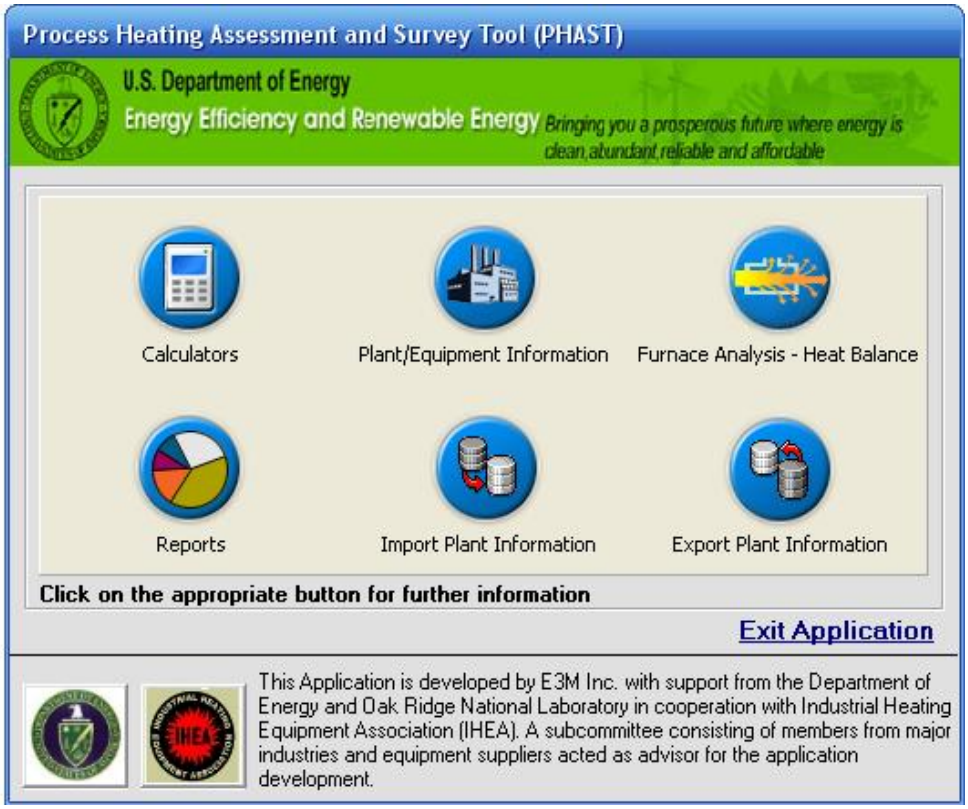
Process Heating Assessment and Survey Tool
PHAST 3.0

Electrotechnology (ET) – US Units

User Manual – Version 1.0
November 2010



Developed by Oak Ridge National Laboratory in cooperation with the Industrial Heating Equipment Association (IHEA). A subcommittee consisting of members from major industries (steel, aluminum, heat treating, petro-chemical industry etc.) and equipment suppliers acted as advisor for the tool development.

Development supported by E3M, Inc.

Please contact ARVIND THEKDI, E3M, Inc. for all comments or suggestions

(Phone: 240.715.4333 or E-mail athekdi@e3minc.com)

What is PHAST 3.0?

PHAST 3.0 *is a user-friendly tool that can be used to assess energy use and estimate energy use reduction, with the application of selected energy efficiency improvement methods, for industrial process heating equipment such as furnaces, ovens, heaters, melters, boilers etc. The tool is designed for use with parameter inputs in U.S. – English or International units of measurements, with the option of using local currency values for energy cost and savings calculations.*

Note: The term "furnace" is used as a generic term to describe all commonly used process-heating equipment such as furnaces, ovens, heaters, melters, boilers, kilns, dryers etc.

The tool serves three major functions:

1. *Provides an introduction to process heating methods and energy conversion tools. It also includes simple calculators for the performance comparison of furnaces at different operating conditions, flow calculations for orifice based gas flow meters and heat input calculations, with links to additional sources of information on topics related to process heating.*

2. *Surveys the process equipment that uses fuel, steam, or electricity as energy source and provides a method to identify the equipment consuming the most energy. The user input is in the form of heat (energy) input and operating schedules of the equipment being surveyed. The end result is a report summarizing estimated annual energy use and energy cost in local currency, as well as in U.S. dollars. The report identifies the high priority equipment that uses the top 80% of the plant's total process heating energy cost.*

3. *Performs an energy (heat) balance for the selected process heating equipment to identify major areas of energy use and to provide guidance on how to reduce the non-productive use or loss of energy. The tool includes explanations of the components of the energy balance, instructions on collecting the data, possible methods for lowering energy usage for each of the major areas of the furnace and a list of resources where the plant can get additional help.*

The tool allows the user to compare performance of the furnace at different operating conditions and test "what-if" scenarios for various energy saving options.

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Please contact ARVIND THEKDI, E3M, Inc. (Phone: 240.715.4333 or E-mail athekdi@e3minc.com) for all comments and suggestions.

Your cooperation and support is greatly appreciated.

Installing PHAST 3.0

The tool can be installed by 1) using a setup CD or 2) downloading from the U. S. Department of Energy web site.

System Requirement:

- A PC running Windows 2000 /Windows XP/ Windows Vista with latest service pack
- At least 1200MB free space in hard disk
- A processor (preferably Pentium) 133 MHz or faster.
- A monitor supporting resolution of at least 1024 x 768.
- A mouse or compatible tracking device.
- An optical drive.
- Microsoft Office 2000 or higher with MS Access 2000 or higher
- Acrobat PDF Reader

1) PHAST 3.0 Setup CD

The CD includes:

- **PHAST 3.0 Setup**
- **User Manual** as PDF document
- **Survey Forms**

Installation Instructions:

- Insert the Setup Disc in the CD-ROM Drive.
- Follow the on screen instructions.
- Unless otherwise specified, the default path of the application is Start ->Programs ->PHAST3.0 -> PHAST3.0.
- Open the Application (Alternatively, PHAST can be opened through the shortcut created on the Desktop).

Note: In case of problem during Installation:

- *Update the operating system with latest service pack and run the PHAST Setup again.*
- *Disable any memory resident programs and run the PHAST setup again.*
- *Contact your IT support personnel for permission/security issues.*

Uninstall Instructions:

- *Start -> Control Panel -> Add or Remove Programs*
- *Select "PHAST3.0" from the list*
- *Click "Change/Remove"*
- *Choose either "Yes" or "Remove None" during course of uninstall*

2) PHAST 3.0 Setup - Web Download

For the web download, go to the U. S. Department of Energy web site- www.eere.energy.gov/industry. On this web site

- Go to the link "Software Tools"

- Go to “Quick link to resources”
- Select “Software Tools”
- Select “Process Heating Assessment and Survey Tool (PHAST v3.0)” to download the tool

Installation Instructions:

- Click ‘Run’ to initiate the setup of PHAST 3.0.
- Follow the on screen instructions.
- Unless otherwise specified, the default path of the application is Start ->Programs ->PHAST3.0 -> PHAST3.0.
- Open the Application (Alternatively, PHAST 3.0 can be opened through the shortcut created on the Desktop).

Table of Contents

Summary:

A. Calculators
This section includes a calculator that can be used to calculate energy equivalency between electrical and fuel-fired heating systems.

B. Plant/Equipment Information
This section can be used to:

- Survey energy use and the annual cost of energy in a local currency or US dollars for a heating system (fuel fired, electrically heated, steam heated) and its auxiliary equipment (i.e. pumps, motors, compressors, fans, vacuum pumps, etc.);
- Assess and summarize the expected annual cost of operation in a local currency or US dollars of each of the surveyed items of equipment;
- Identify specific heating equipment that accounts for a large (80%) percentage of the plant's process heating energy cost;
- Determine the effect of adding new heating equipment on the plant's overall annual energy use and costs;
- Evaluate the effect of decommissioning or eliminating any one or more existing pieces of heating equipment;
- Select equipment for detailed analysis to identify the distribution of energy used in various portions of the furnace.

C. Furnace Analysis - Heat Balance
This section can be used to analyze the energy used in various parts of the selected furnace under a given operating condition. The furnace has to be first entered into the Plant/Equipment Information section. The areas for energy use include the charge or load, fixtures, trays, and other material handling equipment, wall losses, water cooling losses, losses through openings and from exposed hot parts, flue products (or exhaust gases) and heat storage. The load or material being processed can be in the form of solid, liquid or gas with or without a phase change (melting or evaporation) and may include a chemical reaction. It allows entering multiple components for the load and various losses. It also allows the user to identify major areas of energy use and the magnitude of losses to study the effect of operating modifications and their effect on the furnace's energy use.

D. Reports
This section provides four reports in the form of tables and charts. The **Plant Summary** report includes a table of energy used and expected operating cost for all the furnaces surveyed. The **Furnace Analysis** report includes a breakdown of energy use in various parts of individual furnaces, their relative importance in terms of total energy use and the effect of changes in key operating parameters on furnace energy consumption. The **Furnace Summary** report is a schematic of heat use and loss components in the form of a "Static' Sankey Diagram. The **Input Data** report includes all the data that was entered for a selected plant.

Note: All reports can be printed or saved as PDFs for future reference.

E. Import Other Plant Information

This section allows importing plant and furnace information exported from another PHAST (Version 3.0) database. Later such information can be analyzed, modified and reviewed as discussed above.

Note: The data entered and analyzed through earlier versions PHAST (such as v1.2, 1.3 and 2.0) *cannot be imported to latest versions of PHAST such as Version 3.0.*

F. Export Plant Information

This section allows exporting plant and furnace information to another PHAST (Version 3.0) database. All information about the plant, its furnaces, heat zones, energy sources, energy costs and heat balance data will be exported as an MS Access database. Later, this information can be imported in to the existing PHAST (Version 3.0) database through Import Feature and new information can be analyzed, modified and reviewed as discussed above.

Note: Data entered and analyzed through PHAST (Version 3.0) *cannot be exported to earlier versions of PHAST such as* v1.2, 1.3 and 2.0*).*

Description and Use of the Tool:

General Notes:

- *On all screens, enter the required information in the "white background" text boxes. The results will be shown in "colored background" text boxes or as labels.*
- *Do not use special characters (',", &,*, #, etc.) while entering the data in different text boxes. This may cause the problem when other users import this data.*
- *Throughout the application, a specific unit converter is available if input data needs to be converted to different units. When the cursor is on any input box, pressing "F2"will open the converter and provide appropriate conversions for the input data's units. PHAST also has a general unit converter accessible by selecting (Information → Unit Converter) on the top menu bar or by clicking the calculator icon*  *at the bottom of the Furnace Analysis screen.*
- *Clicking on the information icon*  *at the bottom left corner of each screen opens a new window with detailed information and explanations related to each field on the screen.*
- *On all screens, move the mouse over the labels next to the input boxes to display a "tool-tip" and get information about data the user is expected to fill in the corresponding box.*
- *Refer to the "Information" menu in the top bar or*  *buttons for additional references or knowledge material.*

Starting PHAST 3.0:

On starting PHAST 3.0, the user is greeted with flash screen for a brief time.

Heating System Selection

After brief display of the splash screen, the user is presented with an option to select the Heating System – "Electrotechnology" or "Fuel Fired". After selecting one, the user clicks **"OK"** to proceed or **"Exit"** to shut down the application. After the system selection, screens with the appropriate unit selections are displayed.

Note: The application remembers which heating system was used on its last run and automatically retains that unit selection for the next run. However, the user can always change the selection.

Unit Selection

After brief display of the splash screen, the user is presented with the unit selection option – US or International (MKS). User can select one of units and click **"OK"** to proceed or **"Exit"** to shut down

the application. Based on the heating system selection and unit selection, screens with the appropriate unit labels are displayed for all modules.

Note: The application remembers which unit system was used on its last run and automatically retains that unit selection for the next run. However, the user can always change the unit selection.

The initial screen describes the six major sections of the application.

1. Calculators
2. Plant/Equipment Information

3. Furnace analysis – Heat Balance
4. Reports
5. Import Plant Information
6. Export Plant Information

Click on **"Exit Application"** to close all screens and leave PHAST 3.0
Click on the DOE or IHEA logos to go their respective websites.

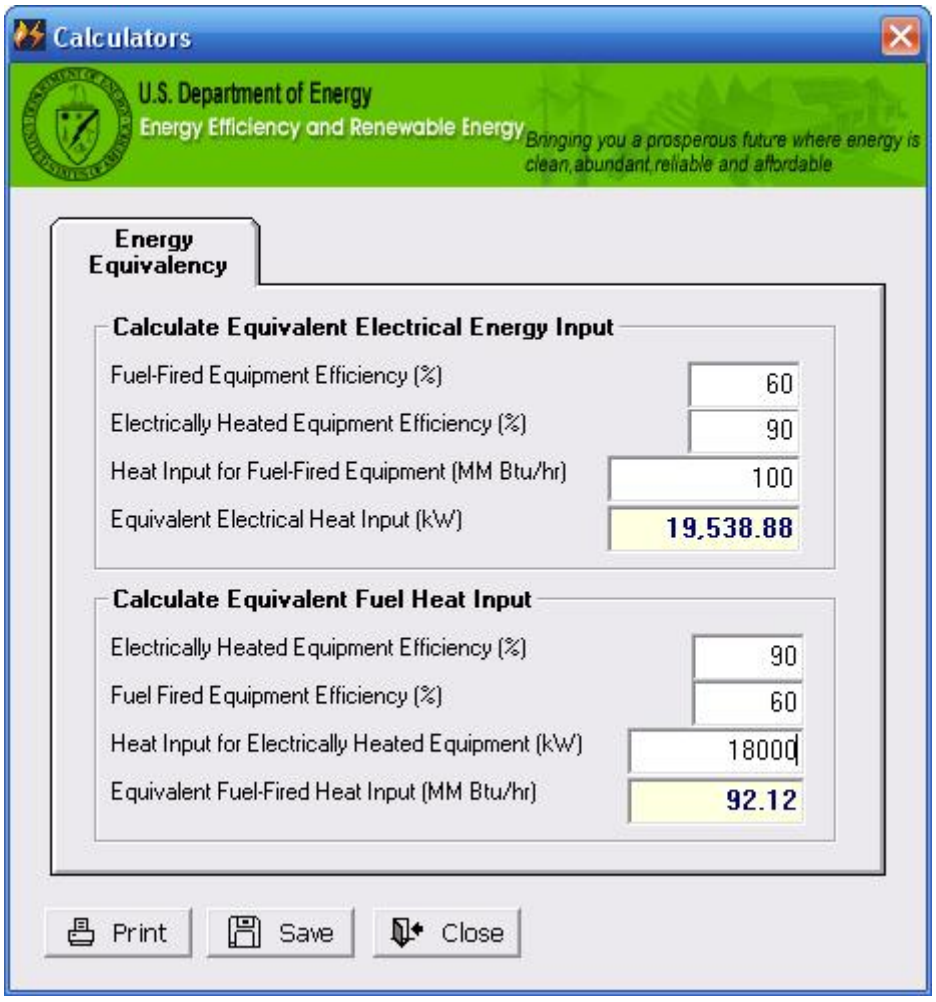
Calculators:

This section includes a calculator that can be used to calculate energy equivalency between electrical and fuel-fired heating systems.

Common Instructions for the tab:

- Insert the required information in the white areas or boxes. The results will be shown in yellow boxes.
- Use the **Tab** key or your mouse to go from one text box to another.
- Click on "**Save"** to save the information so it can be displayed next time. Save the changes in information on each tab before moving to the next tab.
- Click on "**Print"** Button to print the current screen.
- Click on the "**Close"** button to close the screen and return to the main screen.

Energy Equivalency:
Calculations for converting values of energy requirements when the heat source is changed from fuel firing (Btu/hr or kJ/hr) to electricity (kW) or vice versa.



- Enter furnace efficiency (in terms of percentage) for fuel fired equipment (60% in the example)
- Enter furnace efficiency (in terms of percentage) for electric heating system (90% in the example)
- Enter Heat Input for Fuel fired equipment (100 Million Btu/hr in the example)
- Equivalent Electrical Heat Input (19,538.88 kW in the example) is calculated and displayed in colored text box.

If the Fuel Fired heating system was selected, three additional calculators are displayed:

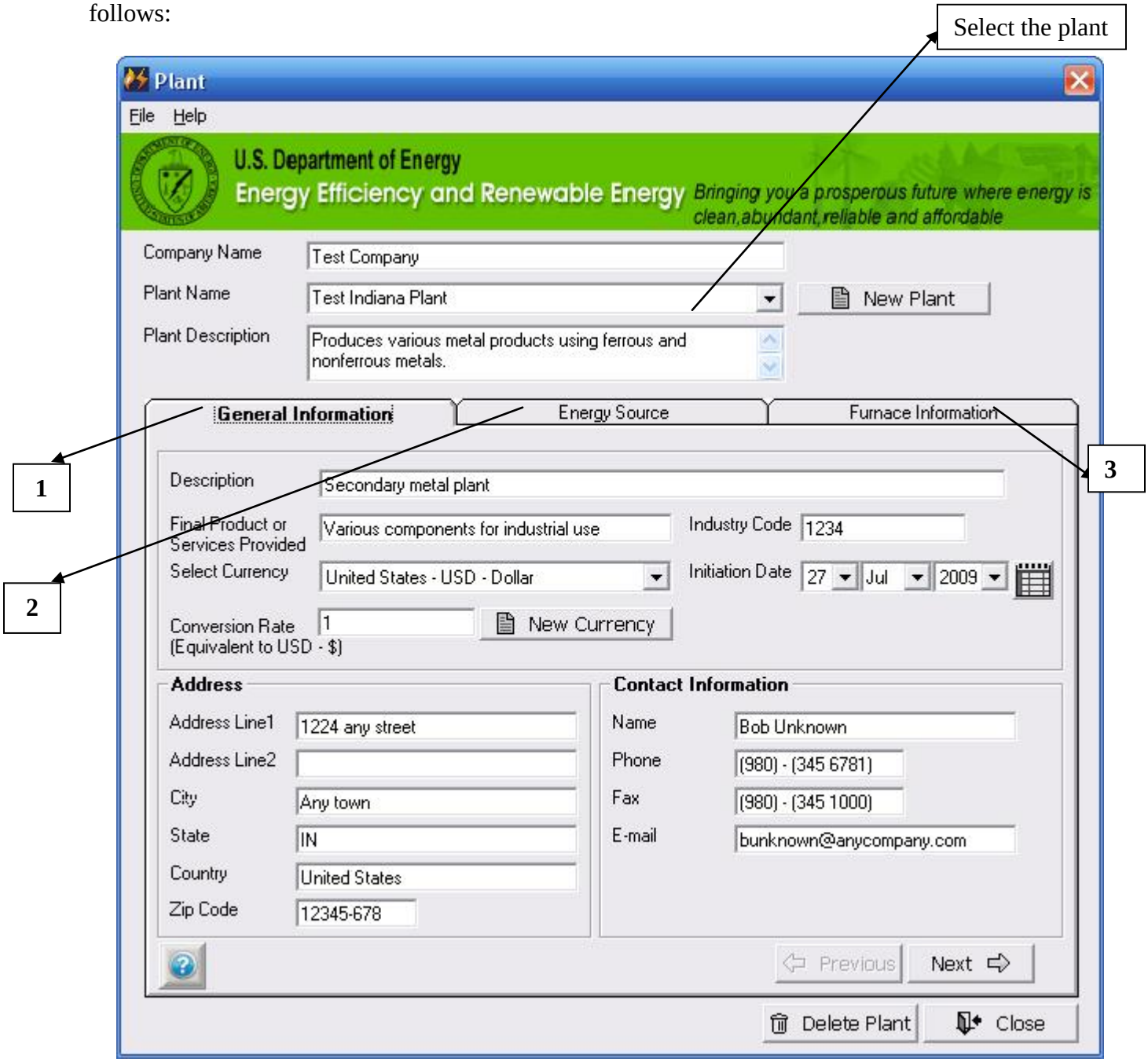
- Efficiency Improvement
- O_2 Enrichment
- Flow Calculations/Energy Use

Plant/Equipment Information:

General Notes:

- *Do not use special characters (‘,”, &,*, #, etc.) while entering the data in different text boxes. This may cause the problem when other user imports such data.*

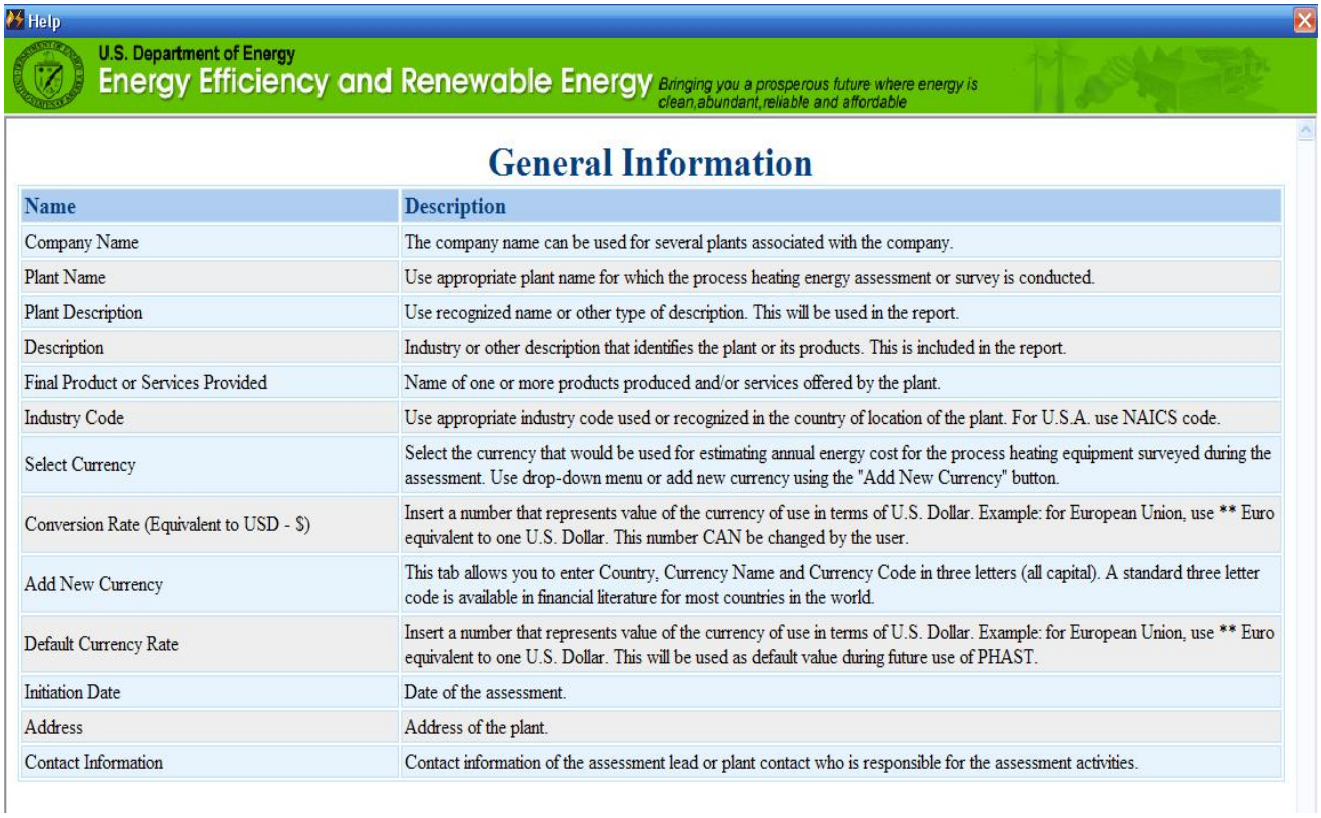
This section contains three tabs. An image of the section is shown below and a description of each tab follows:



1. **General Information:**
   Collect general information related to the plant, including its Description, Final Product, Industry Segment, Contact Information and Currency for Cost Estimation.
2. **Energy Source:**
   Select available energy sources for the plant and input values for the fuel heating value and cost data using appropriate units. A library of energy sources, which are used in the plant's process heating equipment, can be prepared and viewed. An option is provided for adding new energy sources, with their heating values and costs in appropriate units.
3. **Furnace Information:**
   View the list of all process heating equipment (furnaces) within the plant. An option for viewing the details of each furnace or adding a new one is provided here.

Common Instructions for ALL tabs:

- Click on "**New Plant"** to add the general information, energy sources used and furnaces for the plant. The user must provide the Plant Name before adding other details.
- Click on either "**Previous"** or **"Next"** to toggle between the different screens of Plant/Equipment Information.
- **Click on "Delete Plant"** to delete all the related information of the currently selected plant. The details *will not* be available for future analysis.
- Click on "**Close"** to close the screen and return to the main screen.
- Click on the  button at bottom left corner of each screen to open a new window containing detailed information related to each field on that screen.



General Information

Name	Description
Company Name	The company name can be used for several plants associated with the company.
Plant Name	Use appropriate plant name for which the process heating energy assessment or survey is conducted.
Plant Description	Use recognized name or other type of description. This will be used in the report.
Description	Industry or other description that identifies the plant or its products. This is included in the report.
Final Product or Services Provided	Name of one or more products produced and/or services offered by the plant.
Industry Code	Use appropriate industry code used or recognized in the country of location of the plant. For U.S.A. use NAICS code.
Select Currency	Select the currency that would be used for estimating annual energy cost for the process heating equipment surveyed during the assessment. Use drop-down menu or add new currency using the "Add New Currency" button.
Conversion Rate (Equivalent to USD - $)	Insert a number that represents value of the currency of use in terms of U.S. Dollar. Example: for European Union, use ** Euro equivalent to one U.S. Dollar. This number CAN be changed by the user.
Add New Currency	This tab allows you to enter Country, Currency Name and Currency Code in three letters (all capital). A standard three letter code is available in financial literature for most countries in the world.
Default Currency Rate	Insert a number that represents value of the currency of use in terms of U.S. Dollar. Example: for European Union, use ** Euro equivalent to one U.S. Dollar. This will be used as default value during future use of PHAST.
Initiation Date	Date of the assessment.
Address	Address of the plant.
Contact Information	Contact information of the assessment lead or plant contact who is responsible for the assessment activities.

General Information:

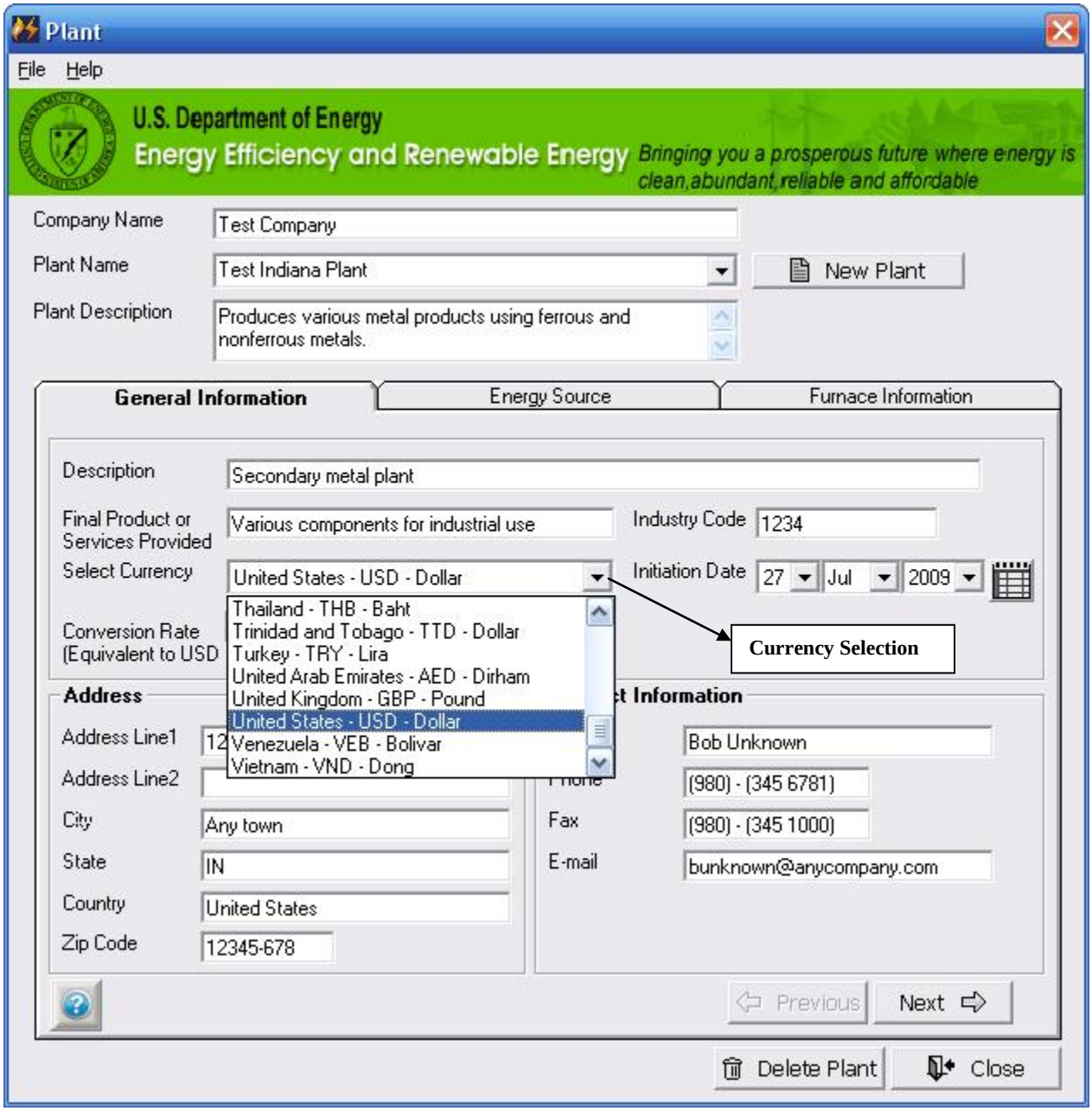
On this tab provide General Information about the plant such as Description, Final Product, Industry Segment, Currency and its conversion rate to USD, Initiation Date and Contact Information.

