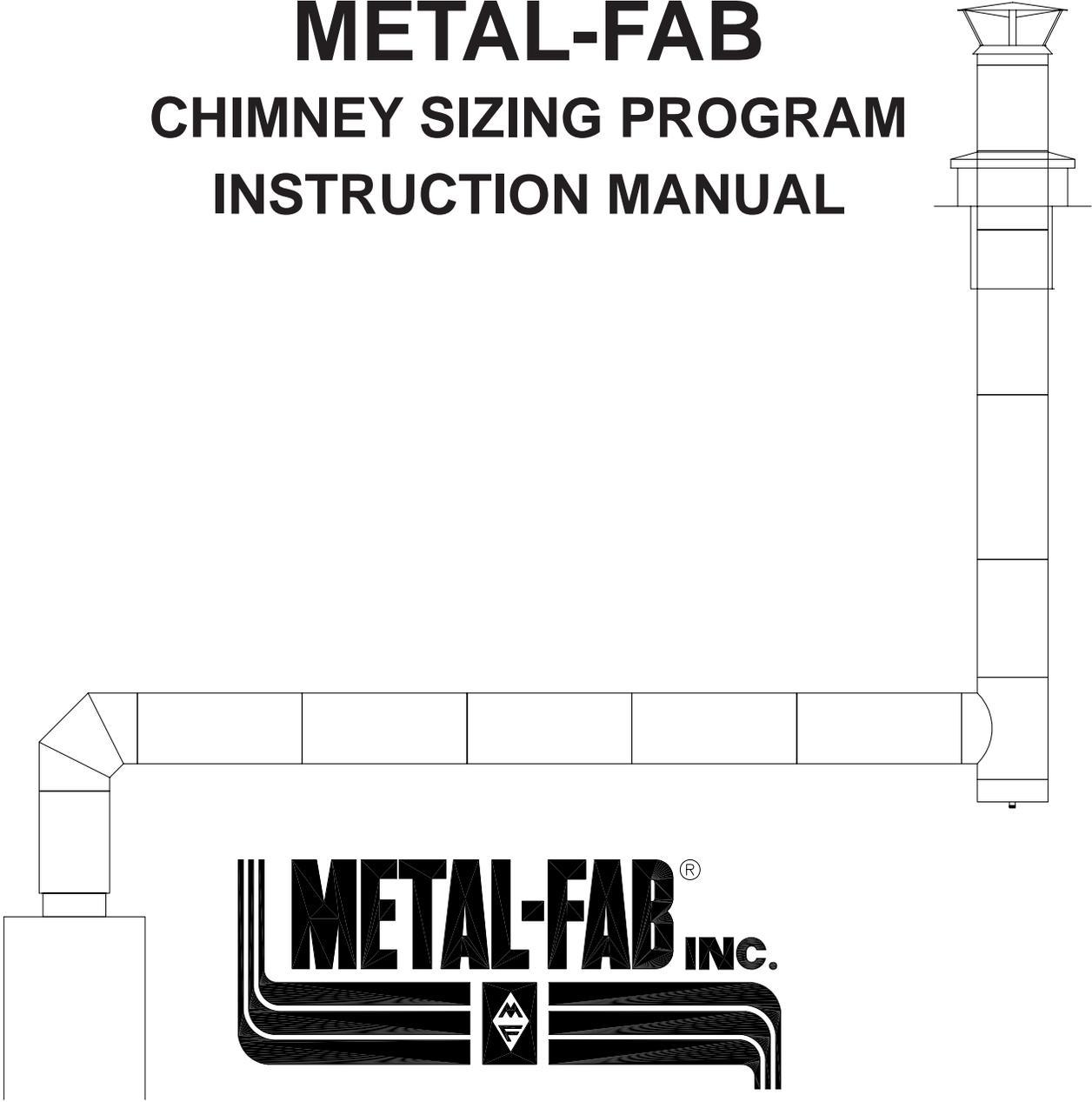


METAL-FAB CHIMNEY SIZING PROGRAM INSTRUCTION MANUAL



Introduction/Overview

Metal-Fab Sizing Program is software specifically designed to assist an engineer in the task of sizing a chimney stack, using Metal-Fab Pipe Products. This software is a combination of ASHRAE calculations and Metal-Fab Inc. specific details that will enable a user to size a chimney stack making best use of space and minimizing costs.

Quick Start:

If you are experienced with pipe sizing and have used the Vent Right software provided by Metal-Fab, the following steps will get you up and going quickly.

1. Insert CD into CD drive, wait for Installation program to begin.
2. Install the CD onto your hard drive. It is strongly recommended that you accept the default file locations.
3. Start the Metal-Fab Inc. Sizing Program from the Program Files menu.
4. Enter your data into the appropriate boxes. Most information directly corresponds to the information entered into the Vent Right program.

