



# Process Heating Assessment User Manual

Created By: Oak Ridge National Laboratory

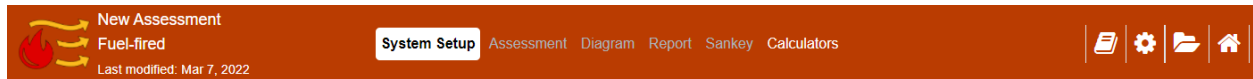
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## Module Navigation

Use the top banner to navigate around the module. A footer bar with “Next” and “Back” button can also be used to move through the System Setup to the Report.



### Main Tabs

System Setup – Establish your baseline by entering the existing data for your process heating system.

Assessment – Modify system scenarios to find potential savings opportunities.

Diagram – Graphical visualization of the existing process heating system and the savings scenarios explored.

Report – Full printable breakdown of the system and potential saving scenarios.

Sankey – Visual representation of the energy consumption and production of the scenarios.

Calculators – Stand alone calculators for process heating properties.

\*Some of the tabs will be disabled until the System Setup is completed.

### Additional Buttons

Book – The book will open a new window with the Process Heating User Manual you are reading.

Gear – The gear wheel will navigate you to MEASUR’s global settings page.

Folder – The folder will navigate you to the assessment dashboard folder this assessment is in..

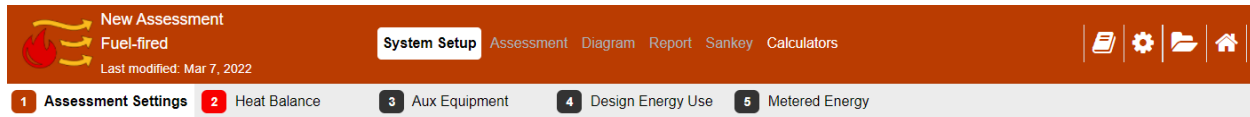
Home – The house will bring you to MEASUR’s home page.

## System Setup

The system setup is where you enter the baseline data for your process heating system. The system setup is broken up into five tabs, each with a related set of input fields to be filled out. Field by field help text is provided for each input field, it will appear in the help panel when an input field is clicked on.

### Navigation

Use the second bar to navigate to different sections of the Setup. The tabs will be color coded to indicate the state of the corresponding tab data. Tabs will be disabled in the previous steps have errors in their data.



Assessment Settings – Select the units for the assessment.

Heat Balance – Data entry relating to heating losses.

Aux Equipment – Data entry relating to Auxiliary Equipment.

Design Energy Use – Design specifications used for comparisons.

Metered Energy - Actual performance data used for comparisons.

Tab colors:

- Green - Valid data entered for tab.
- Red – Invalid or missing data entered for tab.
- Yellow – Data entered outside of expected range.
- Gray – Disabled tab, previous tab's are incomplete.

## Assessment Settings

Use the “Assessment Settings” tab to set the units of measure you would like to use throughout the assessment. Select the energy source type for your system here as well, this will drive the rest of your assessment.

1 **Assessment Settings** 2 Heat Balance 3 Aux Equipment 4 Design Energy Use 5 Metered Energy

PROCESS HEATING - FUEL EXAMPLE SETTINGS

Language [Translate Application Using Google Translate](#)

Currency \$

Units of Measure ☒ Imperial ☐ Metric

Energy Result Unit Millions British Thermal Units (MMBtu)

Select Energy Source Type ☒ **Fuel-fired** ☐ Electrotechnology ☐ Steam-based

Common Result Unit Millions British Thermal Units (MMBtu)

Common Fuel Unit Millions British Thermal Units (MMBtu)

Common Electricity Unit Kilowatt-hours (kWh)

Common Steam Unit Millions British Thermal Units (MMBtu)

Equipment Notes

Add additional information for your equipment

Operating Conditions at time of Assessment

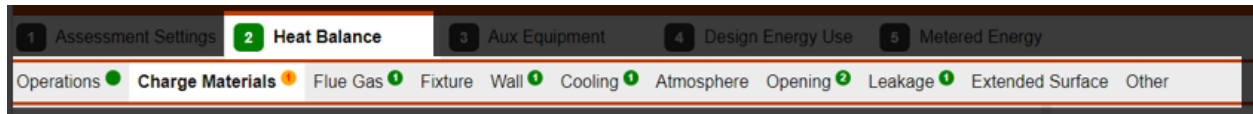
The furnace was running at the full load capacity during the PH assessment.

