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Revision Memo

12/04	Minor updates to include recent furnace burner technology, recent furnace noise control methods, and other editorial updates.
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1 SCOPE / BACKGROUND

This is a section to [DP XVIII-C](#), *Guidelines and Considerations for Noise Control Design Practice*, and its purpose is to provide the basic understanding and methods required to calculate the noise levels radiated by natural-draft fired heaters and process flares. The calculation methods do not include forced-draft fired heater noise levels because this type of fired heater typically will not be either a workplace or community noise problem if precautions are taken during its design and construction.

Specific information is presented which describes the noise abatement measures and techniques that are available to affiliates when either implementing corrective actions or installing new or replacement natural-draft fired heaters, forced-draft fired heaters, and process flares. Fired heater acoustic plenums and special flare tip designs are the primary devices for controlling combustion noise. Sufficient details are provided to enable the fired heater/flare designer to completely review and evaluate proposed contractor designs and manufacturer equipment performances to ensure adequate controls to meet community and workplace noise criteria. To illustrate the calculation methods described in this Design Practice, a sample problem is presented for both natural-draft fired heaters and flares.

2 REFERENCES

2.1 DESIGN PRACTICES

- [DP XVIII-C](#) Guidelines and Considerations for Noise Control
- [DP VIII-F](#) Fired Heaters - Burners
- [DP VIII-G](#) Furnaces - Forced-Draft Systems
- [DP XV-E](#) Flares

2.2 OTHER LITERATURE

- Wang, J. S., *Benicia Refinery Flare Rumbling Abatement*, 89 ECSI 115, 1989.
- Stephan, R. K., *BOP Flare Noise Generation & Abatement Action Plan Update*, Notegram to D. M. Mitchell and D. E. Walker, October 24, 1994.
- Stephan, R. K., *BOP Flare Noise Survey Results & Recommendations*, Notegram, R. K. Stephan and D. E. Walker, November 7, 1994.
- Rice, S. C., *Noise Prediction for Elevated Flares*, ER&E Report No. EE.27E.76, February, 1976.

3 DEFINITIONS

Basic Acoustical Terms

See [DP XVIII-C](#), *Guidelines and Considerations for Noise Control Design Practice, Definitions*.

Fired Heater Terms

See [DP VIII-F](#), *Fired Heaters - Burners*.

Reverberation

Reverberation occurs when there are multiple reflections of sound waves within an enclosed space. The summation of the reflected waves results in a higher noise level compared to the situation where the same noise source is located in an open space. The area under a fired heater or between two adjacent side fired heaters is a reverberant space.