Note:

- *Currency selection and its conversion rate are required to proceed further.*
- *Conversion Rate entered on this screen (tab) is used for cost calculations.*
- *Instead of entering an Initiation Date, a calendar image can be used to select the date*

Add New Plant:

Click on **"New Plant"** to add a new plant. On the same screen, all the input boxes will clear out for new data entry.

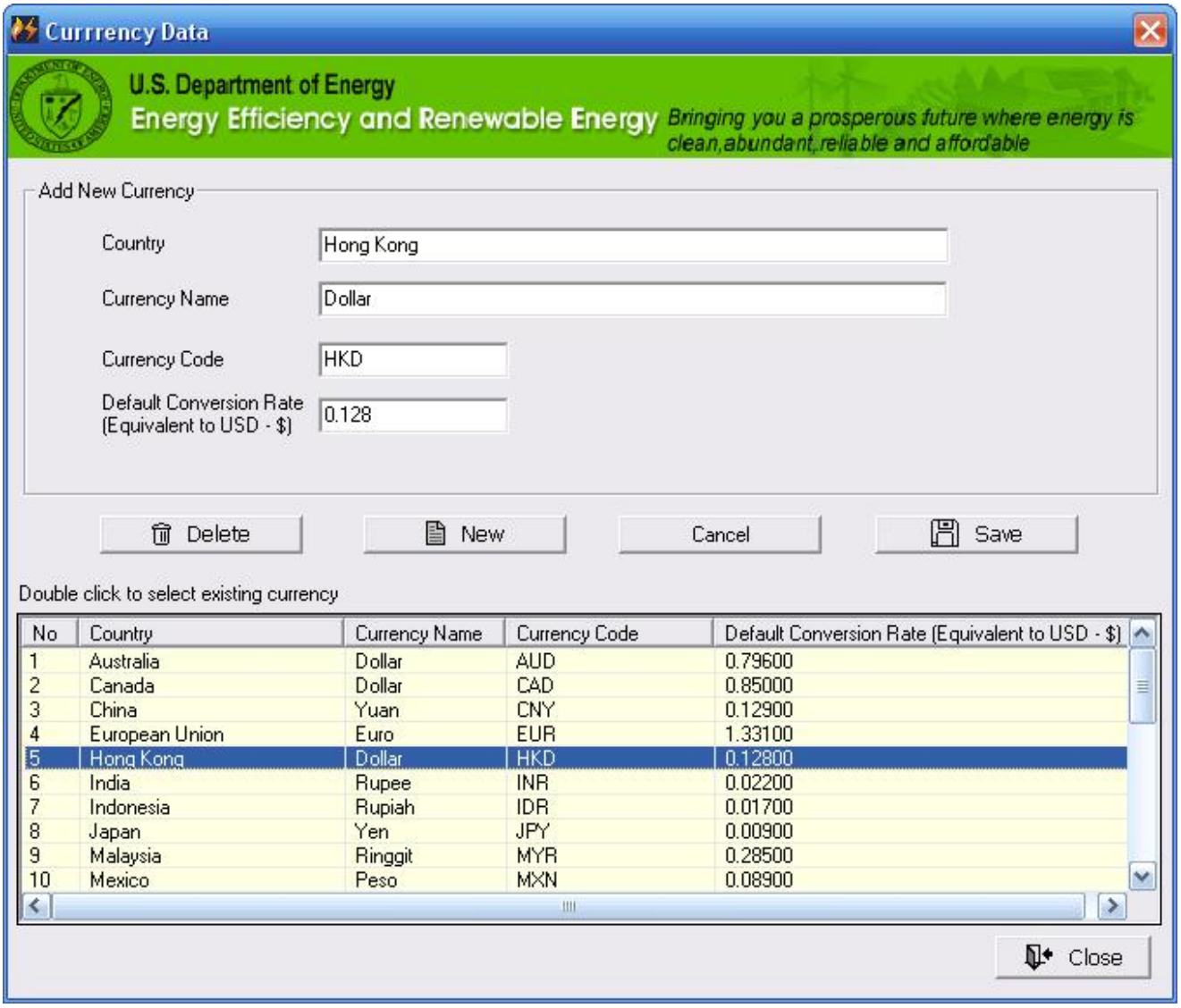


- Enter **"Company Name"** (mandatory to proceed further or save the data)
- Enter **"Plant Name"** (mandatory to proceed further or save the data)
- Select **"Currency"** from the drop down list (mandatory to proceed further or save the data)
- Enter/modify **"Conversion Rate"** for currency (mandatory to proceed further or save the data)
- Enter other data (optional) such as description, product, address, contact information etc.

Add New Currency:

If US units have been selected, PHAST selects US Dollars as the default currency. However, the user can change the selection from the available drop-down list of currencies (Appendix – B). A new currency that is not in the list can be added to the database.

Click on **"Add New Currency"** to add a new currency. A new screen will be presented to enter the data of new currency as given below.



The grid table displays all currencies available in the database. Double click on any row of the currency to place the data in the upper boxes.

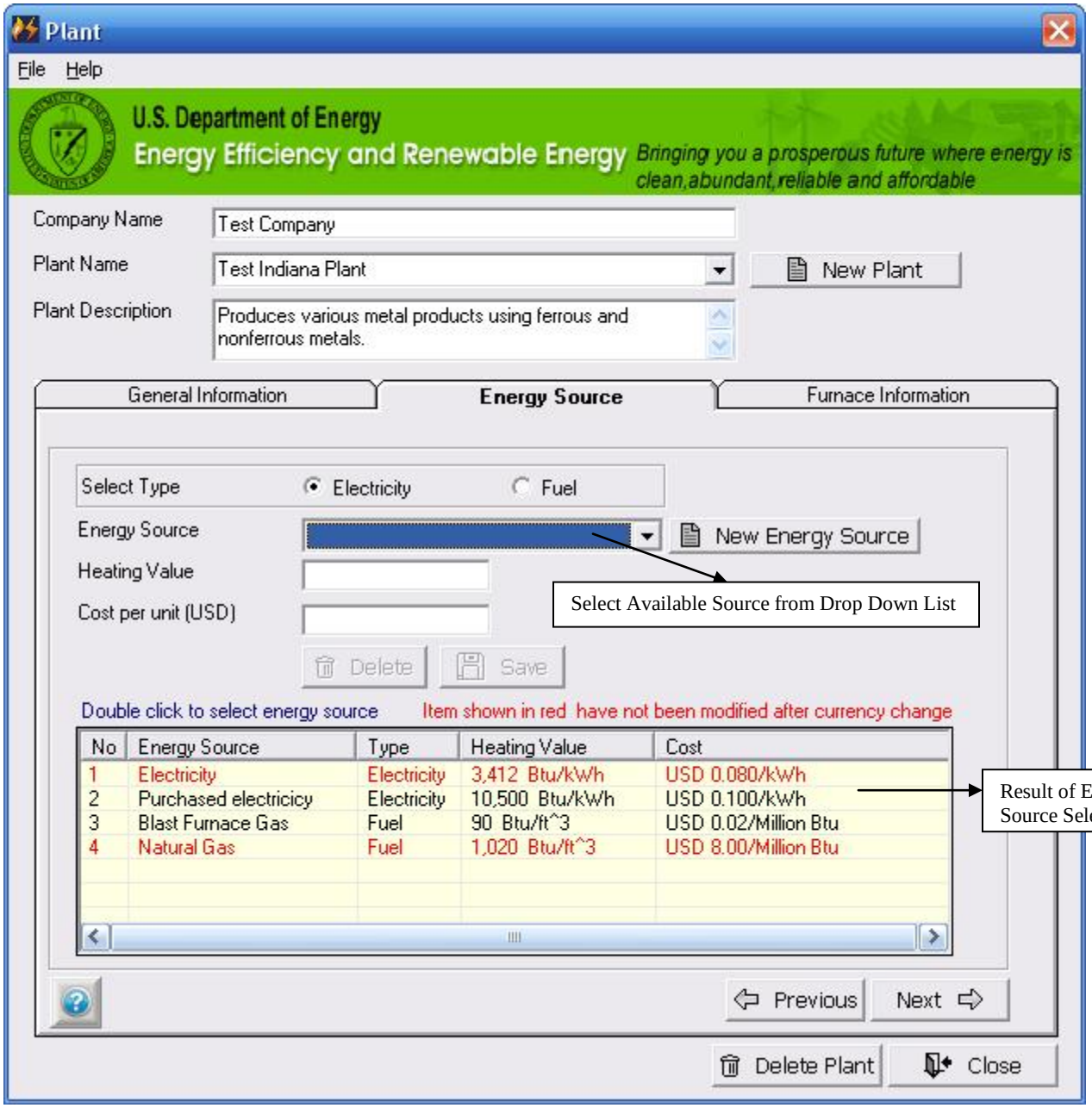
The user cannot edit the details of the default currencies shown in Appendix – B and is encouraged to enter a new currency if it is not available in the list. The details of currency entered by the user can later be edited.

- Click on "**New"** to add a new currency.

Note: Country Name, Currency Name, three letters Currency Code and conversion rate with reference to US Dollar are required to have a new currency for future use.

- Click on **"Save"** to save the new currency data for future use.
- Click on **"Delete"** to delete the selected currency
  Note: Currency cannot be deleted if it is used the plant analysis or is part of the master list in Appendix –B. If the currency cannot be deleted, PHAST will display the message explaining the reason.
- Click on **"Cancel"** to cancel the action.
- Click on "**Close"** to close the screen and return to the Plant – General Information tab.

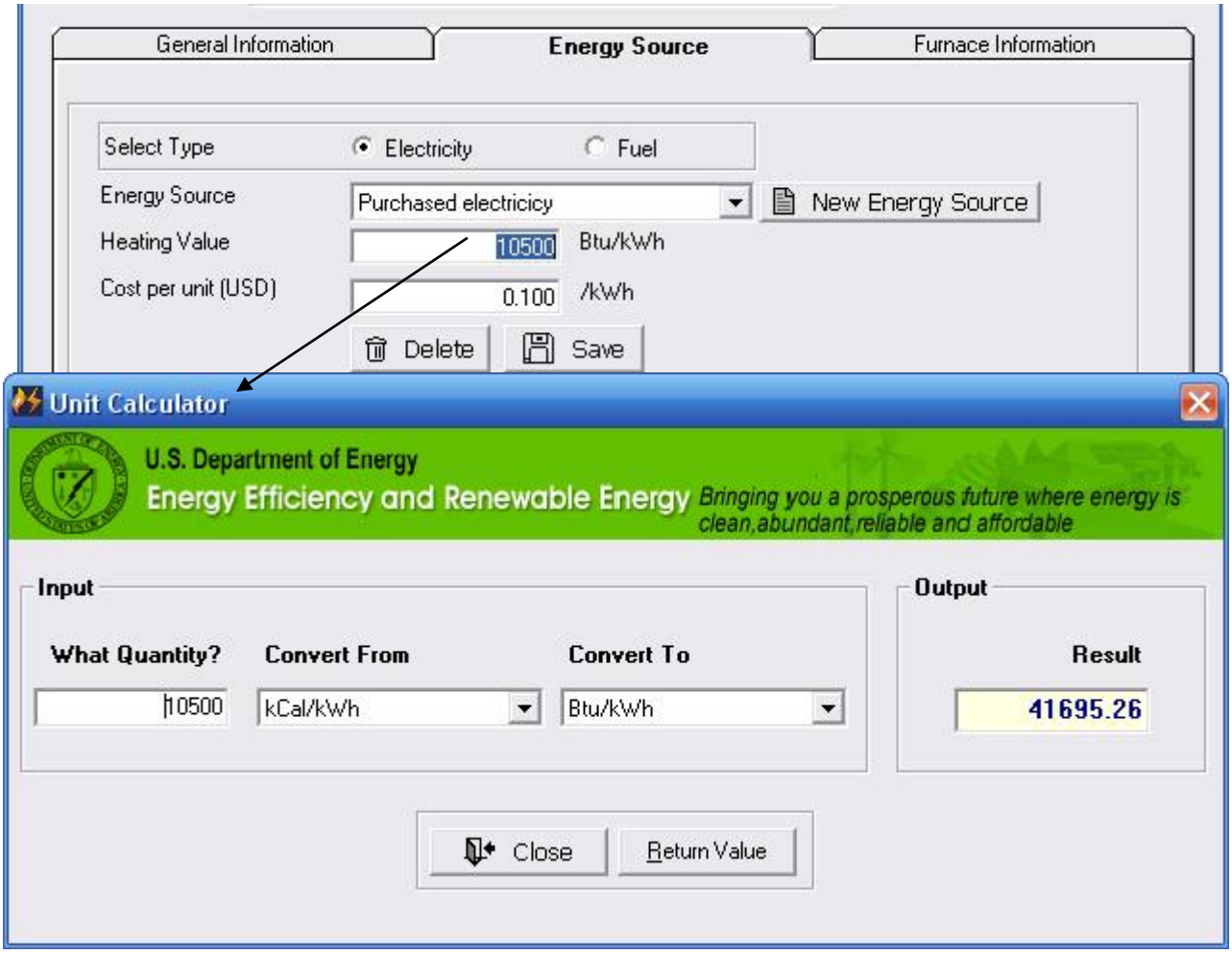
Energy Source:
On this tab, provide information on energy sources, such as fuel heating value and cost.



For any new plant, PHAST provides three energy sources - Electricity, Natural Gas and Steam, along with their heating values and standard costs in US dollars. However, the user can change these default values to ones of his/her choice. The user may also add additional energy sources for the plant from available drop-down list (Appendix – C). A new energy source not on the list can be added to the database. PHAST must have at least one energy source of each type for analysis, otherwise a selection for Fuel/Electricity in the Heat Zone information will not be available. The heating values and cost data for Fuel, Electricity and Steam are used to calculate plant wide energy consumption and its cost distribution.

Note: Heating value and cost units are required to have this energy source available for the plant.

- Select the energy source from the drop list.
- Edit/enter the Heating Value input box *(Note: this value will be used for calculation).*
  Note: If the cursor is in Heating Value input box, the user can call up the specific unit converter by pressing F2. The unit converter screen, shown below, will appear.



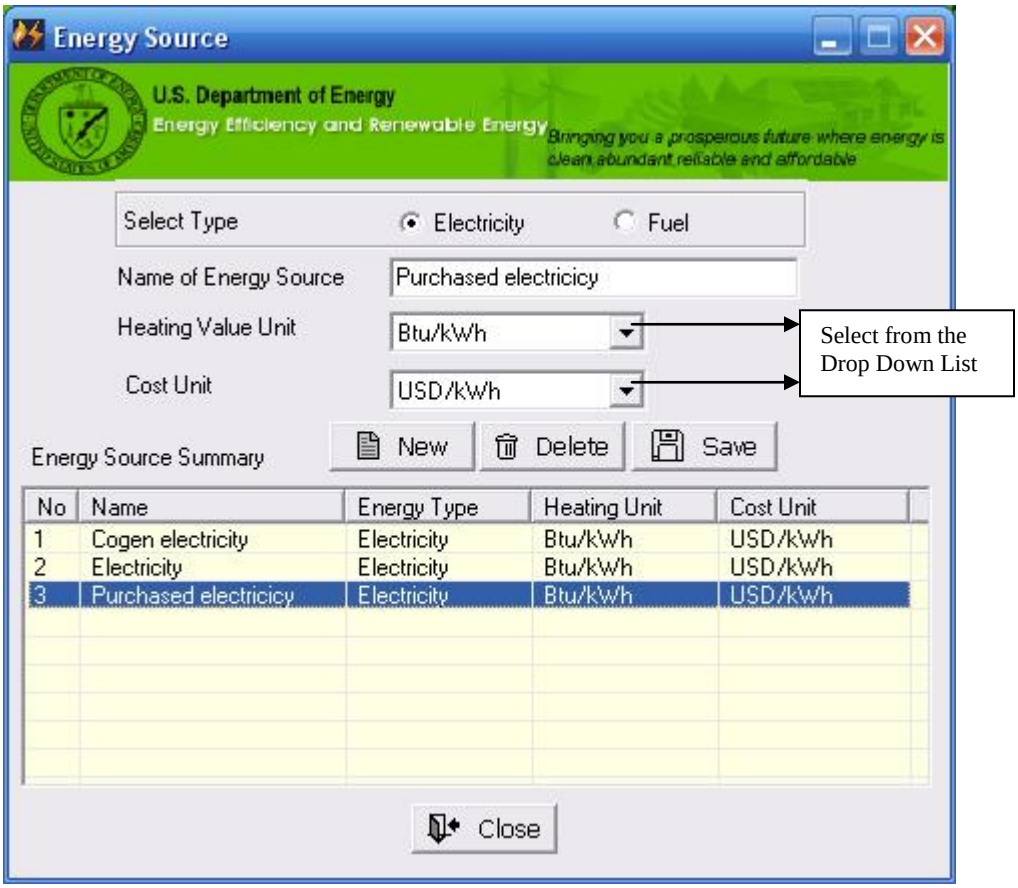
  - Enter/Edit the **"What Quantity"** value.
  - Select the unit from **"Convert From"** list.
  - Select the unit from **"Convert To"** list.
  - Click on **'Return Value"** to copy the calculated result (output) to the input box from where F2 was pressed; i.e., Heating Value on energy source tab.
  - Click on **"Close"** to close the unit converter form without copying the calculated result (output) to the input box.
- Edit/enter the cost of energy source in the selected currency (Note: this value will be used for calculation).
- Click on **"Save"** to save the energy source for the selected plant.
  Note: The grid table displays all energy sources that are saved and available for the plant. Double click on any row of the energy source to place the data in the upper boxes.

- Click on **"Delete"** to delete the selected energy source.
  Note: Energy source cannot be deleted if it is used the plant analysis. PHAST will display the message with the reason the user cannot delete the energy source.

PHAST has a provision for adding more than one type of Electricity and Steam with a different name, heating value and cost. PHAST calculates the energy cost on the basis of the energy source selected in the heat zone data in furnace information section.

Add New Energy Source

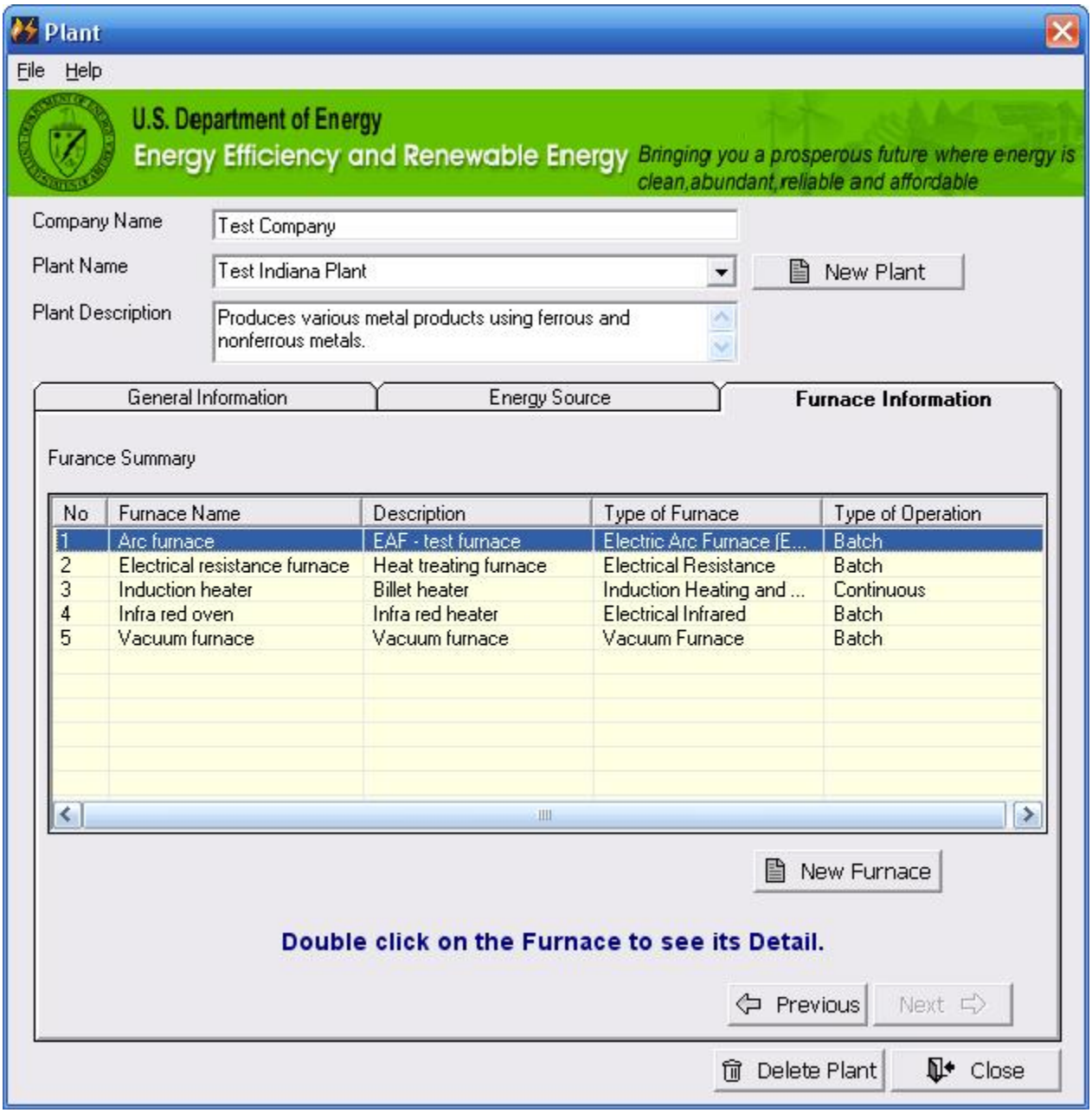
Click the "**New"** button to add a new Energy Source. A separate screen (shown below) will pop up.



- Select **Type of new Energy Source** (Electricity or Fuel)
- Enter/Input the **"Name of Energy Source"**
- Select the "**Heating Value Unit"** form the drop down list *(Note: The list of available units is dependent on the selected fuel type)*
- Select the **"Cost Unit"** form the drop down list *(Note: The list of available units is dependent on the selected fuel type and currency)*
- Click on **"Save"** to save the information. *(Note: The saved information can be viewed in the Summary list and is later available when this energy source is selected for plant analysis.)*
- Click on **"New"** to add another Energy Source and its information. *(Note: Double click any row in the Summary list to select it for editing or updating).*

- Click on **"Delete"** to delete the current Energy Source selection *(Note: Energy source cannot be deleted if it is used in the plant analysis or is part of master list (Appendix –C). If the user cannot delete the energy source PHAST will display a message explaining why.)*
- Click on **"Close"** to return to the Energy Source tab of the **Plant/Equipment Information** section.

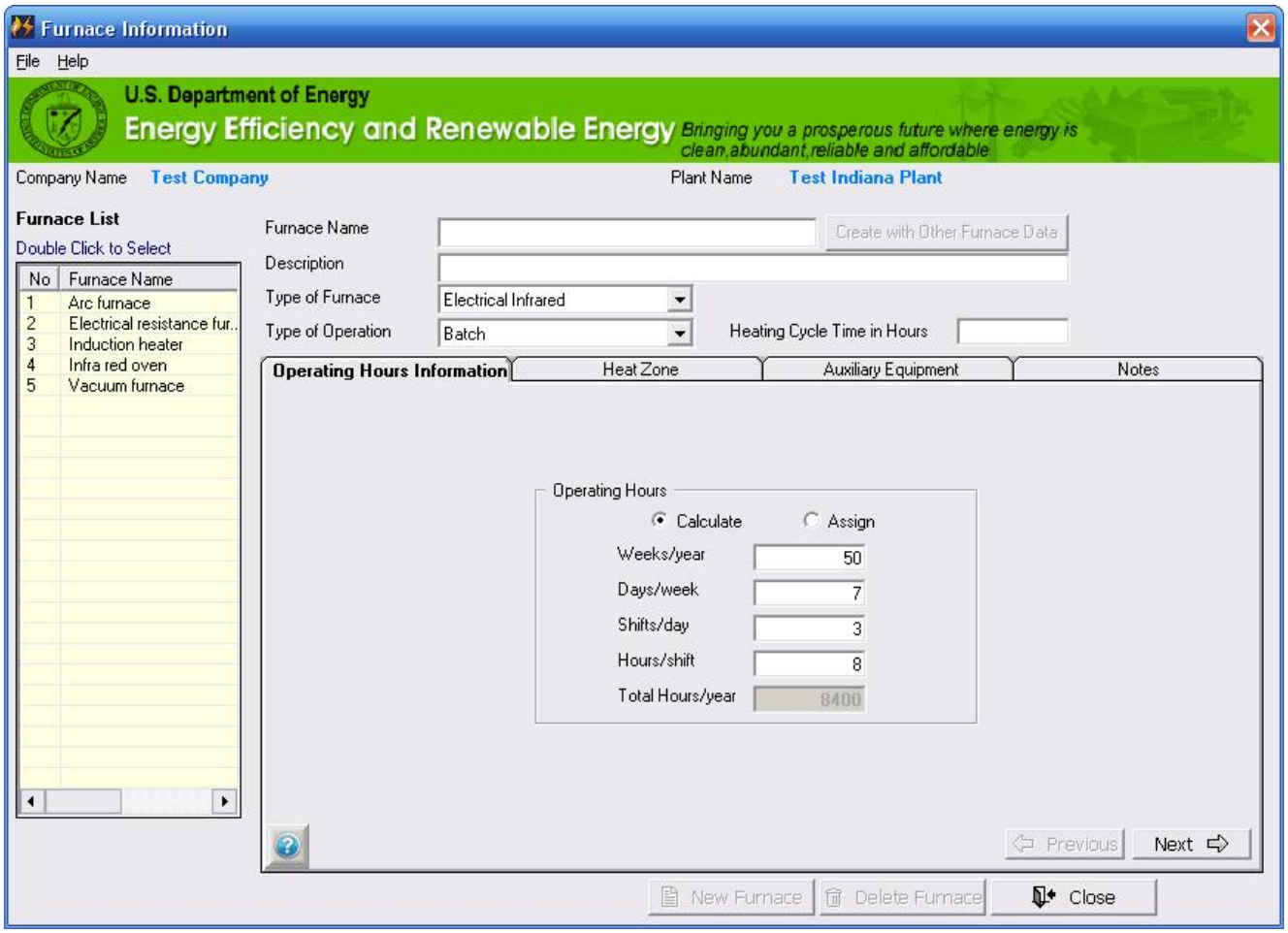
Furnace Information:
The user can view a list of all the Process Heating Equipment (Furnaces) previously entered for analysis.



Double click on any row of the list, and a separate screen will pop up showing previously entered and saved information about the selected furnace.
Note: For a new plant, the summary list will not show any furnaces, and the user must add furnaces and their operational information using the "New Furnace" section.

Add New Furnace:

Click on **"New Furnace"** to add operational information for a new furnace. A separate interface screen as shown below will pop up, allowing appropriate information for the new furnace to be added.



To start with, enter furnace name (mandatory), description and select type of furnace and operation. If the furnace operates in a batch mode, enter the heating cycle time (mandatory).