The **Heat Balance** is different for “Fuel-fired”, “Electrotechnology” or “Steam-based” Process Heaters. Once you move on to the **Heat Balance**, this CANNOT be changed without deleting your losses.

Notes added to this page will be added to the report for this assessment.

## Heat Balance

Heat balance.... Yada yada **KRISTINA PLEASE FILL OUT THIS QUICK DESCRIPTION OF HEAT BALANCE**



A third set of tabs will appear for heat balance. Each tab corresponds to a loss calculator that are used to add different losses corresponding to your process heating system.

The badges will indicate how many losses are entered for each calculator type. They will be three different colors.

- Green: Valid loss data entered
- Red: Invalid loss data entered, needs to be fixed
- Orange: Data entered is outside of an expected range

## Data Entry

The screenshots below show how to enter data for the Heat Balance.

BASELINE		+Add Charge Material
Material #1	✕	
Select Type	Solid	
Name of Material	Aluminum	
<a href="#">Add New Solid Material</a>		
Average Specific Heat of Solid	2.038	kJ/(kg-°C)
Latent Heat of Fusion	393.094	kJ/kg
Average Specific Heat of Molten Material	1.089	kJ/(kg-°C)
Melting Point	657.2222	°C
Charge Feed Rate (Wet)	40000	kg/hr
Charge Inlet Temperature	60	°C
Charge Outlet Temperature	3000	°C
The Charge Outlet Temperature is higher than the melting point, please enter proper percentage for charge melted.		
Water Content (Charged)	0	%
Water Content (Discharged)	0	%
Water Vapor Discharge Temperature	0	°C
Charge Melted	0	%
The Charge Outlet Temperature is higher than the melting point, please enter proper percentage for charge melted.		
Charge Reacted	0	%
Heat of Reaction	0	kJ/kg
Type of Reaction (Exothermic/Endothermic)	Endothermic	
Additional Heat Required	0	kJ/hr
Material #1 Heat Required		227.162 MMBtu/hr
Material #1 Reaction Heat		--
Material #1 Total Heat Required		227.162 MMBtu/hr

The left hand panel will be used for data entry of the losses.

Use the “+Add” buttons on the top right of the panel to add losses of the given type.

For many losses, a database of known substances can be selected from to fill out portions of the loss.

If those values are changed from the value in the database then the field is highlighted green.

Blue links under input labels can be used to calculate the input values or add new materials to the database for use later.

Yellow highlighting will appear around input fields with warning messages when data values are outside of an expected range.

Red errors will appear when data is outside of an accepted range.

The total value of each loss is shown underneath the corresponding calculator fields.

RESULTS	HELP
<b>Energy Loss/Use</b>	<b>Baseline</b>
	<b>MMBtu/hr</b>
Charge Materials	188.36
Fixtures, trays etc.	—
Wall Losses	7.47
Cooling Losses	24.16
Atmosphere Losses	—
Opening Losses	2.81
Leakage Losses	3.26
Extended Surface Losses	—
Other Losses	—
Annual CO <sub>2</sub> Emissions (kg CO <sub>2</sub> /hr)	20.4
Total Net Heat Required	226.07
Available Heat (%)	58.8%
Flue Gas Losses	158.62
Exothermic Heat from Process	—
<b>Gross Heat Input</b>	<b>384.69</b>

The right hand panel will show a results summary of all the losses entered in your system. Total results for your system will also be shown.

RESULTS

HELP

### Charge Material Help

Enter measured data to calculate your system's annual savings potential.

▼ Savings Suggestions

- Explore possibilities of lowering the final product temperature
- Preheating the charge or load material entering the furnace
- Pre-drying to reduce moisture content of the load entering the furnace
- Maintain charge feed rate as close to the rated capacity as possible
- Consider possibility of reducing endothermic reactions by controlling process conditions

Note: These energy saving measures are for guidance only. Not all measures are applicable under all operating conditions. There may additional measures when considering specific situations and the user is encouraged to review and apply the appropriate measures

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#### Charge Outlet Temperature

Discharge temperature for the material as it is discharged from the furnace or oven. Use production data or actual measurement.

Help text can be found under the “Help” tab in the right hand panel. Overall help for the loss will be at the top and field by field help text will be underneath that. As you click on each input field this section will be updated.