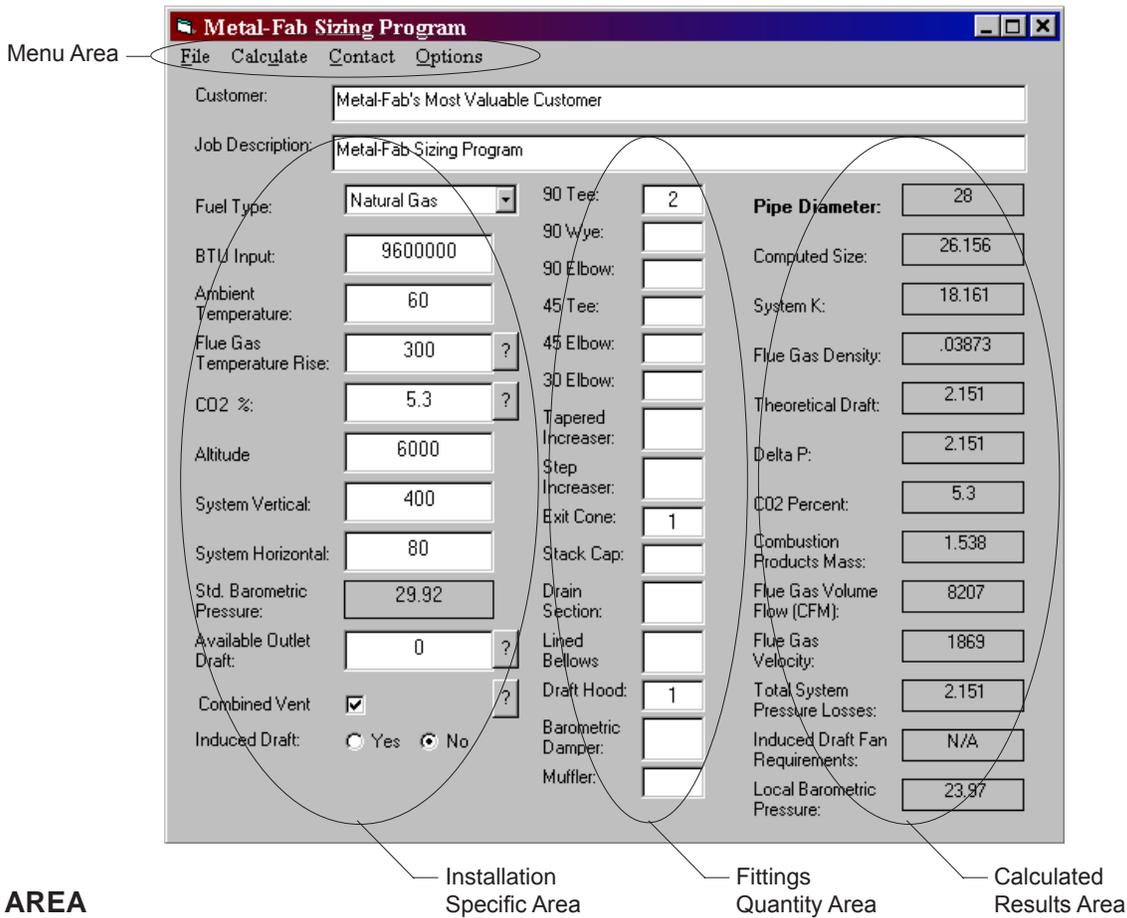
NOTE: You no longer enter total system length; you enter a horizontal length and vertical length.

5. Click on Calculate, or press ENTER, for pipe sizing.
6. You can save, print or even E-mail the resulting calculations by selecting from the File menu.

NOTE: If you E-mail the results as an attachment, the recipient must also have the sizing program.

Metal-Fab Inc. Sizing Program Environment:

The sizing program environment can be broken down into a few distinct areas. The first area is the MENU AREA. This section contains options that can be accessed before/during/after the pipe sizing is initiated. The INSTALLATION SPECIFIC INFORMATION is a section of data that is input by the user and is required to calculate a pipe diameter. The FITTING QUANTITIES AREA is a section that details all the special fittings required for the installation. The CALCULATED RESULTS AREA displays the results of the information provided.



MENU AREA

The menu system allows users access to an assortment of information and options at anytime the program is in use. Below is a detail of the options available:

File

- Open.....Use to open previously saved sizing data.
- Save AsUse to save the current data to a size file for future retrieval.
- Print Form.....Used to print a copy of the form as shown on the screen.
- Print ReportUsed to print a text report of current sizing. Good for fax.
- Email.....Used to email the current sizing info. Requires email and Internet Connection.
- ExitQuits Program.

Calculate..... Causes program to calculate results from data entered.

Contact

- AddressBrings up a form that stores the users contact information.

Options

- K-Factor.....Shows a list of K-Factors for each Metal-Fab Inc. Fitting.
- Clear AllClears all data from the input boxes.
- BackgroundColors Allows user to customize background colors.
- Altitude of Cities..... Gives a list of some U.S. Cities over 1000ft with their Altitude.

INSTALLATION SPECIFIC INFORMATION

The Installation Specific Information Area contains information required to compute the pipe sizing and is specific to the particular job being sized. All input must be provided to complete the calculations. The following is an explanation of the data required:

Fuel Type: Product being burned in appliance.

BTU Input: (BTU/Hour Input) Maximum input capacity for the burner in the appliance(s).

Ambient Temperature: (°F) Maximum outside temperature expected during the operation of the appliance.

Flue Gas Temperature Rise: (°F) Temperature of exhaust gases minus the ambient temperature.

CO₂ %: (%) Carbon Dioxide content of the exhaust gas. This information is supplied by the appliance manufacture.

Altitude: (Ft.) Elevation above sea level where the appliance will operate.

System Vertical: (Ft.) Total vertical rise of vent system from the connection of the tallest appliance to the termination.