Note:
The options for types of furnaces are:

1. *Electrical Infrared*
2. *Induction Heating and Melting*
3. *Electrical Resistance*
4. *Vacuum Furnace*
5. *Electric Arc Furnace (EAF)*

The Options for types of operations are:

1. *Batch*
2. *Continuous*

Operating Hours

- Select the option of **"Calculate"** or **"Assign".**
    - For the "Calculate" option *(Note: the user must enter all the numbers specified below. PHAAST will calculate the total hours based on these inputs):*
        - Enter the number of **"Weeks/year"** for which furnace is operating.
        - Enter the number of **"Days/week"** for which furnace is operating.
        - Enter the number of **"Shifts/day"** for which furnace is operating.
        - Enter the number of **"Hours/shift"** for which furnace is operating.
        - PHAST will calculate and display the **"Total Hours/year".**
    - For the "Assign" option *(Note: user won't be given an option to enter individual numbers and must enter the total hours):*
        - Enter the number of "**Total Hours/year"**
- Click on **"Next"** or **"Heat Zone"** tab to enter information about the furnace's zones *(Note: The Operating Hours entries are saved and will be available for later editing or updating).*

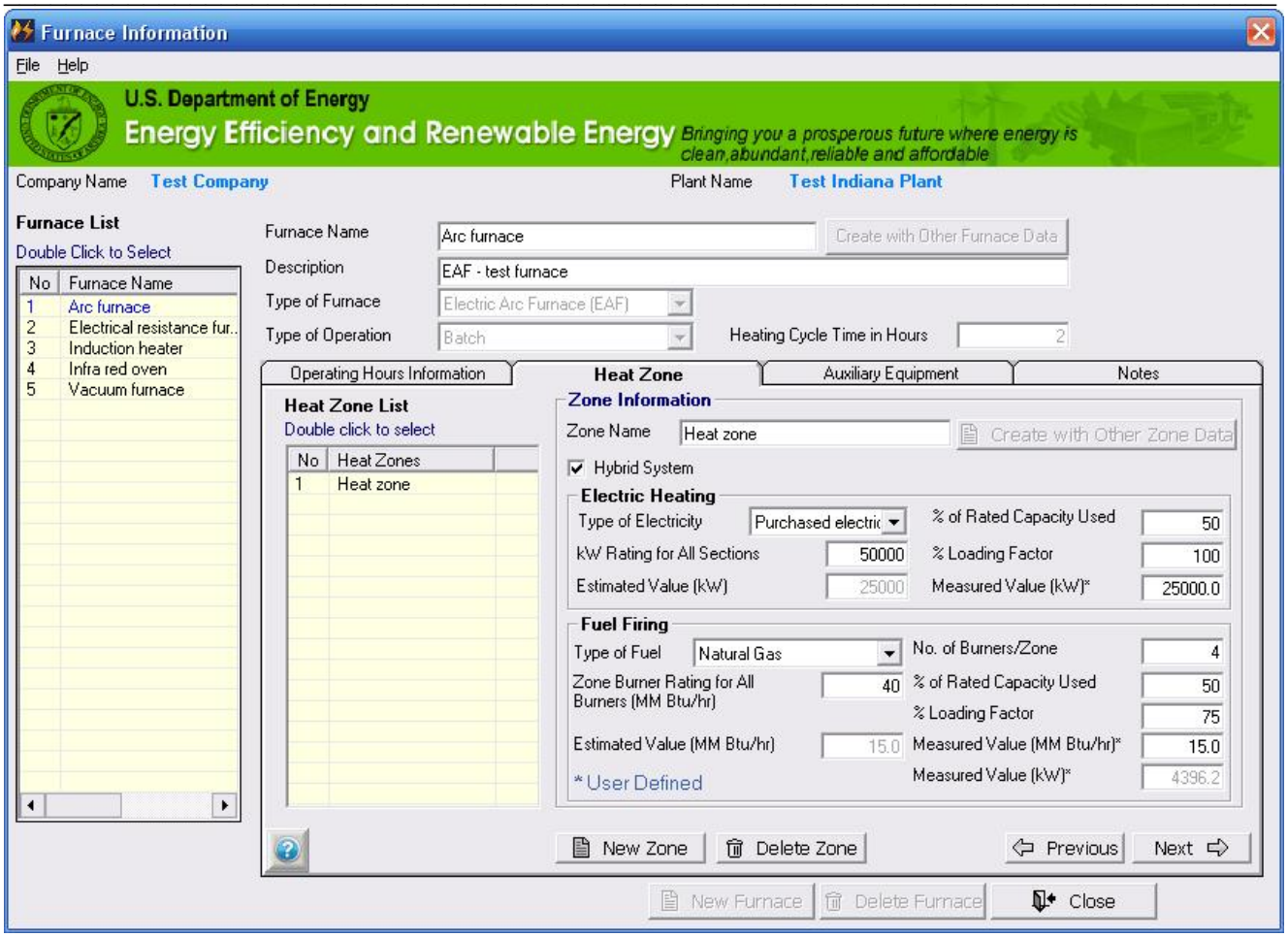
Heat Zone

A separate screen as shown below will be displayed where user can enter each zone's information or add or delete zones.

The zone information has two options. Depending on the source of heat, the user can select Electric Heating (resistance heating, induction heating, electric arc/plasma or other types), or Fuel Firing, using burners.

- In case of Electric Heating, the drop down list of electricity types will display only that electricity that is available in the "Energy Sources" of the plant information.
- In case of Fuel Firing, the drop down list of fuel type will display only those fuels that are available in the "Energy Sources" of the plant information.

Note: The Fuel Firing section will appear only if the "Hybrid System" option is selected.



- Enter the zone operating information in the input boxes.
- Click on **"Next"** to enter Auxiliary Equipment information. *(Note: The zone information entries are saved and will be available for later editing or updating).*
- Click on **"Previous"** to go to the operational information tab *(Note: The zone entries are saved and will be available for later editing or updating).*
- Click **"New Zone"** to add a new zone to a furnace. All input boxes turn to blank or default values for data entry. *(Note: The zone entries are saved and will be available for later editing or updating. The saved zone is displayed in the zone list).*
- Click **"Delete Zone"** to delete the selected heat zone of current furnace. *(Note: Make sure that the appropriate zone is selected before attempting to delete its information).*
- Click on "**Close"** to close the screen and return to the **Plant/Equipment Information** screen. *(Note: The zone entries are saved and will be available for later editing or updating).*

On this screen, the specific unit converter can also be called up by pressing the "F2" key. It can be used with the following data input boxes:

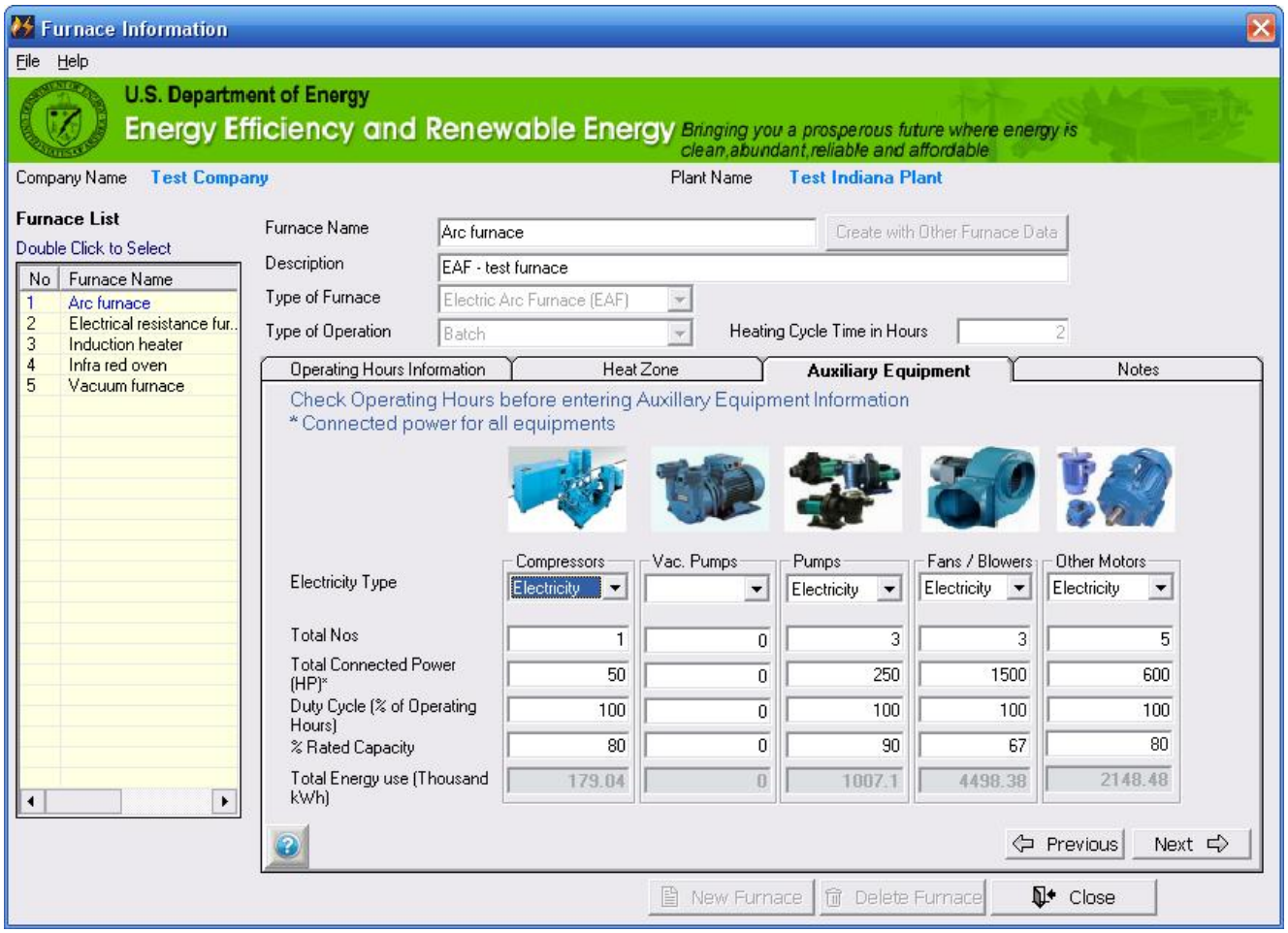
- Zone Burner Rating for All Burners
- kW Rating for All Sections

Note: A furnace can be selected by double clicking its name in the furnace list. The respective information about Operation, Heat Zone and Auxiliary Equipment will be available for review and modification. Similarly, the heat zone for a particular furnace can be selected by double clicking its name in the heat zone list (Heat Zone tab), and the respective data will be available for review and modification.

Auxiliary Equipment

Click on **"Auxiliary Equipment"** tab to enter information about plant's auxiliary equipment, including compressors, fans and blowers (outside or inside the furnace), vacuum pumps and other electric motors used for material handling and processing or other motor driven production equipment. This information is used to calculate the energy used by auxiliary equipment associated with the furnace. A separate screen as shown below will be displayed where the user can enter such information.

Note: It is assumed that all auxiliary equipment is powered by electricity. The drop down list of electricity types will display only the type of electricity that is available in the "Energy Sources" section of the plant information.

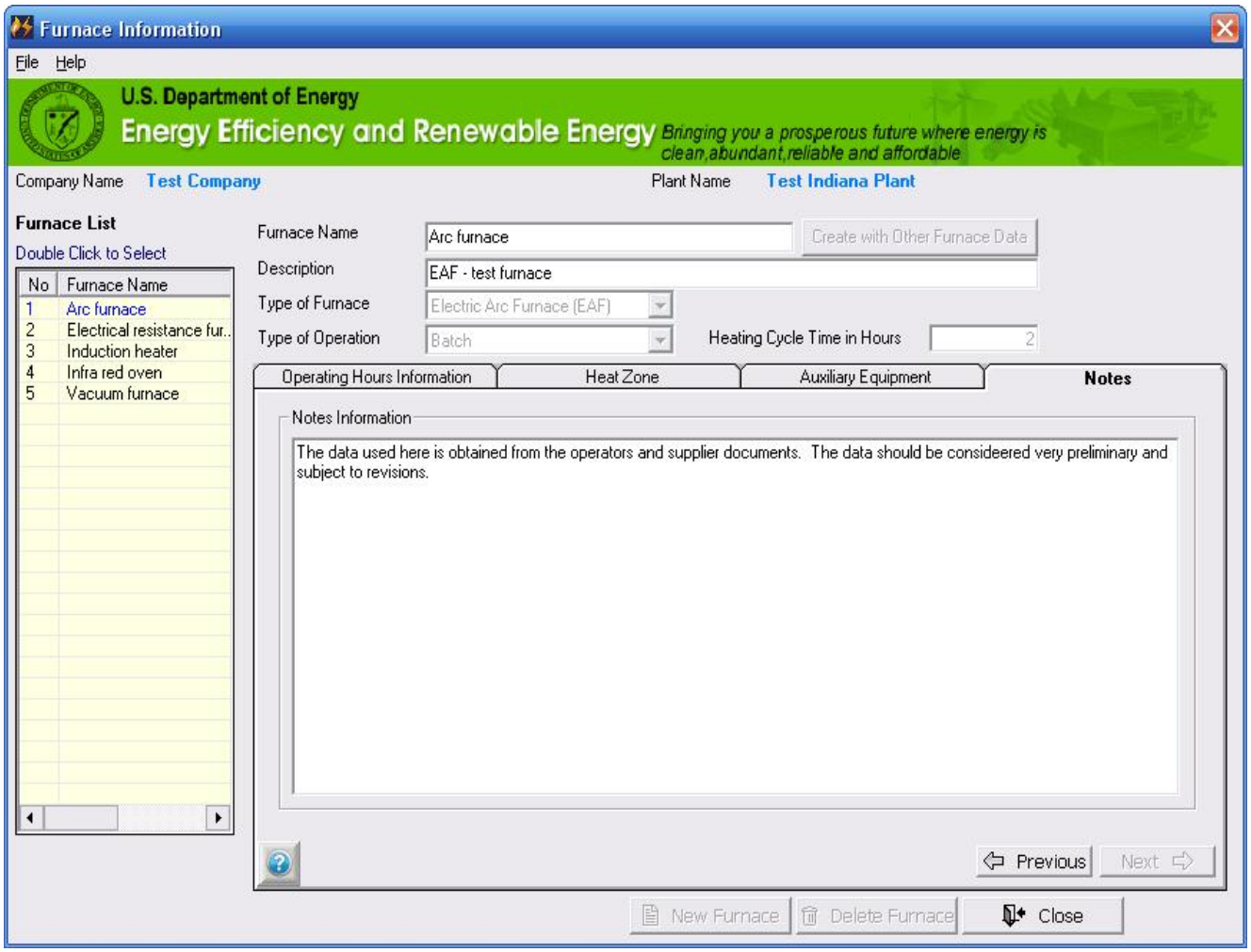


- Enter the auxiliary equipment operating information in the input boxes.
- Click on **"Next"** to go to Notes/Comments tab *(Note: The information entries are saved and will be available for later editing or updating).*

- Click on **"Previous"** to go to zone information tab *(Note: The zone information entries are saved and will be available for later editing or updating).*
- *Note: On this screen, the specific unit converter can be opened by pressing the "F2" key to change units for Total connected Power.*
- Click on **"New Furnace"** to add information for a new furnace.
- Click on **"Delete Furnace"** to delete the currently selected furnace. *(Note: Make sure that the correct furnace is selected before attempting to delete its information).*
  Note: These two buttons are enabled only for the Operating Hours Information tab of furnace information screen.
- Click the **"Close"** button to close the screen and return to the main screen.

Notes:

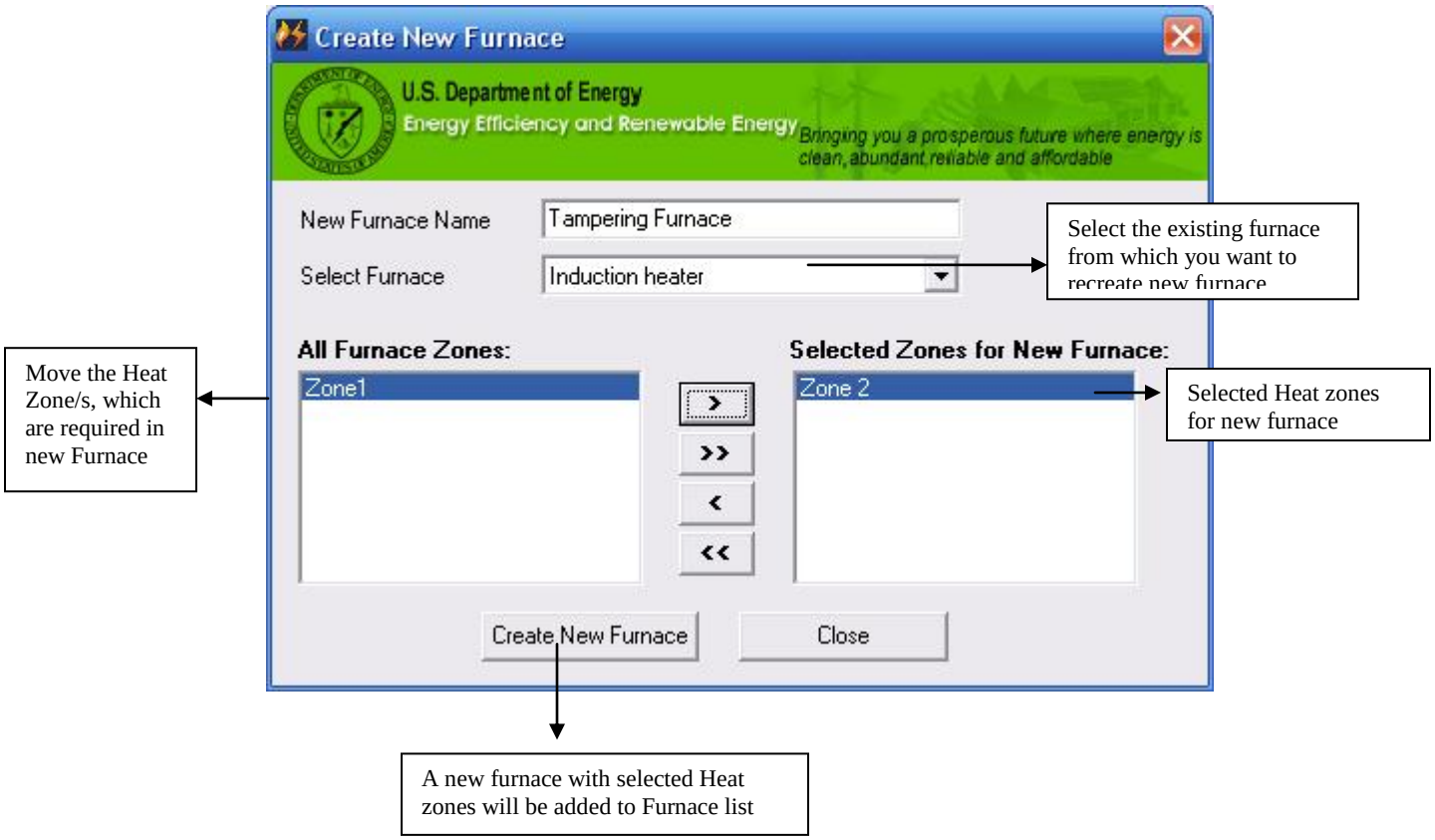
Click on the **"Notes"** tab to enter general notes and comments information about the plant and furnace.



Create New Furnace:

PHAST has an option to create a new furnace using the information, including heat zone information, from an existing furnace. The newly created furnace will have identical information to the existing one. Further information for the Heat Zone, Auxiliary Equipment or other Operation can be added or modified later.

- Click on **"Create with Other Furnace Data"** next to the **Furnace Name** on the screen. A separate screen interface will pop up as shown below.
  *Note: This button is enabled only when new furnace is being added and at least one character is entered in **"Furnace Name"** Text box.*

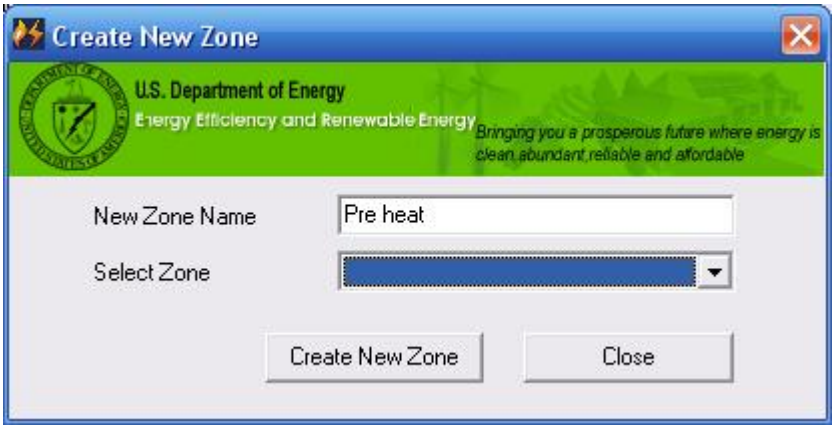


- Select the **furnace from the drop-down list** of existing furnaces; i.e., the one which is to be duplicated.
- Select the **zones from left side window** (All Furnace Zones) and move **to the right side window** (Selected Zones for New Furnace)
  Notes:
  - *For multiple selections of zones hold CTRL key and select zones from the list.*
  - *Use Arrow Keys (>, >>, <, <<) to move the zones between two windows.*
- Click on **"Create New Furnace"** to create a new furnace with selected zones and their data. *(Note: The newly created furnace will appear in the furnace list)*
- Click on **"Close"** to close the screen without saving the data and return to the **Furnace Information** screen.

Create New Zone:

PHAST provides the option of creating a new furnace using the existing zone information for that furnace. The newly created zone will have identical information to the existing one, and can be modified later.

- Click on **"Create with Other Zone Data"** next to the **Zone Name** on the screen. A separate screen interface will pop up as shown below.
  *Note: This button is enabled only when a new zone is being added and at least one character is entered in **"Zone Name"** Text box*

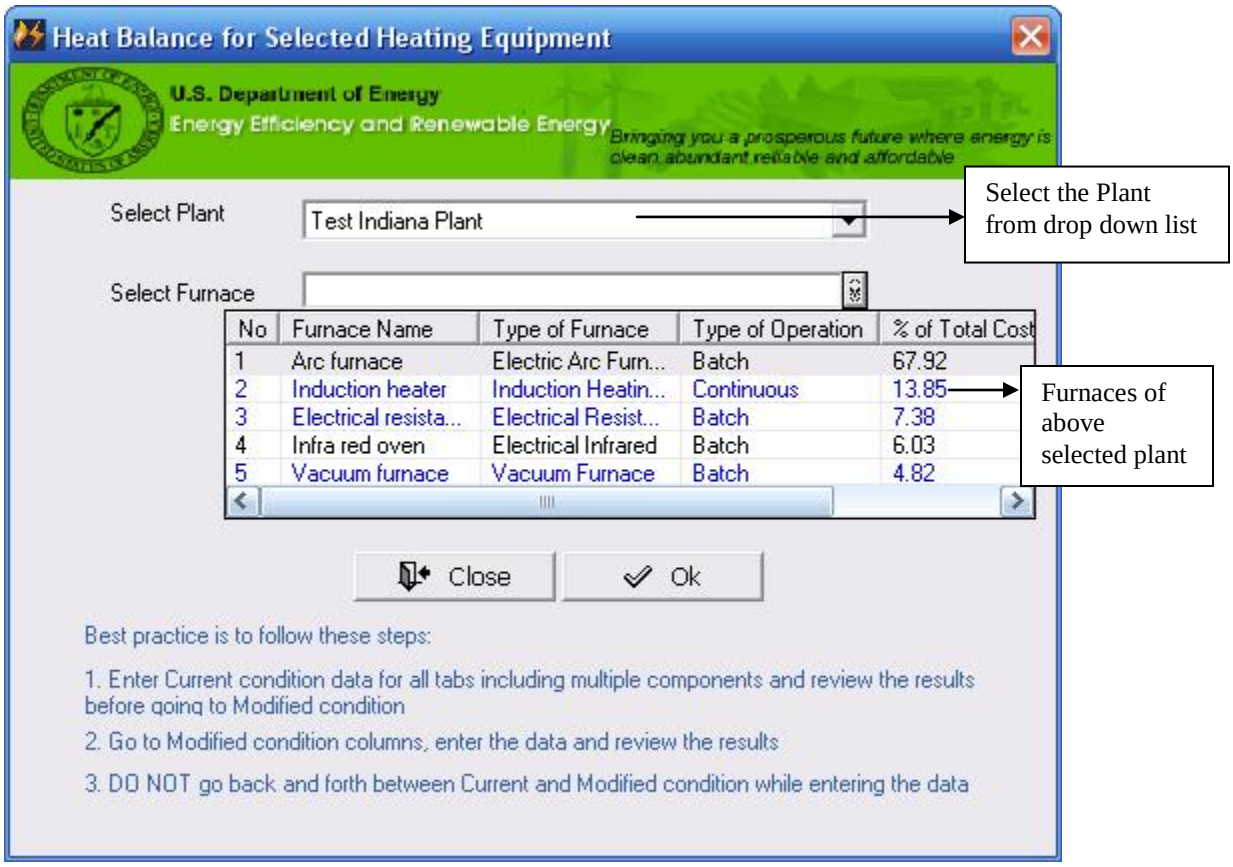


- **From the drop-down list** of existing zones, select the **zone** which is to be duplicated.
- Click on **"Create New Zone"** to create a new zone with this data. (*Note: The newly created zone will appear in the zone list of the Zone Information tab of the Furnace Information page.*)
- Click on **"Close"** to close the screen without saving the data and return to the Heat Zone tab screen.

Furnace Analysis and Heat Balance:

This section is used to analyze the energy used in various parts of the furnace under given operating conditions. The areas for energy use include charge or load, fixtures, trays etc., wall losses, water cooling losses, losses through openings and exposed hot parts and flue products (or exhaust gases). It allows the user to identify major areas where energy is consumed and to study the effect of changes in operating conditions which affect the furnace's energy consumption.

Select Furnace for Analysis
Click on **"Furnace Analysis"** from the main screen. Separate screens will pop-up as shown below



The screen includes a list of furnaces surveyed in the Plant Information section with the percentage of the total energy cost calculated during the survey for each furnace. The furnace analysis can be carried out for any of the furnaces, one at a time. It is recommended that to begin with, you select the furnaces that, together, use a relatively large amount of energy. In the case shown above, the top two furnaces use approximately 80% of the total plant energy, and it will be advisable to begin by performing a detailed analysis for these two.

Note: Furnace Names shown in blue text indicates that those furnaces have never been analyzed, while black have been previously analyzed previously and their data has been saved.

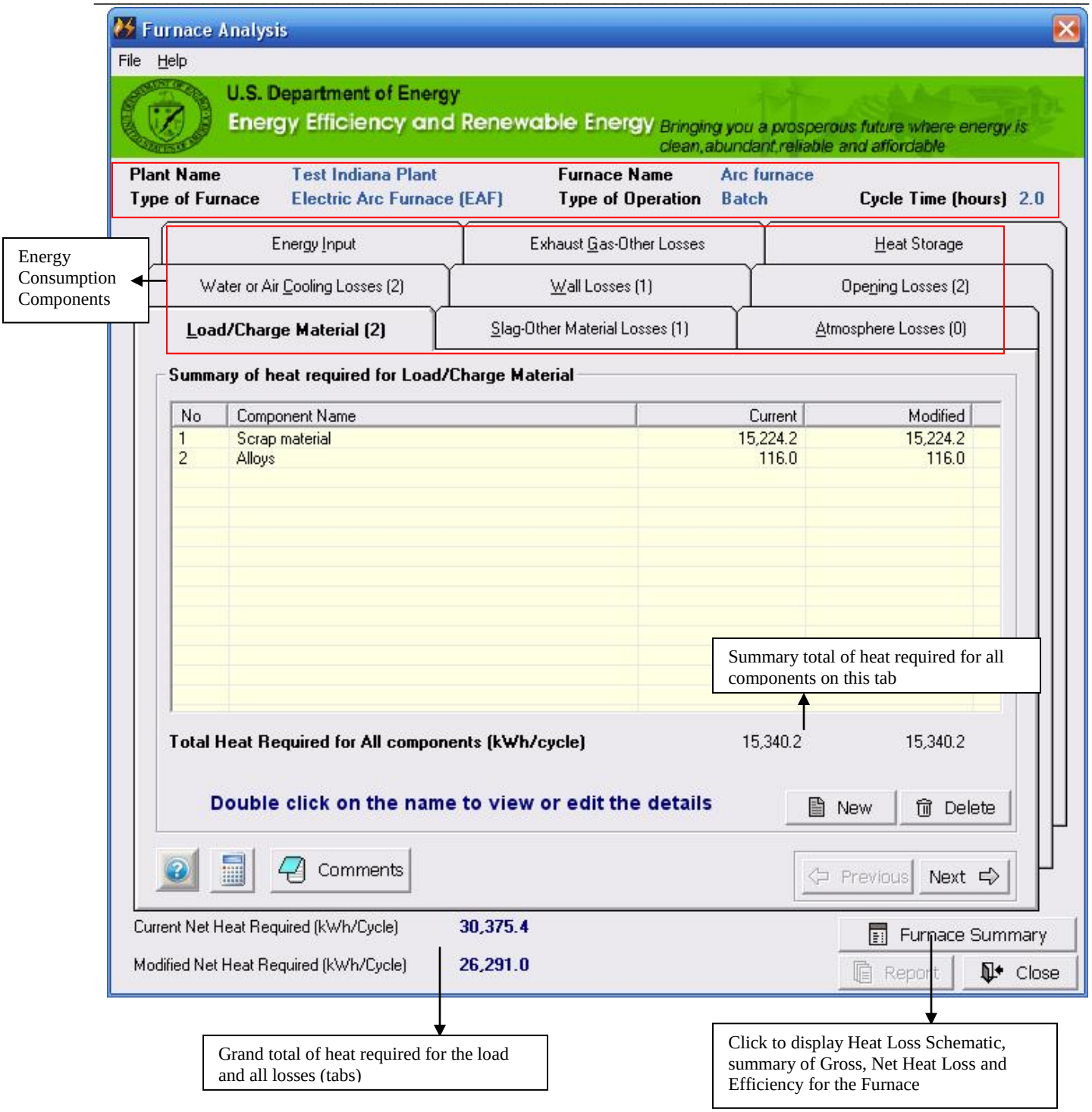
- Select the **Plant** from the drop down list.
- Select the **Furnace** from the drop down list.
- Click **"OK"** to analyze the selected furnace. A new screen as shown below will open. Information on energy use for the product and losses from the furnace can be viewed or added.
- Click **"Close"** to exit without analyzing any furnace and return to main screen.

