

Refresher for PHAST

By

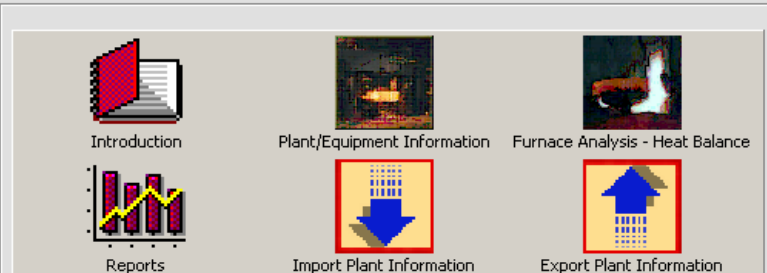
Ms. Barkha Sharif

**Masters
(ComputerScience)**

Process Heating Assessment and Survey Tool (PHAST)

Refresher

Process Heating Assessment and Survey Tool (PHAST)





The main menu of the PHAST application features six icons arranged in a 2x3 grid. The top row includes: 'Introduction' (red book icon), 'Plant/Equipment Information' (industrial plant icon), and 'Furnace Analysis - Heat Balance' (furnace icon). The bottom row includes: 'Reports' (bar chart icon), 'Import Plant Information' (blue arrow pointing down icon), and 'Export Plant Information' (blue arrow pointing up icon). Below the icons is the instruction 'Click on the Desired Button For Information' and a link for 'Exit Application'.

Introduction Plant/Equipment Information Furnace Analysis - Heat Balance

Reports Import Plant Information Export Plant Information

Click on the Desired Button For Information

[Exit Application](#)

  **Development supported by E3M Inc.**

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This Application is developed by Oak Ridge National Laboratory in cooperation with Industrial Heating Equipment Association (IHEA) and a subcommittee consisting of members from major industries and equipment suppliers acting as advisor for the tool development.

Available Resources for Use in Assessment

- Software tools – PHAST. Current version allows assessment of most commonly used fired heating equipment.
- Calculators to estimate savings (in \$s and Btus) for some of the energy saving ideas-suggestions
- Other resources for use in unusual conditions not covered by PHAST.
- Energy saving recommendations and associated Tip Sheets (see attached list)
 - Six Tip Sheets and two Technical Briefs



Process Heating Assessment and Survey Tool (PHAST)

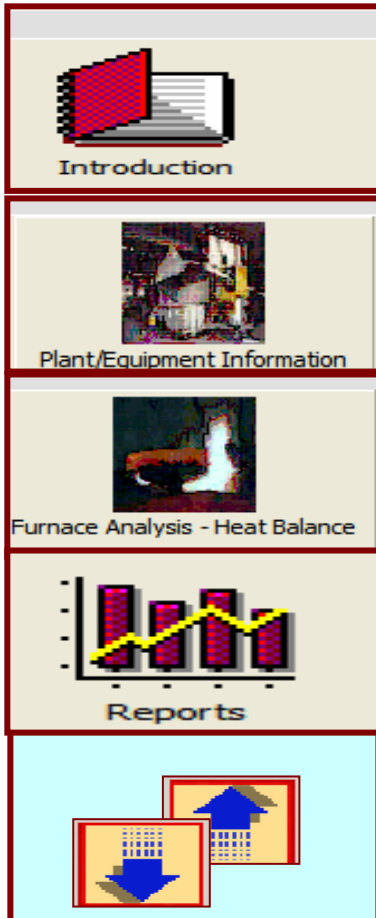
Download it from

http://www.oit.doe.gov/bestpractices/software_tools.shtml

It includes

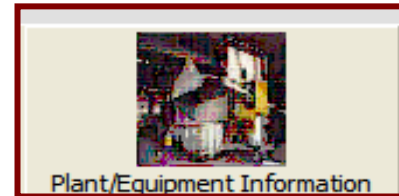
- Installation instructions for MS Windows 2000 and XP
- User manual
- Useful calculators
- Survey forms
- PHAST program

Major Sections of PHAST



- **Introduction**
- **Plant Equipment Information**
- **Furnace Analysis – Heat Balance**
- **Reports**
- **Transfer (Import/Export) of Data Files**

Process Heating Assessment and Survey Tool (PHAST)



Process Heating Assessment and Survey Tool (PHAST) Survey Form

Furnace - Heat Balance Analysis

Plant Name		Furnace		Furnace Dimension		Is there opening in furnace if you give distribution	
Type of Furnace	Rectangular □ Indirect	Diatic - □					
Inside temp - Degree F		Length - Ft					
Ambient temp - Degree F		Width - Ft					
Please provide appropriate information for each type of gas for current and modified condition							
	Current	Modified condition					
Furnace load (Heat)							
Type of material		Average					
Charge Weights or Rate lb/hr		Approx.					
Material composition		Analysis					
Inside temp - Degree F		Temp					
Exit temp - Degree F		Type of gas					
% change wt		Inside temp					
Heat of reaction		Pressure					
Re charge or Recycled		Flow rate					
Flux rate, lbs/sq ft		Wall Loss					
Top surface		Top Loss					
Charge weights or Rate lb/hr		Average					
Inside temp - Degree F		Degree F					
Water cooling Loss		Flux Rate					
Water flow - GPM		Temp					
Water cooled areas		Inside temp					
Inside temp - Degree F		Exit temp					
Outside temp - Degree F		Combust					
% time remained open		Flow rate					
Head storage		Wall Loss					
Top		Top Loss					
NOF layer composition		Flux Rate					
Thickness of layer 1 - Inches		Temp					
Thickness of layer 2 - Inches		Inside temp					
NOF layer 2 - Inches		Exit temp					
NOF layer composition		Flow rate					
Thickness of layer 1 - Inches		Wall Loss					
Thickness of layer 2 - Inches		Top Loss					
NOF layer 2 - Inches		Flux Rate					
NOF layer composition		Temp					
Thickness of layer 1 - Inches		Inside temp					
Thickness of layer 2 - Inches		Exit temp					
NOF layer 2 - Inches		Flow rate					
Wall Loss		Wall Loss					
Top Loss		Top Loss					
Flux Rate		Flux Rate					
Temp		Temp					
Inside temp		Inside temp					
Exit temp		Exit temp					
Flow rate		Flow rate					
Wall Loss		Wall Loss					
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Inside temp		Inside temp					
Exit temp		Exit temp					
Flow rate		Flow rate					
Wall Loss		Wall Loss					
Top Loss		Top Loss					
Flux Rate		Flux Rate					
Temp		Temp					
Inside temp		Inside temp					
Exit temp		Exit temp					
Flow rate							

