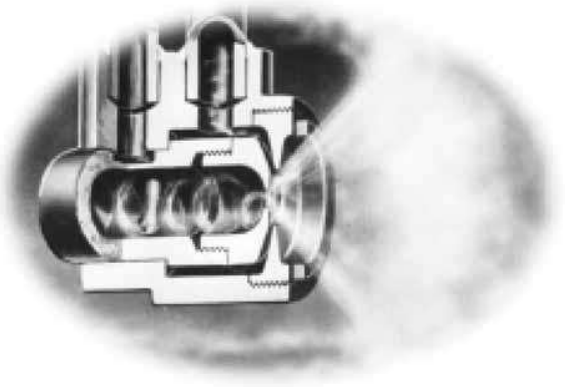
DESUPERHEATERS

SPECIFICATIONS

The Desuperheater shall be air operated, consisting of atomizing injector nozzle, dual controller, air pilot and strainers. It shall be capable of handing wide load variations from full load to 5% of maximum and control within ±5°F.

The injector nozzle shall be designed and installed to disperse the minute water particles and atomizing steam counter to the flow of superheated steam, enabling the fine mist to be easily evaporated.

The dual controller shall be so constructed that it will maintain a balanced, modulated flow of steam and water to the injector nozzle at all times and shall be so arranged that the atomizing steam shall lead the water on opening and trail on closing, so that it is impossible for the water to reach the injector nozzle before the steam.



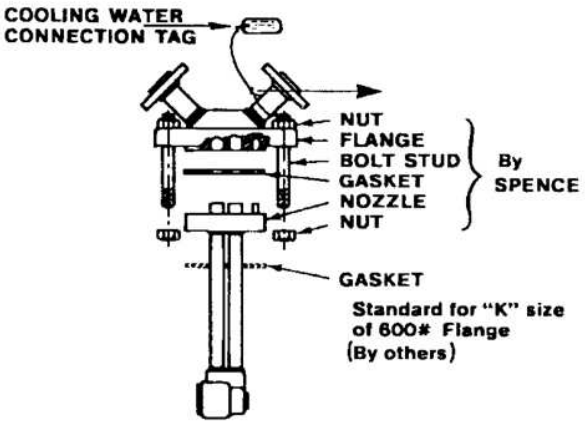
DUAL CONTROL DESUPERHEATER NOZZLE

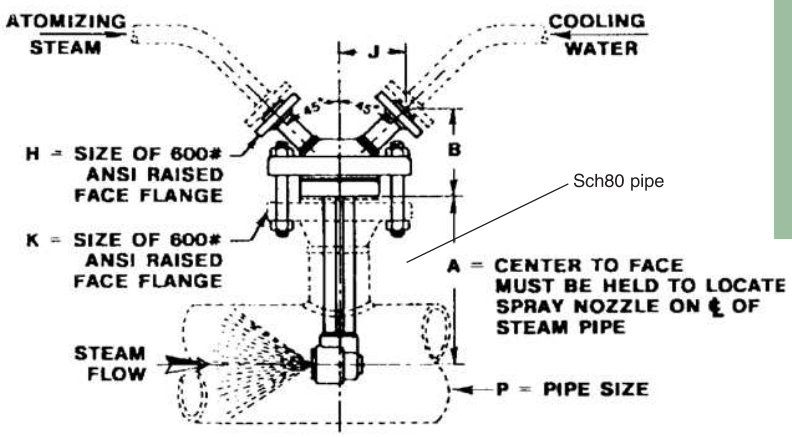
MATERIALS OF CONSTRUCTION

.....300 Series Stainless Steel

STEAM ATOMIZING DIMENSIONS, inches (mm) **AND WEIGHTS**, pounds (kg)

Size	B	H	J	K	A P = MAIN STEAM PIPE 3	3½	4	5	6	8	10	12	14	16	18	20	24	Weight
#1	5 (127)	¼ (6)	3¾ (95)	2 (51)	7 (178)	7½ (191)	8½ (216)	10 (254)	11 (280)	13 (330)	— —	— —	— —	— —	— —	— —	— —	18 (8)1
#3	5¼ (133)	½ (13)	2¹¹⁄₁₆ (68)	2½ (64)	— —	— —	8½ (216)	10 (254)	11 (280)	13 (330)	15½ (394)	16½ (419)	— —	— —	— —	— —	— —	28 (13)
#5	5⅞ (148)	1 (25)	3¾ (95)	4 (102)	— —	— —	— —	— —	11 (280)	13 (330)	15½ (394)	16½ (419)	17½ (445)	19½ (495)	21½ (546)	23½ (597)	27½ (699)	68 (31)
#6	6⁹⁄₁₆ (243)	1¼ (32)	6 (152)	5 (127)	— —	— —	— —	— —	— —	13 (330)	15½ (394)	16½ (419)	17½ (445)	19½ (495)	21½ (546)	— —	— —	110 (50)
#8	8¼ (210)	2 (51)	6 (152)	8 (203)	— —	— —	— —	— —	— —	— —	15½ (394)	16½ (419)	17½ (445)	19½ (495)	21½ (546)	23½ (597)	27½ (699)	270 (123)





RULES FOR SIZING DESUPERHEATERS

The required amount of cooling water to be injected into the superheated steam is the basis on which a Desuperheater size is determined. Since the heat gained by the injected cooling water equals the heat lost by the superheated steam, the required cooling water, G, in gallons per minute is calculated as follows:

$$G = \frac{W_S}{500} \times \frac{h_S - h_d}{h_d - (t - 32)} \text{ gpm}$$

Where: W_S = Superheated steam flow, lb per hour

h_S = Total heat of the superheated steam, Btu per lb

h_d = Total heat of the desuperheated steam, Btu per lb

t = Temperature of the cooling water, °F

The values h_S and h_d may be taken from the Steam Tables on the inside back cover. Having determined the amount of cooling water, G, choice of the size unit may be made directly from the Selection table below.

Cooling water supply pressure must always be at least 75 psig higher than the pressure of the steam being desuperheated.

With Steam Atomizing Desuperheaters, the atomizing steam pressure must always be at least 50 psig higher than the pressure of the steam being desuperheated. Also, when there is more than approximately 100 psig difference between cooling water and atomizing steam pressures, a pressure reduction should be made on the higher of the two.

SELECTION TABLE–STEAM ATOMIZING AND MECHANICAL ATOMIZING DESUPERHEATERS

	J VALVE OPERATED			
SIZE NUMBER	No. 3	No. 5	No. 6	No. 8
COOLING WATER CAPACITY, GPM	4.0	12	22	52
PIPE CONNECTIONS FOR COOLING WATER AND ATOMIZING STEAM	½"	1"	1¼"	2"
MINIMUM SIZE OF MAIN STEAM PIPE	4"	6"	8"	12"

STEAM FOR ATOMIZATION

A source of higher pressure atomizing steam offers no problem on most desuperheater installations. Generally, the steam being desuperheated is at reduced pressure, having either been throttled by a reducing valve or extracted from an intermediate stage of a turbine.