On selection of one of the furnaces from the list, a new screen will come up. It has nine tabs that represent the commonly encountered components of a furnace's energy consumption.

1. Load/Charge Material
2. Slag-Other Material Losses
3. Atmosphere Losses
4. Water or Air Cooling losses
5. Wall Losses
6. Opening Losses
7. Energy Input / Auxiliary Power – Heat Use
8. Exhaust Gas – Other Losses/Energy Input – Exhaust Gas Losses
9. Heat Storage

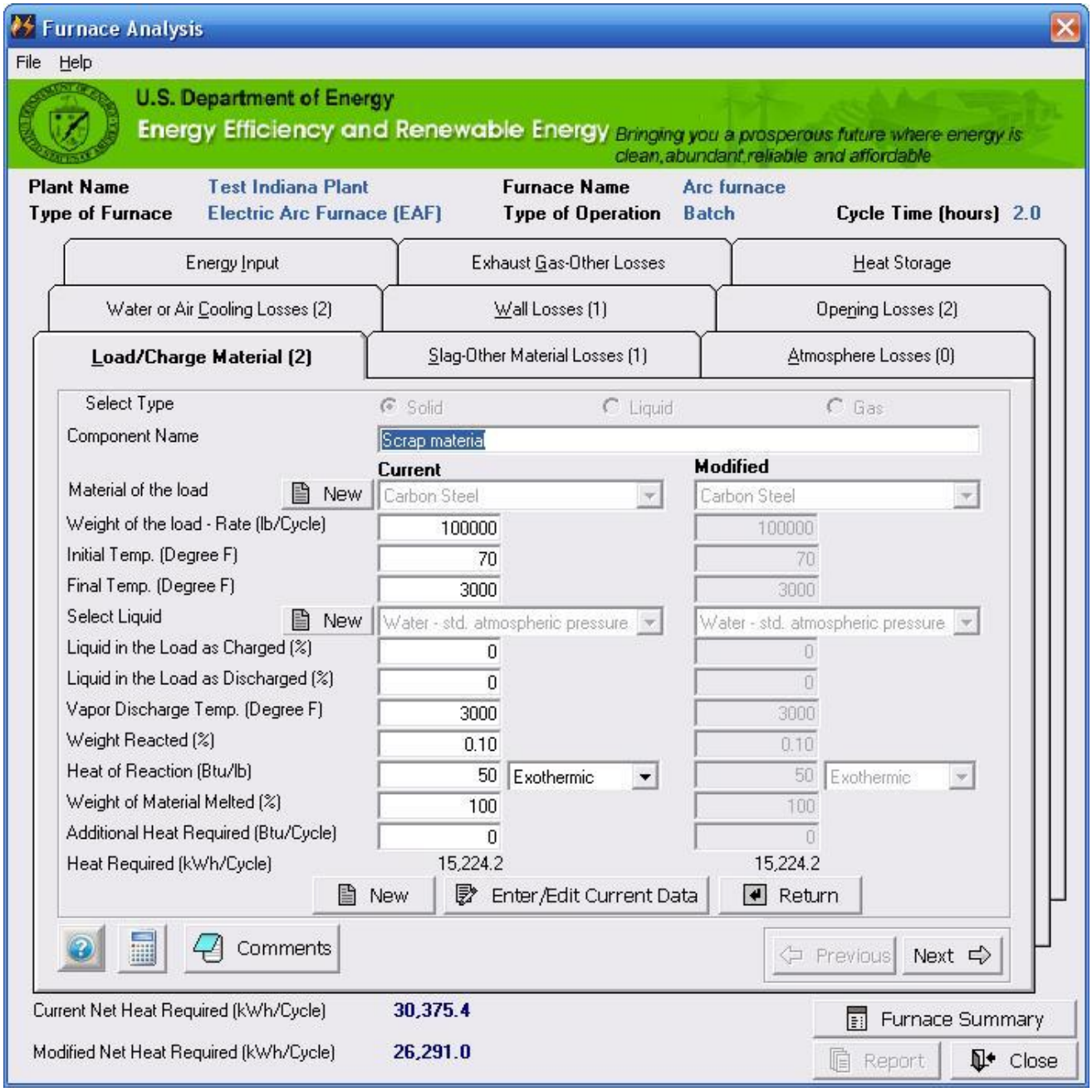
Each tab's screens are designed in two parts – The first screen (below) displays the summary of details entered on the second screen. Multiple components for this screen can be added via the heating system detail (second) screen, described later in this section.

Note:
The number of components entered for each tab is displayed in parentheses, along with the tab name on the summary screen.
The name, type and other details for the furnace currently being analyzed are displayed as a header on the screen.



- To edit or update details on a component already entered on this list, double click its row.
- Click on "**New**" to enter new details of a specific loss component.
- Click on "**Delete**" to delete the selected component from the list. Once deleted, the component information will not be available for analysis or modification.
- Click on "**Previous**" or **Next** to toggle between different summary screens in the Furnace Analysis section. Alternatively, the user can click on the name of the tab of a specific screen.

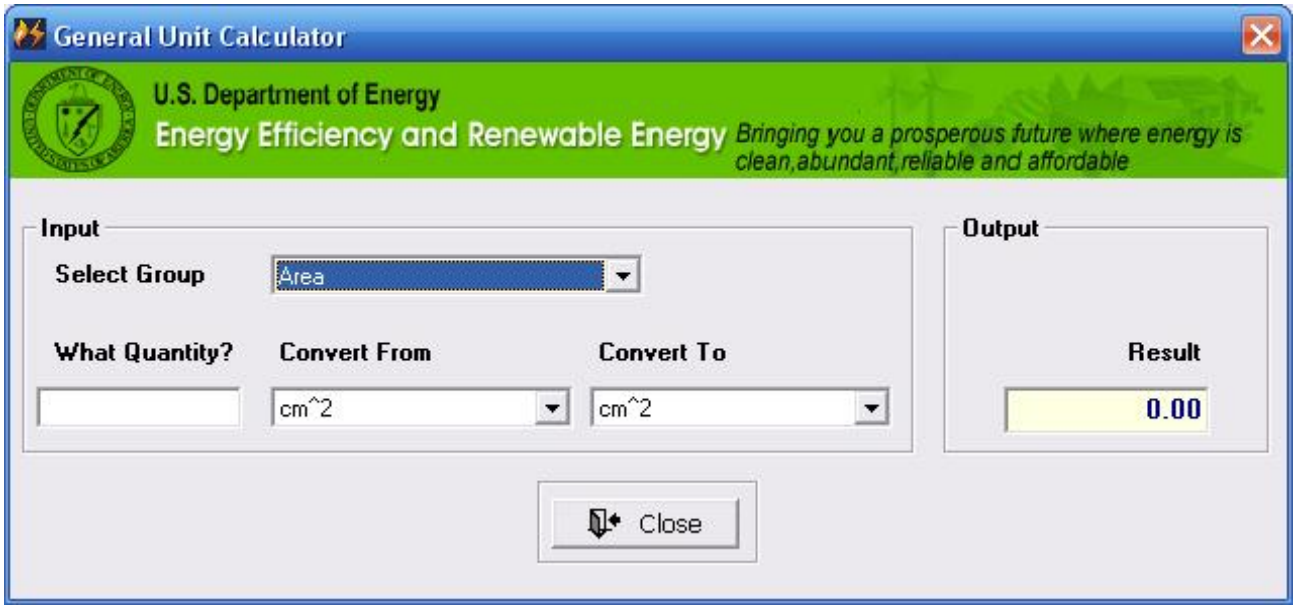
- Click on "**Furnace Summary**" to open up a new screen where summarized data of Heat Losses, Energy Used and Furnace Efficiency, along with schematic (a static Sankey diagram) of furnace losses can be viewed.
- Click on "**Close"** to close the screen and return to the main screen.



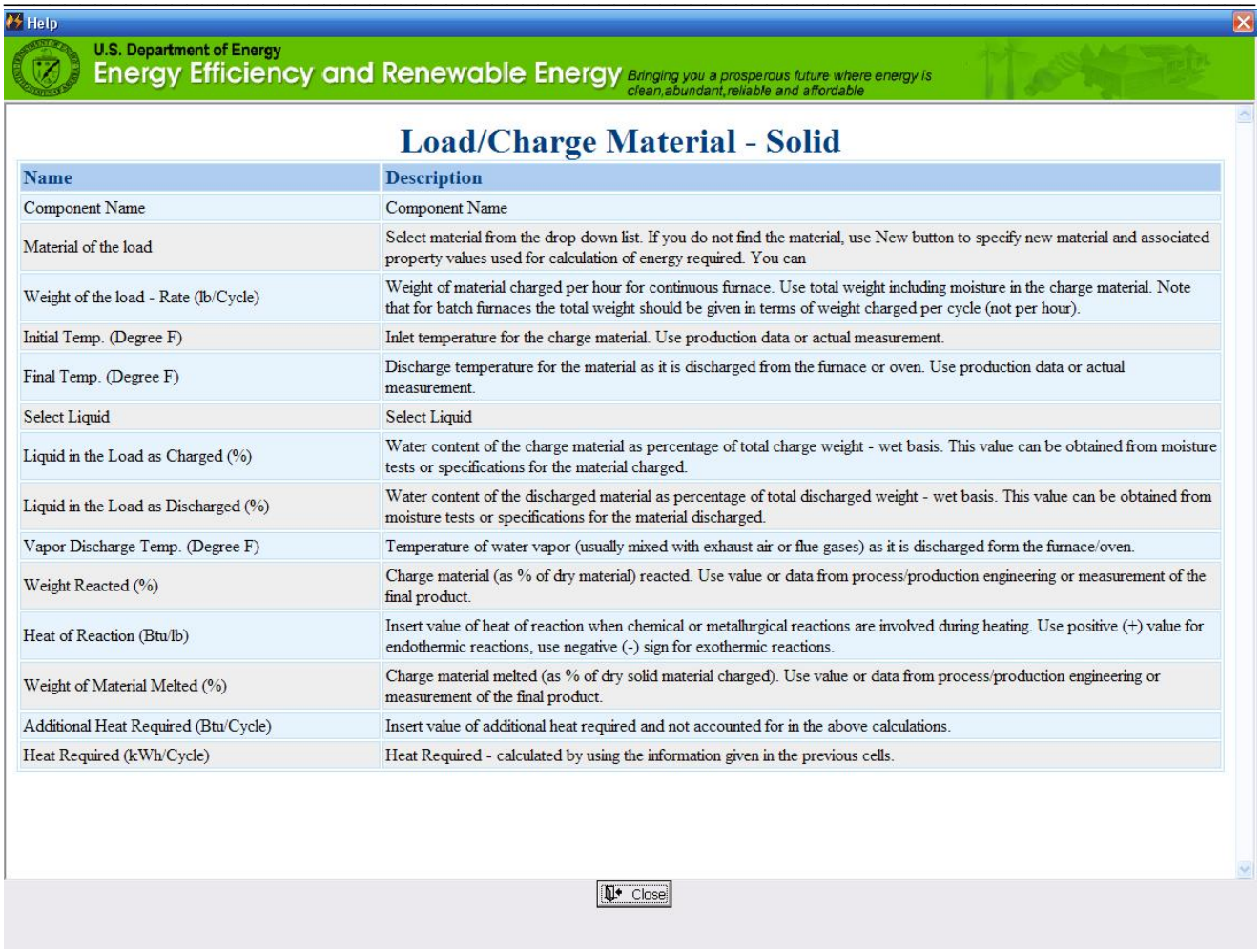
Common Instructions for ALL tabs

Each screen has two columns. One is used to enter "current" operating information and the other for "modified" operating conditions. At any particular moment, only one of these is enabled. The user should start with the current information column for each tab and complete the analysis to study the results. These results can then be used to decide on possible changes to make in the operating These changes can be inserted in the "modified" column to study their effect.

- Click on "**New"** to enter new component details of a specific loss (tab). You can enter multiple components while on this screen.
- Click on "**Return**" to go back to summary screen to view the list of entered components.
- Click on **"Enter/Edit Modified Data"** to switch to the portion of the screen where the user can enter information changed from the current/modified condition of the Furnace. This button toggles between the current and modified conditions. Later, this information is used in evaluating the performance impact of the changes in the Summary and Furnace Analysis reports.
  *Note: When clicking on **"Enter/Edit Current Data**" for the first time, data entered for the "Current" condition will automatically be transferred to the "Modified" column. The user can then alter this data. The purpose is to reduce unnecessary data input.*
- Click on "**Previous"** or **Next** to toggle between the different Furnace Analysis summary screens. Alternatively, click on the name of the tab to access a specific screen.
  *Note: The current screen is highlighted with **bold text** on the tab.*
- Click on **"Report"** to view the Furnace Analysis Report (described in detail at end of this manual) for the current furnace. This button is enabled only for the tab *Exhaust Gas - Other Losses* as it is usually one of the largest areas of heat consumption. The purpose of this is to ensure that the user has entered the data for all previous tabs before viewing the report.
- Click on "**Close"** to close the screen and return to the main screen.
- Click on  to access the general unit converter. A separate screen will pop up where the user can select different unit groups and their conversions. Appendix A contains the table of units.

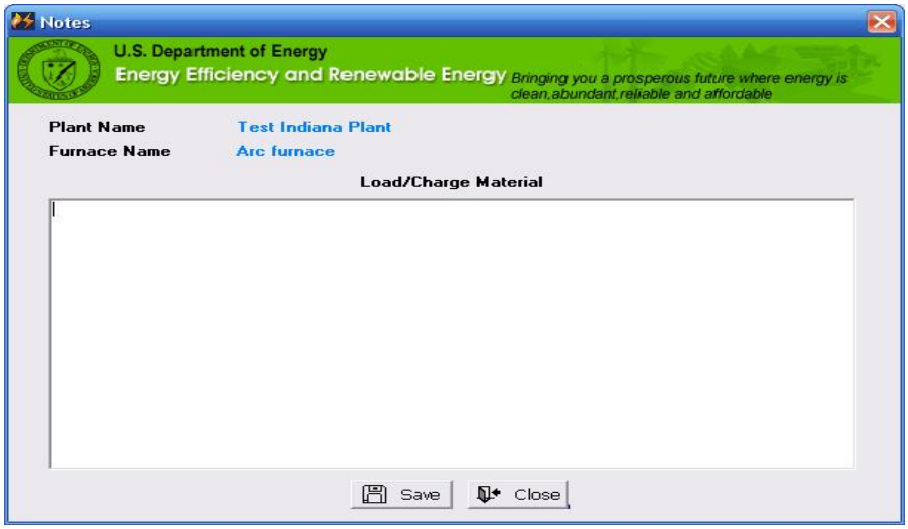


- Click on  to view the each field's description and a detailed explanation for each tab. A separate screen will pop up to display the help content specific to the tab from which it was clicked.

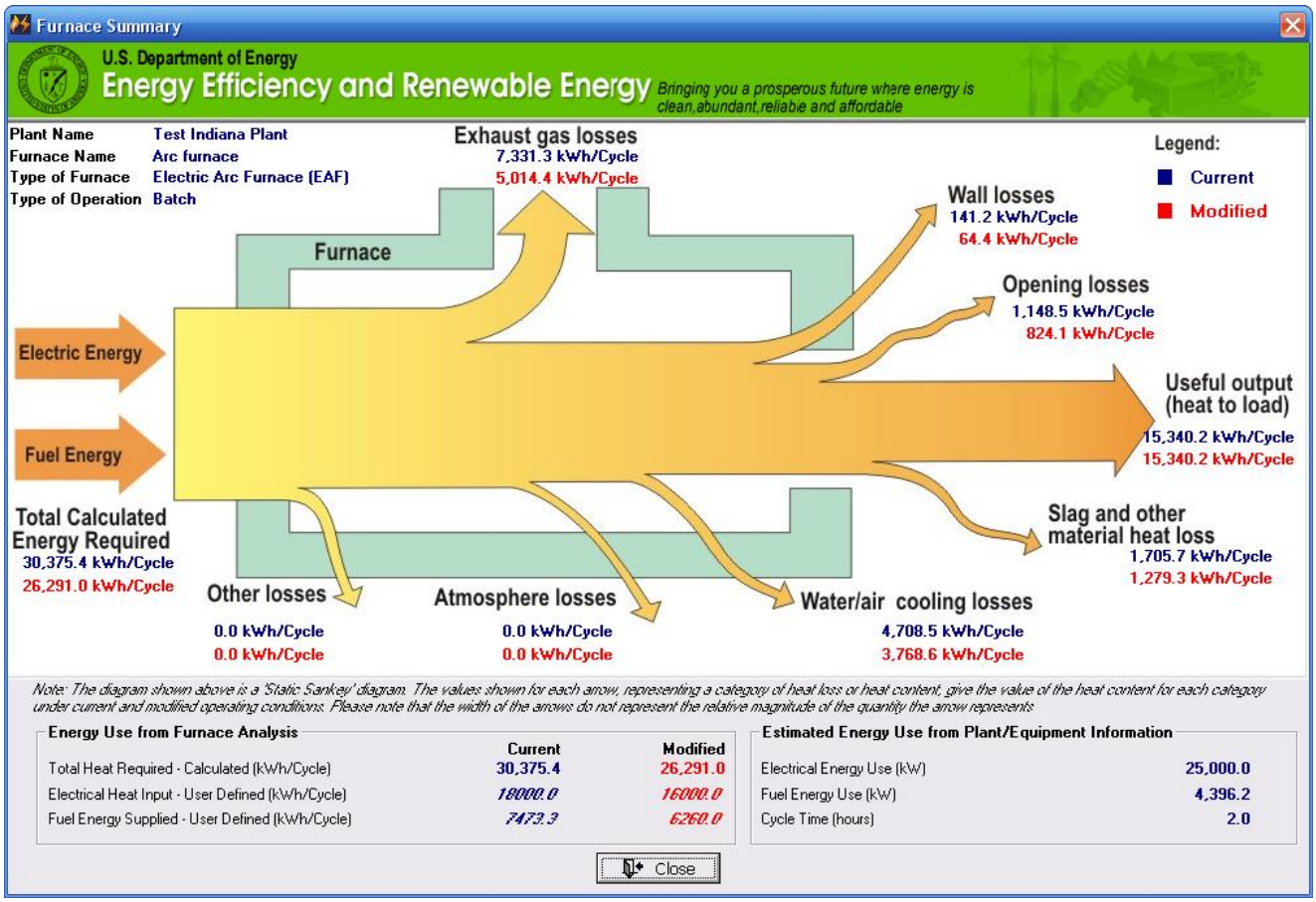


Name	Description
Component Name	Component Name
Material of the load	Select material from the drop down list. If you do not find the material, use New button to specify new material and associated property values used for calculation of energy required. You can
Weight of the load - Rate (lb/Cycle)	Weight of material charged per hour for continuous furnace. Use total weight including moisture in the charge material. Note that for batch furnaces the total weight should be given in terms of weight charged per cycle (not per hour).
Initial Temp. (Degree F)	Inlet temperature for the charge material. Use production data or actual measurement.
Final Temp. (Degree F)	Discharge temperature for the material as it is discharged from the furnace or oven. Use production data or actual measurement.
Select Liquid	Select Liquid
Liquid in the Load as Charged (%)	Water content of the charge material as percentage of total charge weight - wet basis. This value can be obtained from moisture tests or specifications for the material charged.
Liquid in the Load as Discharged (%)	Water content of the discharged material as percentage of total discharged weight - wet basis. This value can be obtained from moisture tests or specifications for the material discharged.
Vapor Discharge Temp. (Degree F)	Temperature of water vapor (usually mixed with exhaust air or flue gases) as it is discharged form the furnace/oven.
Weight Reacted (%)	Charge material (as % of dry material) reacted. Use value or data from process/production engineering or measurement of the final product.
Heat of Reaction (Btu/lb)	Insert value of heat of reaction when chemical or metallurgical reactions are involved during heating. Use positive (+) value for endothermic reactions, use negative (-) sign for exothermic reactions.
Weight of Material Melted (%)	Charge material melted (as % of dry solid material charged). Use value or data from process/production engineering or measurement of the final product.
Additional Heat Required (Btu/Cycle)	Insert value of additional heat required and not accounted for in the above calculations.
Heat Required (kWh/Cycle)	Heat Required - calculated by using the information given in the previous cells.

- Click on " Comments " to enter the additional notes or comments while analyzing each type of heat loss or consumption. A separate screen will pop up where the user can enter notes and comments pertinent to the data on that tab.



Click on " Furnace Summary " to open a new screen where summarized data of Heat Losses, Energy Used and Furnace Efficiency, along with a schematic of furnace losses, can be viewed. A sample furnace summary schematic is shown below.

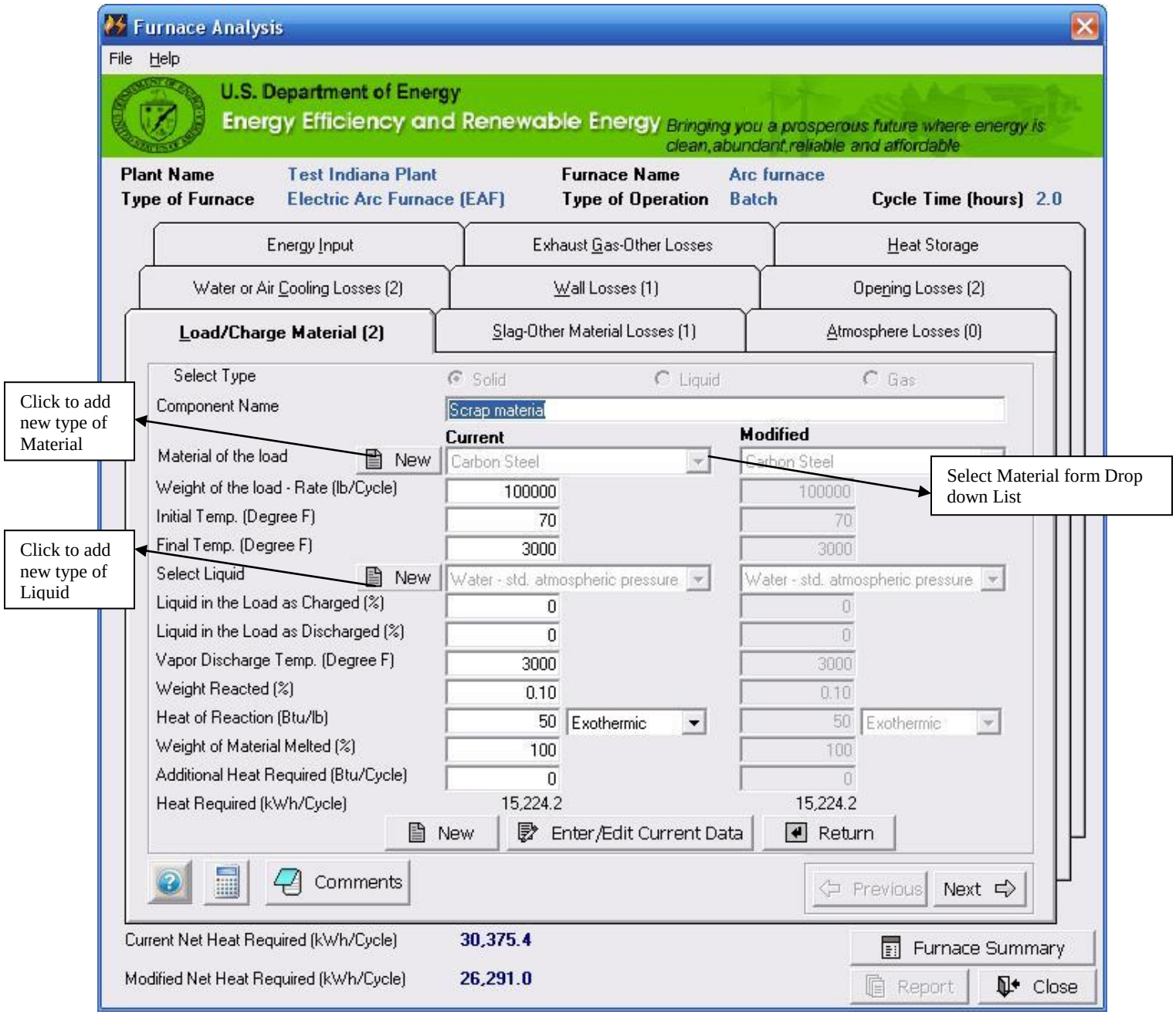


Additional Notes:

- *Refer to "Help", "Calculator", "Look up" or "Tool-tip" for additional references or knowledge material.*
- *Move the mouse cursor over the label on each screen to display a "tool-tip" and get hint about the information the user is expected to fill in the respective data box.*
- *On all screens, a specific unit converter can be opened by pressing the "F2" key when the cursor is in a specific data box. Data boxes that allow opening of the specific unit converter are mentioned in each tab's details.*
- *Changing a value in the data boxes will change the Gross and Net Heat Required for the Current or Modified Condition. PHAST calculates and displays these real-time values at the bottom of each screen. The overall status and comparison of Current and Modified conditions can be found in the Furnace Analysis Report, described later in this document.*

Load Charge Material:

A list of commonly used materials for furnace charges, fixtures and process atmospheres is given in the Type of Material drop-down menus. As described below, it is possible to add additional materials (or modify the properties of the existing materials) if the one for your specific application is not available in this list. The user-added material and data will be automatically added to the database.



- Select the **Type** of material (i.e., Solid, Liquid, or Gas) for load charge.
- Enter "**Component Name**" for load charge.
- Select the **Material** from drop down list *(Note: if the desired material is not available, a new material can be added as described later in this section)*

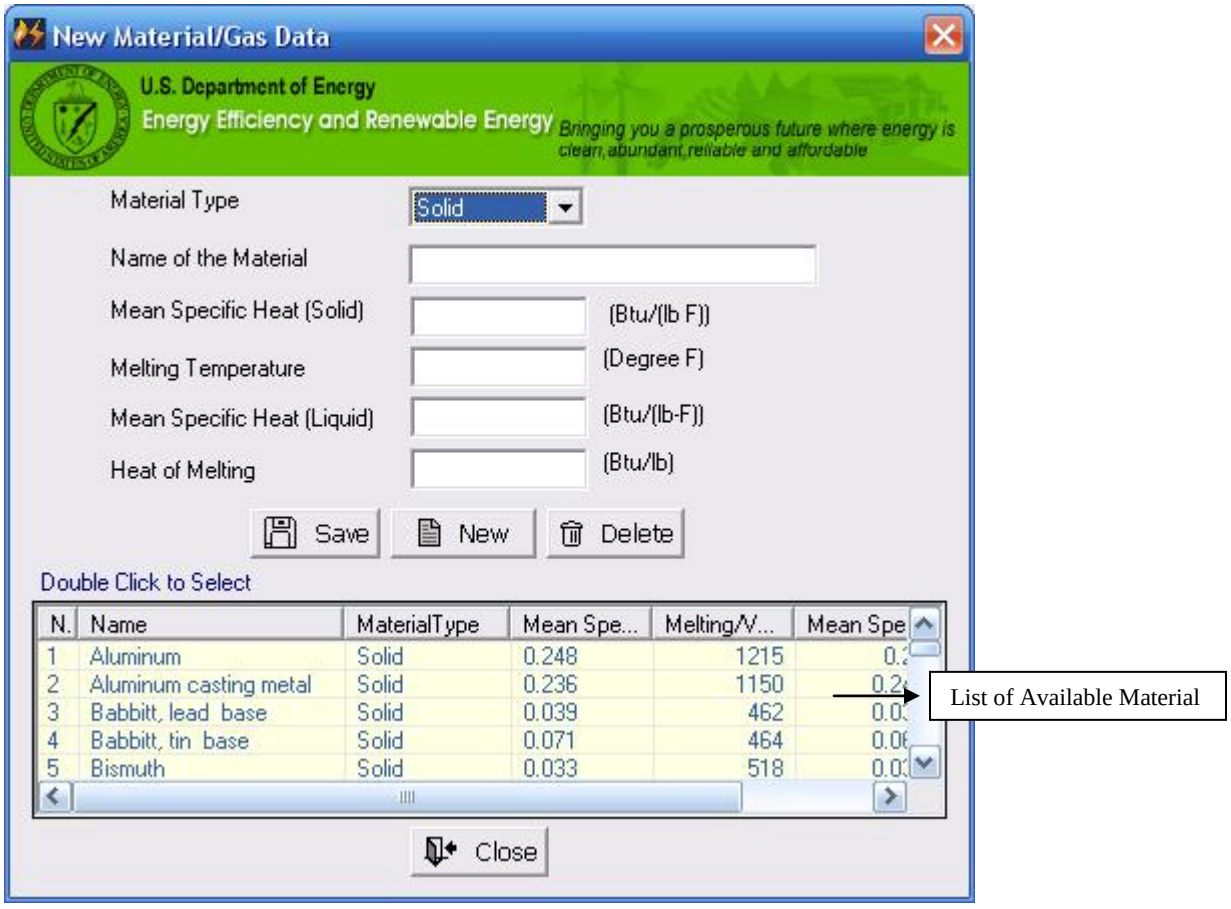
- Enter data in the **other input boxes** on the screen.
- **"Heat Required"** is calculated based on the data provided and is displayed at the bottom of the tab.
- Click on "**Return**" to go back to summary screen to view the list of entered components. A pop up message box will appear asking to save the entered data.
- Click on **"New"** to enter new component. You can enter multiple components while on this screen.

