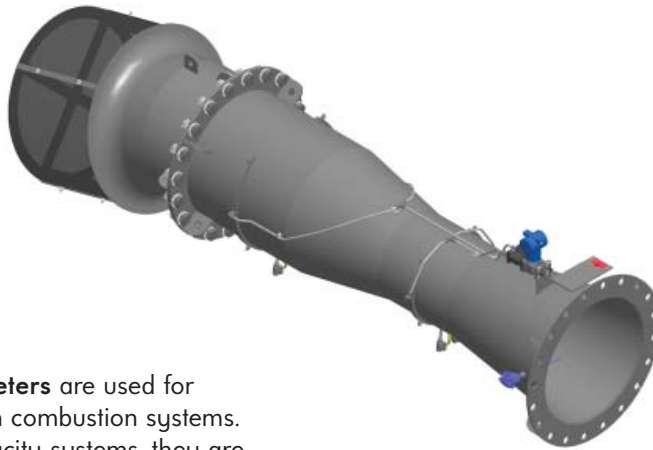


## North American 8631 Venturi Meter

Bulletin 8631



**North American 8631 Venturi Meters** are used for measuring low pressure air flow in combustion systems. Typically deployed on higher-capacity systems, they are an economic and highly efficient alternative to orifice plates. Venturi meters can recover as much as 88% of their operating pressure differential compared with the 48% recovery of an orifice plate having the same beta ratio. This low permanent pressure loss can greatly reduce fan power consumption and provide significant payback over the life of a combustion system.

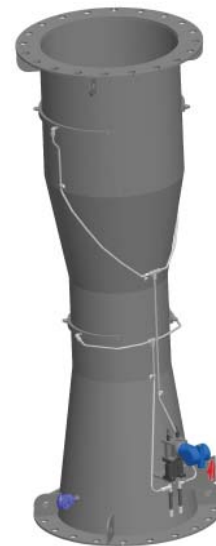
**8631 Venturis** are simple, robust and easy to commission. They are a practical alternative to the much more expensive pitot tube array or probe devices that can be difficult to set up, characterize and maintain.

**8631 Venturis** are supplied pre-assembled as a complete package which includes an all-fabricated venturi based on the ISO 5167-4 standard; high-accuracy, low-drift, transmitter; Type J mineral-insulated thermocouple; stainless steel 3-valve manifold, drip leg valves, tubing and fittings. The venturi shell is fabricated from carbon steel and epoxy coated, with fabricated plate ANSI or DIN bolt circle flanged end connections. They are available in 12" through 40" pipe sizes for design air flow rates of approximately 20,000 to 1,900,000 standard cubic feet per hour (500 to 51,000 normal cubic meters per hour).

**8631 Venturis** can be ordered with the tubing and drip legs orientation for either vertical (down flow) piping or horizontal piping installations. They can be installed inline or on the inlet of the piping (e.g. on the inlet side of a combustion air blower). They can be installed indoors or outdoors but must be supplied with the rain cap-bird screen-inlet bell when no inlet piping is used.

Standard **8631 Venturis** are paired with a highly-accurate low range transmitter chosen for its low drift with temperature. A data sheet calculated from the ISO Venturi flow equation is available for each venturi, providing flow versus differential pressure data at standard and at given conditions. For assured accuracy an individually calibrated 8631 venturi can be provided at extra cost - a multi-point differential pressure versus flow rate calibration report is supplied with each such calibrated venturi.

A range of standard **8631 Venturi** sizes make selection easy. For special applications and/or those outside the pre-specified standards, our engineering team will design custom 8631 Venturis on request.



## SELECTION from STANDARD 8631 OFFERING

The design of the standard series of North American 8631 Venturi Meters is based on several default parameter choices driven by its most common application - metering of low pressure combustion air for burner systems. The venturi physical dimensions are defined by the pipe size and the choices made to allow a low permanent pressure loss (0.3" wc approx.) and a design pressure differential (2.5"wc) to drive a 3"-range transmitter. The capacity chart shows the STP air flow rate for pressure differentials from 0.03" wc (the recommended minimum-use point) to 3.0"wc (transmitter saturation point) across a range of pipe sizes from 12 to 40" ID.

The 2.5"wc recommended design pressure drop column is highlighted, and the 2.7"wc column indicates the suggested maximum flow used to avoid transmitter saturation (at 3" wc).

### Venturi Selection Example:

Actual Use Conditions: Dry air, 1000' amsl elevation (atmospheric pressure 14.146), venturi installed on inlet to blower with no inlet piping resistance, 250,000 scfh flow, 5:1 turndown (to 50,000 scfh).