Toewall

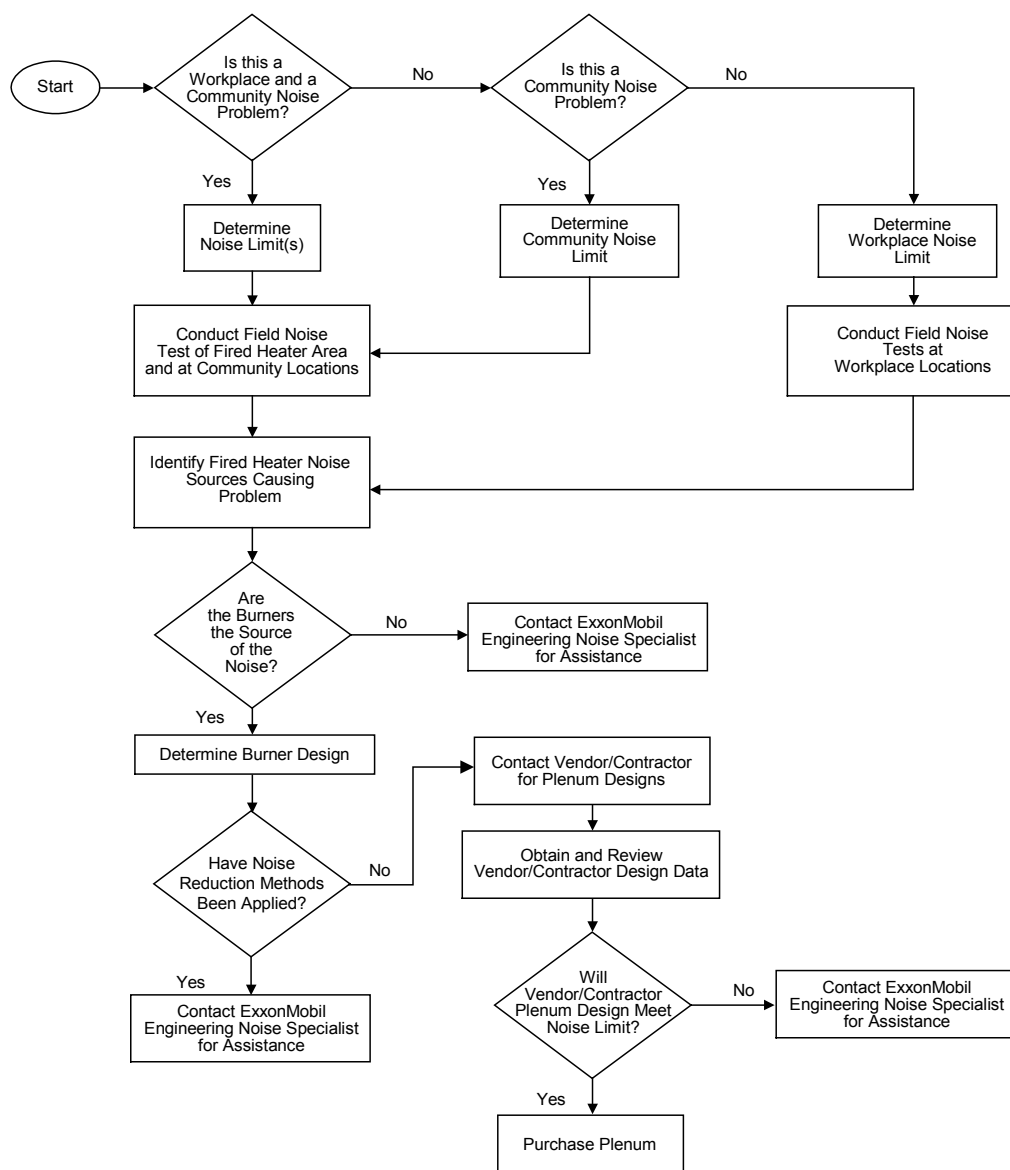
The toewall is the raised curb that is constructed around a fired heater at a distance of about three-ft, or more, from the fired heater walls.

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4 DECISION TREES FOR FIRED HEATER AND FLARE NOISE CONTROL

To provide guidance to design engineers, decision trees for controlling the noise from fired heaters and flares are shown in this section. Though the decision trees contain specific suggestions appropriate for fired heater and flare noise control, they are consistent with the approaches introduced in [DP XVIII-C](#). For implementing corrective actions to existing facilities, see [Figure 1](#) for fired heater noise problems and [Figure 2](#) for flares. For purchasing new or replacement equipment, see [Figure 3](#) (fired heaters) and [Figure 4](#) (flares). For those situations that may not fit into these scenarios, such as major capital project equipment, contact the ExxonMobil Engineering noise control specialists for assistance.