Note: To insure correct and meaningful data, pop up message box will appear while entering the data. Each pop up validates the entered data and displays an informational message and/or provides further instructions.

Add New Material:

Click on **"New"** next to the label of *Material of the Load* to enter new material that is not in the list or to edit information about an existing material. A new interface screen as shown below will open for users can enter or edit the data.

Note: Please do not change the property values for default materials included in the master database. Changing these values can give inaccurate results when the application is exported and used by another user. If the new material is similar to one in the master database, add it as a new material with a different name.

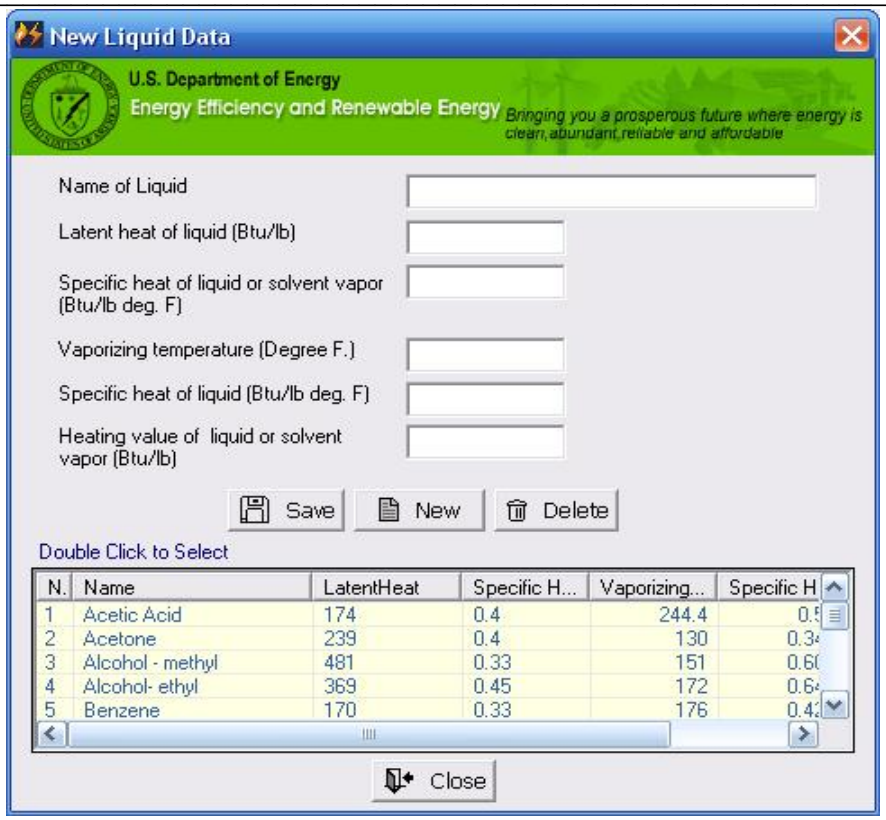


- Select the **Type** of material from drop down list (i.e., Solid, Liquid or Gas)
- Enter the required **Information** for the Mean Specific Heat (Solid), Melting Temperature, Mean Specific Heat (Liquid), and Heat of Melting.
- Click on **"Save"** to save the new material. The saved material will appear in the bottom list as well as in the drop down list on the **Furnace Analysis** screen.
- Click on **"New"** to add another new material with the required information
  Note: Name, Mean specific Heat (Solid) and Melting point of the Material are mandatory information for a new material. If the final temperature of the process is greater than the melting point of the material, Mean Specific Heat (Liquid) and Heat of Melting will be required and must be provided here. Otherwise, Heat Loss calculations will be incorrect.
- Click on **"Delete"** to delete the material from the list. The material will not be available for selection from Drop down list on the Furnace Analysis screen. PHAST will not allow deletion of materials which are in the master database or which have been selected in any of the plants covered by the database.

Add New Liquid:

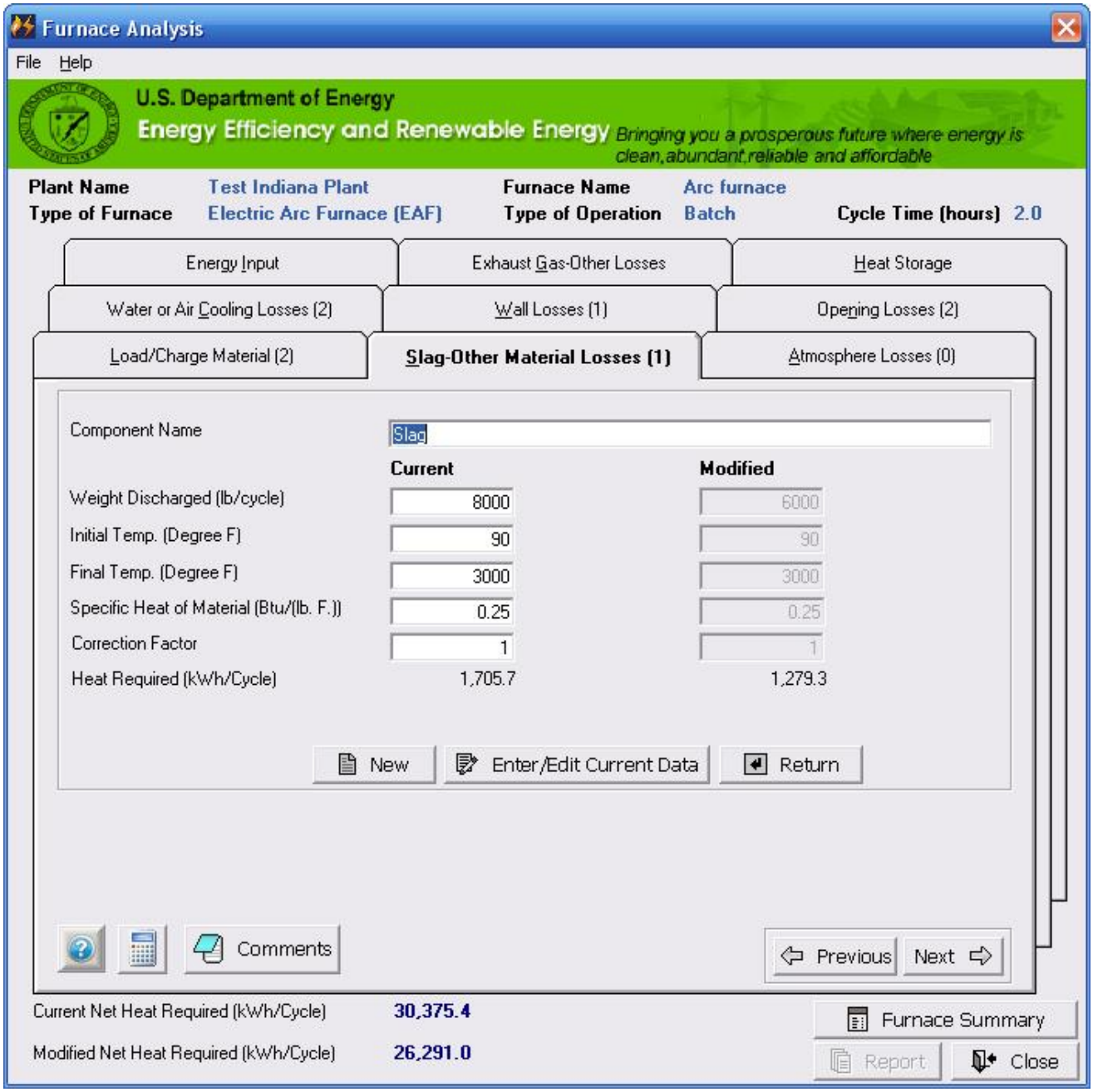
Click on **"New"** next to the label of *Select Liquid* to enter a new material that is not in the list or to edit information about an existing material. A new interface screen as shown below will open for the user to enter or edit the data.

Note: Please do not change the property values for the default materials included in the master database. Changes in these values can give inaccurate results when the application is exported and used by another user. If the new material is similar to one in the master database, add it as a new material with a different name.



- Enter the **Name** of the new Liquid Material.
- Enter the required **Information** of the Mean Specific Heat (Liquid), Vaporizing Temperature, Latent Heat of Vaporization, Mean Specific Heat (Vapor), and, if applicable, the heating value of the liquid or solvent vapor..
- Click on **"Save"** to save the new material. The saved material will appear in the bottom list as well as in the drop down list on the **Furnace Analysis** screen.
- Click on **"New"** to add another new material with its required information.
  Note: Name, Mean specific Heat (Liquid) and Vaporizing point of the Material are mandatory information for the new material. If the final temperature of the process is greater than the vaporizing point of the material, Mean Specific Heat (Vapor) and Latent Heat of Vaporization will be required and must be provided here. Otherwise, Heat Loss calculations will be incorrect.
- Click on **"Delete"** to delete the material from the list. The material will not be available for selection from Drop down list on the Furnace Analysis screen. The application will not allow deletion of materials that are in the master database or which have been selected in any of the plants covered by the database.

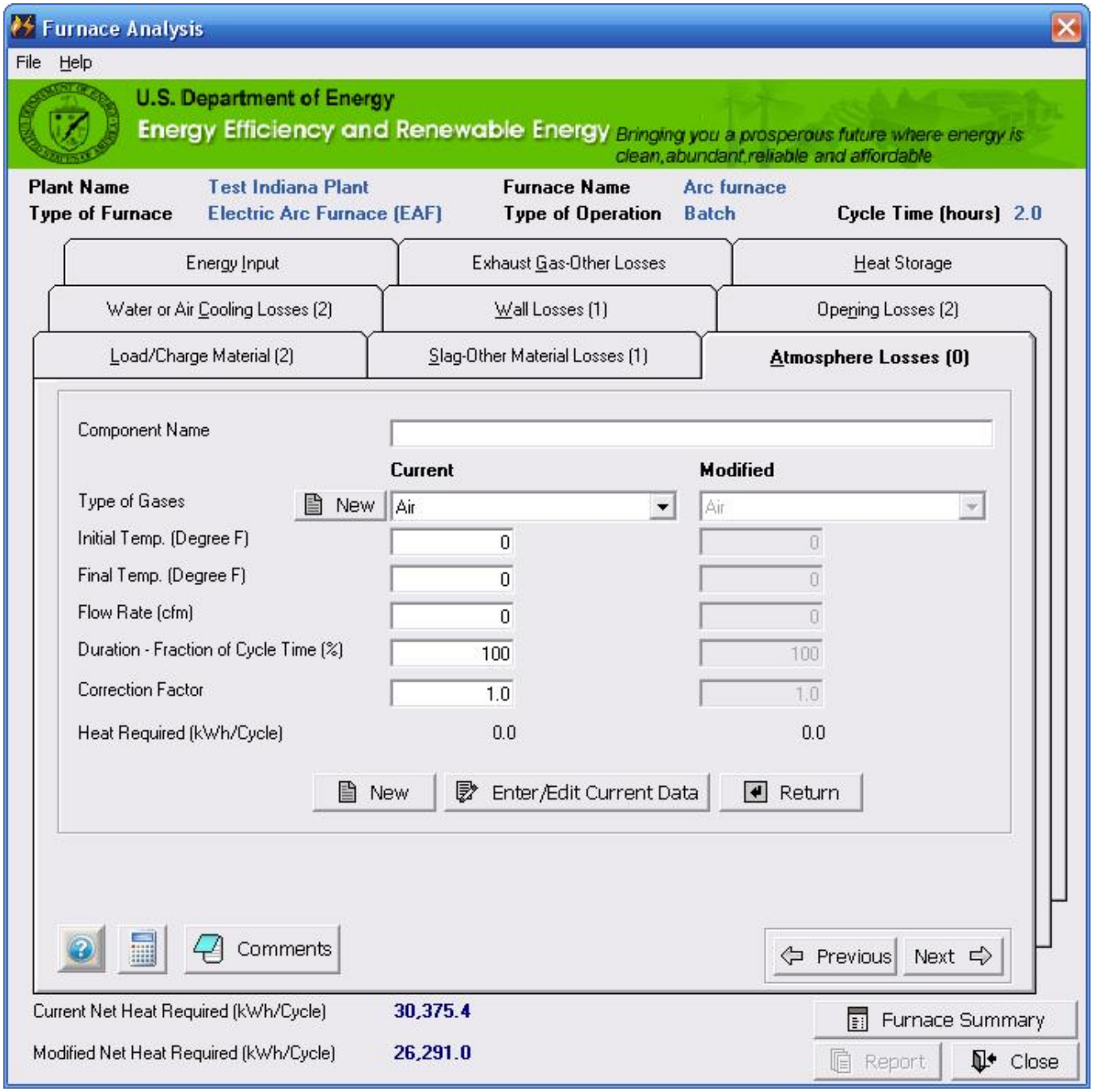
Slag-Other Material Losses



- Enter "**Component Name**" for Slag-Other Material Losses.
- Enter data in the **other input boxes** on the screen.
- **"Heat Required"** is calculated based on the input provided and is displayed at the bottom of the screen.
- Click on "**Return**" to go back to summary screen to view the list of entered components. A pop up message box will appear asking to save the entered data.
- Click on **"New"** to enter new component. You can enter multiple components while on this screen.

Note: To insure correct and meaningful data, pop up message box will appear while entering the data. Each pop up validates the entered data and displays an informational message and/or provides further instructions.

Atmosphere Losses



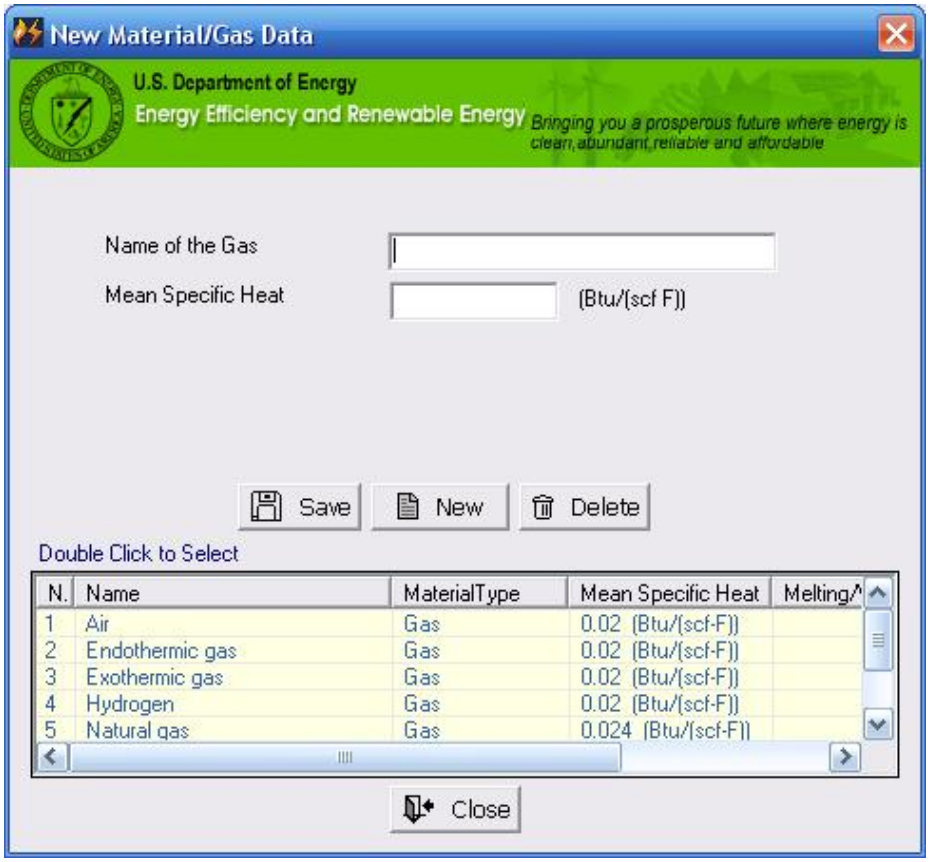
- Enter "**Component Name**" for Atmosphere Losses.
- Enter data in thr **other input boxes** on the screen.
- **"Heat Required"** is calculated based on the input provided and is displayed at the bottom of the screen.
- Click on "**Return**" to go back to summary screen to view the list of entered components. A pop up message box will appear asking to save the entered data.
- Click on **"New"** to enter a new component. You can enter multiple components while on this screen.

Note: To insure correct and meaningful data, a pop up message box will appear while entering the data. Each pop up validates the entered data and displays an informational message and/or provides further instructions.

Add New Gas:

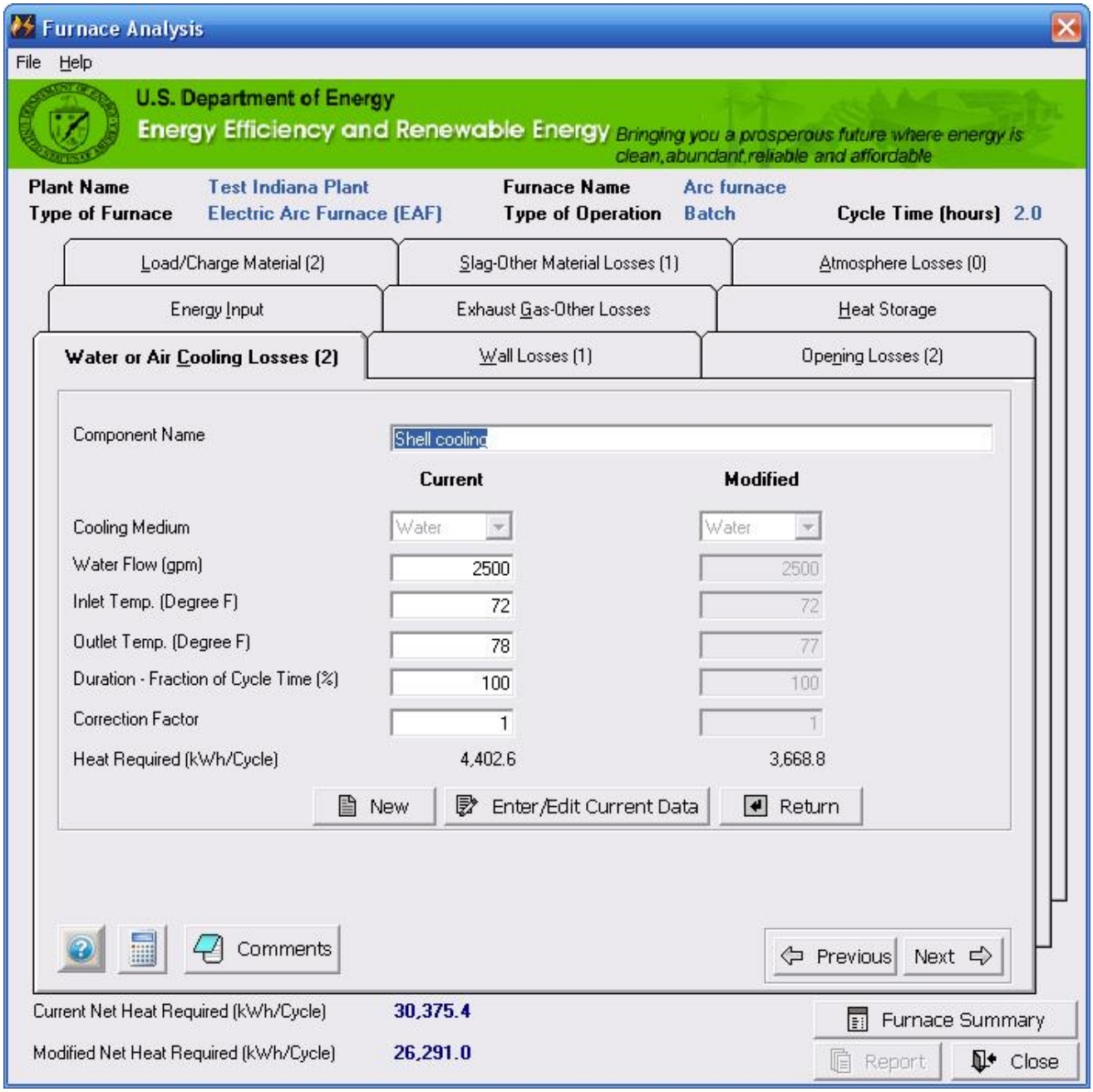
Click on **"New"** next to the label of *Type of Gases* to enter a new gas that is not in the list or to edit information about an existing atmosphere gas. A new interface screen as shown below will open for the users can enter or edit data.

Note: Please do not change the property values for default gases included in the master database. Changes in these values can give inaccurate results when the application is exported and used by another user. *If the new material is similar to one in the master database, add it as a new material with a different name.*



- Enter the required **Information** for the Name of the Gas and Mean Specific Heat .
- Click on **"Save"** to save the new gas. It will appear in the bottom list as well as in the drop down list on the **Furnace Analysis - Atmosphere Losses** tab screen.
- Click on **"New"** to add another new material with required information.
- *Note: Name and Mean specific Heat of the Gas is mandatory information for the new gas.*
- Click on **"Delete"** to delete the gas from the list. The gas will not be available for selection from the drop down list on the **Furnace Analysis - Atmosphere Losses** tab screen. PHAST will not allow deletion of materials that are in the master database or which have been selected in any of the plants covered by the database.

Water or Air Cooling Losses

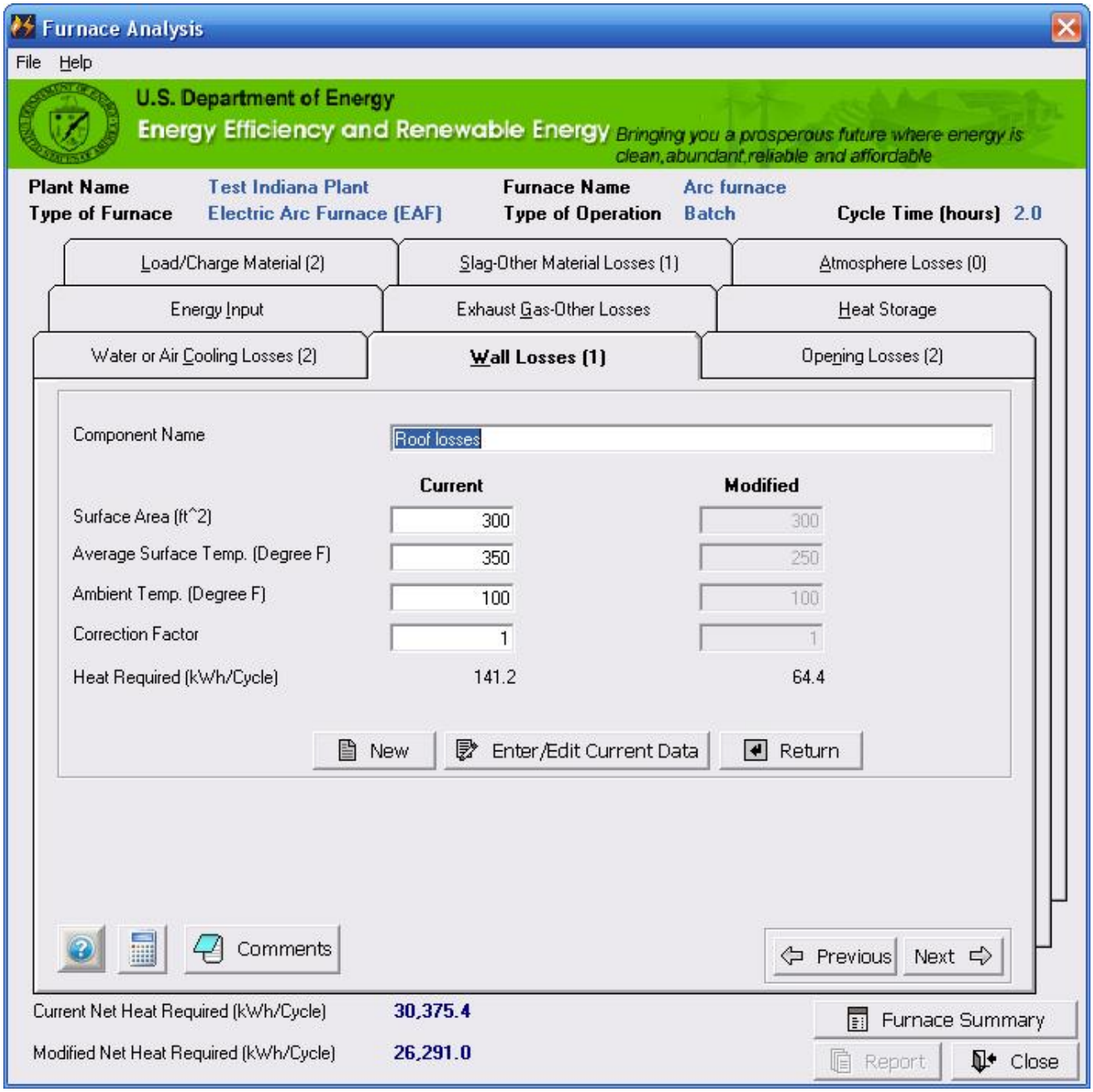


- Enter "**Component Name**" for Water or Air Cooling Losses.
- Enter data in the **other input boxes** on the screen.
  Note:
  Cooling Medium has two options – Water or Air.
  The default value of the Correction Factor is 1.0. The user can always change to a different number, if necessary.
- **"Heat Required"** is calculated based on the input provided and is displayed at the bottom of the screen.

- Click on "**Return**" to go back to the summary screen to view the list of entered components. A pop up message box will appear asking to save the entered data.
- Click on **"New"** to enter new component. You can enter multiple components while on this screen.

Note: To insure correct and meaningful data, pop up message box will appear while entering the data. Each pop up validates the entered data and displays an informational message and/or provides further instructions.

Wall Losses

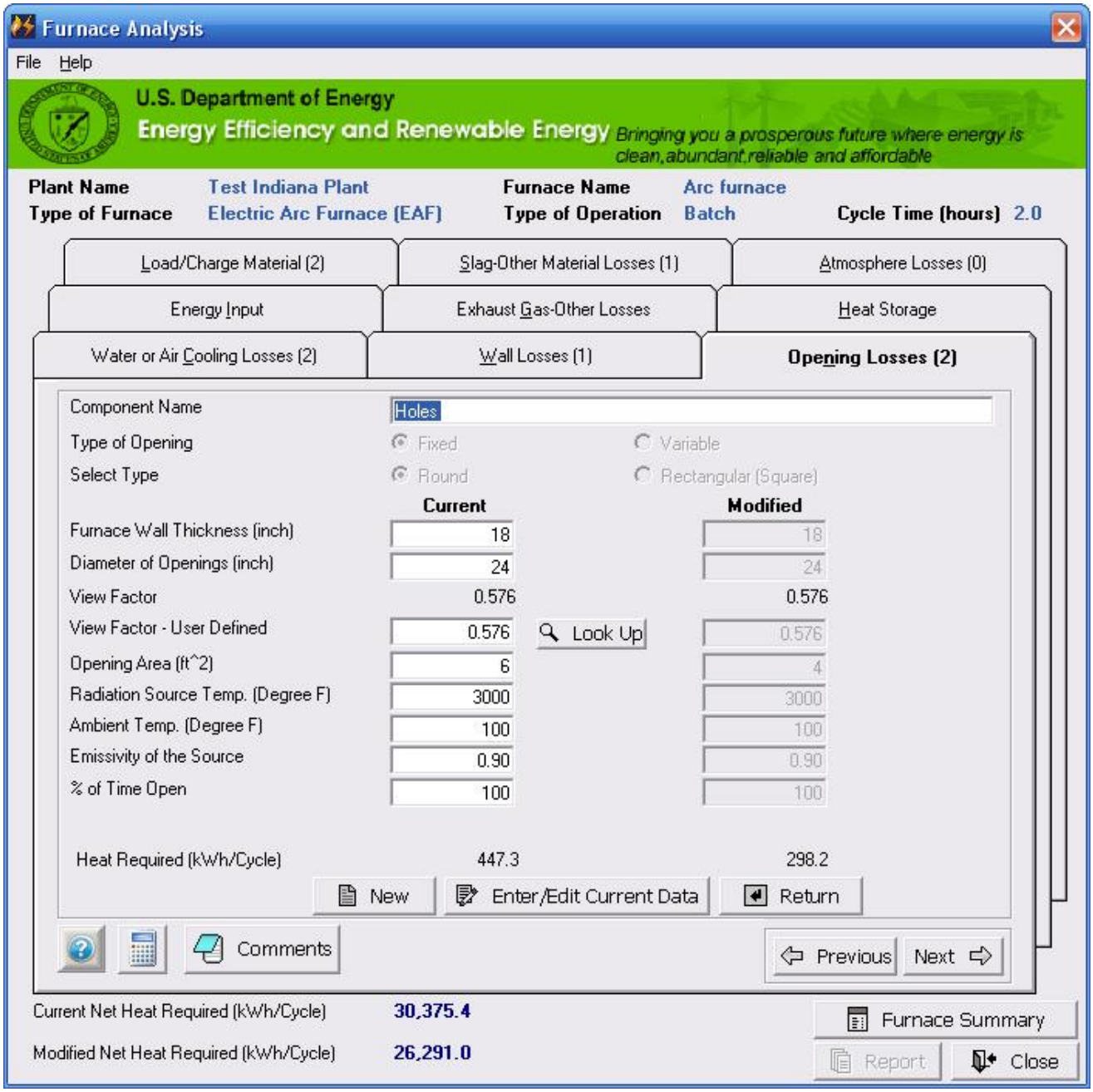


- Enter "**Component Name**" for Wall Losses.
- Enter data in the **other input boxes** on the screen.
  Note: Default value of the Correction Factor is 1.0. The user can always change to a different number, if necessary.
- **"Heat Required"** is calculated based on the input provided and is displayed at the bottom of the screen.
- Click "**Return**" to go back to summary screen to view the list of entered components. A pop up message box will appear asking to save the entered data.