1. Correct the actual STP flow at application conditions to the STP flow at design conditions used in the capacity chart (60F and 14.696 psia) using the formula:

- Q1 = STP flow at application conditions
- Q2 = STP flow at design conditions
- T1 = Application absolute temperature
- T2 = Design absolute temperature
- P1 = Application absolute pressure
- P2 = Design absolute pressure

$$Q2 = Q1 \sqrt{\left(\frac{T1}{T2}\right)\left(\frac{P2}{P1}\right)}$$

$$Q2 = 250,000 \sqrt{\left(\frac{459.67+100}{459.67+60}\right)\left(\frac{14.696}{14.146}\right)} = 264,438 \text{ scfh}$$

2. Select a venturi using the following sizing considerations:

- The 3" wc. differential pressure (dp) column is maximum flow. The venturi should not be sized at this point to avoid transmitter saturation.
- 2.5" wc. dp is the 8631 Venturi's suggested design point for sizing - follow the 2.5" wc. dp column to determine the appropriate size for the application.
- IMPORTANT: Include a sizing safety factor to avoid transmitter saturation. Always consider the maximum possible flow at given conditions when sizing. It is suggested that it does not exceed the capacities listed in the 2.7" wc dp column.
- Below 0.03" wc dp the Reynolds number will typically be below the Venturi equation's limit and accuracy will be uncertain below this point.

- The transmitter cannot read dp's lower than 0.01" wc dp.
- After selecting the venturi based on maximum flow, check that the minimum flow condition is within acceptable conditions with respect to the two points above.

3. Using the Capacity Chart on Page 3 to select an 8631 Venturi for 264,438 scfh air flow:

- Choose the 8631-16 which has a capacity of 272,100 scfh at the 2.5" design point.
- Check the dp at the minimum flow of 50,000 scfh - it is above the 29,180 scfh flow listed for the minimum dp of 0.03"wc and thus in the recommended range.

## PERMANENT PRESSURE LOSS and UPSTREAM PRESSURE

**To determine Total permanent pressure loss when the venturi is installed in line and with an upstream piping run:**

Based on the values in the sizing table of this bulletin, the estimated total permanent pressure loss will simply be the permanent pressure drop across the venturi, or 12.3% of the throat DP.

**To determine Total permanent pressure loss when no inlet piping is used and when the "required" inlet bell (cap/filter) is installed:**

The total permanent pressure loss will be a sum of the permanent pressure drop across the venturi loss (as noted above) plus the combination of initial acceleration of the air and entry configuration loss. Based on the values in the sizing table of this bulletin, venturi permanent pressure loss will be 12.3% of the throat DP plus an acceleration and entry configuration loss of 33%. Or an estimated total permanent pressure loss of 45.3% of throat DP. *This total permanent pressure loss value can then be used to determine the "negative" inlet pressure value for accurate flow calculations when inlet is open to atmospheric pressure.*

### Example:

8631-24 designed for 600,100 SCFH has a throat differential pressure of 2.3"wc.

The permanent pressure loss across the venturi would be 2.3"wc x .123 = 0.28"wc.

The initial acceleration and entry loss would be 2.3"wc x 0.33 = .76"wc.

Total permanent pressure loss when the venturi is installed in line with an upstream piping run = **0.28"wc.**

Total permanent pressure loss when no inlet piping is used and when the "required" inlet bell (cap/filter) is installed = 0.76" + 0.28" = **1.04"wc.**

CAPACITY CHART

SIZING CHART scfh air (60°F; 14.696 psia; S.G. 1.0) Class 150 ANSI Flanges		Differential Pressure (In. wc.)						
		0.03*	1.5	1.9	2.3	2.5	2.7	3
8631 (nominal pipe size inches)	8631-12	18,650	134,900	151,700	166,800	173,800	180,600	190,300
	8631-14	22,140	160,200	180,100	198,000	206,400	214,400	225,900
	8631-16	29,180	211,100	237,500	261,100	272,100	282,600	297,800
	8631-18	37,200	269,200	302,700	332,800	346,800	360,300	379,600
	8631-20	46,670	334,200	375,800	413,200	430,600	447,400	471,300
	8631-22	56,730	406,300	456,900	502,300	523,500	543,800	572,900
	8631-24	67,780	485,400	545,800	600,100	625,400	649,700	684,500
	8631-26	79,060	566,100	636,700	700,000	729,500	757,800	798,400
	8631-28	92,010	658,900	741,000	814,600	849,000	882,000	929,100
	8631-30	105,900	758,600	853,200	938,000	977,500	1,016,000	1,070,000
	8631-32	122,100	865,400	973,300	1,070,000	1,115,000	1,158,000	1,220,000
	8631-34	138,200	979,300	1,101,000	1,211,000	1,262,000	1,311,000	1,381,000
	8631-36	155,200	1,100,000	1,237,000	1,360,000	1,418,000	1,473,000	1,551,000
	8631-38	173,000	1,228,000	1,381,000	1,518,000	1,582,000	1,644,000	1,732,000
	8631-40	192,300	1,363,000	1,533,000	1,685,000	1,756,000	1,824,000	1,922,000