System Horizontal: (Ft.) Longest horizontal distance from any one appliance to the termination of the system.

Std Barometric Pressure: (In/Hg) This is a constant value of 29.92 inches mercury.

Available Outlet Draft: (Inches Water Column) Positive pressure available or negative pressure required by appliance. This information is supplied by appliance manufacture.

Combined Vent: (Check for Yes) Check only if the application is a system that has multiple appliances with draft hoods.

Induced Draft: Check only if the application is a system that is utilizing an induced draft fan.

Diameter: (Inches) Use only when sizing a system with an induced-draft fan; enter desired diameter of pipe.

FITTING QUANTITIES AREA

This area is where specific fittings are identified. Each possible fitting has an input box associated with it where the quantity is entered. If a quantity of two 90 Tees are used then 2 should be entered into the appropriate box. If none of the fittings are used a quantity is not necessary. However 0 (zero) can be entered.

NOTE: If combined vent is used, at least one draft hood must be used.

CALCULATED RESULTS AREA

This section is an area that cannot be edited by the user. It displays the results of the calculations performed. Each item displays a different piece of information about the system specified. The following is a description of the results:

Pipe Diameter: (Inches) This is the minimum standard size of pipe available from Metal-Fab Inc. that is required for the data provided. It is determined from the computed size.

Computed Size: (Inches) This is the actual minimum size of pipe required for the data provided. It is determined through 2000 ASHRAE calculations for chimney venting. Refer to the 2000 ASHRAE Handbook – HVAC Systems and Equipment I-P Edition, or contact Metal-Fab for more information on the calculations used.

System K: Resistance coefficient for the entire chimney system including piping and fittings.

Flue Gas Density: (lb/ft³) Mass per unit volume of gas at an average temperature and local barometric pressure.

Theoretical Draft: *The difference in weight between a given column of warm (light) chimney gas and an equal column of cold (heavy) ambient air. Chimney gas density or temperature, chimney height, and barometric pressure determine theoretical draft; flow is not a factor. (2000 ASHRAE Handbook – HVAC Systems and Equipment I-P Edition)*

Delta P: Flow losses resulting from gas velocity and resistance (friction) of the pipe to flow.

CO₂ %: Percentage of Carbon Dioxide in the gas. Ratio is determined by fuel type.

Combustion Products Mass: Weight of flue gases conveyed through the flue.

Flue Gas Volume: Amount of gas being transferred through the flue during a given amount of time. Measured in CFM (ft³/min).

Flue Gas Velocity: Distance that the Flue Gas will move in a given amount of time. Measured in ft/min

Total System Pressure Losses: Total of all losses in the chimney. Measured in inches water column.

Induced Draft Fan Requirements: Amount of assist required by a fan to properly vent chimney.

Local Barometric Pressure: Barometric pressure at installation site based on elevation.

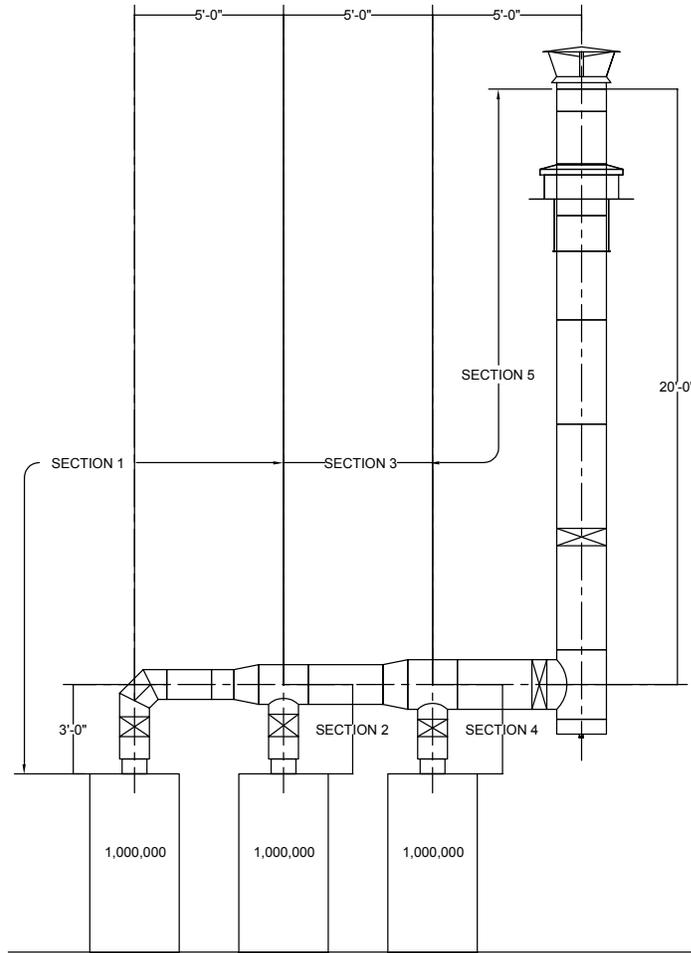
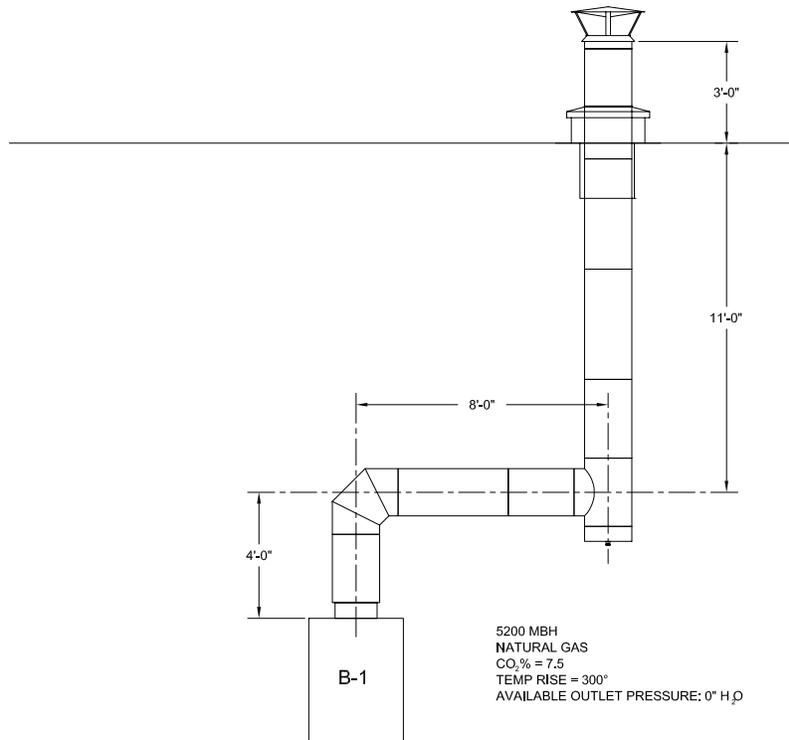