When a pressure reduction is required in conjunction with desuperheating the steam, it is recommended that the reduction take place prior to desuperheating for the following reasons:

1. Auxiliary high pressure steam for atomization is immediately available.
2. The Pressure Regulator is not subject to a damaging accumulation of soluble salts precipitated by evaporation from the cooling water.
3. Elimination of resuperheating when the pressure reduction is after the point of superheat control.

If higher pressure steam is not available, a Mechanical Atomizing Desuperheater must be employed. The Injector Nozzle is identical with the Steam Atomizing Nozzle except that it does not have the advantage of secondary atomization into mist by the action of the steam.

NOISE REDUCTION

NOISE SUPPRESSOR

SERVICE to 500°F

- **Standard sizes 3/8" to 8". Consult Factory for additional sizes**
- **Effective over a broad frequency band (up to 12,000 Hz)**
- **Noise attenuation up to 26 dBA**
- **Expansion fittings not required**
- **Straight through design minimizes pressure drop, permitting normal valve sizing**

Canadian Registration # CSA-OH 6266.5R1C

NOISE SUPPRESSORS

APPLICATION DATA

- Steam Pressure Reduction Stations where Noise Reduction is Desired

SUPPRESSOR ENDS

INLET ANSI	OUTLET ANSI
NPT	NPT
NPT	150#
NPT	300#
150#	150#
300#	150#
300#	300#

NOTE: ANSI 150# Flanges are flat faced.
It is recommended that the Noise Suppressor be insulated to reduce condensation formation in the acoustic material.

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DIMENSIONS inches (mm) **AND WEIGHTS** pounds (kg)
INLET SIZE 2½" TO 8"

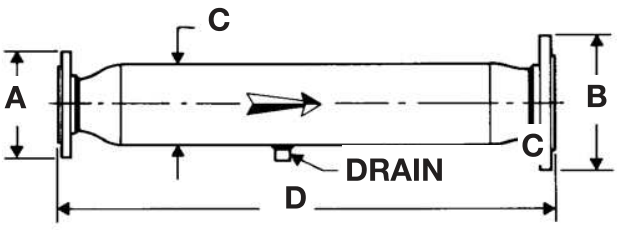
NOMINAL PIPE SIZE			D*-INSTALLED LENGTH		APPROX. WEIGHT		Average Atten-uation dBa†
A INLET	B OUTLET	C SHELL	150# x 150#	300# x 300#	150# x 150#	300# x 300#	
2½ (65)	4 (100)	6 (150)	47 (1010)	47 (1194)	97 (44)	109 (49)	16
2½ (65)	5 (125)	6 (150)	47½ (1200)	48⅛ (1222)	99 (45)	115 (52)	16
3 (80)	4 (100)	6 (150)	47 (1009)	47¾ (1214)	99 (45)	103 (47)	14
3 (80)	5 (125)	6 (150)	47½ (1207)	48¼ (1227)	101 (46)	119 (54)	14
3 (80)	6 (150)	8 (200)	58⁹⁄₁₆ 1488)	59⁵⁄₁₆ (1506)	150 (68)	181 (82)	19
4 (100)	5 (125)	6 (150)	47¾ (1214)	48⅛ (1222)	105 (48)	129 (59)	12
4 (100)	6 (150)	8 (200)	54¾ (1392)	55½ (1410)	162 (74)	178 (81)	16
4 (100)	8 (200)	10 (250)	66¼ (1684)	67 (1702)	256 (116)	299 (134)	21
5 (125)	6 (150)	8 (200)	55¼ (1405)	56 (1422)	180 (82)	167 (76)	14
5 (125)	8 (200)	10 (250)	66¾ (1696)	67½ (1715)	289 (131)	247 (130)	19
5 (125)	10 (250)	12 (300)	89⁵⁄₁₆ (2268)	90⁵⁄₁₆ (2294)	455 (207)	428 (194)	26
6 (150)	8 (200)	10 (350)	66¾ (1697)	67½ (1715)	295 (134)	299 (136)	17
6 (150)	10 (250)	12 (300)	83¾ (2129)	84¾ (2154)	451 (205)	490 (222)	24
8 (200)	10 (250)	12 (300)	84¼ (2141)	85¼ (2166)	468 (213)	507 (230)	21

* ±1/4" for 8" Shell and under, otherwise ± 3/8". † Consult factory for specifics.

NOISE SUPPRESSOR

SPECIFICATION

Noise Suppression equipment shall be of the dissipative reactive type. Suppressor shall not induce back pressure. It shall have expanded outlet flange for attachment to downstream piping. Equipment shall provide a minimum of 10 dBA reduction in noise. Installation must be insulated.



MATERIALS OF CONSTRUCTION

Pressure Shell .....Welded Steel Components
Acoustic Material .....Stainless Steel

MAXIMUM OUTLET VELOCITY
feet per minute
(meters per minute)

NOMINAL PIPE SIZE	MAXIMUM VELOCITY
0 - 2 (0 - 51)	17,000 (5182)
21/2 - 8 (64 - 203)	11,000 (3353)
>8 (>203)	9,000 (2734)

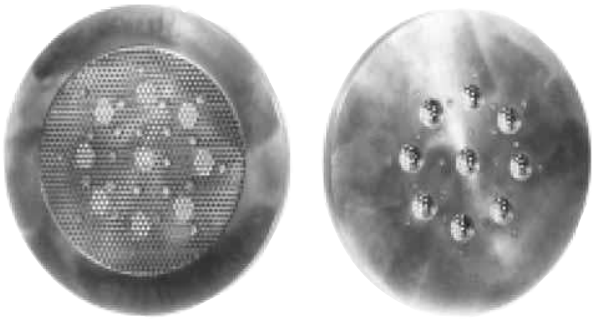
DIMENSIONS inches (mm) **AND WEIGHTS** pounds (kg)
INLET SIZES 3/8" TO 2"

NOMINAL PIPE SIZE			D* — INSTALLED LENGTH			APPROX. WEIGHT					Average Attenuation dBa†
A INLET	B OUTLET	C SHELL	NPTxNPT	150x150#	300x300#	NPT x NPT	150# x 150#	300# x 300#	150# x 150#	300# x 300#	
3/8 (10)	3/4 (20)	2 (50)	18 (457)								16
3/8 (10)	1 (25)	2 (50)	18 5/16 (465)								16
3/8 (10)	1 1/2 (40)	3 (80)	26 5/8 (676)								22
1/2 (15)	1 (25)	2 (50)	21 5/16 (541)	19 7/8 (505)	20 5/16 (516)				12 (5.4)	13 (5.9)	12
1/2 (15)	1 1/4 (32)	2 1/2 (65)	23 15/16 (608)	22 1/8 (561)	22 5/8 (575)				15 (6.8)	17 (7.7)	15
1/2 (15)	1 1/2 (40)	3 (80)	27 1/16 (687)	25 5/8 (650)	22 1/16 (662)	19 (9)	26 (12)	29 (13)			20
3/4 (20)	1 1/4 (32)	3 (80)	28 3/8 (721)	26 5/8 (676)	27 1/8 (689)	19 (9)	25 (11)	28 (13)			16
3/4 (20)	2 (50)	3 (80)	28 5/8 (727)	26 5/8 (676)	27 1/8 (689)	19 (9)	31 (14)	34 (15)			16
1 (25)	1 1/2 (40)	3 (80)	25 3/4 (654)	23 7/8 (607)	24 3/8 (619)	18 (8)	27 (12)	31 (14)			12
1 (25)	2 (50)	4 (100)	36 (914)	34 (864)	34 1/2 (876)	28 (13)	33 (15)	36 (16)			13
1 1/4 (32)	2 (50)	4 (100)	36 1/16 (916)	34 1/16 (86)	34 5/8 (889)	29 (13)	34 (15)	38 (17)			14
1 1/4 (32)	3 (80)	4 (100)		34 5/16 (872)	35 (889)		34 (15)	39 (18)			14
1 1/2 (40)	3 (80)	4 (100)		31 7/16 (798)	32 1/16 (814)		31 (14)	34 (15)			12
2 (50)	3 (80)	4 (100)		31 1/2 (800)	32 1/8 (816)		37 (17)	45 (20)			10
2 (50)	4 (100)	5 (125)		39 3/4 (1010)	40 3/8 (1026)		67 (30)	69 (31)			14

