

Process Boiler Hybrid Measure



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Equation - Basic Savings

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- Annual unit energy savings (**UES**):

$$UES = UEC_{base} - UEC_{meas}$$

UEC_{base} = Annual unit energy consumption – gas, baseline (therm/yr)

UEC_{meas} = Annual unit energy consumption – gas, measure case (therm/yr)

- Annual unit energy consumption – measure case (**UEC_{meas}**)

$$UEC_{meas} = UEC_{base} * \left(\frac{eff_{base}}{eff_{meas}} \right)$$

UEC_{base} = Annual unit energy consumption – gas, baseline (therm/yr)

Eff_{meas} = Measure case boiler's efficiency (%)

Eff_{base} = Base case boiler's efficiency (%)

Equation – Baseline Consumption

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- Annual unit energy consumption – baseline (UEC_{base})

$$UEC_{base} = \frac{Rated\ Load * LF * opHr}{CFac}$$

- Rated Load = Boiler's rated capacity/input (BTU/hr)
- LF = Load Factor (%)
- opHr = Annual hours of operation (8,760 hrs/yr)
- Cfac = Conversion factor (1 therm / 100,000 BTU)

Equation – Load Factor

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- Only One Load:

$$LF = \frac{\text{Actual UEC}}{\text{Max UEC}}$$

- Actual UEC = Meter gas consumption during a designated period
- Max UEC = Full load based upon boiler capacity

- Multiple Loads SCG Load Balance Tool:

□ Multiple gas equipment connect to 1 common gas meter.

✦ Want to find the individual UEC.

□ Problem: $\sum_{i=Equip}^{N} UEC_i \neq UEC_{meter}$

□ Solution: Apply a calibration factor to each LF

$$\text{Calibration Factor} = \frac{CFac * Q_m}{\sum_{i=1}^N \text{Rated Load}_i * LF_i * opHr_i} \rightarrow LF_{adj} = SF * LF$$

ased on your selections, the following gas consumption data will be used:

| | |
|---------------------|--------------------------------|
| Gas Use (therms/yr) | 84,000 |
| Source | Actual monthly billing records |

| | | | | |
|--------------------------|--------|--------|--------|--------|
| Total Therms | 38,400 | 81,000 | 87,000 | 45,600 |
| Avg. Gas Use (therms/yr) | 76,800 | 81,000 | 87,000 | 91,200 |
| | 84,000 | | | |

Values left blank are excluded.

Qm = Average annual total gas UEC at meter

3. Gas Equipment Hide Instructions

In this section, prepare a list of the customer's gas equipment associated with the billing account ID number.

- To **add** a gas system, use the Data Entry Worksheet below. Select the Equipment Type and Equipment Use from the dropdown menus, and enter the Quantity and Connected Load (values in blue indicate user entry fields). Click the Add Equipment button, and the entry will be added to the Gas Equipment Table that is displayed immediately below the Data Entry Worksheet.
- To **edit** an entry in the Gas Equipment Table, you can make changes directly to the entries in the Gas Equipment Table, or delete the entry and re-enter the desired data. Note that in the Gas Equipment Table, the Operating Time and Load Factor values can be modified if desired (default values loaded initially).
- To **delete** a single equipment entry, highlight the desired row in the Gas Equipment table, and then click the Delete Selected button. To clear all of the equipment entries, click the Delete All Equipment button.
- Repeat Steps 1 through 3 until the Gas Equipment table contains a complete list of all gas equipment associated with the billing account ID number.

Data Entry Worksheet

| Description | Equipment Type | Equipment Use | Qty | Connected Load (MBtu/hr) |
|-------------|----------------|----------------------|-----|--------------------------|
| Enter Name | INCINERATOR | INCIN OF SOLID WASTE | 1 | 1,000 |

Add Equipment Delete Selected Delete All Equipment

Gas Equipment Table

| Description | Equipment Type | Equipment Use | Qty | Connected Load (MBtu/hr) | Operating Time | | | Load Factor | Annual Gas Use (therms/yr) | Default Op Time (hours/yr) | Default Load Factor |
|-------------|----------------|----------------------|-----|--------------------------|----------------|-------------|------------|-------------|----------------------------|----------------------------|---------------------|
| | | | | | (hrs / day) | (days / wk) | (wks / yr) | | | | |
| -1, B-2 | BOILER | HEATING HUMAN COM. | 2 | 1,000 | 10 | 7 | 52 | 0.16 | 11,680 | 3,650 | 0.16 |
| -1 | FURNACE | HEAT TREATING | 1 | 2,000 | 10 | 5 | 46 | 0.20 | 7,160 | 2,306 | 0.20 |
| -2 | FURNACE | HEAT TREATING | 1 | 3,000 | 10 | 5 | 46 | 0.20 | 13,838 | 2,306 | 0.20 |
| O-1 | INCINERATOR | INCIN OF HYDROCARBON | 1 | 4,000 | 12 | 7 | 46 | 0.20 | 30,997 | 3,875 | 0.20 |
| O-2 | INCINERATOR | INCIN OF HYDROCARBON | 1 | 5,000 | 12 | 7 | 46 | 0.20 | 38,746 | 3,875 | 0.20 |
| 104,486 | | | | | | | | | | | |