- Click on **"New"** to enter new component. You can enter multiple components while on this screen.

Note: To insure correct and meaningful data, pop up message box will appear while entering the data. Each pop up validates the entered data and displays an informational message and/or provides further instructions.

Opening Losses



- Enter "**Component Name**" for Opening Losses.
- Select the **Type of opening;** i.e., Fixed or Variable.
- Select the **Type;** i.e., Round or Rectangular
- Enter the **dimensions** of the openings.
- Modify **"View Factor-User Defined"** (Optional)
  *Note: PHAST calculates a view factor based on user inputs and sets it as a default value for View Factor-User Defined. Users preferring to define their own view factor can refer to a chart accessible by clicking the **"Look Up"** button next to the input box.*

- Enter **"Other Information"** related to the opening.
- **"Heat Required"** is calculated based on the input provided and is displayed at the bottom of the screen.
- Click on "**Return**" to go back to the summary screen to view the list of entered components. A pop up message box will appear, asking you to save the entered data.
- Click on **"New"** to enter new a component. You can enter multiple components on this screen.

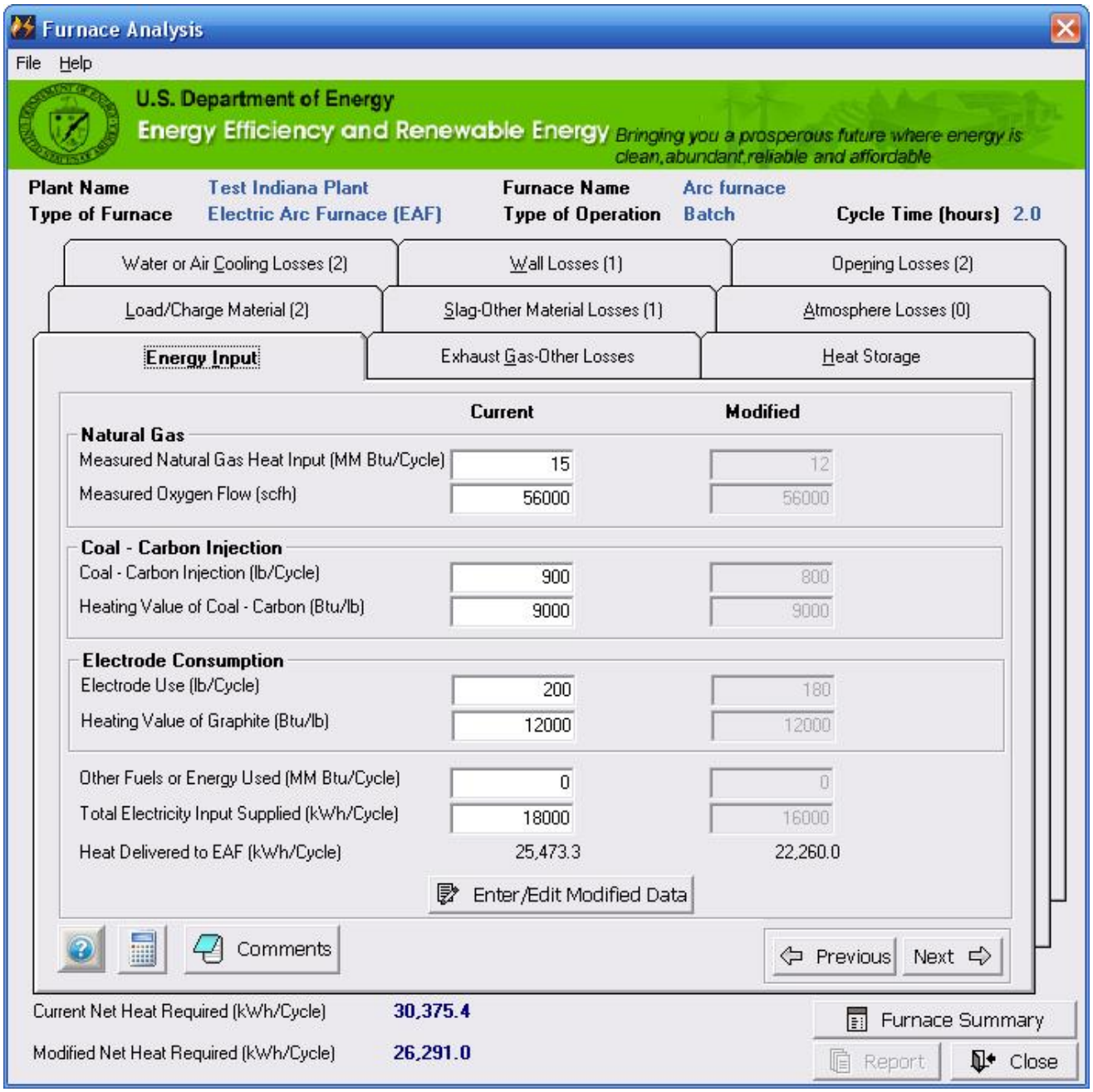
Note: To insure correct and meaningful data, a pop up message box will appear while entering the data. Each pop up validates the entered data and displays an informational message and/or provides further instructions.

Energy Input/Auxiliary Power – Heat Use

The screen displayed will depend on the type of furnace type selected under "Plant Information". The screen for the *Electric Arc Furnace (EAF)* is different from rest of the furnace types (*Electric Infrared, Induction Heating and Melting, Electric Resistance and Vacuum Furnace).*

Screen for Electric Arc Furnace (EAF)

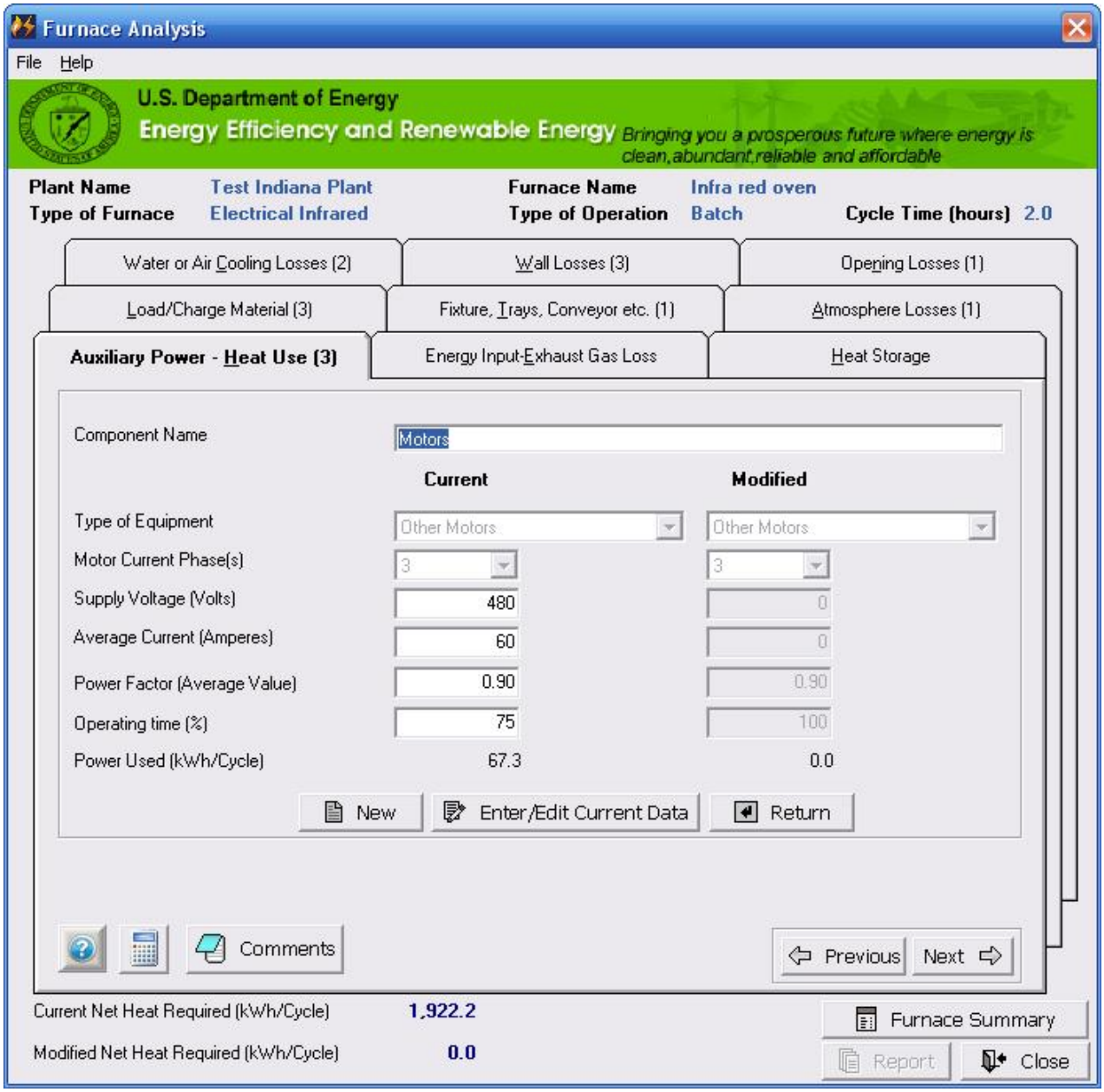
This screen is for the Energy Input for the Electric Arc Furnace (EAF) and doesn't have the option of adding multiple components. All possible sources of energy are listed and are based on the data previously entered; the heat delivered to EAF is calculated by PHAST.



- Enter data for **the input text boxes** on the screen.
- **"Heat Delivered"** is calculated based on the inputs provided and is displayed at the bottom of the tab.

Note: To insure correct and meaningful data, a pop up message box will appear while entering the data. Each pop up validates the entered data and displays an informational message and/or provides further instructions.

Screens for Electric Infrared, Induction Heating and Melting, Electric Resistance and Vacuum Furnace
These screens are for calculating the power used for furnaces and have the feature of listing multiple components.



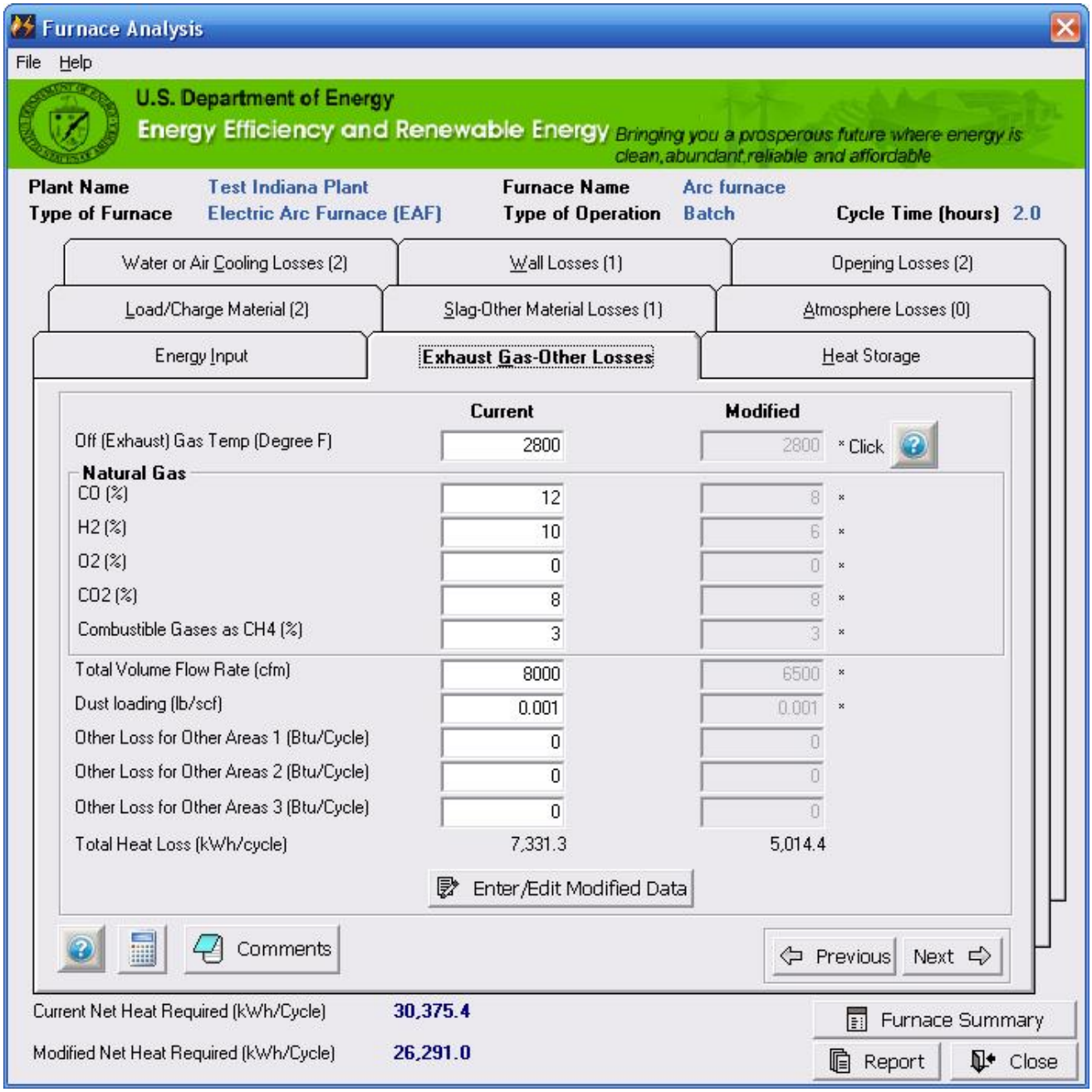
- Enter data in the **input text boxes** on the screen.
  Note: The possible options for Current Phase are Single and Three Phase. Possible options for types of equipment are
  1. *Compressor*
  2. *Vacuum Pump*
  3. *Pump*
  4. *Fan/Blower*
  5. *Other Motor*
- **"Heat Delivered"** is calculated based on the inputs provided and is displayed at the bottom of the screen.

Note: To insure correct and meaningful data, a pop up message box will appear while entering the data. Each pop up validates the entered data and displays an informational message and/or provides further instructions.

Exhaust Gas - Other Losses/ Energy Input - Exhaust Gas Losses

This screen is for the Exhaust Gas –Other Losses for the Electric Arc Furnace (EAF) and doesn't have the option of listing multiple components. Based on the data entered, the heat delivered to EAF is calculated.

Screen for Electric Arc Furnace (EAF)

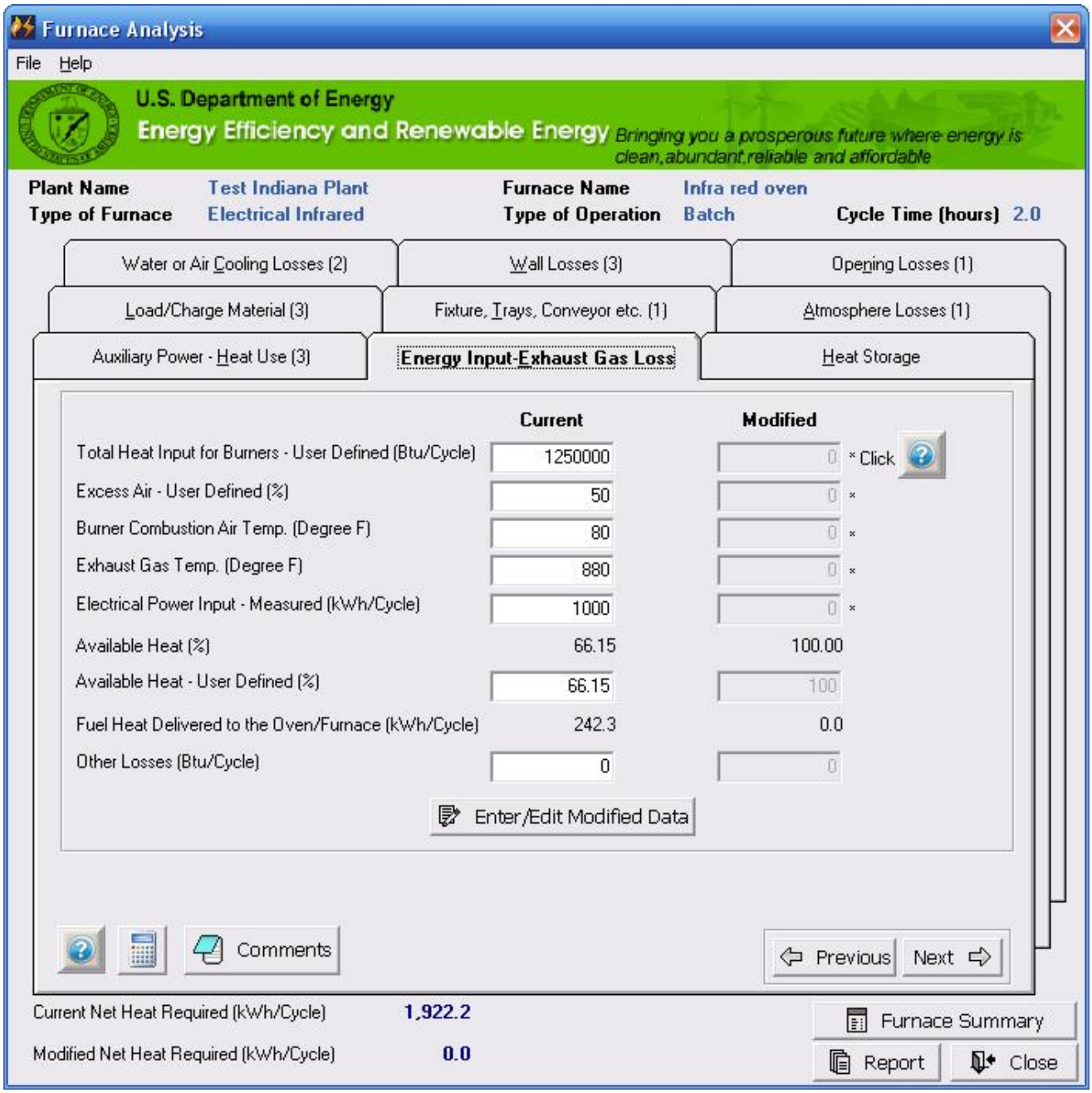


- Enter data in **input text boxes**

- **"Total Heat Loss"** is calculated based on the inputs provided and is displayed at the bottom of the screen.

Note: To insure correct and meaningful data, a pop up message box will appear while entering the data. Each pop up validates the entered data and displays an informational message and/or provides further instructions.

Screen for Electric Infrared, Induction Heating and Melting, Electric Resistance and Vacuum Furnaces
This screen is for calculating the Energy Input- Exhaust Gas Loss for these furnaces.



- Enter data in **input text boxes.**
- If desired, modify **"Available Heat-User Defined"** (Optional).

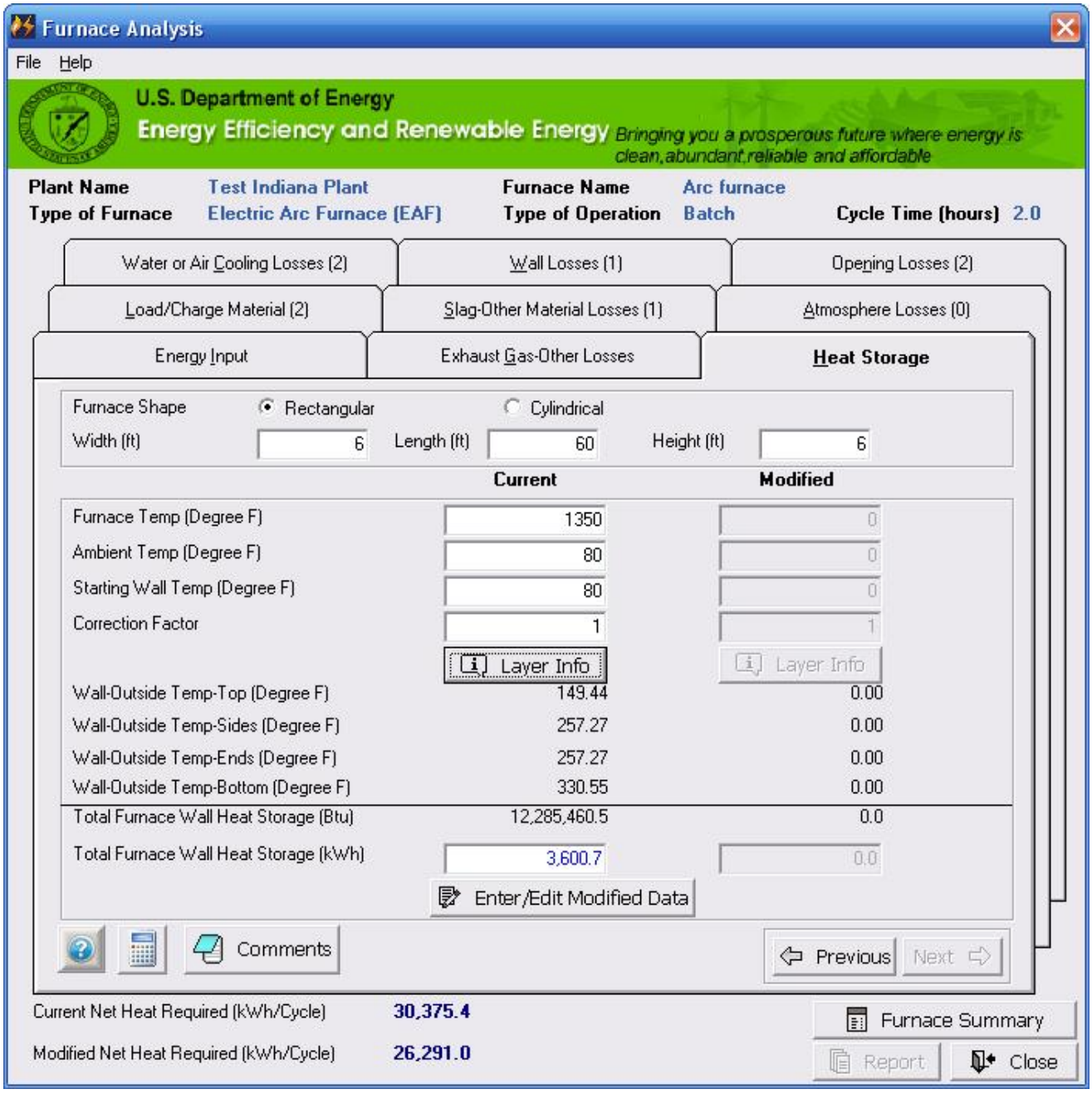
Note: Available Heat is calculated based on the inputs and is set as a default value for Available Heat-User Defined.

- Based on the input provided, a **Fuel Heat Delivered** is calculated and displayed.
- Click on **"Next"** to move to the next tab. The option to save the entered data will be displayed.

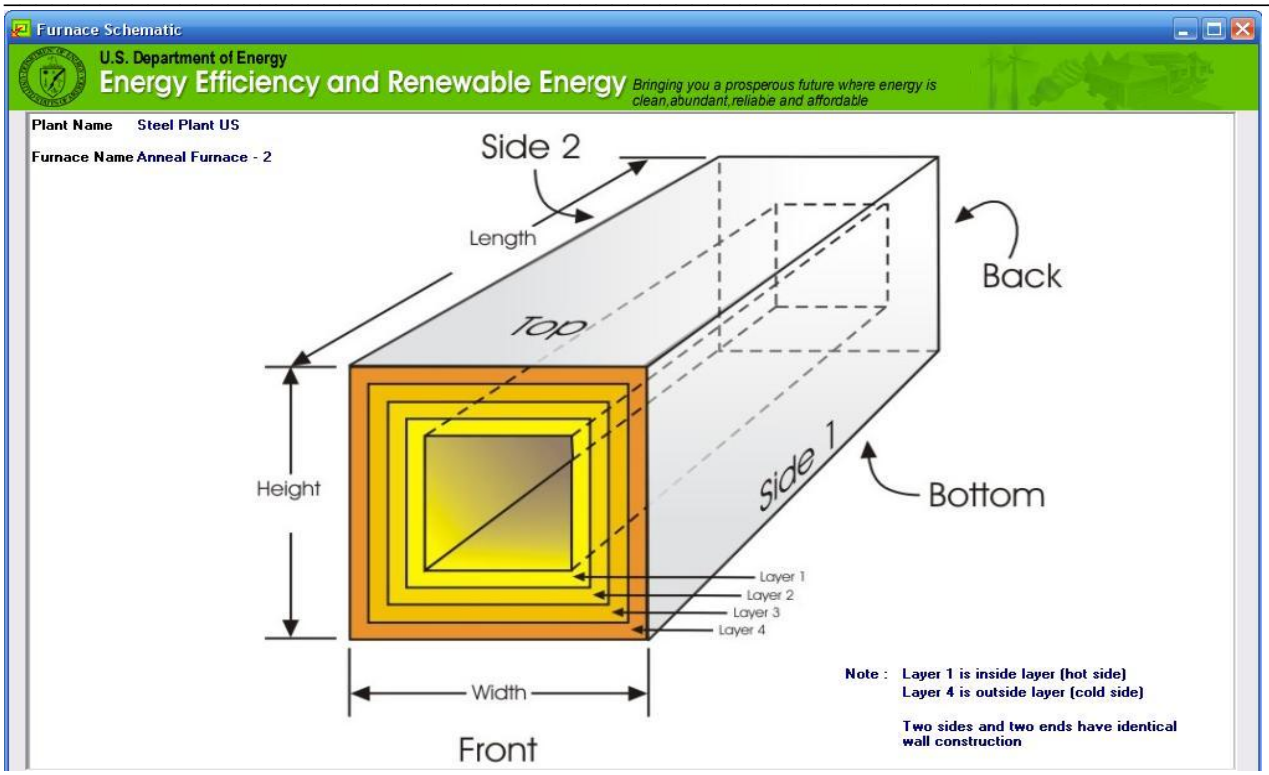
Note: To insure correct and meaningful data, pop up message box will appear while entering the data. Each pop up validates the entered data and displays an informational message and/or provides further instructions.