\* represents approximate ISO standard minimum Re number limit

SIZING CHART Nm <sup>3</sup> /hr air (0°C; 760 mm Hg; S.G. 1.0) PN 10 DIN Flanges		Differential Pressure (mbar)						
		0.075*	3.736	4.733	5.729	6.227	6.725	7.473
8631 (nominal pipe size mm)	M8631-300	500	3,614	4,064	4,469	4,656	4,838	5,098
	M8631-350	593	4,292	4,825	5,305	5,530	5,744	6,052
	M8631-400	782	5,656	6,363	6,995	7,290	7,571	7,978
	M8631-450	997	7,212	8,110	8,916	9,291	9,653	10,170
	M8631-500	1,250	8,954	10,068	11,070	11,536	11,986	12,627
	M8631-550	1,520	10,885	12,241	13,457	14,025	14,569	15,349
	M8631-600	1,816	13,004	14,623	16,077	16,755	17,406	18,338
	M8631-650	2,118	15,166	17,058	18,754	19,544	20,302	21,390
	M8631-700	2,465	17,653	19,852	21,824	22,746	23,630	24,891
	M8631-750	2,837	20,324	22,858	25,130	26,188	27,220	28,666
	M8631-800	3,271	23,185	26,076	28,666	29,872	31,024	32,685
	M8631-850	3,703	26,236	29,497	32,444	33,810	35,123	36,998
	M8631-900	4,158	29,470	33,140	36,436	37,990	39,463	41,553
	M8631-950	4,635	32,899	36,998	40,669	42,383	44,044	46,402
	M8631-1000	5,152	36,516	41,071	45,143	47,045	48,867	51,492

\* represents approximate ISO standard minimum Re number limit

## SPECIFICATIONS

### Venturi Meter

- Design Fluid Duty: Ambient Air
- Materials of Construction: Carbon Steel Fabrication, Epoxy Coating, Stainless Steel Valves, Fittings and Tubing
- Sizes: 12"-40" NPS - I.D. equal to schedule 10 pipe(where applicable); *flange type does not effect I.D*
- End Connections: Specify ANSI or DIN flanged
- Maximum Fluid Temperature: 180° F
- Maximum Ambient Temperature: 185° F
- Design inlet Pressure: -2 psig to 2 psig
- Standard Flow Accuracy: 3%-5% for inlet duct flow at 200,000 to 2,000,000 Reynolds Number (*Re*)
- Turndown Flow Accuracy: 4%-6% for *Re* between 60,000 to 199,999
- High Turndown Flow Accuracy: 4.5%-6.5% for *Re* between 59,999 to 40,000(accuracy cannot be estimated for flow streams at lower *Re* numbers)
- Flow Accuracy for Calibrated 8631 Venturi: 1% at points of calibration
- Installation: Specify Horizontal or Vertical (vertical design is for down flow only)
- Inlet option: Rain Cap - Bird Screen - inlet bell (required when no upstream piping is used)
- Beta Ratio: 0.7

### Thermocouple

- Type: J, mineral insulated (MgO)
- Length: 8"
- Sheath Material: 304 Stainless Steel
- Connection: ½" NPT conduit
- Part Number: R860-3921

### Pressure Transmitter

- Range: -3" to +3" wc.
- Span: 0-3" wc
- Accuracy as spanned (with transmitter zeroed after installation): ± 0.003" wc.
- Ambient temperature effect as spanned: ±0.009" wc./50°F
- Total error w/0F temp. change: .1% at 3" wc dp; 2.5% at .12" wc. dp; 10% at .03" dp
- Total error w/50F temp. change: .32% at 3" wc dp; 7.91% at .12" wc. dp; 31.62% at .03" dp
- Minimum dp limit: 0.01" wc
- Output: 4-20 mA DC Linear
- Protocol: Hart
- Ambient Temperature range: -40 to 185F
- Process Fluid Temperature Range: -40 to 212F
- Pressure Rating: 0.5 psia to 750 psig
- Connections: ½" NPT conduit
- 3 Valve Manifold connections: ¼" NPT
- Certifications: FM Explosion Proof, Dust and Ignition Proof; Class I, Div1, Groups B, C, D. T5; Class II and III Div 1, Groups E, F,G, T5
- Enclosure type: 4X
- Part Number: R895-8631