TABLE 1

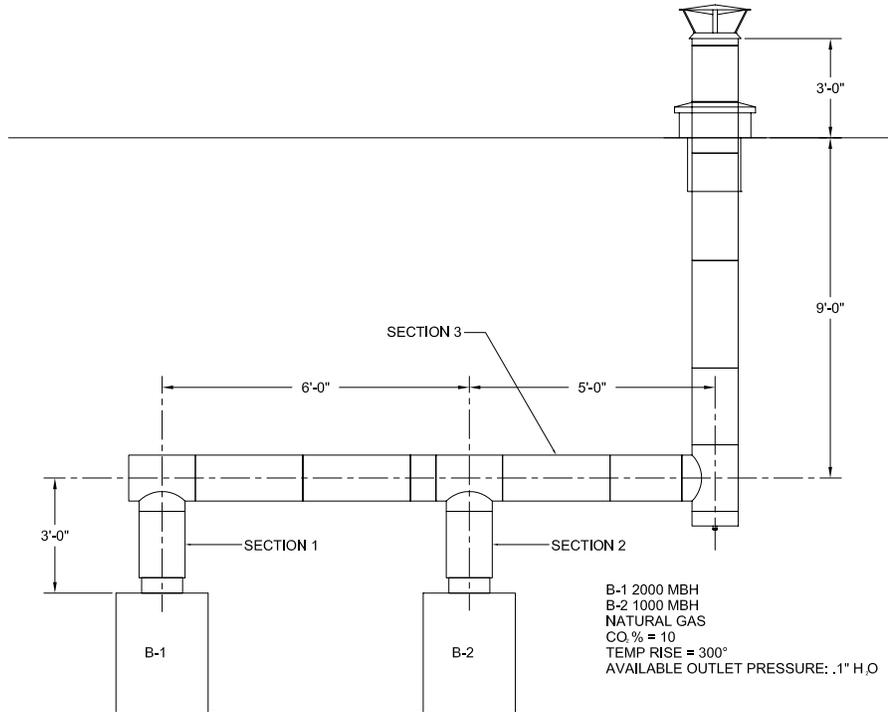
| SECTION | BTU'S | SYSTEM HEIGHT | TOTAL LENGTH | FITTINGS |
|-----------|-----------|---------------|--------------|-------------------------------------|
| SECTION 1 | 1,000,000 | 23'-0" | 38'-0" | 1 TEE, 1 CAP, 1 ELBOW, 2 INCREASERS |
| SECTION 2 | 1,000,000 | 23'-0" | 33'-0" | 2 TEES, 1 CAP, 1 INCREASER |
| SECTION 3 | 2,000,000 | 20'-0" | 30'-0" | 2 TEES, 1 CAP, 1 INCREASER |
| SECTION 4 | 1,000,000 | 23'-0" | 28'-0" | 2 TEES, 1 CAP |
| SECTION 5 | 3,000,000 | 20'-0" | 25'-0" | 2 TEES, 1 CAP |