* ±1/4" for 8" Shell and under, otherwise ± 3/8".

† Consult factory for specifics.

MUFFLING ORIFICE PLATES (MOPS)



INLET OUTLET
MUFFLING ORIFICE

- **Reduces noise by 6 dBA to 12 dBA**
- **Engineered for each application**
- **Designed to fit between ANSI flanges (DIN upon request)**
- **For noise reduction estimates, consult your Representative.**

Canadian Registration # CSA-OH 6266.5R1C

Application Data

- Spence Pressure Regulators or Control Valves where noise reduction is desired

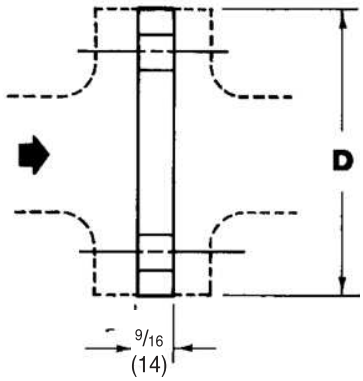
SIZING INFO PAGE 193

Materials of Construction

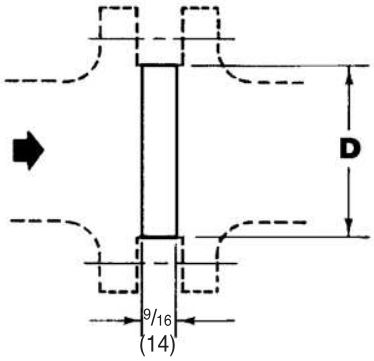
Plate .....Steel ASTM A285-78 Gr. C.
Disc .....St. St. 302-2B

Specification

A Muffling Orifice Plate to be constructed of materials suitable for the installation and compatible with the piping. Generally, it is to be of steel construction with stainless steel plate weldedto the primary plate. The orifices are to be on the stainless steel plate. Orifice plates are to be designed for installation between two ANSI flanges in the enlarged piping downstream of the regulator or noise suppressor. Muffling Orifice Plates are to be designed to provide between 6 to 12 dBA of noise reduction on a high flow PRV.



ANSI 125 & 150 FLANGED

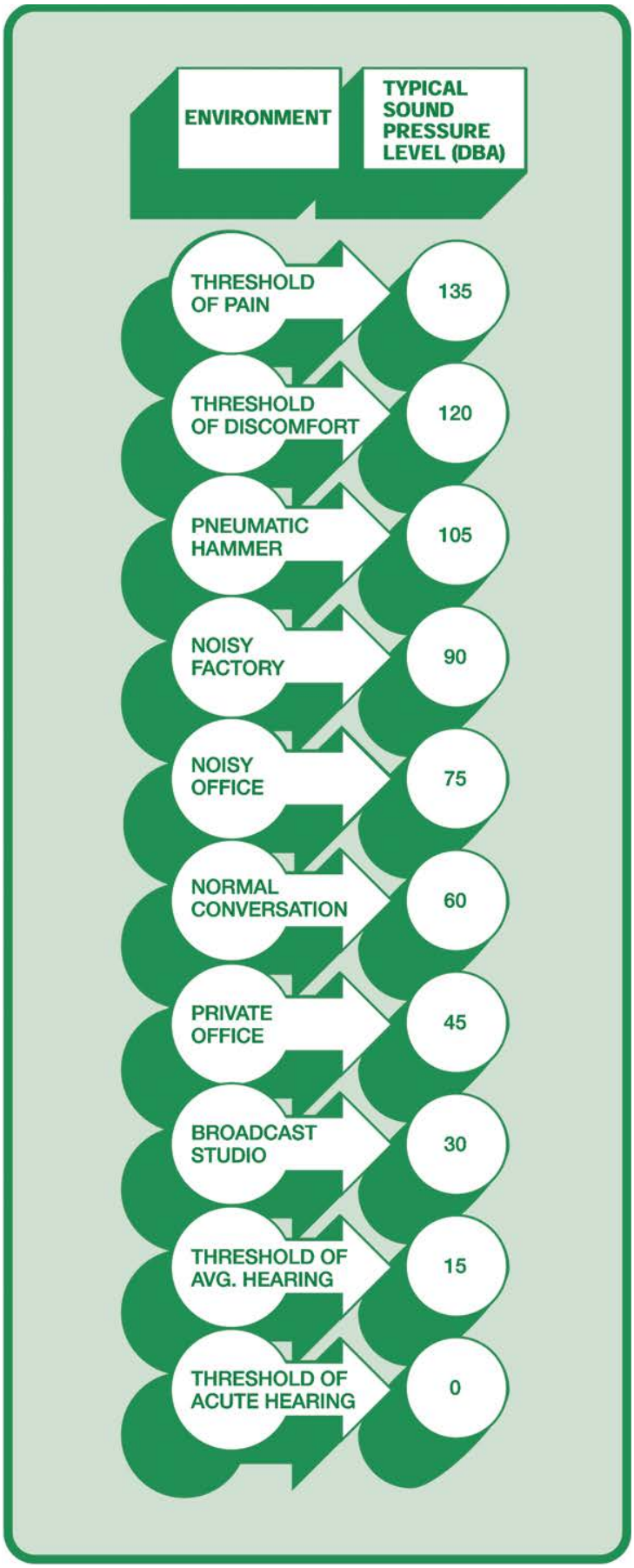


ANSI 250, 300 & 600 FLANGED

DIMENSIONS inches (mm)