## Assessment

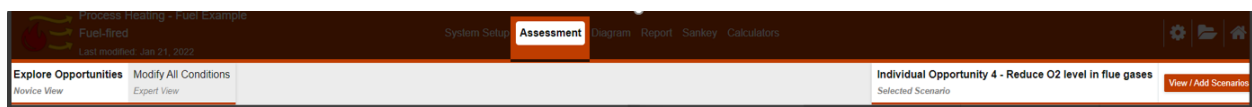
The assessment section of the module allows you to explore how modification scenarios for your system may provide cost, energy and emissions savings. Your baseline must be setup completely prior to making modifications.

There are two ways to conduct assessments which will be explained in further detail later in this section.

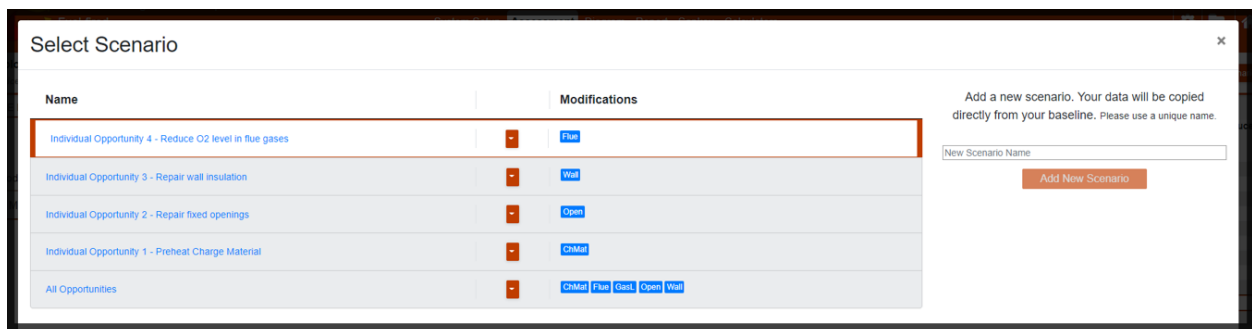
- Explore Opportunities (Novice View)
- Modify All Conditions (Expert View)

## Navigation

As with the System Setup, there is a secondary set of tabs to navigate between the two assessment options.



Multiple scenarios can be created, the current “Selected Scenario” will be displayed on the right hand side of this bar. The “View / Add Scenarios” button opens up a modal used to manage your scenarios:



The modal can be used to:

- Create new scenarios
- Create copies of existing scenarios
- Delete or rename scenarios
- Selecting scenarios for viewing and modifying

## Explore Opportunities (Novice View)

In “Explore Opportunities” there are fewer data entry fields to find savings opportunities. The page is split into two sections. The left hand side has a checklist of likely modifications to improve your system. The right hand side provides results, a sankey diagram and field by field help text.

**Explore Opportunities** Modify All Conditions  
Novice View Expert View

**SELECT POTENTIAL ADJUSTMENT PROJECTS**  
Select potential adjustment projects to explore opportunities to increase efficiency and the effectiveness of your system.

**Add New Scenario**

Modification Name: Individual Opportunity 4 - Reduce O2 level in flue gases

☒ Maintain Optimum Air/Fuel Ratio or Recommended O<sub>2</sub> Level in Flue Gas

Baseline	Modifications
Oxygen Calculation Method	Oxygen Calculation Method
Oxygen in Flue Gas	Oxygen in Flue Gas
Oxygen in Flue Gas	Oxygen in Flue Gas
6%	2%
Excess Air in Flue Gas	Excess Air in Flue Gas
36.52 %	09.90 %

☐ Preheat Combustion Air

☐ Preheat Charge Material

Each checklist item will provide input fields to modify the scenario. The data for your baseline is also displayed on the left.

RESULTS	SANKEY	HELP	NOTES
<b>Energy Loss/Use</b>	<b>Baseline</b>		<b>Individual Opportunity 4 - Reduce O2 level in flue gases</b>
	MMBtu/hr		MMBtu/hr
Charge Materials	143.56		143.56
Fixtures, trays etc.	—		—
Wall Losses	7.47		7.47
Cooling Losses	24.16		24.16
Atmosphere Losses	—		—
Opening Losses	2.81		2.81
Leakage Losses	3.26		3.26
Extended Surface Losses	—		—
Other Losses	—		—
Annual CO <sub>2</sub> Emissions (kg CO <sub>2</sub> /hr)	16.4		15.1
Total Net Heat Required	181.27		181.27
Available Heat (%)	58.8%		63.5%
Flue Gas Losses	127.19		104.15
Exothermic Heat from Process	—		—
<b>Gross Heat Input</b>	<b>308.45</b>		<b>285.42</b>

The “Results” tab will show the calculated results and savings of the modified scenario.