EXAMPLE 1



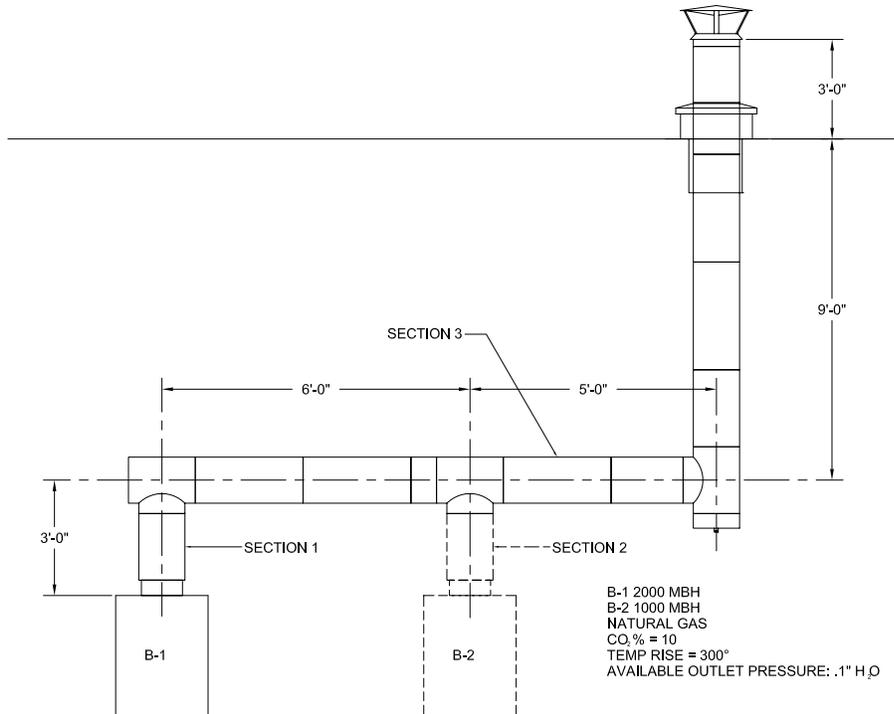
| Metal-Fab Sizing Program | | | |
|--|---|---------------------------------|--------|
| File Calculate Contact Options | | | |
| Customer: | Example 1 | | |
| Job Description: | From B - 1 to Termination | | |
| Fuel Type: | Natural Gas | 90 Tee: | 1 |
| BTU Input: | 5200000 | 90 Wye: | |
| Ambient Temperature: | 60 | 90 Elbow: | 1 |
| Flue Gas Temperature Rise: | 300 ? | 45 Tee: | |
| CO ₂ %: | 7.5 ? | 45 Elbow: | |
| Altitude: | 0 ? | 30 Elbow: | |
| System Vertical: | 18 | Tapered In increaser: | |
| System Horizontal: | 8 | Step In increaser: | |
| Std. Barometric Pressure: | 29.92 | Exit Cone: | |
| Available Outlet Draft: | 0 ? | Stack Cap: | 1 |
| Combined Vent: | <input type="checkbox"/> ? | Drain Section: | |
| Induced Draft: | <input type="radio"/> Yes <input checked="" type="radio"/> No | Lined Bellows: | |
| | | Draft Hood: | |
| | | Barometric Damper: | |
| | | Muffler: | |
| | | Pipe Diameter: | 20 |
| | | Computed Size: | 19.412 |
| | | System K: | 2.57 |
| | | Flue Gas Density: | .04834 |
| | | Theoretical Draft: | .097 |
| | | Delta P: | .097 |
| | | CO ₂ Percent: | 7.5 |
| | | Combustion Products Mass: | 1.12 |
| | | Flue Gas Volume Flow (CFM): | 2116 |
| | | Flue Gas Velocity: | 912 |
| | | Total System Pressure Losses: | .097 |
| | | Induced Draft Fan Requirements: | N/A |
| | | Local Barometric Pressure: | 29.92 |