Muffling Orifice Plates			
Size	Rating	OD	
		inch	mm
1	125/150	4.25	108
	250/300	2.81	71
	600	2.00	51
1-1/4"	125/150	4.62	117
	250/300	3.00	76
	600	2.50	64
1-1/2"	125/300	5.00	127
	250/300	3.62	92
	600	2.88	73
2"	125/150	6.00	152
	250/300	4.19	106
	600	3.62	92
2-1/2"	125/150	7.00	178
	250/300	4.94	125
	600	4.12	105
3"	125/150	7.50	191
	250/300	5.69	145
	600	5.00	127
4"	125/150	9.00	229
	250/300	6.94	176
	600	6.19	157
5"	125/150	10.00	254
	250/300	8.31	211
	600	7.31	186
6"	125/150	11.00	279
	250/300	9.69	246
	600	8.50	216
8"	125/150	13.50	343
	250/300	11.94	303
	600	10.62	270
10"	125/150	16.00	406
	250/300	14.06	357
	600	12.75	324
12"	125/150	19.00	483
	250/300	16.44	418
	600	15.00	381
14"	125/150	21.00	533
	250/300	18.94	481
	600	16.25	413
16"	125/150	23.50	597
	250/300	21.06	535
	600	18.12	460
18"	125/150	25.00	635
	250/300	23.31	592
	600	23.00	584

STEAM PRESSURE REDUCING STATION NOISE REDUCTION



INTRODUCTION TO NOISE REDUCTION

WHY IS NOISE IMPORTANT?

Excessive noise is stressful to the human body and constitutes a serious health hazard. The Walsh-Healy Public Contracts Act and the Occupational Safety and Health Act have prompted system designers to pay careful attention to the noise generated by pressure reducing stations.

OSHA has established limits on the length of time any employee may be exposed to various sound levels. These limits are shown in Figure 1 below. For a typical eight hour working day, the limit is 90 dBA. OSHA does not provide sound level limits for periods longer than eight hours. Figure 1 extrapolates the OSHA limits to a full 24 hour day.

When daily exposure is composed of two or more at differing sound levels, their combined effect must be considered. In such cases, the sum of the ratios of actual to permissible exposure times must not exceed unity. that is:

$$\frac{t_1}{T_1} + \frac{t_2}{T_2} = \ldots = \frac{t_n}{Tn} \leq 1$$

Where:

T = permissible time at specified noise level
t = actual time at specified noise level
1, 2, ..., n = differing noise levels

FIGURE 1: OSHA MANDATED NOISE EXPOSURE LIMITS*

SOUND PRESSURE LEVEL (DBA)	115	110	105	100	95	90	85	82
PERMISSIBLE EXPOSURE (HOURS PER DAY)	¼	½	1	2	4	8	12	24

* Values for 12 and 24 hour per day exposure are extrapolated.
NOTE: Ear protection must be worn above 90 dBA.

WHAT IS A DBA?

Sound results from pressure fluctuations in the air. The sound pressure level which the most sensitive listener can detect is about 20μN/m². This level is normally taken as the reference point for the measurement of sound pressure levels.

Sound pressure level cover an enormous range of values. In order to compress this range, sound levels are usually expressed in decibels. A decibel (dB) is simply the logarithm of the ratio of two quantities. In this case, the two quantities are the sound pressure level being measured and the reference level. The reference level is, by definition, 0 dB.

The human ear does not respond equally to all frequencies. It tends to be insensitive to very low and very high frequencies. Standard sound level meters are equipped with a scale which approximates the human ear's response. Sounds measured on this scale are expressed as A-weighted decibels (dBA). The dBA is commonly used in engineering work.

IMPORTANT CHARACTERISTICS OF DECIBELS

Adding Sound Levels

Since decibels express a logarithmic ratio, they cannot simply be added or subtracted. Figure 2 below provides a means of adding decibels without lengthy calculations.

To add two sound levels:

1. Determine difference between sound level
2. Find correction from Figure 2.
3. Add the correction to the **higher** sound level.

DECIBEL DIFFERENCE	0	1	2	3	4	5	6	7	8	9	10
DECIBEL CORRECTION	3.0	2.6	2.1	1.8	1.5	1.2	1.0	0.8	0.6	0.5	0.4

FIGURE 2

Sound Level Reductions

Similarly, a 10% reduction in the decibel level does not represent a 10% reduction in absolute sound pressure level. For example, a reduction from 60 dB to 54 dB (a 10% dB reduction) produces a 50% reduction in the absolute sound pressure level. A 6 dB reduction always cuts the absolute sound pressure in half. The relationship between decibel and absolute sound pressure level reductions is summarized in Figure 3.

RELATIVE REDUCTION (dB)	1	2	3	4	5	6	10	20	40
ABSOLUTE REDUCTION (%)	11	21	29	37	44	50	68	90	99

FIGURE 3

Sound Levels Decrease with Distance

Sound ratings for reducing valves are conventionally established at a point three feet downstream from the valve's outlet and three feet from the outlet pipe's surface. At further distances from the pipe surface, the radiated sound drops off in intensity. Some typical values are shown below in Figure 4.

The values shown in Figure 4 assume that the valve is acoustically isolated from the surrounding structure. Sound can be transmitted throughout the structure with little attenuation if the piping system is not properly isolated or if surroundings are acoustically "hard". The piping system itself can also act as a conduit for sound.

DISTANCE FROM PIPE	3 Ft.	6 Ft.	12 Ft.	25 Ft.	50 Ft.
SOUND REDUCTION	0 dBA	3 dBA	6 dBA	9 dBA	12 dBA

FIGURE 4

NOISE REDUCTION DESIGN GUIDELINES

1. Size the regulator to provide a maximum inlet velocity of about 10,000 FPM.
2. Determine the regulator outlet velocity. If it would exceed 30,000 FPM, use a Spence Muffling Orifice or a second stage regulator.
3. Expand regulator outlet piping to limit discharge line velocity to about 10,000 FPM.
4. Avoid abrupt changes in pipe size. Limit pipe diameter changes to two pipe sizes per stage of expansion. Do not use eccentric reducers.
5. Directional changes in downstream piping should be made only after the line size has been increased. Use long radius fittings; avoid bullhead tee connections.
6. Provide as much straight run of pipe on both sides of the regulator as possible:
   a. 10 pipe diameters minimum to the inlet.
   b. 20 pipe diameters minimum of expanded line size from the outlet.
7. Size all piping components, including strainer and stop valves for a maximum flow velocity of about 10,000 FPM (Exception: An outlet stop valve mounted at the regulator outlet should be equal in size to the regulator.) In areas where low sound levels are specified, reduce this limit by 25% to 50%.
8. To limit noise transmission through the building's structure, keep the regulator and piping at least 3 feet away from solid surfaces. Use sound isolating piping supports.
9. Apply high density insulation to regulator body, piping and system components. Insulation reduces heat loss significantly and can provide moderate (3-6 dB) local noise attenuation. For greater noise reduction, use removable Spence Insulcap Jacket with lead lining on regulator body.
10. Use a Spence Noise Suppressor to reduce the propagation of noise via the downstream piping.

SELECTING NOISE REDUCING DEVICES

Source Treatment

A Spence Muffling Orifice will reduce high flow pressure regulator noise by 6 to 10 dBA. Installed in the expanded downstream piping, the Muffling Orifice reduces the generation of noise at its source.