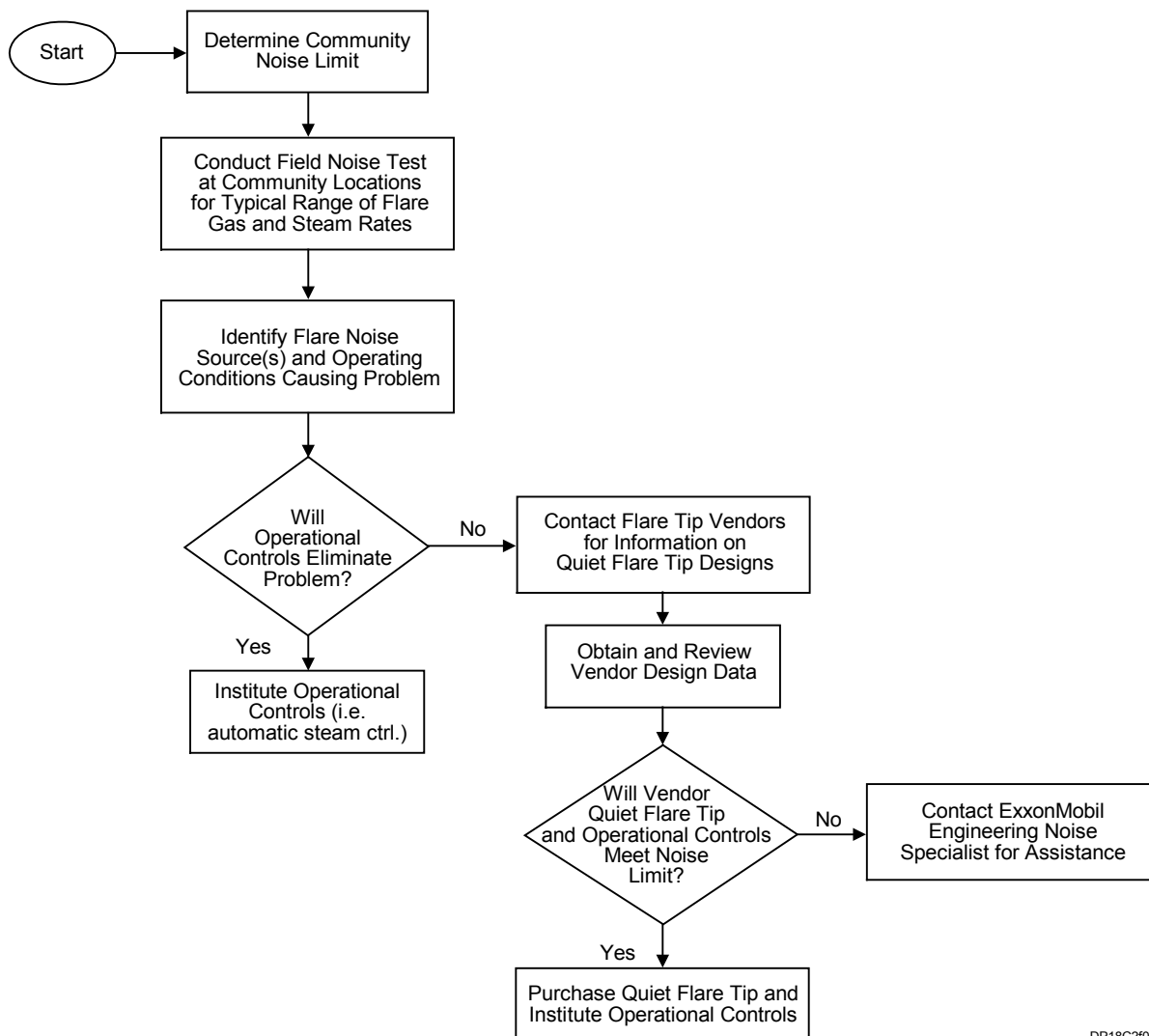
Figure 1
Decision Tree for Noise Problem with an Existing Fired Heater