The “Sankey” tab will display a sankey diagram for either the baseline or selected modification scenario.

Field by field help text will display in the “Help” panel as input fields are clicked on.

“Notes” provides an area to take notes for each scenario that will be added to the final report.

## Modify All Conditions (Expert View)

The “Modify All Conditions” tab allows you to adjust all aspects of the process heating system that was entered in the System Setup, allowing more control of the changes you make to your baseline.

The screenshot displays the 'Modify All Conditions' interface in 'Expert View'. It features a top navigation bar with tabs: 'Explore Opportunities', 'Modify All Conditions' (highlighted), and 'Expert View'. Below this is a row of category tabs: 'Operations' (green dot), 'Charge Materials' (orange dot), 'Flue Gas' (blue dot), 'Fixture' (orange dot), 'Wall' (orange dot), 'Cooling' (orange dot), 'Atmosphere' (orange dot), 'Opening' (green dot), 'Leakage' (green dot), 'Extended Surface' (orange dot), and 'Other' (orange dot). The main area is split into two panels. The left panel, titled 'BASELINE', and the right panel, titled 'INDIVIDUAL OPPORTUNITY 4 - REDUCE O2 LEVEL IN FLUE GASES', both show identical input fields for 'Material #1'. Each panel includes a 'Select Type' dropdown set to 'Solid' and a 'Name of Material' dropdown set to 'Carbon Steel'. Below these are input fields for 'Average Specific Heat of Solid' (0.16 Btu/(lb-°F)), 'Latent Heat of Fusion' (60 Btu/lb), 'Average Specific Heat of Molten Material' (0.175 Btu/(lb-°F)), and 'Melting Point' (2800 °F). Further down are fields for 'Charge Feed Rate (Wet)' (400000 lb/hr), 'Charge Inlet Temperature' (60 °F), 'Charge Outlet Temperature' (2300 °F), 'Water Content (Charged)' (0 %), 'Water Content (Discharged)' (0 %), 'Water Vapor Discharge Temperature' (0 °F), 'Charge Melted' (0 %), 'Charge Reacted' (1 %), and 'Heat of Reaction' (50 Btu/lb). A 'Type of Reaction (Exothermic/Endothermic)' dropdown is set to 'Endothermic', and 'Additional Heat Required' is 0 Btu/hr. At the bottom of each panel, a summary table shows: 'Material #1 Heat Required' (143.360 MMBtu/hr), 'Material #1 Reaction Heat' (0.200000 MMBtu/hr), 'Material #1 Total Heat Required' (143.560 MMBtu/hr), 'All Materials Heat Required' (143.360 MMBtu/hr), 'All Materials Reaction Heat' (0.200000 MMBtu/hr), and 'All Materials Total Heat Required' (143.560 MMBtu/hr).

BASELINE	
Material #1	
Select Type	Solid
Name of Material	Carbon Steel
Average Specific Heat of Solid	0.16 Btu/(lb-°F)
Latent Heat of Fusion	60 Btu/lb
Average Specific Heat of Molten Material	0.175 Btu/(lb-°F)
Melting Point	2800 °F
Charge Feed Rate (Wet)	400000 lb/hr
Charge Inlet Temperature	60 °F
Charge Outlet Temperature	2300 °F
Water Content (Charged)	0 %
Water Content (Discharged)	0 %
Water Vapor Discharge Temperature	0 °F
Charge Melted	0 %
Charge Reacted	1 %
Heat of Reaction	50 Btu/lb
Type of Reaction (Exothermic/Endothermic)	Endothermic
Additional Heat Required	0 Btu/hr
Material #1 Heat Required	143.360 MMBtu/hr
Material #1 Reaction Heat	0.200000 MMBtu/hr
Material #1 Total Heat Required	143.560 MMBtu/hr
All Materials Heat Required	143.360 MMBtu/hr
All Materials Reaction Heat	0.200000 MMBtu/hr
All Materials Total Heat Required	143.560 MMBtu/hr