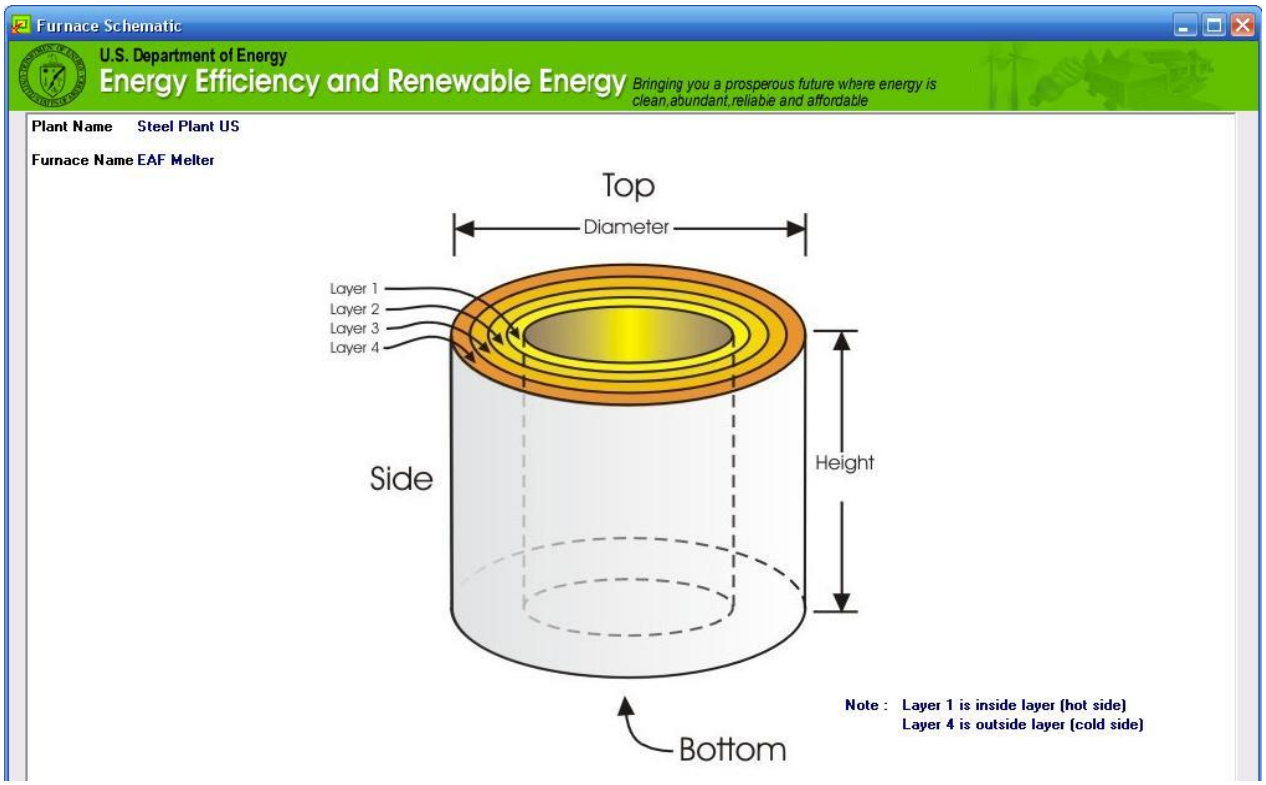
Heat Storage

Click on the **Heat Storage tab** to display the following screen for calculating heat storage for current and modified conditions. The result is displayed in the Heat Storage data box near the bottom of the screen.



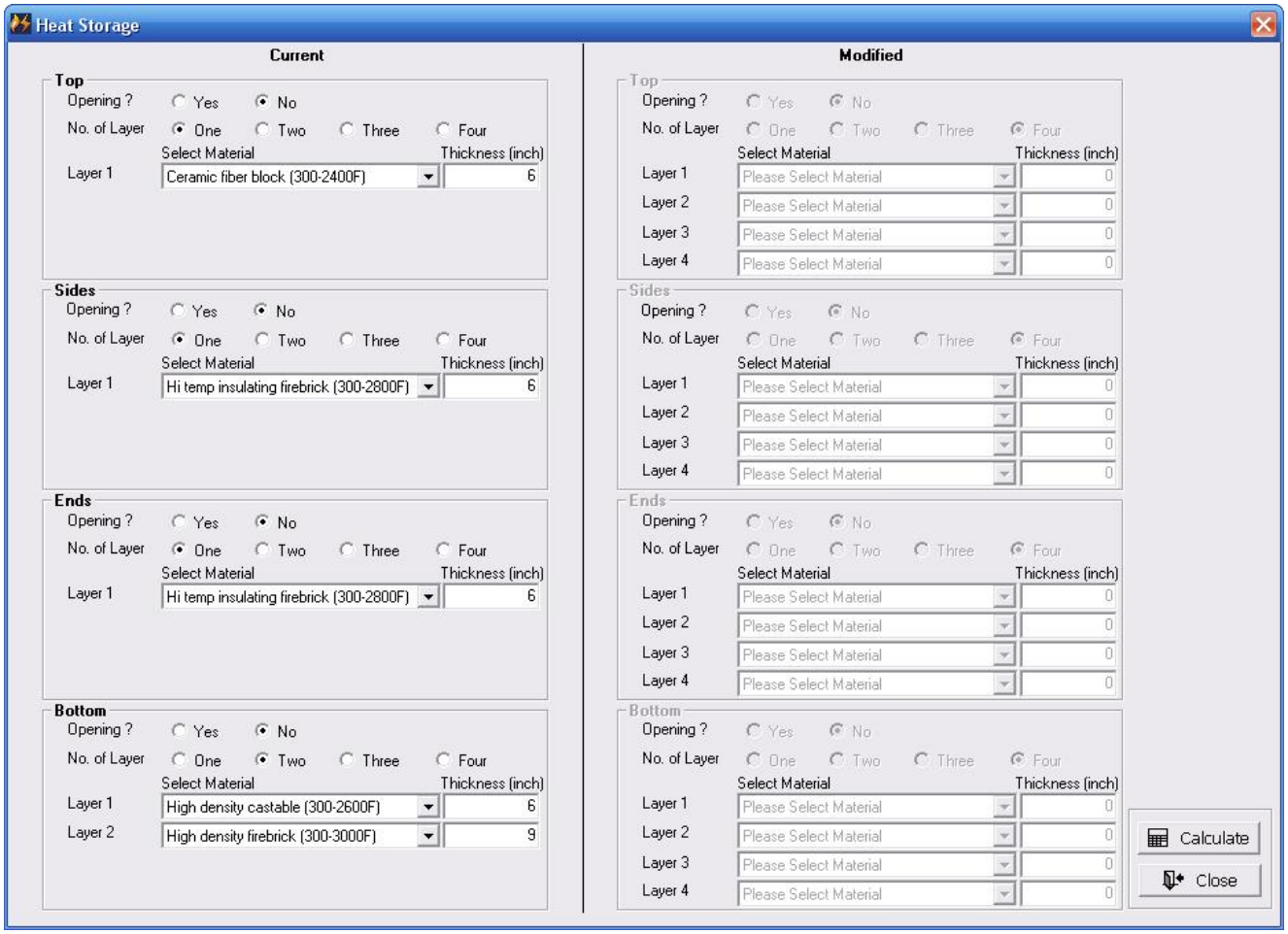
- Enter the **Information** about furnace shape, dimensions and temperatures.
- Click on " Furnace Schematic " or " Furnace Schematic " to select the correct furnace shape. This will open a new window where the user can refer the schematics of rectangular or round furnaces.





- Click on **"Layer Info"** to open a new screen (as shown below) for entering the required information.
  Note: The user can select up to four layers for each furnace wall, along with the materials from the pull-down menu and the thickness of each layer. The user can edit the information or

change the material selection before performing calculations. The selections and input data will be available later when the user selects the same furnace for review.

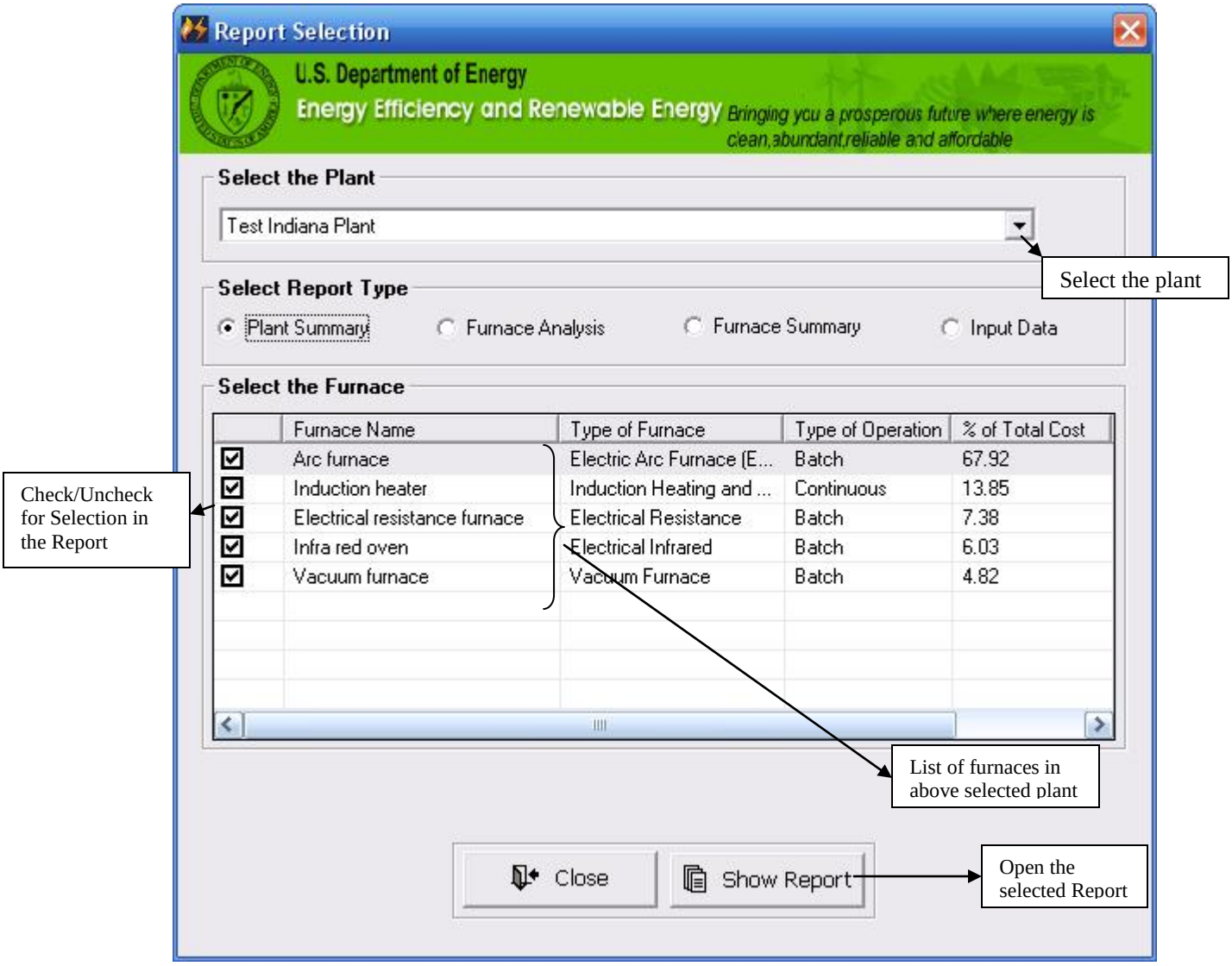


- Select an option of **Opening**. Provide the area of opening if there is one.
- Select the **Number of Layers**. *(Note: Based on this selection, the drop down for material selection and input box for thickness will appear).*
- Select **Material** for each layer.
- Enter **Thickness** for each layer.
- Click on **"Calculate"** to calculate the heat storage from the given input and return to the furnace analysis-heat balance screen. The calculated results are displayed on the Furnace Analysis - Heat Balance screen.
- Click on **"Close"** to return to the Furnace Analysis - Heat Balance screen without performing calculations or saving the newly entered data.

Reports:

This section provides four summary reports in the form of tables and charts. The **Plant Summary** report includes a table of energy used, expected cost of operation for the furnaces surveyed and a comparison of them. The **Furnace Analysis** report includes a table of energy used in various parts of the furnace analyzed, their relative importance in terms of the percentage of the total energy used and the effect of changes in key operating parameters on the furnace's energy consumption. The **Furnace Summary** report presents a schematic of heat losses and use distribution of the selected furnace. The **Input Data** report presents all the data that has been entered for the selected plant.

Click on **Reports** on the main screen to open a new user interface. Here the user can opt to view or print four pre-formatted reports.



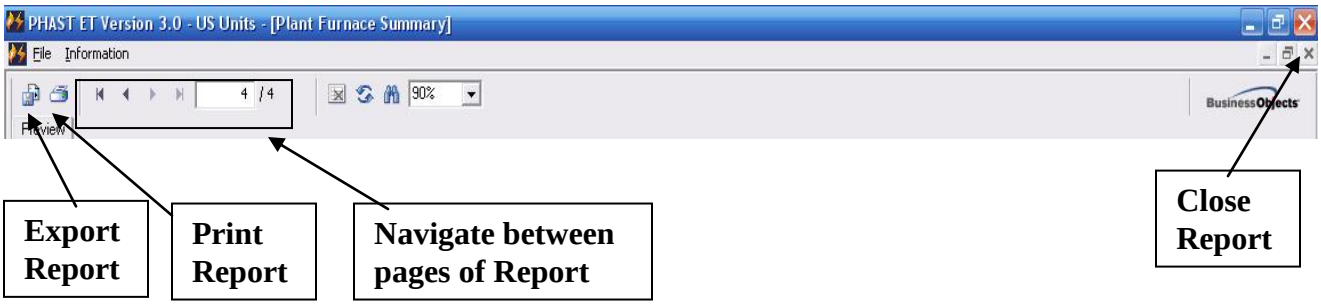
- Select a **Plant** from the drop down list. All furnaces of the selected plant will be displayed as a list, with their percentages of the plant's total energy cost.

- Select the desired type of report.
- Select the **Furnace/s** from the displayed list.
  - For **Plant Summary** option, the user can select <u>any number</u> of furnaces that are required for analysis.
  - For **Furnace Analysis** or **Furnace Summary or Input Data** option, the user can select <u>any one</u> furnace for detailed analysis.
- Click **"Show Report"** to generate a pre-formatted report with actual data and calculations and graphs or images. *(Note: Generating a report calls for intensive background calculations and may take time to display. A status bar with a note on the screen indicates the progress of the report).*
- Click **"Close"** to return to the main screen without displaying the report.

Common Instructions for the Report Viewer Window:

Each report is opened in a window that has header tool bar (as shown below). The user has the following options when working with reports:

- Navigate between the pages of the reports
- Print the displayed report
- Export the displayed report in PDF format for electronic transfer or later analysis
- Close the displayed report



The following pages are representative images of actual reports generated from PHAST.

Plant Summary:

Initiation Date : 7/27/2009

Plant Summary

Company Name	New Company		
Plant Name	Test Indiana Plant		
Address	1224 any street Any town IN United States 12345-678_		
Contact Information	Bob Unknown **EMail** bunknown@anycompany.com	**Phone** (980) - (345 6781) **Fax** (980) - (345 1000)	
Currency	United States - USD - Dollar	**Conversion Rate Used** (Equivalent to USD)	1.0000

Summary of Energy Sources Used

Energy Name	Heating Value	Heating Value Units	Cost (USD per Unit)	Cost Units
Blast Furnace Gas	90	Btu/ft^3	0.02	/Million Btu
Electricity	3,412	Btu/kWh	0.08	/kWh
Natural Gas	1,020	Btu/ft^3	8.00	/Million Btu
Purchased electricicy	10,500	Btu/kWh	0.10	/kWh

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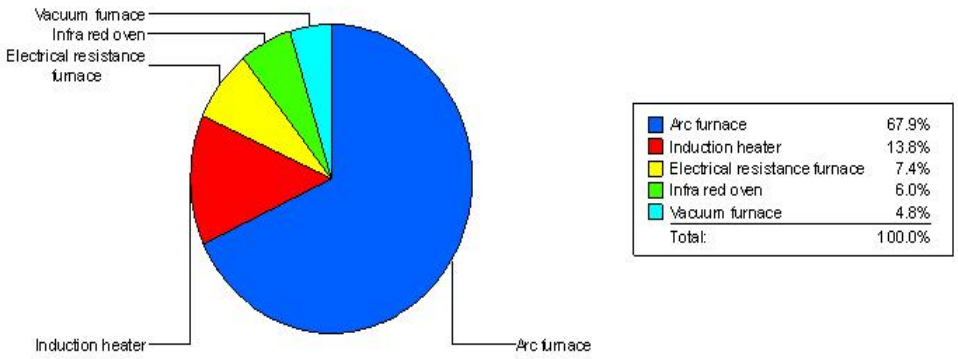
Initiation Date : 7/27/2009

Plant Summary

Company Name	Test Company
Plant Name	Test Indiana Plant

Process Heating Equipment - Energy Cost Distribution



Print Date : 10/19/2010 PHAST v3.0 Page 2 of 4

Initiation Date : 7/27/2009

Plant Summary

Company Name	Test Company
Plant Name	Test Indiana Plant

Process Heating Equipment-Energy Used and Cost Distribution

Heating Equipment	Type of Furnace	Type of Operation	Operating hours / year	Electric Energy Use (Thousand kWh/Year)	Annual Cost (USD/Year)	Fuel Energy Use (Million Btu/Year)	Annual Cost (USD/Year)	Annual Total Cost (USD/Year)	% of Total Cost
Arc furnace	Electric Arc Furnace (EAF)	Batch	6,000	160,500	15,840,000	90,000	720,000	16,560,000	67.92
Induction heater	Induction Heating and Melting	Continuous	7,500	33,770	3,376,284	0	0	3,376,284	13.85
Electrical resistance furnace	Electrical Resistance	Batch	8,064	20,483	1,799,885	0	0	1,799,885	7.38
Infra red oven	Electrical Infrared	Batch	8,064	8,274	825,754	80,640	645,120	1,470,874	6.03
Vacuum furnace	Vacuum Furnace	Batch	8,400	11,551	1,134,101	5,040	40,320	1,174,421	4.82
Total				**234,577**	**22,976,024**	**175,680**	**1,405,440**	**24,381,464**	**100.00**

Initiation Date : 7/27/2009

Plant Summary

Company Name	Test Company
Plant Name	Test Indiana Plant

Comments / Notes

Furnace Name : Arc furnace

The data used here is obtained from the operators and supplier documents. The data should be consideered very preliminary and subject to revisions.

Furnace Name : Induction heater

This is a brand new furnace and is considered as pilot unit for testing several different sizes and shapes of bilelts.

Furnace Name : Electrical resistance furnace

The furnace is used for several different cycles. The cycle represented here is typical and actual values may vary substantially.

Furnace Name : Infra red oven

This is hybrid oven with electric heating in drying zone and gas heating in heating zone.

Furnace Name : Vacuum furnace

Vacuum furnace is designed to use gas fired burners in the earlier part of the cycle for preheating and deoiling of parts before the vacuum is used.

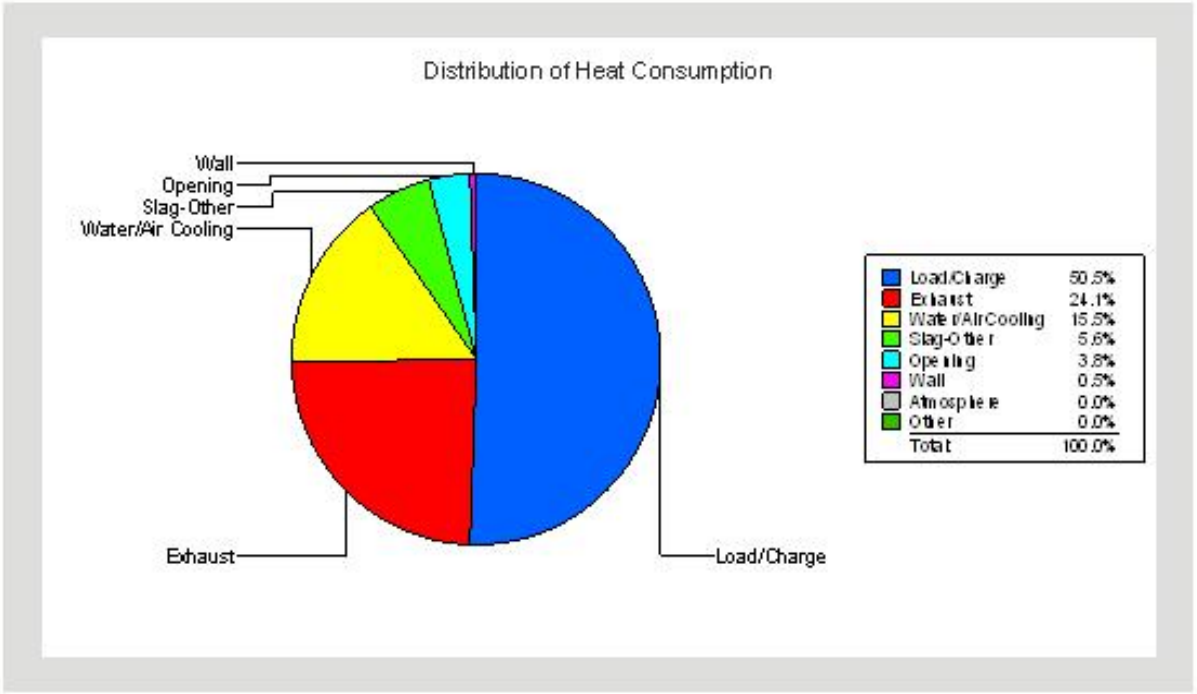
Furnace Analysis:

Initiation Date : 7/27/2009

Furnace Analysis

Company	Test Company	Furnace	Arc furnace
Plant	Test Indiana Plant	Type of Operation	Batch
Type of Furnace	Electric Arc Furnace (EAF)	Cycle Time (hours)	2.0

Current Condition Heat - Energy Consumption (kWh/Cycle) Gross Heat Consumption Data



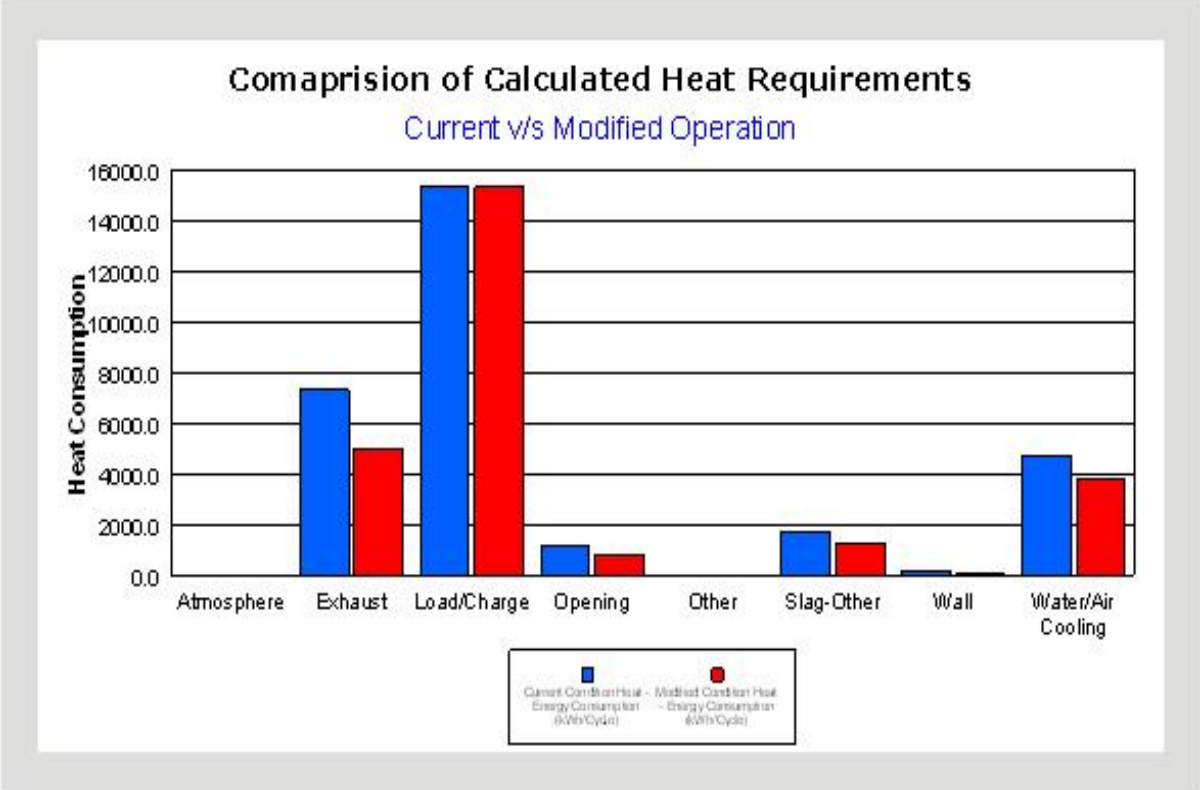
Area of Heat - Energy Consumption	kWh/Cycle
Load/Charge Material	15,340.2
Exhaust Gas Losses	7,331.3
Water or Air Cooling Losses	4,708.5
Slag-Other Material Losses	1,705.7
Opening Losses	1,148.5
Wall Losses	141.2
Atmosphere Losses	0.0
Other Losses	0.0
Total heat losses or heat requirement - Calculated	**30,375.4**

Electrical Heat Input - User Defined:	18,000.0 kWh/Cycle
Total Gross Fuel Input to Furnace - User Defined:	7,473.3 kWh/Cycle

Initiation Date : 7/27/2009

Furnace Analysis

Company	Test Company	**Furnace**	Arc furnace
Plant	Test Indiana Plant	**Type of Operation**	Batch
Type of Furnace	Electric Arc Furnace (EAF)	**Cycle Time (hours)**	2.0



	Current Condition Heat - Energy Consumption (kWh/Cycle)	Modified Condition Heat - Energy Consumption (kWh/Cycle)
Atmosphere Losses	0.0	0.0
Exhaust Gas Losses	7,331.3	5,014.4
Load/Charge Material	15,340.2	15,340.2
Opening Losses	1,148.5	824.1
Other Losses	0.0	0.0
Slag-Other Material Losses	1,705.7	1,279.3
Wall Losses	141.2	64.4
Water or Air Cooling Losses	4,708.5	3,768.6
Total	**30,375.4**	**26,291.0**

Initiation Date : 7/27/2009

Furnace Analysis

Company	Test Company	**Furnace**	Arc furnace
Plant	Test Indiana Plant	**Type of Operation**	Batch
Type of Furnace	Electric Arc Furnace (EAF)	**Cycle Time (hours)**	2.0

Details

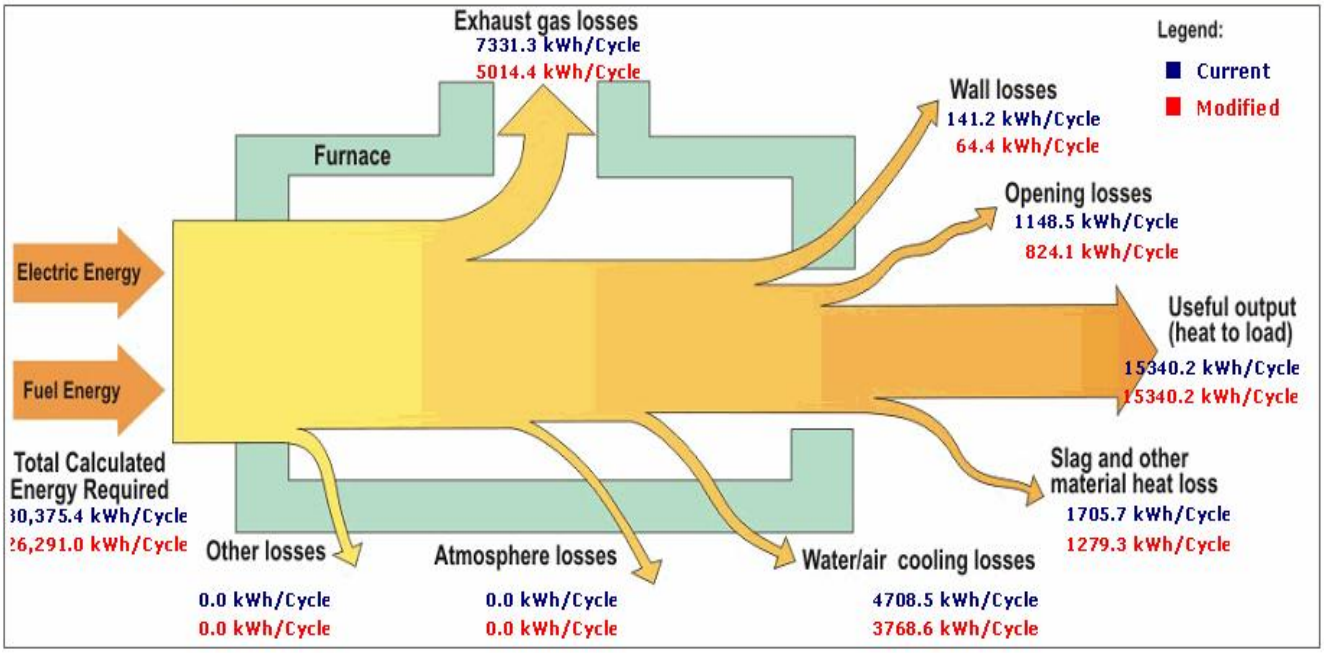
Load/Charge Material		**Current**	**Modified**
Scrap material	kWh/Cycle	15,224.0	15,224.0
Alloys	kWh/Cycle	116.0	116.0
Total	kWh/Cycle	15,340.0	15,340.2
Slag-Other Material Losses		**Current**	**Modified**
Slag	kWh/Cycle	1,706.0	1,279.C
Total	kWh/Cycle	1,706.0	1,279.3
Water or Air Cooling Losses		**Current**	**Modified**
Shell cooling	kWh/Cycle	4,403.0	3,669.C
Roof cooling	kWh/Cycle	306.0	100.0
Total	kWh/Cycle	4,709.0	3,768.6
Wall Losses		**Current**	**Modified**
Roof losses	kWh/Cycle	141.0	64.0
Total	kWh/Cycle	141.0	64.4
Opening Losses		**Current**	**Modified**
Holes	kWh/Cycle	447.0	298.0
Charge time heat loss	kWh/Cycle	701.0	526.0
Total	kWh/Cycle	1,148.0	824.1
Energy Input		**Current**	**Modified**
	kWh/Cycle	25,473.0	22,260.0
Total	kWh/Cycle	25,473.0	22,260.0
Exhaust Gas-Other Losses		**Current**	**Modified**
Exhaust Losses	kWh/Cycle	7,331.0	5,014.C
Total	kWh/Cycle	7,331.0	5,014.4

Furnace Summary:

Initiation Date : 7/27/2009

Furnace Summary

Company	Test Company	**Furnace**	Arc furnace
Plant	Test Indiana Plant	**Type of Operation**	Batch
Type of Furnace	Electric Arc Furnace (EAF)	**Cycle Time (hours)**	2.0



Energy Use from Furnace Analysis

Description	Current	Modified
Total Heat Required - Calculated (kWh/Cycle)	30,375.4	26,291.0
Electrical Heat Input - User Defined (kWh/Cycle)	*18,000.0*	*16,000.0*
Fuel Energy Supplied - User Defined (kWh/Cycle	*7,473.3*	*6,260.0*

Estimated Energy Use from Plant/Equipment information

Description	Estimated Value
Electrical Energy Use (kW)	25,000.0
Fuel Energy Use (kW)	4,396.2

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<u>Note:</u> The diagram shown above is a "static" Sankey diagram.
Each arrow represents a category of heat loss or heat content. The values shown represent the heat content for each category under current and modified operating conditions. Please note that, unlike a true Sankey diagram, the widths of the arrows do not represent the relative magnitude of the quantity the arrow represents.