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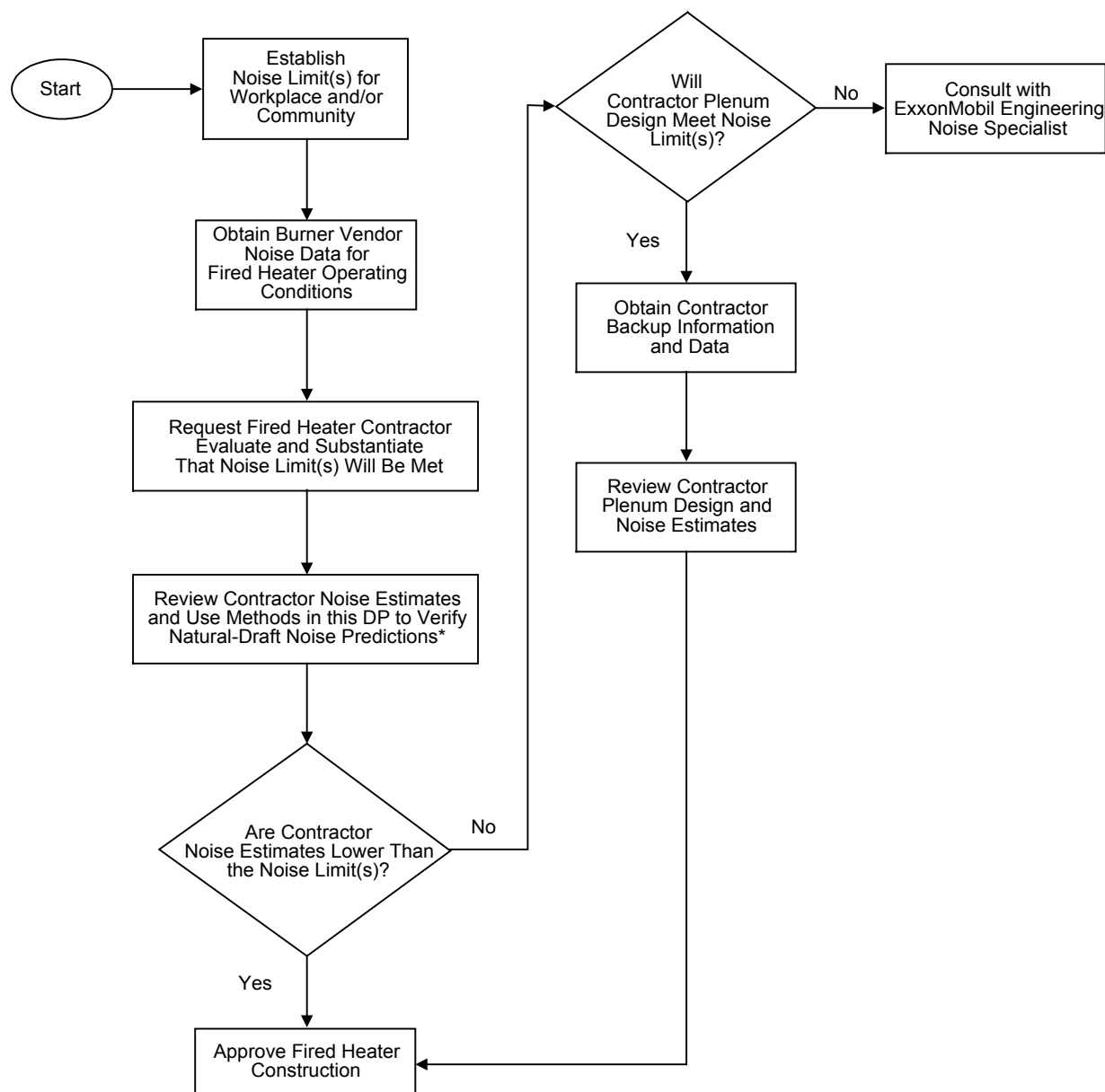
Figure 2
Decision Tree for Noise Problem with an Existing Flare