EXAMPLE 2



SEE EXAMPLE BREAK DOWNS ON FOLLOWING PAGES

EXAMPLE 2 SECTION 1



Metal-Fab Sizing Program

File Calculate Contact Options

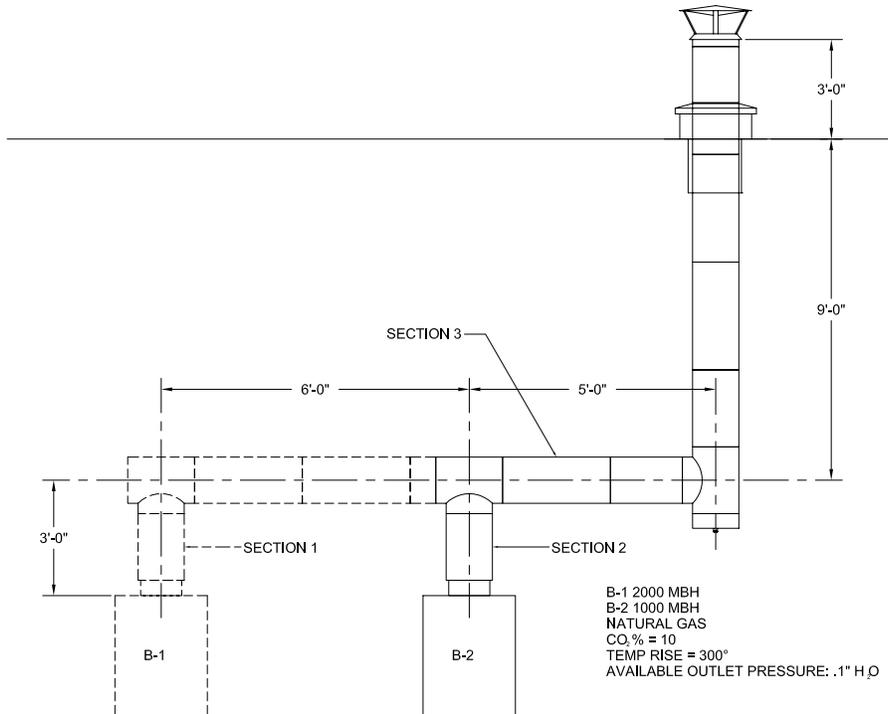
Customer: Example 2

Job Description: Connector Size for B - 1

| | | | | | |
|----------------------------|--|--------------------|---|---------------------------------|--------|
| Fuel Type: | Natural Gas | 90 Tee: | 2 | Pipe Diameter: | 12 |
| BTU Input: | 2000000 | 90 W/ye: | | Computed Size: | 10.322 |
| Ambient Temperature: | 60 | 90 Elbow: | | System K: | 4.317 |
| Flue Gas Temperature Rise: | 300 ? | 45 Tee: | | Flue Gas Density: | .04834 |
| CO ₂ %: | 10 ? | 45 Elbow: | | Theoretical Draft: | .081 |
| Altitude: | 0 ? | 30 Elbow: | | Delta P: | .181 |
| System Vertical: | 15 | Tapered Inserter: | | CO ₂ Percent: | 10 |
| System Horizontal: | 11 | Step Inserter: | 1 | Combustion Products Mass: | .868 |
| Std. Barometric Pressure: | 29.92 | Exit Cone: | | Flue Gas Volume Flow (CFM): | 803 |
| Available Outlet Draft: | .1 ? | Stack Cap: | 1 | Flue Gas Velocity: | 755 |
| Combined Vent: | <input type="checkbox"/> ? | Drain Section: | | Total System Pressure Losses: | .181 |
| Induced Draft: | <input checked="" type="radio"/> Yes <input checked="" type="radio"/> No | Lined Bellows: | | Induced Draft Fan Requirements: | N/A |
| | | Draft Hood: | | Local Barometric Pressure: | 29.92 |
| | | Barometric Damper: | | | |
| | | Muffler: | | | |

Example output from program

EXAMPLE 2 SECTION 2



Metal-Fab Sizing Program

File Calculate Contact Options

Customer: Example 2

Job Description: Connector Size for B - 2

Fuel Type: Natural Gas

BTU Input: 1000000

Ambient Temperature: 60

Flue Gas Temperature Rise: 300 ?

CO₂ %: 10 ?

Altitude: 0 ?

System Vertical: 15

System Horizontal: 5

Std. Barometric Pressure: 29.92

Available Outlet Draft: .1 ?

Combined Vent: ?

Induced Draft: Yes No

90 Tee: 2

90 Wye:

90 Elbow:

45 Tee:

45 Elbow:

30 Elbow:

Tapered Inserter:

Step Inserter: 1

Exit Cone:

Stack Cap: 1

Drain Section:

Lined Bellows:

Draft Hood:

Barometric Damper:

Muffler:

Pipe Diameter: 8

Computed Size: 7.355

System K: 4.45

Flue Gas Density: .04834

Theoretical Draft: .081

Delta P: .181

CO₂ Percent: 10

Combustion Products Mass: .868

Flue Gas Volume Flow (CFM): 351

Flue Gas Velocity: 849

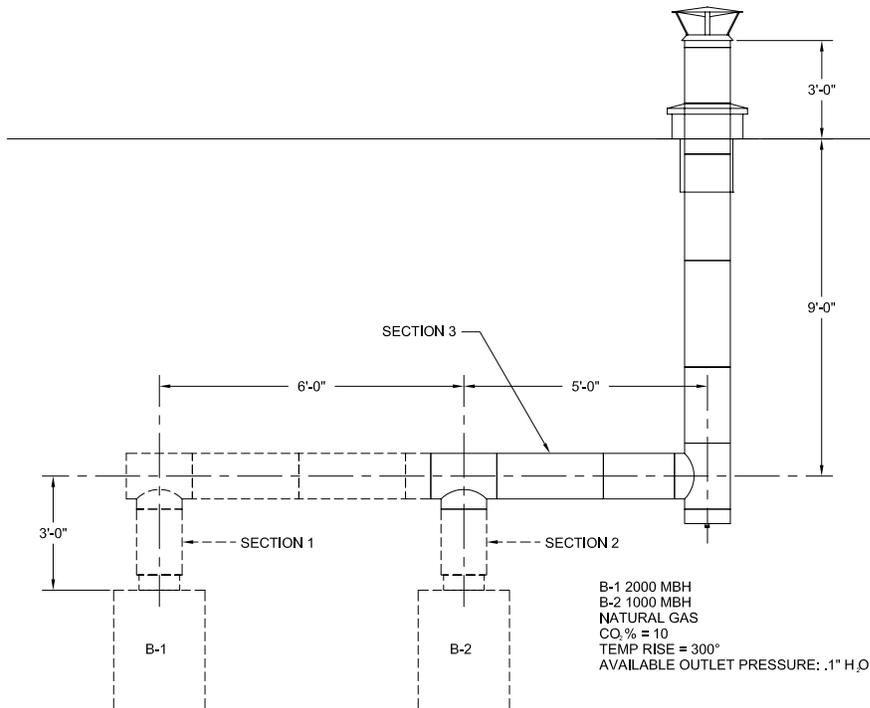
Total System Pressure Losses: .181

Induced Draft Fan Requirements: N/A

Local Barometric Pressure: 29.92

Example output from program

EXAMPLE 2 SECTION 3



Metal-Fab Sizing Program

File Calculate Contact Options

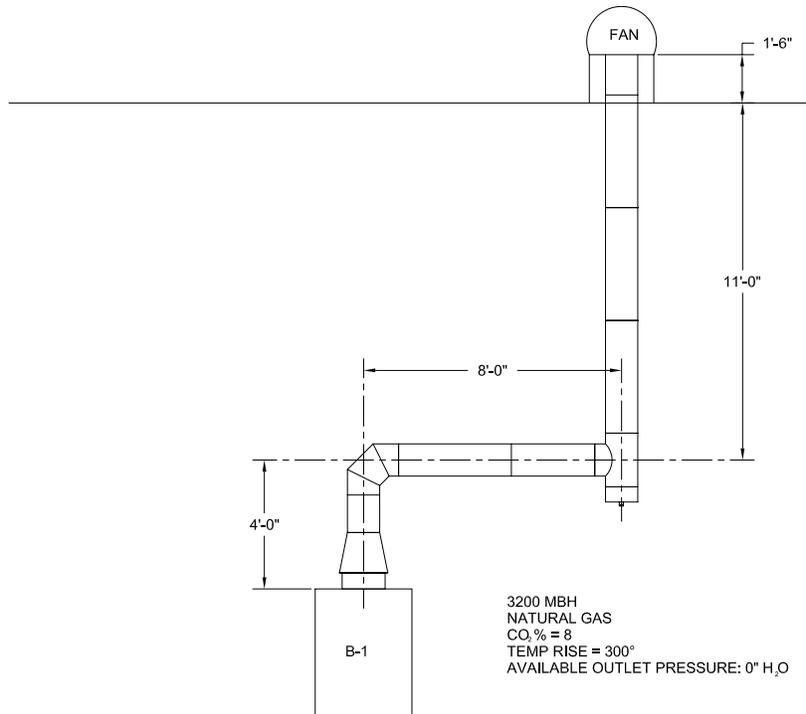
Customer: Example 2

Job Description: Common Breeching and Stack Size

| | | | | | |
|----------------------------|---|--------------------|---|---------------------------------|--------|
| Fuel Type: | Natural Gas | 90 Tee: | 2 | Pipe Diameter: | 14 |
| BTU Input: | 3000000 | 90 Wye: | | Computed Size: | 12.645 |
| Ambient Temperature: | 60 | 90 Elbow: | | System K: | 3.936 |
| Flue Gas Temperature Rise: | 300 ? | 45 Tee: | | Flue Gas Density: | .04834 |
| CO2 %: | 10 ? | 45 Elbow: | | Theoretical Draft: | .065 |
| Altitude: | 0 ? | 30 Elbow: | | Delta P: | .165 |
| System Vertical: | 12 | Tapered Inserter: | | CO2 Percent: | 10 |
| System Horizontal: | 5 | Step Inserter: | 1 | Combustion Products Mass: | .868 |
| Std. Barometric Pressure: | 29.92 | Exit Cone: | | Flue Gas Volume Flow (CFM): | 1092 |
| Available Outlet Draft: | .1 ? | Stack Cap: | 1 | Flue Gas Velocity: | 832 |
| Combined Vent: | <input type="checkbox"/> | Drain Section: | | Total System Pressure Losses: | .165 |
| Induced Draft: | <input type="radio"/> Yes <input checked="" type="radio"/> No | Lined Bellows: | | Induced Draft Fan Requirements: | N/A |
| | | Draft Hood: | | Local Barometric Pressure: | 29.92 |
| | | Barometric Damper: | | | |
| | | Muffler: | | | |

Example output from program

EXAMPLE 3



| Metal-Fab Sizing Program | | | |
|--------------------------------------|---|--|---------|
| File | Calculate | Contact | Options |
| Customer: | Example 3 | | |
| Job Description: | B-1 to Termination Fan | | |
| Fuel Type: | Natural Gas | 90 Tee: | 1 |
| BTU Input: | 3200000 | 90 Wye: | |
| Ambient Temperature: | 60 | 90 Elbow: | 1 |
| Flue Gas Temperature Rise: | 300 | 45 Tee: | |
| CO2 %: | 8 | 45 Elbow: | |
| Altitude: | 0 | 30 Elbow: | |
| System Vertical: | 16.5 | Tapered Increaser: | 1 |
| System Horizontal: | 8 | Step Increaser: | |
| Std. Barometric Pressure: | 29.92 | Exit Cone: | |
| Available Outlet Draft: | 0 | Stack Cap: | |
| Combined Vent: | <input type="checkbox"/> | Drain Section: | |
| Induced Draft: | <input checked="" type="radio"/> Yes <input type="radio"/> No | Lined Bellows: | |
| Diameter: | 12 | Draft Hood: | |
| | | Barometric Damper: | |
| | | Muffler: | |
| Pipe Diameter: | 12 | Computed Size: | 12 |
| System K: | 2.667 | Flue Gas Density: | .04834 |
| Theoretical Draft: | .089 | Delta P: | .236 |
| CO2 Percent: | 8 | Combustion Products Mass: | 1.057 |
| Flue Gas Volume Flow (CFM): | 1166 | Flue Gas Velocity: | 1485 |
| Total System Pressure Losses: | .236 | Induced Draft Fan Requirements: | .232 |
| Local Barometric Pressure: | 29.92 | | |