8631 VENTURI SAMPLE STANDARD DATA SHEET

<b>Customer/order/job number:</b> Sizing example data sheet	<b>Item Number:</b> 8631-16-V	<b>Date:</b>
<b>Standard Conditions</b>		
Standard Day Flow	<b>250000</b>	SCFH
Standard Day Flow	<b>4167</b>	SCFM
Fluid	<b>Dry Air</b>	
Standard Day Density	<b>0.0763</b>	lb/ft <sup>3</sup>
Standard Day Temperature	<b>60</b>	degrees F
Standard Day Pressure	<b>14.696</b>	psi
<b>Actual Conditions</b>		
Temperature	<b>100</b>	degrees F
Elevation	<b>1000</b>	FT. amsl
Density	<b>0.0682</b>	lb/ft <sup>3</sup>
Atmospheric Pressure	<b>14.146</b>	psi
Upstream Pressure	<b>0</b>	"wc
Pressure Differential	<b>2.361</b>	"wc
Actual Flow	<b>279702</b>	ACFH
Actual Flow	<b>4662</b>	ACFM
Mass Flow	<b>327</b>	lb/min
Permanent Pressure Loss	<b>0.291</b>	"wc
Reynolds Number	<b>405925</b>	
Discharge Coefficient	<b>0.985</b>	
<b>Venturi Size</b>		
Venturi Inlet ID	<b>15.5</b>	in
Venturi Throat ID	<b>10.85</b>	in
Venturi Beta Ratio	<b>0.7</b>	

% of dP	Output (mADC)	dp ("wc)	Flow Rate (scfh)	Flow Rate (acfh)	Mass Flow (lb/min)	Reynolds Number	Discharge Coefficient	Permanent Pressure Loss ("wc)	
0	4	0	0	0	0.000	0	0	0.000	
0.33	4.0528	0.01	0	0	0.000	0	0	0.001	below min. Re number
10	5.60	0.30	89,018	99,594	113.241	144539	0.98	0.037	1% additional flow error
20	7.20	0.60	126,459	141,484	160.870	205332	0.985	0.074	
30	8.80	0.90	154,790	173,180	196.909	251332	0.985	0.111	
40	10.40	1.20	178,631	199,855	227.239	290044	0.985	0.148	
50	12.00	1.50	199,599	223,314	253.912	324090	0.985	0.185	
60	13.60	1.80	218,523	244,485	277.985	354815	0.985	0.222	
70	15.20	2.10	235,893	263,920	300.082	383020	0.985	0.259	
80	16.80	2.40	252,033	281,977	320.614	409227	0.985	0.295	
90	18.40	2.70	267,165	298,907	339.864	433797	0.985	0.332	
100	20.00	3.00	281,452	314,892	358.038	456994	0.985	0.369	
78.7	16.592	<b>2.361</b>	<b>250,000</b>	279,702	327.161	405925	0.985	0.291	Design point
0.8	4.128	0.024	24,677	27,609	31.392	40069	0.96	0.003	Minimum flow: 1.5% additional flow error

## INSTALLATION

### Piping Considerations:

A certain length of straight upstream and downstream piping is necessary to optimize the accuracy of any differential pressure device.

**Upstream:** The following tabulation provides the minimum straight upstream lengths (expressed as multiples of pipe ID) required for 0.0% and 0.5% additional potential affect in base flow accuracy.

Upstream feature	Single 90° bend		Two 90° bends within 15D		Reducer 1.33D to D w/length of 2.3D		Expander 0.67D to D w/length of 2.5D		Reducer 3D to D w/length of 3.5D		Expander 0.75D to D w/length of D		Full bore ball or gate valve fully open	
Additional Uncertainty	0.00%	0.50%	0.00%	0.50%	0.00%	0.50%	0.00%	0.50%	0.00%	0.50%	0.00%	0.50%	0.00%	0.50%
Length	14D	3D	18D	3D	4D	-----	7D	5D	10.5D	2.5D	5.5D	3.5D	5.5D	.3.5D

**Downstream:** For zero additional uncertainty due to downstream piping, ensure that there are no fittings for 1.5D downstream of the Venturi.