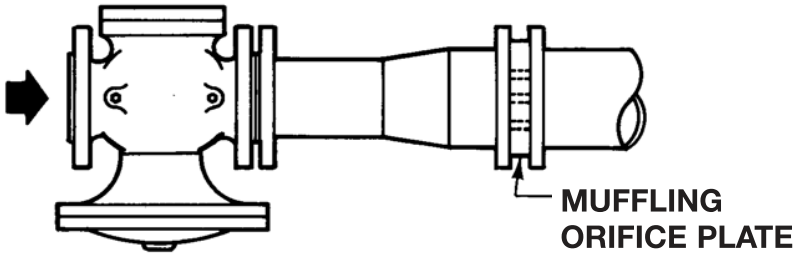


FIGURE 5A: SINGLE STAGE INSTALLATION WITH MUFFLING ORIFICE

Path Treatment

A Spence Noise Suppressor will reduce pipeline carried noise by 10 to 20 dBA. Installed at the regulator outlet, the Suppressor absorbs noise generated by the pressure regulator and limits its propagation through the piping system.

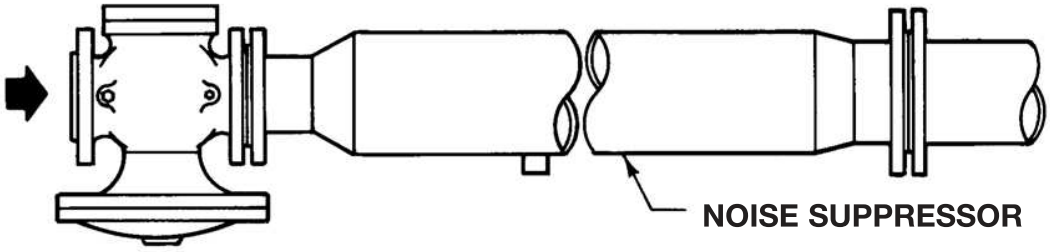


FIGURE 5B: SINGLE STAGE INSTALLATION WITH NOISE SUPPRESSOR

Source and Path Treatment

For maximum reduction of pipeline transmitted noise, the combined installation of a Spence Muffling Orifice and Spence Noise Suppressor will reduce the sound pressure level by 15 to 30 dBA. Installation of a Spence Insulcap Jacket with lead lining on the regulator body will further reduce sound pressure levels.

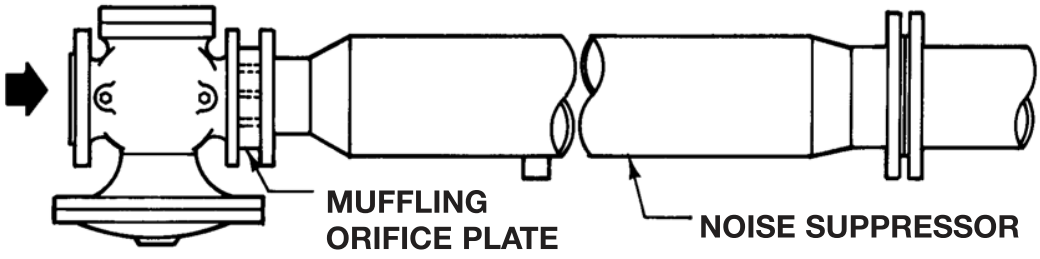


FIGURE 5C: SINGLE STAGE INSTALLATION WITH MUFFLING ORIFICE AND NOISE SUPPRESSOR

SIZING NOISE REDUCTION COMPONENTS

Selection of Size and Type of Components

REGULATOR SIZE

1. Enter Saturated Steam Flow Table (opposite) at the specified **initial pressure**. Read across the first tabulated value which includes the specified steam flow. The regulator size at the head of this column is the minimum required to limit inlet velocity to 10,000 FPM.
2. Move up this column to the specified **reduced pressure** (chosen outlet pressure, if Muffling Orifice is used) and note the tabulated flow value. If the specified flow is more than three times the tabulated flow, the regulator's exit velocity will exceed 30,000 FPM. (Use a Spence Muffling orifice or a second stage reduction.)

DELIVERY PIPE SIZE

Enter Saturated Steam Flow Table (opposite) at the specified reduced pressure. Read across to the first tabulated value which includes the specified steam flow. The pipe size at the head of this column is the minimum expanded pipe size to limit velocity to 10,000 FPM.

MUFFLING ORIFICE SIZE

If a Noise Suppressor is installed, the Muffling Orifice size is the same as the regulator size. Otherwise, it is the same as the delivery pipe size.

NOISE SUPPRESSOR SIZE

The inlet size of the Noise Suppressor is the same as the regulator size. The outlet size is the same as the delivery pipe size.

Example

SPECIFIED CONDITIONS

Saturated Steam Flow = 5,000 lb/hr
Initial Pressure = 100 PSIG
Reduced Pressure = 15 PSIG

REGULATOR SIZE

Entering Saturated Steam Flow Table (opposite) at 100 psig, the first tabulated value which includes 5,000 lb/hr is 5141 lb/hr. The head of this column indicates a 2½" regulator is required to limit inlet velocity to 10,000 FPM.
Moving up this column to 15 psig, the tabulated flow is 1452 lb/hr. Specified flow is 3.47 times the tabulated flow. The exit velocity for a 2½" regulator will be 34,700 FPM. The use of a Muffling Orifice is indicated.

DELIVERY PIPE SIZE

Entering Saturated Steam Flow Table (opposite) at 15 psig, the first tabulated value which includes 5000 lb/hr is 6030 lb/hr. The delivery pipe size at the head of this column is 5". For this pipe size, flow velocity will be 8,290 FPM.

ANSWER: 2½" SPENCE REGULATOR WITH MUFFLING ORIFICE, NOISE SUPPRESSOR AND 5" DELIVERY PIPE.

NOTE: Regulators should always be protected by properly designed Strainers.

CALCULATING VELOCITY

Velocity Formula

The Saturated Steam Flow Tables (opposite) provide a convenient means of calculating flow velocity. The flows tabulated are based on 10,000 feet per minute (FPM) velocity. The velocities at other steam flows can be obtained by simple proportioning:

$$\text{Actual Velocity} = \frac{\text{Actual Flow}}{\text{Tabulated Flow}} \times 10{,}000 \text{ FPM}$$

Example

Pipe size = 5"
Pressure = 15 psig
Tabulated flow = 6,030 lb/hr
Actual flow = 5,000 lb/hr

$$\text{Actual Velocity} = \frac{5{,}000}{6{,}030} \times 10{,}000 \text{ FPM} = 8{,}290 \text{ FPM}$$

SATURATED STEAM FLOW TABLE

(LB/HR) AT 10,000 FPM

Based on Schedule 40 Pipe

SIZES 3/8" THROUGH 4"