Example output from program

APPENDIX

TABLE 1
CONVERSION FACTORS (FOR CHIMNEY DESIGN PURPOSES)

| | |
|--------------|---|
| input BTU/HR | = boiler horsepower * 33,475 / (% efficiency/100) |
| | = BHP (75% efficiency) * 44,500 |
| | = BHP (80% efficiency) * 42,000 |
| | = gallons per hour oil (No. 1 or 2) * 140,000 |
| | = gallons per hour oil (No 4 or 6) * 150,000 |
| | = lbs. per hour coal (bituminous) * 13,000 |
| | = lbs. per hour coal (anthracite) * 15,000 |
| | = watt rating * 3,412 |
| | = MBH (thousand BTU per hour) * 1,000 |

TABLE 2
TYPICAL CHIMNEY AND VENT DESIGN CONDITIONS

| Fuel | Appliance | %CO ₂ | Temperature Rise Degrees Fahrenheit | M, per 1000 BTU Burned | SEA LEVEL | |
|-------------|-----------------------------|------------------|-------------------------------------|------------------------|-------------------|--|
| | | | | | Gas Density LB/CF | CFM per 1000 BTU/HR at Gas Temperature |
| Natural Gas | Draft Hood | 5.30 | 300° | 1.60 | 0.0483 | 0.522 |
| LP Gas | Draft Hood | 6.00 | 300° | 1.64 | 0.0483 | 0.566 |
| Natural Gas | No Draft Hood | 8.00 | 400° | 1.10 | 0.0431 | 0.425 |
| No. 2 Oil | Residential | 9.00 | 500° | 1.24 | 0.0389 | 0.531 |
| Oil | Forced Draft (Over 400 MBH) | 13.50 | 300° | 0.86 | 0.0483 | 1.297 |

TABLE 2a
MASS FLOW EQUATIONS FOR COMMON FUELS

| Fuel | M, Pounds Total Product /1000 BTU Burned |
|-------------------|--|
| Natural Gas | 0.72 (0.15 + 11.0 / % CO ₂) |
| LP Gas | 0.72 (0.15 + 12.8 / % CO ₂) |
| No. 2 Oil (Light) | 0.72 (0.15 + 14.4 / % CO ₂) |
| No. 6 Oil (Heavy) | 0.72 (0.12 + 15.8 / % CO ₂) |
| Bituminous Coal | 0.76 (0.11 + 18.2 / % CO ₂) |

% CO₂ is determined in products with water condensed (dry basis)

APPENDIX

TABLE 3
TYPICAL CHIMNEY AND VENT DESIGN CONDITIONS

| Gas Temp. Rise ° F. | Dt INWC | Gas Temp. Rise ° F. | Dt INWC | Gas Temp. Rise ° F. | Dt INWC |
|------------------------|------------|------------------------|------------|------------------------|------------|
| 50° | 0.129 | 600° | 0.787 | 1300° | 1.050 |
| 100° | 0.237 | 650° | 0.816 | 1400° | 1.071 |
| 150° | 0.329 | 700° | 0.843 | 1500° | 1.091 |
| 200° | 0.408 | 750° | 0.868 | 1600° | 1.109 |
| 250° | 0.477 | 800° | 0.891 | 1700° | 1.140 |
| 300° | 0.537 | 850° | 0.912 | 1800° | 1.154 |
| 350° | 0.591 | 900° | 0.931 | 2000° | 1.166 |
| 400° | 0.639 | 950° | 0.950 | 2200° | 1.188 |
| 450° | 0.682 | 1000° | 0.967 | 2400° | 1.207 |
| 500° | 0.720 | 1100° | 0.998 | 2600° | 1.224 |
| 550° | 0.755 | 1200° | 1.025 | 2800° | 1.239 |

Chimney gas density same as that of air .
Sea level barometric pressure (29.92 in Hg)
Draft is relative to ambient air at 60° F or 520° R.

TABLE 4
ALTITUDE CORRECTION

| Altitude, ft. | Factor | B, in Hg |
|---------------|--------|----------|
| Sea Level | 1.00 | 29.92 |
| 2,000 | 1.08 | 27.80 |
| 4,000 | 1.16 | 25.80 |
| 6,000 | 1.25 | 24.00 |
| 8,000 | 1.34 | 22.30 |
| 10,000 | 1.45 | 20.60 |

Multiply operating input by factor to obtain design input
m = ft * 0.3048

TABLE 5
RESISTANCE LOSS COEFFICIENTS

| | |
|---|---------|
| Piping (Including Pipe, Expansion Joint, Variable Length, Single Wall Boiler Adapter, Flange Adapter, and Flip Top) | 0.40L/D |
| 90° Tee | 1.25 |
| 45° Tee | 0.40 |
| 30° Elbow | 0.12 |
| 45° Elbow | 0.15 |
| 90° Elbow | 0.30 |
| 90° Wye | 0.60 |
| Exit Cone | 1.25 |
| Stack Cap | 0.50 |
| Drain Section | 0.25 |
| Lined Bellows | 0.08 |
| Nozzle Section | 0.25 |
| Duct Drain | 0.25 |

| | |
|----------------------------|--|
| Step In increaser | $\frac{[1 - (\frac{\text{small diameter}}{\text{large diameter}})^2]^2}{(\frac{\text{small diameter}}{\text{large diameter}})^4}$ |
| Tapered In increaser | $\frac{.51[1 - (\frac{\text{small diameter}}{\text{large diameter}})^2]^2}{(\frac{\text{small diameter}}{\text{large diameter}})^4}$ |



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