### Lifting Instructions

All Venturis may be lifted using a pair of lift points in the same plane. A four-point lift is preferable as it will reduce the stress on the Venturi.

### Rain Cap and Bird Screen Lift points

The horizontal rain cap-bird screen lift point is solely for the lifting of the rain cap-bird screen alone. It must not be used for lifting the overall assembled horizontal Venturi with rain cap-bird screen.

The vertical rain cap-bird screen lift point may be used to lift the entire assembled venturi with rain cap-bird screen.

### Flow Transmitter

After installing the Venturi, the flow transmitter must be zero trimmed before commissioning into service.

## ORDERING INFORMATION

8631	Venturi Model (ANSI class 150 type flanged)
M8631	Venturi Model (DIN PN 10 type flanged)
-12 thru -40	Pipe size (ex. -16 = 16" nps)
-300 thru -1000	Pipe size (ex. -400 = 16" nps)
-V	Vertical installation
-H	Horizontal installation
-VR	Vertical installation with Rain cap-Bird screen-inlet bell
-HR	Horizontal installation with Rain cap-Bird screen-inlet bell
-CAL	Calibrated version

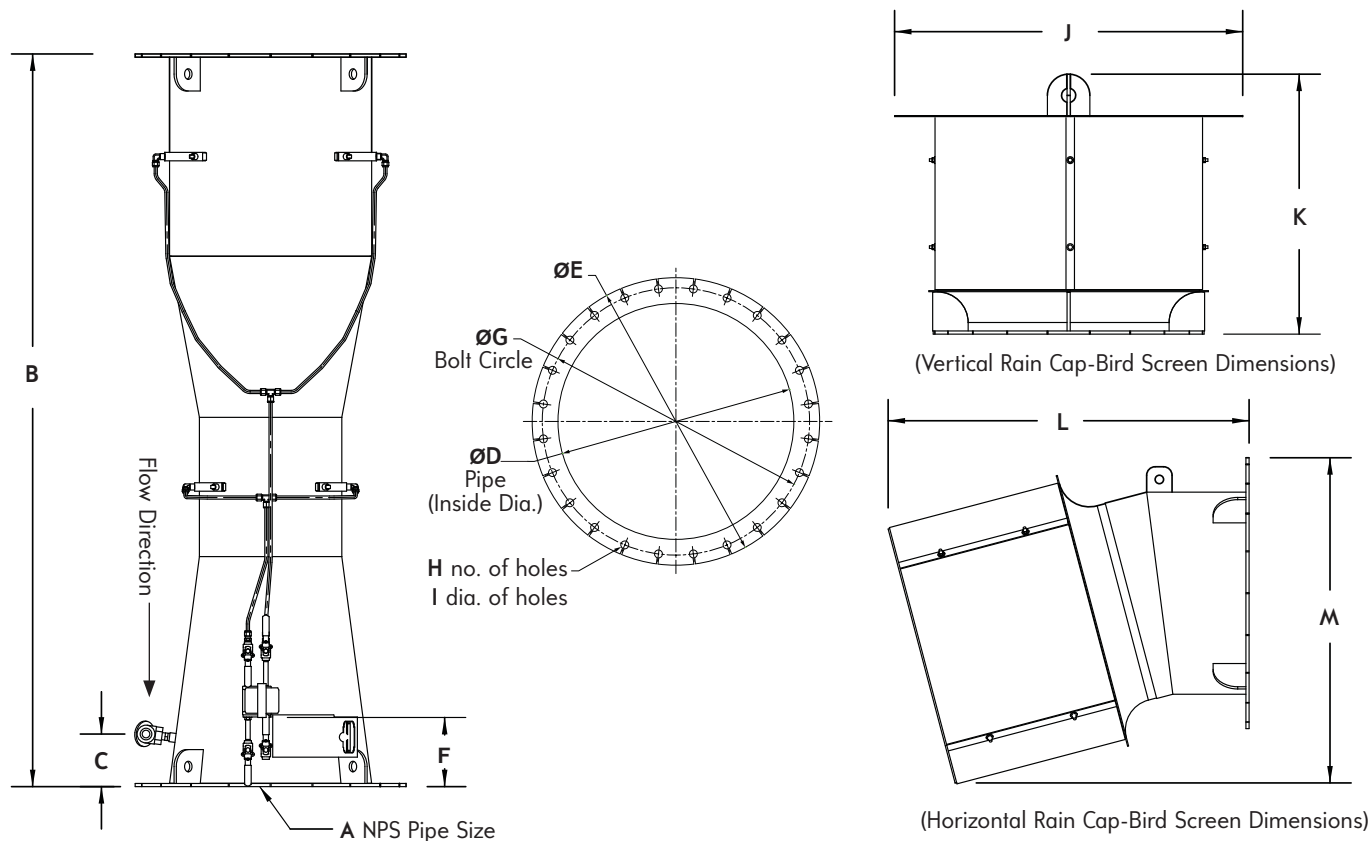
### Examples:

8631-16-V	16" Venturi for vertical installation
8631-24-HR	24" Venturi for horizontal installation with rain cap-bird screen
M8631-750-H	30" Venturi for horizontal installation with PN 10 DIN type flanges
8631-28-VR-CAL	28" calibrated Venturi for vertical installation with rain cap-bird screen

### Flange Gaskets:

1/4" diameter GORE-TEX® sealant rope is available as a convenient flange gasket material. To be ordered by the foot (example: For 8631-24 size, order a quantity of (17) feet of item number **R540-0370** to accommodate two flanges with a circumference of approximately 100.5" each based on dimension "E" from page 7).

## DIMENSIONS



DIMENSIONS SHOWN ARE SUBJECT TO CHANGE. PLEASE OBTAIN CERTIFIED PRINTS FROM FIVES NORTH AMERICAN COMBUSITON, INC. IF SPACE LIMITATIONS OR OTHER CONSIDERATIONS MAKE EXACT DIMENSION(S) CRITICAL.

Venturi Designation	A	B	C	D	ANSI (in) E	DIN (mm) E	F	G	ANSI (in) H	DIN (mm) H	ANSI (in) I	DIN (mm) I	J	K	L	M
8631-12	12	45.7	3.5	12.39	19.0	400	5.6	17.0	12	12	1.00	22	21.7	16.7	22.3	21.7
8631-14	14	49.8	3.8	13.5	21.0	460	5.8	18.8	12	16	1.13	22	23.6	18.1	25.7	23.7
8631-16	16	57.1	4.3	15.5	23.5	515	6.3	21.3	16	16	1.13	26	27.1	20.6	29.1	26.8
8631-18	18	64.4	4.7	17.5	25.0	565	6.7	22.8	16	20	1.25	26	30.6	23.1	32.5	29.4
8631-20	20	71.7	5.2	19.5	27.5	620	7.2	25.0	20	20	1.25	26	34.1	25.6	35.8	32.5
8631-22	22	79.3	5.8	21.5	29.5	725	7.8	27.3	20	20	1.38	30	37.6	28.2	39.3	35.3
8631-24	24	86.6	6.2	23.5	32.0	725	8.2	29.5	20	20	1.38	30	41.1	30.7	42.6	38.4
8631-26	26	93.4	6.6	25.38	30.9	840	8.7	29.3	36	24	0.88	30	44.4	33.1	45.8	39.6
8631-28	28	100.7	7.1	27.38	32.9	840	9.1	31.3	40	24	0.88	30	47.9	35.6	49.1	42.9
8631-30	30	108.0	7.6	29.38	34.9	950	9.6	33.3	44	24	0.88	33	51.4	38.1	52.5	45.3
8631-32	32	115.6	8.1	31.38	37.1	950	10.1	35.4	48	24	0.88	33	54.9	40.7	55.9	48.2
8631-34	34	122.9	8.6	33.38	39.6	1050	10.6	37.7	40	28	1.00	33	58.4	43.2	59.3	51.3
8631-36	36	130.2	9.1	35.38	41.6	1050	11.1	39.8	44	28	1.00	33	61.9	45.7	62.6	54.2
8631-38	38	137.5	9.5	37.38	44.3	1160	11.5	42.1	40	28	1.13	36	65.4	48.2	65.9	57.3
8631-40	40	144.7	10.0	39.38	46.3	1160	12.0	44.1	44	28	1.13	36	68.9	50.7	69.3	60.2

**WARNING:** Situations dangerous to personnel and property may exist with the operation and maintenance of any combustion equipment. The presence of fuels, oxidants, hot and cold combustion products, hot surfaces, electrical power in control and ignition circuits, etc., is inherent with any combustion application. Parts of this product may exceed 160F in operation and present a contact hazard. Fives North American Combustion, Inc. urges compliance with National Safety Standards and Insurance Underwriters' recommendations, and care in operation.



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