PRESS. (PSIG)	TEMP (°F)	REGULATOR or PIPE SIZE (inches)									
		3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
-10	160	10	15	27	43	75	102	168	239	370	637
-5	192	21	33	58	94	162	221	364	519	802	1381
0	212	30	47	83	134	233	317	522	744	1149	1979
5	228	40	63	111	179	310	422	696	993	1533	2641
10	240	49	78	136	221	382	520	858	1224	1890	3254
15	250	58	92	162	262	454	617	1018	1452	2242	3860
20	259	67	106	187	303	524	713	1176	1678	2591	4461
25	267	76	121	212	343	594	809	1333	1902	2936	5057
30	274	85	135	237	383	664	903	1489	2124	3280	5649
40	287	102	163	286	463	801	1090	1797	2564	3959	6818
50	298	120	190	334	542	937	1276	2103	3000	4632	7976
60	308	137	218	382	620	1073	1460	2406	3434	5302	9130
70	316	154	245	430	697	1205	1641	2704	3859	5958	10260
80	324	171	272	478	774	1340	1824	3007	4290	6624	11407
90	331	188	299	525	851	1473	2005	3305	4716	7282	12540
100	338	205	326	573	928	1606	2186	3604	5141	7939	13671
125	353	247	394	691	1119	1937	2637	4346	6201	9575	16488
150	366	289	460	808	1309	2266	3085	5084	7254	11201	19288
175	378	331	528	926	1500	2597	3534	5826	8312	12834	22101
200	388	373	594	1043	1691	2926	3982	6564	9366	14461	24903
250	406	457	728	1277	2070	3582	4875	8035	11465	17703	30484
300	422	545	867	1522	2466	4269	5810	9576	13664	21098	36331
400	448	710	1130	1984	3215	5564	7574	12484	17812	27502	47360
500	470	884	1407	2469	4001	6925	9425	15535	22166	34225	58936
600	489	1061	1688	2963	4801	8310	11310	18642	26599	41070	70724

SIZES 5" THROUGH 24"

PRESS. (PSIG)	TEMP (°F)	REGULATOR or PIPE SIZE (inches)									
		5	6	8	10	12	14	16	18	20	24
-10	160	1001	1445	2502	3944	5599	6767	8839	11189	13903	20108
-5	192	2170	3133	5425	8552	12139	14671	19165	24258	30143	43597
0	212	3110	4492	7778	12260	17403	21033	27475	34778	43215	62503
5	228	4150	5993	10377	16357	23218	28061	36656	46398	57655	83388
10	240	5114	7385	12787	20156	28611	34578	45170	57175	71045	102755
15	250	6067	8761	15171	23913	33943	41023	53589	67831	84287	121908
20	259	7011	10124	17531	27633	39225	47406	61927	78386	97402	140876
25	267	7946	11475	19871	31321	44460	53732	70192	88847	110401	159677
30	274	8877	12820	22199	34990	49668	60027	78414	99255	123334	178382
40	287	10714	15473	26793	42231	59946	72449	94641	119795	148857	215297
50	298	12535	18102	31345	49407	70133	84760	110723	140151	174151	251881
60	308	14347	20719	35877	56551	80272	97014	126732	160414	199330	288298
70	316	16123	23284	40318	63551	90209	109024	142420	180272	224005	323986
80	324	17926	25887	44827	70658	100297	121215	158346	200431	249055	360217
90	331	19706	28458	49278	77674	110256	133251	174069	220332	273784	395983
100	338	21484	31025	53723	84680	120202	145271	189771	240207	298481	431704
125	353	25912	37419	64795	102132	144974	175210	228881	289712	359996	520675
150	366	30312	43773	75798	119476	169593	204964	267749	338910	421130	609095
175	378	34732	50157	86852	136900	194326	234855	306796	388335	482544	697921
200	388	39135	56515	97862	154253	218959	264625	345686	437560	543712	786390
250	406	47907	69182	119796	188827	268036	323938	423167	535634	665579	962649
300	422	57094	82449	142771	225041	319440	386063	504322	638359	793224	1147267
400	448	74426	107479	186112	293357	416413	503261	657420	832146	1034024	1495545
500	470	92620	133751	231607	365066	518202	626280	818123	1035560	1286785	1861122
600	489	111143	160501	277928	438079	621843	751536	981748	1242672	1544142	2233347

NOISE REDUCTION COMPONENT FLOW COEFFICIENTS

1. Enter C_V Table below at the component's (regulator or orifice) **inlet pressure**. Read the tabulated value for **W/C_V** at the component's **outlet pressure**.

   Note that the lowest outlet pressure listed for each inlet pressure corresponds to a critical pressure drop. An outlet pressure lower than this will not provide any further increase in flow.

2. Divide the specified steam flow by the tabulated W/C_V to obtain the regulator (Cv_R) or orifice (Cv_O) required flow coefficient.

   Refer to Rated Steam Capacity Tables earlier in this Section for rated capacities and minimum pressure drops for Spence Regulators. The definition of component **inlet** and **outlet pressures** is below.

FLOW FOR C_V = 1 TABLE

(W/C_V – LB/HR)

INLET PRESSURE (PSIG)	OUTLET PRESSURE (PSIG)	W/C_V
600	550	510
	500	706
	450	845
	400	953
	350	1040
	342	1050
550	500	488
	450	674
	400	805
	350	905
	325	947
	313	966
500	450	465
	400	640
	350	763
	325	812
	300	855
	284	881
450	400	440
	350	605
	325	666
	300	718
	275	763
	255	795
400	350	415
	325	500
	300	567
	275	623
	250	670
	226	709
350	300	387
	275	465
	250	527
	225	577
	200	619
	197	624

INLET PRESSURE (PSIG)	OUTLET PRESSURE (PSIG)	W/C_V
300	275	258
	250	357
	225	428
	200	483
	175	527
	168	538
250	225	236
	200	325
	175	388
	150	435
	145	433
	139	453
200	190	136
	175	211
	150	289
	125	342
	115	359
	110	367
175	165	128
	150	198
	125	270
	115	291
	100	317
	95	325
150	140	119
	125	183
	100	248
	90	267
	85	275
	81	282
125	115	109
	100	168
	90	194
	80	216
	75	225
	66	239

INLET PRESSURE (PSIG)	OUTLET PRESSURE (PSIG)	W/C_V
100	90	98.4
	80	136
	70	162
	60	183
	55	191
	52	196
90	80	93.8
	75	113
	70	129
	60	154
	50	173
	46	179
80	70	88.9
	60	122
	55	135
	50	145
	45	154
	40	162
70	60	83.8
	55	101
	50	115
	45	126
	40	136
	34	145
60	50	78.4
	45	94.3
	40	107
	35	117
	30	126
	29	128
50	45	52.4
	40	72.6
	35	87.0
	30	98.2
	25	107
	23	111

INLET PRESSURE (PSIG)	OUTLET PRESSURE (PSIG)	W/C_V
40	35	48.0
	33	56.2
	30	66.2
	25	79.0
	20	88.8
	17	93.6
30	25	43.1
	24	47.0
	22	53.6
	20	59.2
	15	70.2
	11	76.5
25	20	40.5
	19	44.1
	18	47.3
	15	55.3
	10	65.3
	8.3	67.9
20	15	37.7
	14	41.0
	13	43.9
	12	46.5
	10	51.2
	5.4	59.4
15	10	34.6
	9	37.6
	8	40.2
	7	42.6
	5	46.7
	2.5	50.8
10	5	31.3
	4	33.9
	3	36.2
	2	38.2
	0	41.7
	-0.4	42.3

DEFINITION OF COMPONENT PRESSURE

COMPONENT	REGULATOR ONLY		REGULATOR PLUS ORIFICE	
	INLET PRESSURE	OUTLET PRESSURE	INLET PRESSURE	OUTLET PRESSURE
REGULATOR	Initial Pressure	Reduced Pressure	Initial Pressure	†
ORIFICE	N/A	N/A	†	Reduced Pressure

† Chosen regulator outlet/orifice inlet pressure. A rule of thumb is to chose this pressure so that regulator flow is barely subcritical.