INDIVIDUAL OPPORTUNITY 4 - REDUCE O2 LEVEL IN FLUE GASES	
Material #1	
Select Type	Solid
Name of Material	Carbon Steel
Average Specific Heat of Solid	0.16 Btu/(lb-°F)
Latent Heat of Fusion	60 Btu/lb
Average Specific Heat of Molten Material	0.175 Btu/(lb-°F)
Melting Point	2800 °F
Charge Feed Rate (Wet)	400000 lb/hr
Charge Inlet Temperature	60 °F
Charge Outlet Temperature	2300 °F
Water Content (Charged)	0 %
Water Content (Discharged)	0 %
Water Vapor Discharge Temperature	0 °F
Charge Melted	0 %
Charge Reacted	1 %
Heat of Reaction	50 Btu/lb
Type of Reaction (Exothermic/Endothermic)	Endothermic
Additional Heat Required	0 Btu/hr
Material #1 Heat Required	143.360 MMBtu/hr
Material #1 Reaction Heat	0.200000 MMBtu/hr
Material #1 Total Heat Required	143.560 MMBtu/hr
All Materials Heat Required	143.360 MMBtu/hr
All Materials Reaction Heat	0.200000 MMBtu/hr
All Materials Total Heat Required	143.560 MMBtu/hr

The left input panel will show the input data for the baseline setup. The right input side will show the input data for the selected scenario you are adjusting.

The tabs correspond to the tabs from the System Setup, with the color coded dots corresponding to the changes that have been made to that category of the fan system.

- Green: Everything is the same as the baseline
- Blue: Something has been changed from the baseline
- Red: There is invalid data somewhere in the baseline or modification scenario
- Orange: A data field has a valid value but is outside of an expected calculated range

The furthest right hand side will have a panel with a set of tabs.

“Results” shows the live results of the baseline and selected scenarios with savings results calculated.

“Help” again provides field by field help text for each input field.

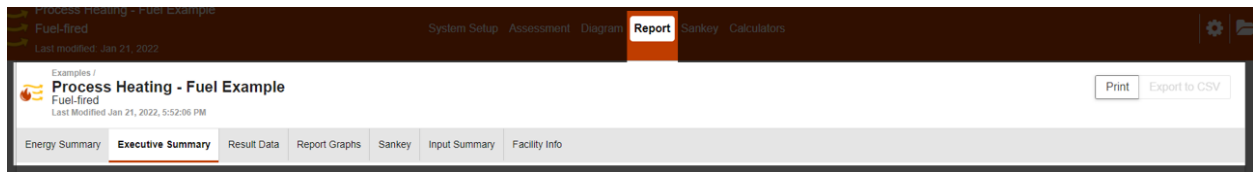
“Notes” is an input box that allows for notes on the selected scenario that will be added to the report.

RESULTS	HELP	NOTES
		Invalid Modification Errors found in Wall
		Individual Opportunity 4 - Reduce O2 level in flue gases
Energy Loss/Use	Baseline MMBtu/hr	MMBtu/hr
Charge Materials	188.36	143.56
Fixtures, trays etc.	— —	— —
Wall Losses	7.47	— —
Cooling Losses	24.16	24.16
Atmosphere Losses	— —	— —
Opening Losses	2.81	2.81
Leakage Losses	3.26	3.26
Extended Surface Losses	— —	— —
Other Losses	— —	— —
Annual CO <sub>2</sub> Emissions (kg CO <sub>2</sub> /hr)	20.4	14.5
Total Net Heat Required	226.07	173.80
Available Heat (%)	58.8%	63.5%
Flue Gas Losses	158.62	99.86
Exothermic Heat from Process	— —	— —
Gross Heat Input	384.69	273.66

RESULTS	HELP	NOTES
<i>Add note for charge material</i>		

## Report

The report is a printable summary of the baseline and scenarios you have created in the assessment. Tables and graphs are provided to analyze the impacts the changes have on each scenario comparitively. There is a secondary set of tabs to navigate to different pieces of the report. The “Print” button in the top right hand corner will generate a PDF report.



- Energy Summary: Provides table with energy use comparisons by energy source. Additionally, a table with calculated, metered and designed energy values is provided. Notes added to the assessment are show here as well.
- Executive Summary: Provides a table of data with energy use and cost savings data.
- Result Data: Breakdown of each loss type and totals summary.
- Report Graphs: Graphical representations of loss data.
- Sankey: Sankey diagrams for the baseline and each scenario.
- Input Summary: A table of the input data for the baseline and each scenario.
- Facility Info: The facility information provided for the folder that this assessment was created in.