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Figure 3
Decision Tree for Noise Control of New or Replacement Fired Heaters



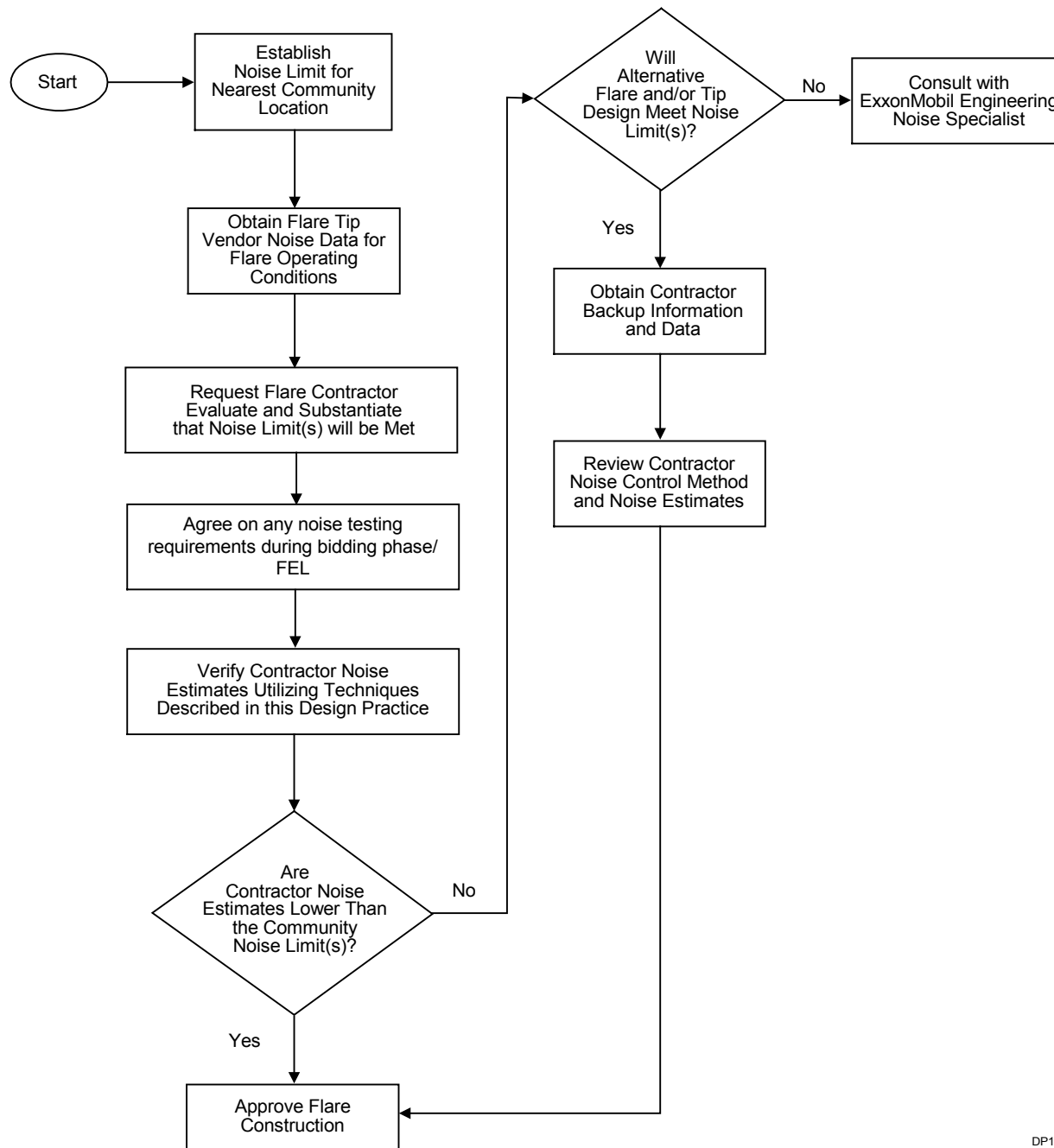
***Notes:**

- (1) Forced-draft fired heaters normally do not present a noise problem. If Contractor forced-draft fired heater noise estimates exceed criteria, then contact an ExxonMobil Engineering Noise Specialist for assistance.

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Figure 4
Decision Tree for Noise Control of New or Replacement Flares



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5 NOISE CRITERIA

Two general types of noise level criteria are usually applicable to process units: workplace noise limits to prevent worker hearing damage (e.g. occupational safety), and community noise limits to prevent annoyance in adjacent communities (e.g. local environmental regulations/laws). Achieving compliance with both of these criteria can be a challenge with natural-draft fired heaters. If proper precautions are taken during the design and construction of forced-draft fired heaters, they typically will not be either a workplace or community noise problem. In addition, flares do not typically pose a workplace noise problem, but due to varying steam and flare gas flow rates, they can be a significant, intermittent community noise contributor.

- Typically, maximum allowable workplace and community sound pressure level criteria are specified in overall A-weighted values (dBA). The location for the workplace criteria for a furnace is the unit's toewall and the maximum acceptable level for new or modified furnaces is 85 dBA. Normally, the most stringent community location is the community boundary closest to the furnace or flare unit. Due to the variation in local community noise criteria and the difficulty in evaluating the noise impact of new or modified equipment, many plants have found it useful to conduct a community noise impact assessment. For assistance in conducting a noise impact assessment survey, contact an ExxonMobil Engineering Noise Specialist.

For further discussion and details on general community and workplace noise criterion, please refer to [DP XVIII-C, Noise Control Guidelines / Considerations](#), **PLANT NOISE CRITERIA**.

6 FIRED HEATER NOISE

6.1 GENERAL CHARACTERISTICS

Fired heater noise levels vary in intensity and frequency distribution with the type of burner, operating conditions (i.e. pressure drop), and fuel characteristics. All burners exhibit low frequency noise which results from the actual combustion process. As a general rule, fired heater noise levels are known to increase with increasing firing rate and fuel pressure, and decreasing fuel gas molecular weight.

The types of natural-draft burners used in present process fired heater applications include pre-mix burners, raw gas burners, combination gas/oil burners, oil burners, low NOx burners, ultra low NOx burners, and next generation burners. In addition to the combustion noise, natural-draft burners also exhibit some high frequency noise. With pre-mix burners, the high frequency noise component is generated at the fuel gas spud and its level is very significant. In raw gas and combination gas/oil burners, high frequency noise is generated at the burner tip. This noise is associated with the high velocity discharge at the fuel jet of the spud or burner tip. The standard noise control treatment for the natural-draft fired heater burners is to enclose the air registers in an acoustic air inlet plenum/muffler design.

Forced-draft fired heaters generally have much lower emitted noise levels than natural-draft heaters because of their enclosed combustion air-burner system which impedes noise radiation to the outside. The workplace noise levels attributable to forced-draft fired heaters are controlled by limiting the transmission of acoustic energy from the fan, its associated ducting, and from the windbox. Normally, the community noise contribution originates from the burners and the furnace walls.