Input Data:

Initiation Date : 7/27/2009

Input Data

Plant General Information

Company Name	Test Company		
Plant Name	Test Indiana Plant		
Plant Description	Produces various metal products using ferrous and nonferrous metals.		
Final Product	Various components for industrial use		
Contact Name	Bob Unknown		
Phone	(980) - (345 6781)	**E-Mail**	bunknown@anycompany.com

Fuel (Energy Source) Information

Name of Fuel-Energy	Heating Value Units	Heating Value	Cost Unit	Cost (USD per Unit)
Blast Furnace Gas	Btu/ft^3	90	/Million Btu	0.02
Electricity	Btu/kWh	3,412	/kWh	0.08
Natural Gas	Btu/ft^3	1,020	/Million Btu	8.00
Purchased electricicy	Btu/kWh	10,500	/kWh	0.10

Initiation Date : 7/27/2009

Input Data

Company	Test Company	Furnace	Arc furnace
Plant	Test Indiana Plant	Type of Operation	Batch
Type of Furnace	Electric Arc Furnace (EAF)	Cycle Time (hours)	2.0

Furnace Information

Furnace Description	Operating Hour Information				
EAF - test furnace	Weeks/ Year	Days/ Week	Shifts/ Day	Hours/ Shift	Hours/Year
					6,000

Auxiliary Equipment Information				
	Total Nos.	Total Connected HP (all equipment)	% of Cycle Time	% Loading
Compressors	1	50	100	80
Vacuum Pumps	0	0	0	0
Pumps	3	250	100	90
Fans / Blowers	3	1,500	100	67
Other Motors	5	600	100	80

Heat Zone Information

Zone Name	Heat zone				
Electric Heating					
Type of Electricity	Purchased electricicy				
kW Rating for All Sections	50,000.00	*% of Rated Capacity Used*	50.00	*% Loading Factor*	100.00
Estimated Value (kW)	18,750.00	*Measured Value (kW)**	25,000.00		
Fuel Firing					
Type of Fuel	Natural Gas		*No. of Burners/Zone*		4
Zone Burner Rating for All Burners (MM Btu/hr)	40.00	*% of Rated Capacity Used*	50.00	*% Loading Factor*	75.00
Estimated Value (MM Btu/hr)	15.0	*Measured Value (MM Btu/hr)*	15.0		
***User Defined**		*Measured Value (kW)**	4,396.2		

Initiation Date : 7/27/2009

Input Data

Company	Test Company	Furnace	Arc furnace
Plant	Test Indiana Plant	Type of Operation	Batch
Type of Furnace	Electric Arc Furnace (EAF)	Cycle Time (hours)	2.0

Description	Current Condition	Modified Condition	Description	Current Condition	Modified Condition
Load/Charge Material (No of Component: 2)					
Component Name	Scrap material		Liquid in the Load as Discharged (%)	0	0
Select Type	Solid		Vapor Discharge Temp. (Degree F)	3000	3000
Material of the load	Carbon Steel		Weight Reacted (%)	0.1	0.1
Weight of the load - Rate (lb/Cycle)	100000	100000	Heat of Reaction (Btu/lb)	50	50
Initial Temp. (Degree F)	70	70	Type of Reaction	Exothermic	Exothermic
Final Temp. (Degree F)	3000	3000	Weight of Material Melted (%)	100	100
Select Liquid	Water - std. atmospheric pressure	Water - std. atmospheric pressure	Additional Heat Required (Btu/Cycle)	0	0
Liquid in the Load as Charged (%)	0	0	Heat Required (kWh/Cycle)	15224.2	15224.2
Component Name	Alloys		Liquid in the Load as Discharged (%)	0	0
Select Type	Solid		Vapor Discharge Temp. (Degree F)	0	0
Material of the load	Magnesium		Weight Reacted (%)	0	0
Weight of the load - Rate (lb/Cycle)	500	500	Heat of Reaction (Btu/lb)	0	0
Initial Temp. (Degree F)	90	90	Type of Reaction	Endothermic	Endothermic
Final Temp. (Degree F)	3000	3000	Weight of Material Melted (%)	0	0
Select Liquid	Water - std. atmospheric pressure	Water - std. atmospheric pressure	Additional Heat Required (Btu/Cycle)	0	0
Liquid in the Load as Charged (%)	0	0	Heat Required (kWh/Cycle)	116	116

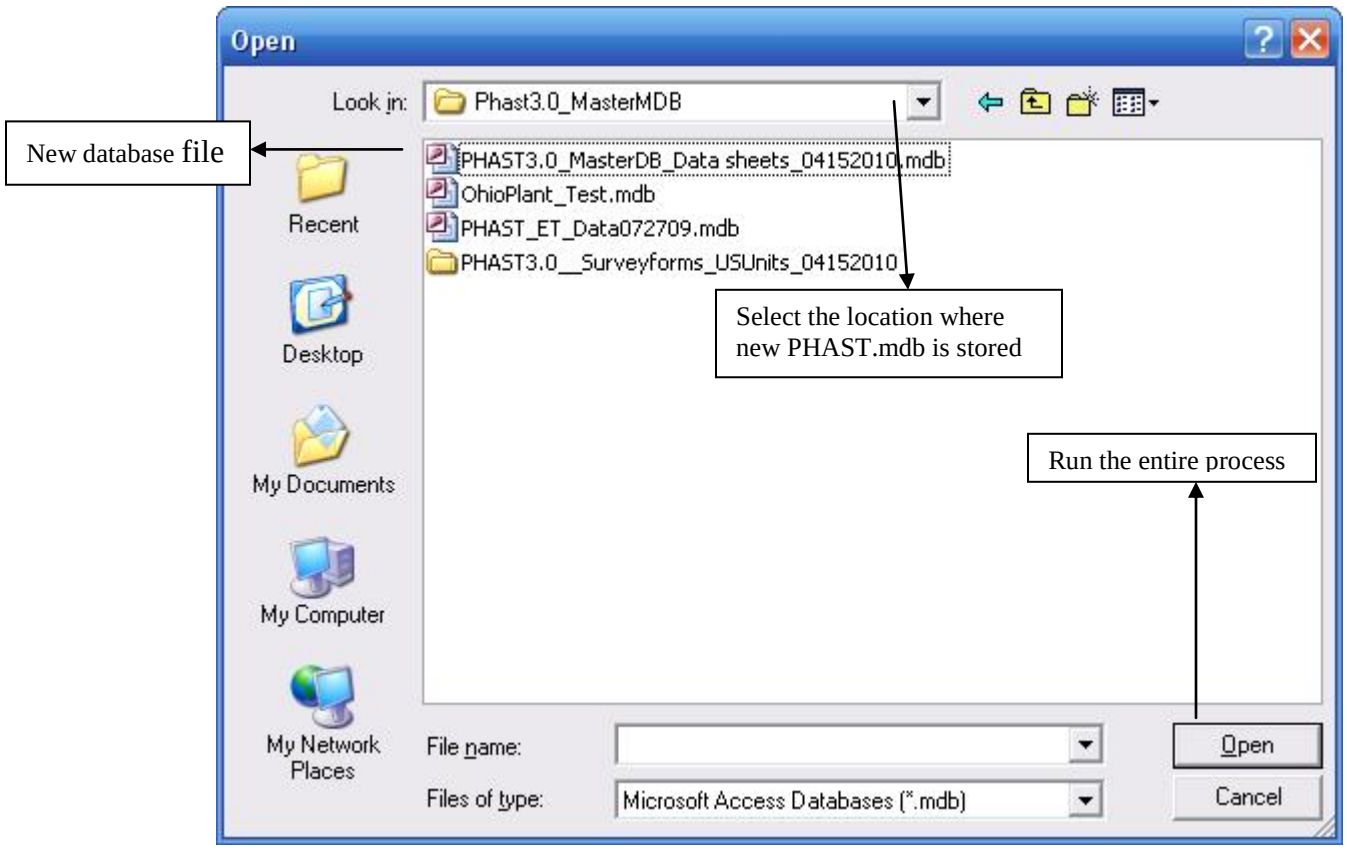
Import Plant Information:

This section provides the capability of importing and integrating the entire information of other plants into the existing PHAST database. **This feature can be used once the user receives the Microsoft Access Application file (*.mdb or with any name as sent by another user) from the plant for which information is to be imported and integrated. Please note that plant information exported with earlier versions of PHAST cannot be imported in this version.** The Microsoft Access Application file can be received via Email or any media and should be stored on the computer or local network from where it can be accessed later. The user can save the received file with either its original or a different name.

Note:
This is a mandatory step and must be performed before importing data.
Do not save the new database file with the name "Phast.mdb" at the default location -- it will replace the existing database. Save the new database file either with different name or at different location.

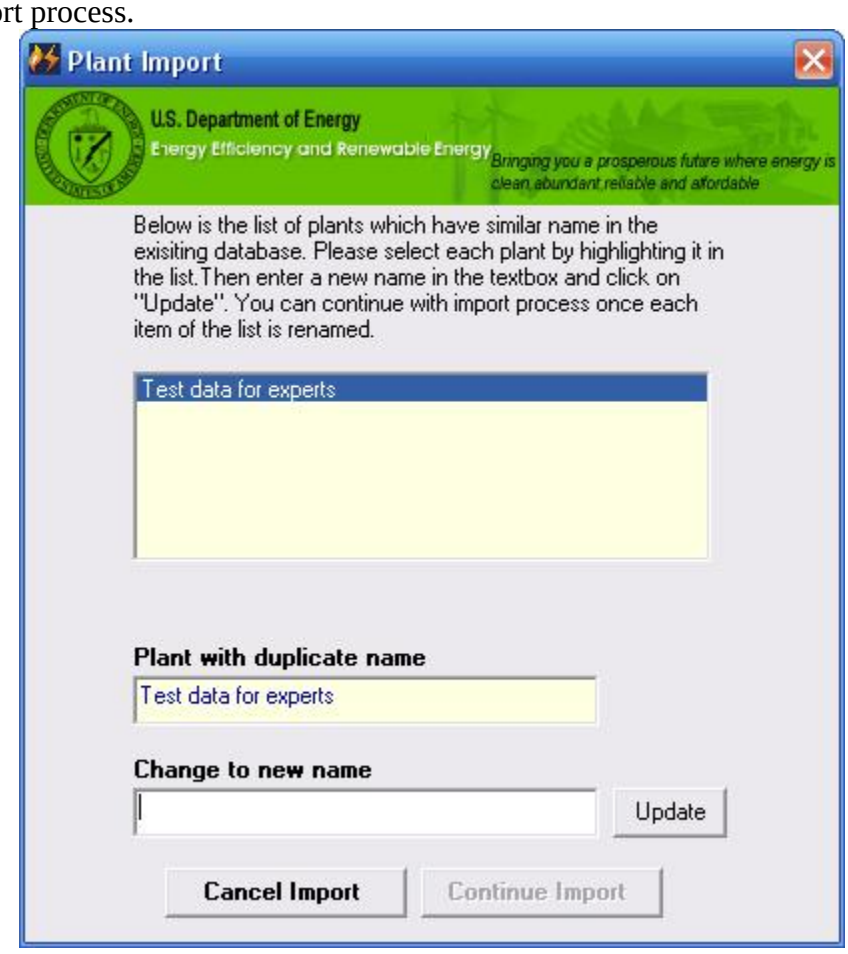
Do not save the Database file as Read-Only.

- Click on "**Import Plant Information"** on the main screen of PHAST. This will open a new user interface as shown below. Here the user can select the Microsoft Access Application file (Phast.mdb or file with any name sent by another user) received from the other plant and stored locally as described above. This file contains the plant information to be imported and integrated with the existing database.



- Select the location from the **Look in** drop-down menu where the received file is stored upon receipt (as described above) and select this file.
- Click on **"Open"** to carry out the entire process of importing the new database and integrating it with existing PHAST database.
  *Note: The screen image above is of a Windows XP operating system file **Open** dialog box. Different versions of the Windows operating system will have a different **Open** dialog box layout.*

If new file information contains a plant with a similar name to those in the existing database, it will display the list of those plants and request that the new file information be renamed; otherwise, it will continue the import process.



- Select each **Plant Name** from the list by clicking on it and change to the new plant name by entering the name in the text box provided.
- **'Update"** will change the plant's name to the new name entered in the text box and remove the old name from the list.
- *Note: If the list has more than one plant with a duplicate name, the user must update each one by entering new name and clicking "Update".*
- Click on **"Continue Import"**. *(Note: This button will be enabled once all duplicate plants' names are changed to a new name.)*

- **Click on "Cancel Import"** to cancel the process. No information will be imported or integrated to PHAST.

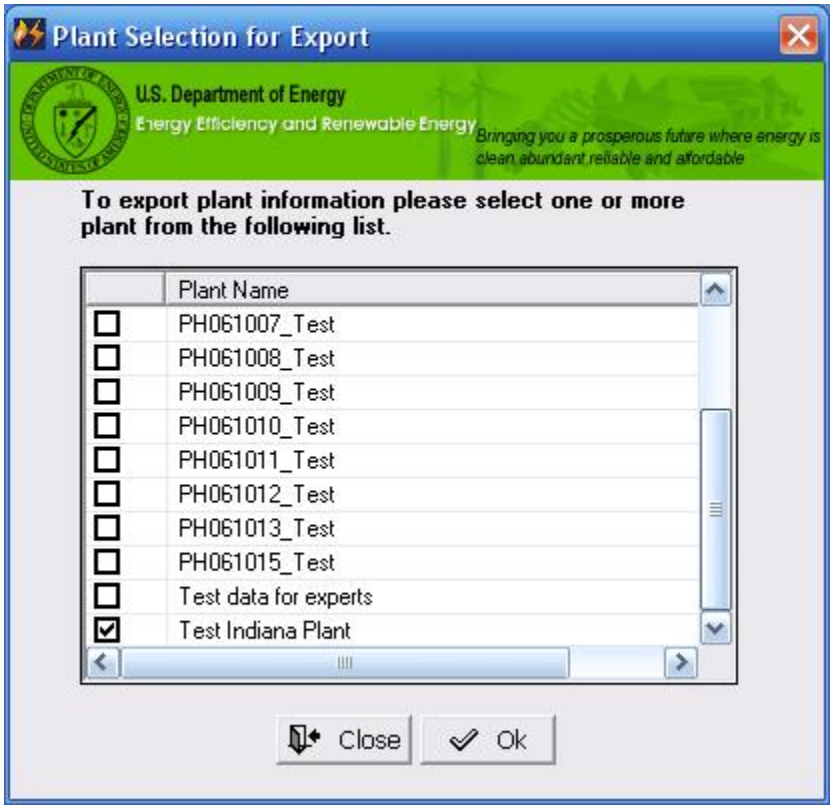
Once the information is imported successfully, it can be viewed, analyzed and modified as described in the earlier sections of this manual. Reports containing the new plant's information can also be generated.

Note:
Do not open the saved database file as a Read-only.

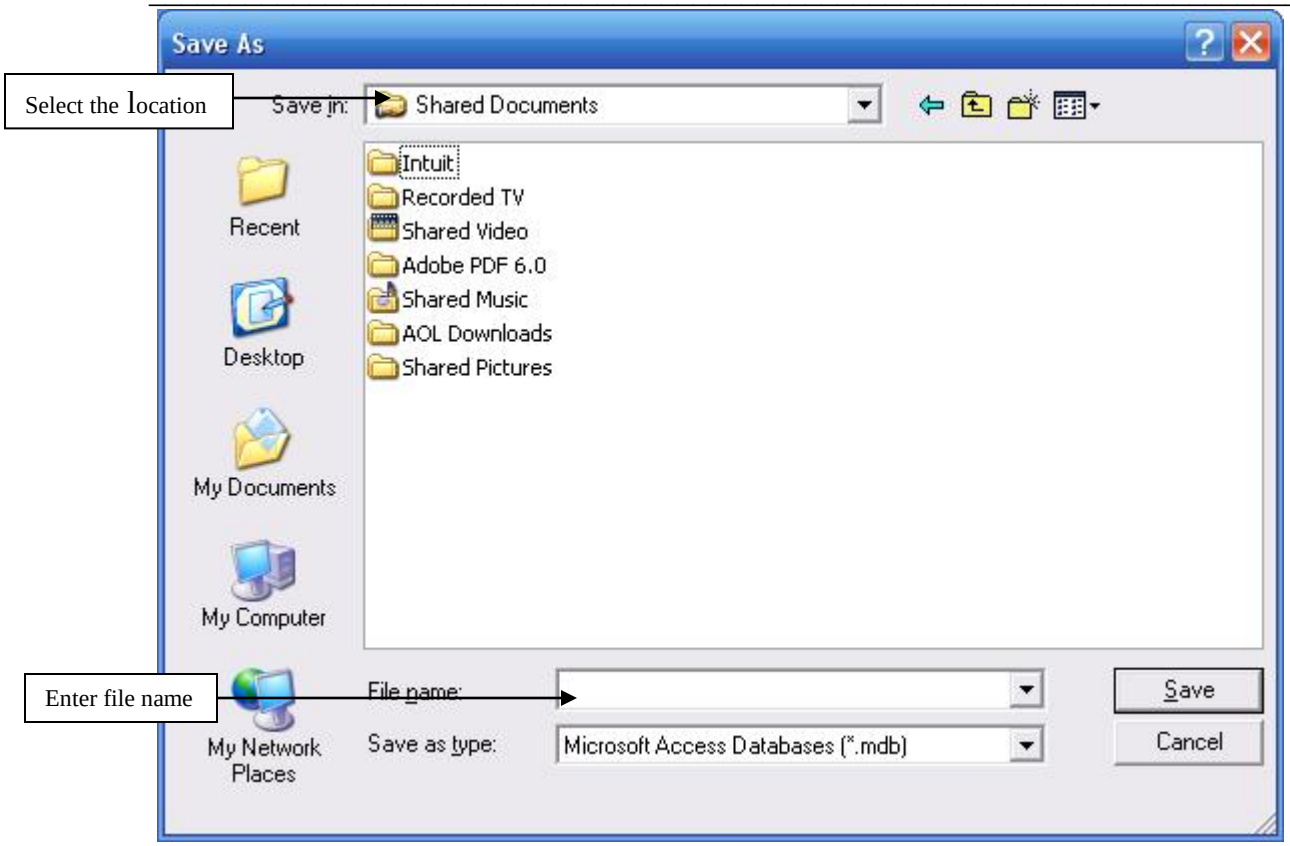
Export Plant Information:

This instruction is for the PHAST user who is sending the file containing all the plant information. This feature will generate a Microsoft Access Application file (.mdb) of selected plants from the entire list. Is file can be sent to other PHAST users via Email or any other media.

- Click **"Export Plant Information"** on the main screen to open a new interface as shown below. It will display the list of plants for which information has been entered into PHAST Version 3.0.



- From the list, select one or more **Plants** for which information is to be exported.
- Click **"Ok"** to proceed further. This will open a new user interface as shown below. *(Note: The file can be saved and stored with any name and in any location.)*



- Select the location from the **Save in** drop-down menu where you want to save the exported file.
- Enter the name of the file you want to save.
- Click on **"Save"** to carry out the entire process of exporting the selected plant database.
  *Note: Users with a different version of Windows than XP will see different layout of the **Save As** dialog box.*

This file can be sent via Email or other media to other PHAST 3.0 users. Other users can import this file by using the import feature described above.

Appendix – A: Units for Conversion

Both the general and specific unit converters have the following categories of units:

Sr. No.	Units
1.	Temperature
2.	Heat Input Rate - Power
3.	Length
4.	Calorific Value of Gas
5.	Pressure
6.	Volumetric Flow Rate
7.	Mass Flow Rate
8.	Heat of Reaction
9.	Liquid Flow
10.	Area
11.	Specific Heat - Entropy
12.	Electrical Power
13.	Heat Rate
14.	Heating Value of Gas
15.	Calorific Value of Liquid Fuel
16.	Thermal Conductivity
17.	Energy
18.	Density
19.	Mass
20.	Heat Transfer Coefficient
21.	Heat Flux Density
22.	Velocity - Speed
23.	Volume
24.	Heating Value of Electricity

Though both converters are essentially the same, the specific unit converter will automatically select only those units appropriate to the data cell from which it was called up.

Appendix – B: Currency and Default Conversion Rate

Country Name	Currency ID	Currency Symbol	Exchange Rate
Australia	Dollar	AUD	0.796
Canada	Dollar	CAD	0.85
China	Yuan	CNY	0.129
European Union	Euro	EUR	1.331
Hong Kong	Dollar	HKD	0.128
India	Rupee	INR	0.022
Indonesia	Rupiah	IDR	0.017
Japan	Yen	JPY	0.009
Malaysia	Ringgit	MYR	0.285
Mexico	Peso	MXN	0.089
New Zealand	Dollar	NZD	0.697
Pakistan	Rupee	PKR	0.017
Philippines	Peso	PHP	0.021
Poland	Zloty	PLN	0.342
Russia	Ruble	RUB	0.038
Saudi Arabia	Riyal	SAR	0.268
South Africa	Rand	ZAR	0.134
South Korea	Won	KRW	0.001
Sweden	Kronor	SEK	0.144
Taiwan	Dollar	TWD	0.03
Thailand	Baht	THB	0.03
Trinidad and Tobago	Dollar	TTD	0.5
Turkey	Lira	TRY	0.7065
United Arab Emirates	Dirham	AED	0.272
United Kingdom	Pound	GBP	1.96
United States	Dollar	USD	1.00
Venezuela	Bolivar	VEB	0.001
Vietnam	Dong	VND	0.017

Appendix – C: Default Energy Sources (Fuel, Electricity, Steam)

Energy Name	Unit	Heating Value unit	Default Heating Value
Electricity	/kWh	Btu/kWh	3,412
Natural Gas	/Million Btu	Btu/ft^3	1,010
Fuel Oil	/Million Btu	Btu/gallon	137,000
Coal	/ton	Btu/lb	14,030
Blast Furnace Gas	/Million Btu	Btu/ft^3	90
Coke Oven Gas	/Million Btu	Btu/ft^3	570
Coke	/ton	Btu/lb	12,700
Propane	/Million Btu	Btu/ft^3	2,500
Steam	/Million Btu	Btu/lb	1,200

Appendix – D: Properties of Default Materials and Gases Used for Furnace Analysis

Substance	Density	Mean Specific Heat	Latent Heat of Fusion	Mean Specific Heat of Liquid	Melting Temp	Average Pouring Temp	Heat Content of Solid at Melting Temp	Heat Content of Liquid at Melting Temp	Heat Content of Liquid at Pouring Temp
SOLID									
Aluminum	166.7	0.248	169	0.26	1215	1380	286	455	497
Babbitt, lead base	0	0.039	26.2	0.038	462	625	15.8	42	48
Babbitt, tin base	462	0.071	34.1	0.063	464	916	28.6	67.7	91
Bismuth	612	0.033	18.5	0.035	518	620	15.1	33.6	37.2
Brass, Muntz metal	524	0.105	69	0.125	1630	1850	165	234	261
Brass, red	546	0.104	86.5	0.115	1952	2250	197	283.5	317.8
Brass, yellow	528	0.105	71	0.123	1688	1950	171	242	274.2
Bronze, bearing	556	0.095	79.9	0.109	1832	2050	168.3	248.2	272
Bronze, aluminum	510	0.126	98.6	0.125	1922	2200	235	333.6	368
Bronze, bell metal	540	0.1	76.3	0.119	1634	1900	157.4	233.7	265.4
Bronze, gun metal	550	0.107	84.2	0.106	1850	2100	191.5	275.7	302
Bronze, Tobin	525	0.107	73.5	0.124	1625	1850	167.5	241	268.9
Carbon Steel	480	0.15	60	0	2800	0	0	0	0
Copper	559	0.104	91	0.111	1982	2200	200	291	315
Die casting metal	176	0.236	163	0.241	1150	1400	257.3	420.3	481
Die casting metal	176	0.038	17.5	0.037	600	820	20.5	38	146
Die casting metal	176	0.07	30.2	0.062	450	650	27.6	57.8	70
Die casting metal	176	0.103	48	0.138	780	980	74	122	150
German silver	176	0.109	86.2	0.123	1850	2100	194	280.2	311
Gold	1205	0.033	28.5	0.034	1945	2150	62.2	90.7	97.7
Inconel - 600	480	0.14	0	0	2500	0	0	0	0
Iron, cast, gray	480	0.19	41.4		2246	2800	415	456	583
Iron, cast, white	480	0.18	60.3		2102	2900	368	428	612
Iron, pig	480	0.153	83.6		2012	2300	299	384	450
Iron, pure	491	0.168	117	0.15	2802	3100	451	568	626
Lead	708	0.032	10	0.034	621	720	18	28	31
Linotype	700	0.036	21.5	0.036	486	620	15.3	36.8	41.6
Magnesium	108.6	0.272	83.7	0.266	1204	1380	311.2	394.9	441.7
Manganese	464	0.171	66	0.192	2246	2400	374	440	469
Monel metal	550	0.129	117.4	0.139	2415	2750	304	421.4	468
Nickel 60 to 2644 F	556	0.134	131.5	0.133	2644	2850	346	477.5	505
Silver	655	0.063	46.8	0.07	1762	1950	107	153.8	167
Solder, bismuth	580	0.04	16.4	0.039	232	330	9.3	25.7	29.5

Solder, plumbers	580	0.051	23	0.049	414	500	18	41	45
Stainless Steel - 300 series	480	0.14	0	0	2550	0	0	0	0
Stainless Steel - 410	480	0.25	48	0	2800	2800	750	126	142
Tin	455	0.069	25	0.0637	450	650	27	52	64
Zinc	445	0.107	48	0.146	786	900	77.8	125.8	142
LIQUID									
Heat Transfer Liquid		0.45	200	0.25	450				
Water - std. atmospheric pressure		1	970.3	0.47	212				
Water - 150 psig		1.05	868	0.54	365				
Acetic Acid		0.51	174	0.4	244.4				
Acetone		0.347	239	0.4	130				
Alcohol- ethyl		0.648	369	0.45	172				
Alcohol - methyl		0.601	481	0.33	151				
Benzene		0.423	170	0.33	176				
Bromine		0.107	82	0.055	142				
Carbon tetrachloride		0.215	83.5	0.25	170				
Fuel oil no. 2 (average)		0.57	105	0.55	375				
Fuel oil no. 6 (average)		0.58	108	0.55	600				
Kerosene		0.57	260	0.62	260				
Methanol		0.6	470	0.6	148				
GASES and VAPORS									
Water vapor - near atmos. pressure		0.47							
Steam - 50 psig, 400 Degree F.		0.49							
Steam - 150 psig, 500 Degree F.		0.51							
Steam - 600 psig, 700 Degree F.		0.59							
Air - low pressure		0.245							
Nitrogen - low pressure		0.25							
Oxygen - low pressure		0.23							
Carbon dioxide - low pressure		0.24							
Carbon monoxide - low pressure		0.25							
Hydrogen - low pressure		3.45							