SOUND PRESSURE LEVEL (SPL) CALCULATIONS

Regulator Sound Pressure Level

1. Enter Regulator Sound Pressure Level Chart L_1 of SPLR at top of following page at the specified **initial pressure**. Move vertically to the specified **reduced pressure** (chosen outlet pressure, if Muffling Orifice is used). Read L_1 to the left of this intersection.
2. Enter Regulator Sound Pressure Level Chart L_2 of SPLR at bottom of following page at the required **regulator flow coefficient** (CV_R). Move vertically to the delivery pipe size. Read L_2 to the left of this intersection.
3. Regulator sound pressure level is:

$$\mathbf{SPLR = L_1 + L_2}$$

NOTE: If SPLR exceeds specified limits, use a Muffling Orifice to reduce the regulator's pressure drop.

Muffling Orifice Sound Pressure Level

1. Enter Muffling Orifice Sound Pressure Level Chart L_3 of SPLO at top of following page at the chosen **orifice inlet** (regulator outlet) pressure. Move vertically to the specified **reduced pressure**. Read L_3 to the left of this intersection.
2. Enter Muffling Orifice Sound Pressure Level Chart L_4 of SPLO at bottom of following page at the required **orifice flow coefficient** (CV_O). Move vertically to the orifice plate size. Read L_4 to the left of this intersection.
3. Regulator sound pressure level is:

$$\mathbf{SPLO = L_3 + L_4}$$

Combined Sound Pressure Level

Combine **SPLO** and **SPLR** as follows:

1. Determine difference between **SPLO** and **SPLR**.
2. Find correction from dB Correction Table at right.
3. Add the correction to the **higher** SPL.

Example

SPECIFIED CONDITIONS

Saturated Steam Flow = 5,000 lb/hr
Initial Pressure = 100 PSIG
Reduced Pressure = 15 PSIG

From the component sizing example on preceding pages, a 2½" regulator with a 5" Muffling Orifice is required. Choose an orifice inlet (regulator outlet) pressure of 55 PSIG (critical pressure is 52 PSIG).

Entering Flow for C_V=1 Table on facing page at 100 PSIG, W/C_V = 191 at 55 PSIG outlet pressure. Thus CVR = (5,000 ÷ 191) = 26.2.

Flow for C_V=1 Table does not provide a listing for 55 PSIG inlet pressure. Using the critical pressures at both 60 PSIG and 50 PSIG, we estimate that W/C_V = (128 + 111) ÷ 2 = 120; thus CV_O = (5,000 ÷ 120) = 41.7.

Entering L_1 of SPLR Chart on following page at 100 PSIG, L_1 = 41 at 55 PSIG outlet pressure. Entering L_2 of SPLR Chart at CV_R = 26.2, L2 = 37 at 5" pipe size. Thus SPLR = $L_1 + L_2$ = 78 dBA.

Entering L_3 of SPLO Chart on following page at 55 PSIG, L_3 = 52 at 15 PSIG reduced pressure. Entering L_4 of SPLO Chart at CV_O = 41.7, L_4 = 16 at 5" plate size. Thus SPLO = $L_3 + L_4$ = 68 dBA.

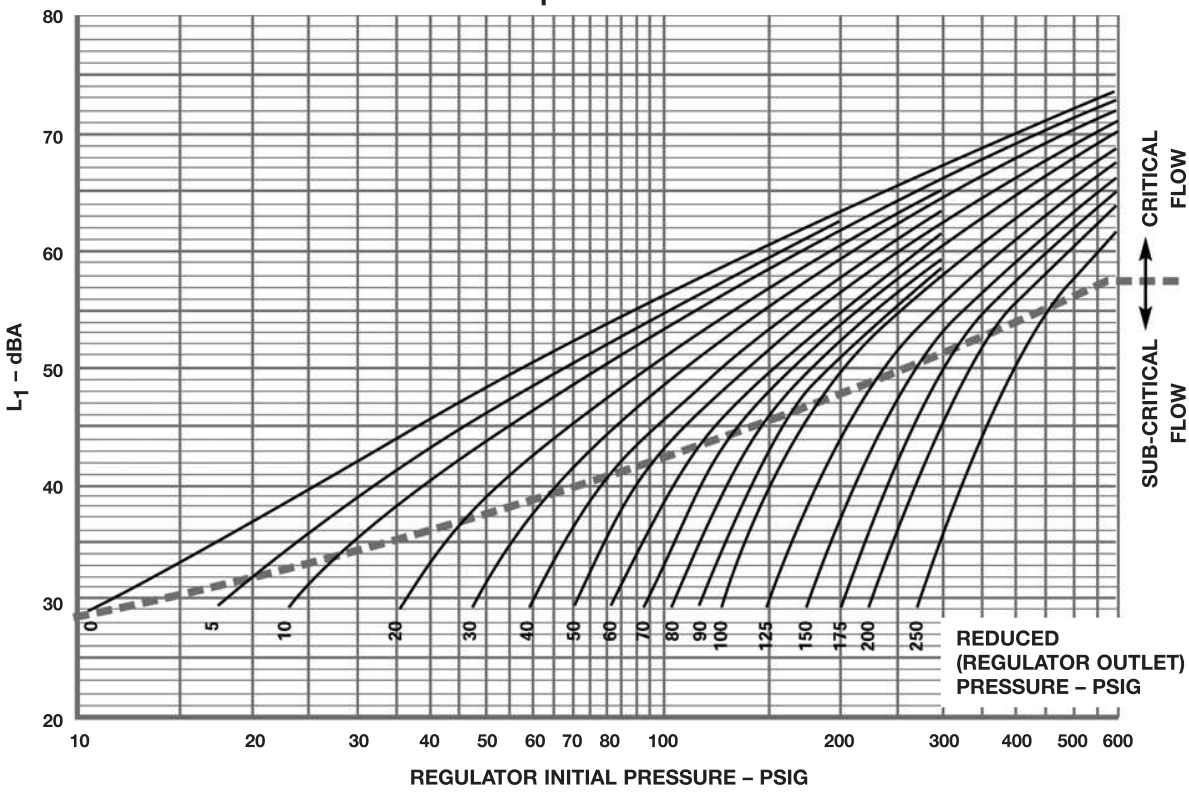
SPLR – SPLO = 10 dBA. From the dB Correction Table below, the decibel correction is 0.4 dB. Thus the combined SPL = SPLR + 0.4 = 78.4 dBA.