6.2 FORCED-DRAFT BURNER AND FIRED HEATER NOISE

In the firebox of a fired heater, forced-draft burners generate higher noise levels than natural-draft burners because they produce more intense flames. However, forced-draft fired heater noise sources usually will not pose a workplace or community compliance problem if the noise control features described in [DP VIII-G](#) and in this Design Practice are included in the fired heater design. Hence, forced-draft fired heater noise calculation techniques are not included in this Design Practice. If contractor estimates of the radiated forced-draft fired heater noise levels exceed the criteria, then contact an ExxonMobil Engineering Noise Specialist for assistance.

6.3 NATURAL-DRAFT BURNER SOUND POWER LEVEL (PWL) ESTIMATES

Estimates of natural-draft fired heater noise levels are dependent on the sound power levels (L_w) generated by the individual burners and the physical configuration of the fired heater. The total generated sound power levels of natural-draft burners are a function of the burner type, number of burners, operating conditions, and fuel characteristics. Typically, the sound power levels of a single burner can and should be provided by the burner vendor during the fired heater design phase. The burner sound power level data provided by the vendor can be used for either floor fired or wall fired burner noise estimates. They represent the natural-draft burner sound power levels emitted outside of the firebox.

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- ♦ The table shown below lists typical vendor-reported single burner sound power levels emitted outside the box for several natural-draft burner styles with given fuel rates. The octave band sound power levels are the estimated values emitted from either a floor fired or wall fired natural-draft burner. In a few of the cases, data are shown for single burners installed in integral plenums with inlet mufflers (designated by an *). The data are presented as examples of the type of sound power level information available from the vendors. It is not meant to provide an indication of relative acoustic performance between burners nor is the data meant to be a complete listing of available burner noise information. In addition, the data should not be arbitrarily applied to any existing or proposed fired heater design without verification from the appropriate manufacturer.

**TYPICAL VENDOR REPORTED SOUND POWER LEVELS (L_w)
FOR A SINGLE NATURAL-DRAFT BURNER**

MANUFACTURER (Process Design)	BURNER TYPE	FUEL	RATE	OCTAVE BAND CENTER FREQUENCY, Hz							
			MMBtu/hr	63	125	250	500	1000	2000	4000	8000
Callidus Tech Inc. (Low Emission, i.e. Ultra Low NOx) (Conventional)	LE-CSG-6W*	Gas - 0% H ₂	6.0	60	72	80	89	81	80	73	62
	LE-CSG-6W*	Gas - 50% H ₂	6.0	60	72	82	94.5	87	85	79	68
	LE-CSG-8W*	Gas - 50% H ₂	8.0	61	73	83	95.5	88	86	80	69
	CRGC-10W*	Gas - 0% H ₂	20.0	69	81	90	98	90	90	83	72
	CRGC-10W*	Gas - 50% H ₂	20.0	79	81	92	104	96	95	89	78
	CRGC-10W*	Oil	20.0	70	82	93	105	97	96	90	79
John Zink Co. (Conventional) (Conventional) (Low NOx)	MA	Oil	5.0	88	100	101	103	99	94	94	95
	MA	Oil	10.0	91	103	104	106	101	97	97	98
	MA	Gas	10.0	91	102	104	106	101	93	92	96
	PMA*	Gas	10.0	87	89	90	87	78	75	76	81
	PSMR*	InfurNO _x Gas	10.0	85	87	86	78	75	74	74	76
	SFG	Fuel Gas	3.0	86	98	103	100	98	93	94	93
	SFG	Fuel Gas	9.0	91	103	109	106	103	98	99	98

Note: Burners installed in integral plenums and/or inlet mufflers are signified with (*).

Based on typical fuel gas design pressure of 25 psig.

Next Generation burner designs are available with vendor noise estimates, however they are not presented in the table above

In those cases when a vendor cannot provide the natural-draft burner sound power levels, then an ExxonMobil Engineering noise specialist should be consulted.

Once the burner sound power levels (L_w) and fired heater configuration are defined, the contractor will estimate the fired heater sound pressure level (L_p) at various criteria locations and compare the results with the criteria levels. Then, as required, the contractor will develop noise control treatments to meet the specified noise criteria.

To assist the design engineer in evaluating the contractor sound pressure level predictions, the following sections describe noise radiation estimate techniques and typical fired heater noise control treatments.

Note that furnace casing noise is not typically considered a major noise contributor for furnace units. However, with very low noise burner constructions, casing noise may require evaluation for certain criteria locations. If this additional evaluation is required, then contact an ExxonMobil Noise specialist.