Load Factors requested from the applicant

4. Load Balance Hide Instructions

In the Gas Equipment Table above, the annual gas use is totaled based on the usage data entered for each individual gas system. This total will frequently differ from the historical or estimated gas use determine for the billing account. To reconcile the gas use, an adjustment to the equipment load factors may be necessary. To make this adjustment, follow these steps:

- For each entry in the Load Adjustment Table shown below, enter yes or no in the Auto Adjust column. In general, entries should be marked yes (Y). However, in some cases -- for example, a standby boiler or engine gen set -- the user may desire to set a pre-determined load factor that does not change. In these cases, enter no (N) in the Auto Adjust column.
- Click the Auto Adjust button below, and the equipment load factors marked yes will be scaled such that the sum of the gas use for all equipment matches the gas consumption shown at the bottom of the Gas Use section (Section 2).
- Deviations from the default operating times and the default load factors are tracked. The criteria for the deviations is set at +/- 10.0%. If deviations beyond the criteria occur, the data values will be colored (follow the color coded arrows to identify the values being compared).

Load Adjustment Table

| Description | Equipment Type | Equipment Use | Qty | Connected Load (MBtu/hr) | Op Time (hrs/yr) | Load Factor | Auto Adjust (Y/N) | Adjusted Load Factor | Adjusted Gas Use (therms/yr) | Default Op Time (hours/yr) | Default Load Factor |
|-------------|----------------|----------------------|-----|--------------------------|------------------|-------------|-------------------|----------------------|------------------------------|----------------------------|---------------------|
| | | | | | | | | | | | |
| -1 | FURNACE | HEAT TREATING | 1 | 2,000 | 2,306 | 0.20 | Y | 0.156 | 7,160 | 2,306 | 0.200 |
| -2 | FURNACE | HEAT TREATING | 1 | 3,000 | 2,306 | 0.20 | Y | 0.156 | 13,783 | 2,306 | 0.200 |
| O-1 | INCINERATOR | INCIN OF HYDROCARBON | 1 | 4,000 | 3,875 | 0.20 | Y | 0.156 | 24,155 | 3,875 | 0.200 |
| O-2 | INCINERATOR | INCIN OF HYDROCARBON | 1 | 5,000 | 3,875 | 0.20 | Y | 0.156 | 30,193 | 3,875 | 0.200 |
| 84,000 | | | | | | | | | | | |

Auto Adjust

Rows = Y when uncertainty exists; then the calibration factor is applied

Calculation Inputs - Deemed

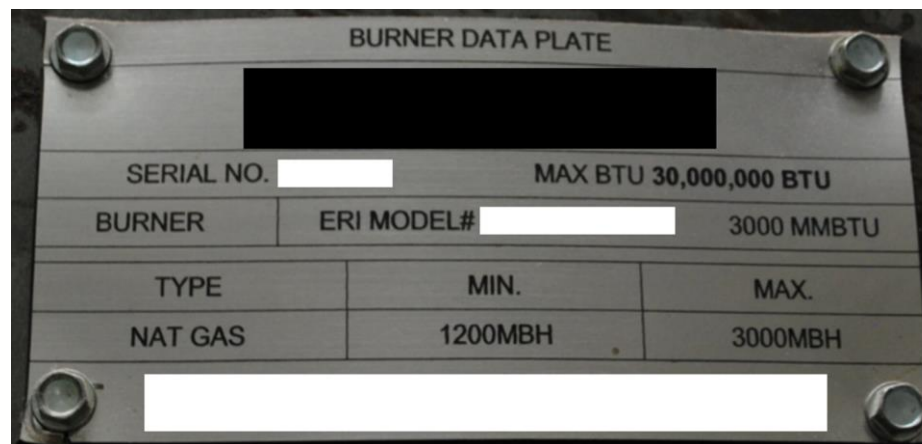
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| Input | Value | Source |
|--|--|---|
| Base case efficiency (%) for NR baseline | 82% CE for Hot Water 80% CE for Steam | California Energy Commission (CEC). 2015. <i>2015 Appliance Efficiency Regulations</i> . CEC 400-2015-021. July. U.S. Department of Energy (DOE), Energy Efficiency & Renewable Energy, Advanced Manufacturing Office. 2012. "Energy Tips: STEAM." DOE/GO-102012-3405. |

Calculation Inputs – Site Specific

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| Input | Value | Source |
|---|--------|--|
| Boiler's rated capacity (Btu/hr) | Varies | Boiler's nameplate Manufacturer spec sheet |
| Base case efficiency (%) for AR base line | Varies | Nameplate Manufacturer spec sheet Flue gas analysis |
| Measure case efficiency (%) | Varies | Nameplate Manufacturer spec sheet <i>Flue gas analysis</i> |
| Load factor (ratio) | Varies | Use "Load Factor Tool" |



Back-up

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