dB CORRECTION TABLE

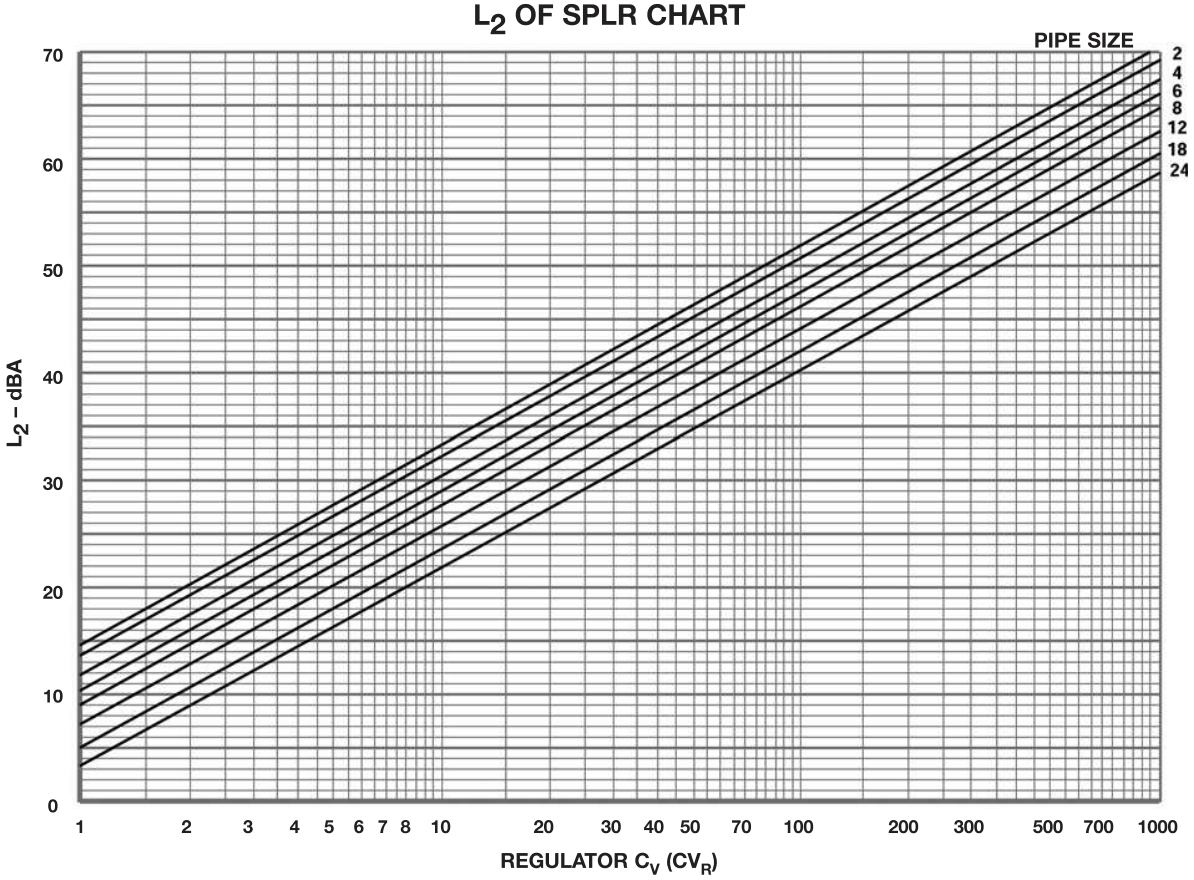
DECIBEL DIFFERENCE	DECIBEL CORRECTION
0	3.0
1	2.6
2	2.1
3	1.8
4	1.5
5	1.2
6	1.0
7	0.8
8	0.6
9	0.5
10	0.4

REGULATOR SOUND PRESSURE LEVEL CHARTS

L_1 OF SPLR CHART

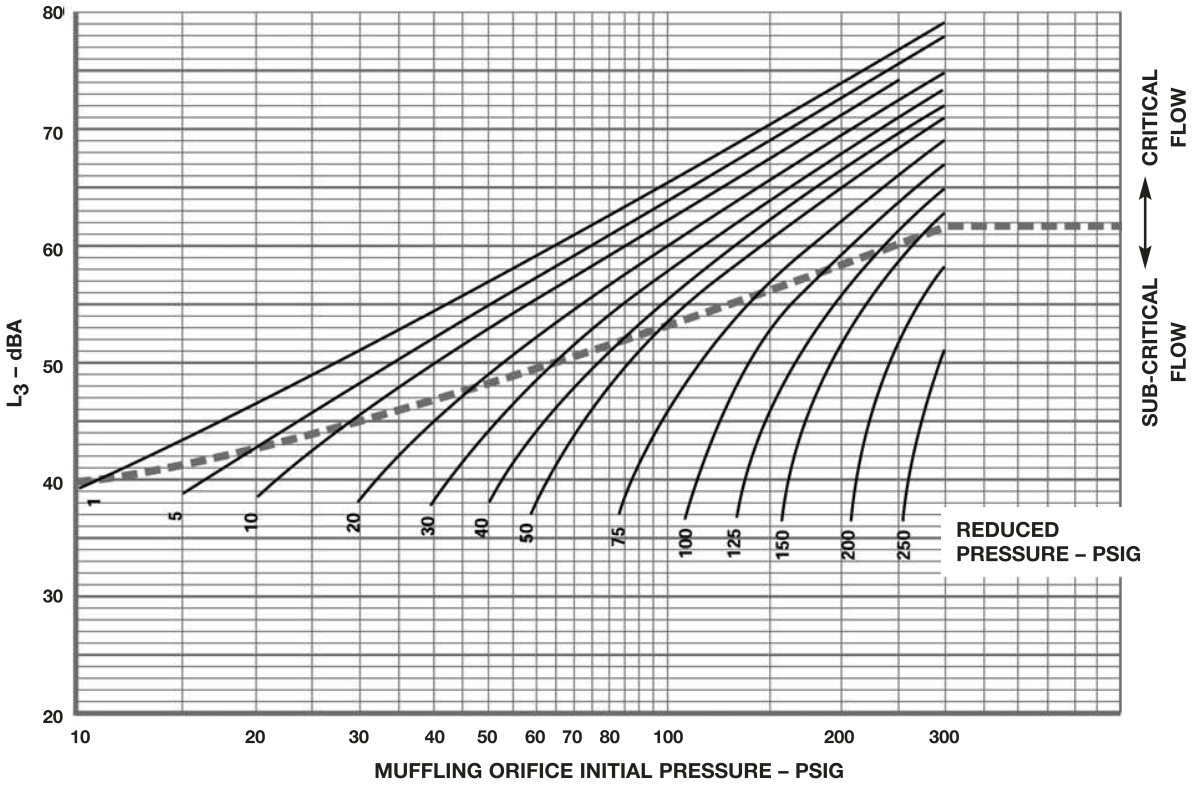


L_2 OF SPLR CHART



MUFFLING ORIFICE SOUND PRESSURE LEVEL CHARTS

L_3 OF SPLO CHART



L_4 OF SPLO CHART