Process Heating Assessment and Survey Tool (PHAST)



General Information | Energy Source | Furnace Information

Industry Segment
Two Digit SIC Category: 29 - Petroleum refining and related industries
Three digit SIC Category: 291 PETROLEUM REFINING
SIC Code: 2911 Acid oil, produced in petroleum refineries-mfg
SIC Code: 2911

Description:
Final Product:
Services Provided:

Address
Address Line:
Address Line:
City:
State:
Zip Code:

Furnace List

No.	Furnace Name	Description
1	Power Plant Boiler - 1	
2	Power Plant Boiler - 2	
3	Crude Charge	
4	Tail Stripper	
5	Naphtha Reboiler	
6	Colur	
7	Alkyf	
8	FCC Preheater	
9	Reaction Furnace	
10	HDS Preheater	
11	Preheater	
12	Feed	

Plant Name: Northern Area Plant

Furnace Name: Crude Charge

Description: Crude heating

Operation Hours Information: Heat Zone | Auxiliary Equipment

Heat Zone List:

No.	Heat Zones
1	Zone - 1

Zone Information: Zone Name: Zone - 1

Fuel Firing: Type of Fuel: Plant Gas - 1 | No. of Burners per Section: 10

Burner Rating - Million Btu/hr All Burner: 240 | % of rated capacity used: 75

Electric Heating: []

Compressor: 0 | Vacuum Pump: 0 | Pumps: 2 | Fans / Blowers: 1 | Other Motors: 2

Total connected HP: 0 | 0 | 250 | 100 | 15

Operating frequency (% of cycle time): 0 | 0 | 100 | 100 | 60

% Loading: 0 | 0 | 60 | 60 | 90

Thousand Kw/h - motors: 0 | 0 | 1253 | 376 | 51

Buttons: Save, Previous Tab, Next Tab, New Furnace, Delete Furnace, Close



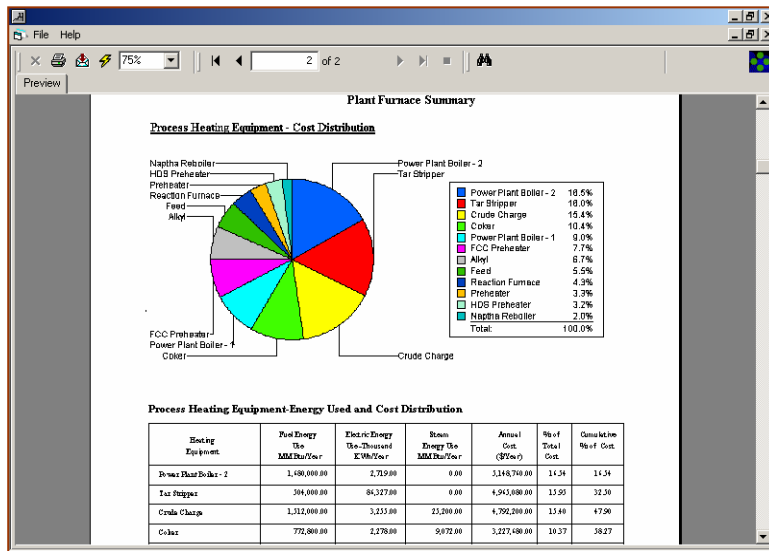
Use "Plant Information" section of PHAST to enter and analyze the data for process heating equipment

Process Heating Assessment and Survey Tool (PHAST)



The report shows:

- Estimated annual energy use and estimate annual cost of energy for heating equipment (furnaces, ovens etc.)
- List of heating equipment and % of total energy cost used for each equipment in order of annual cost of energy used



Process Heating Assessment and Survey Tool (PHAST)



Process Heating Assessment and Survey Tool (PHAST) Survey Form

Plant Name: Northern Area Plant Furnace Name: Crude Charge

Type of Furnace: Recirculating Oil Furnace Furnace Orientation: In Stack Heating Medium: Crude Oil

Process: Heavy Crude Charge Length: 10 Diameter: 10

Process Heating Balance Information for each part of the plant. If you are not sure, please contact the support team.

Current Net Heat (Btu/hr): 127,337,122 Modified Net Heat (Btu/hr): 112,611,931

Source of Data / Information: Flue gas losses combustion conditions

	Current	Modified
Net Load Weight	Crude	Crude
Type of Material	Crude	Crude
Moisture content (% of material charged)	0	0
Charge weight #s or rate #s/hr	330,000	325,000
I. Temp (F)	300	325
F. Temp (F)	700	700
Heat of melting/vaporization (Btu/#)	400	400
% of Charge Vaporized		
Heat of reaction		
Heat Btu/hr		

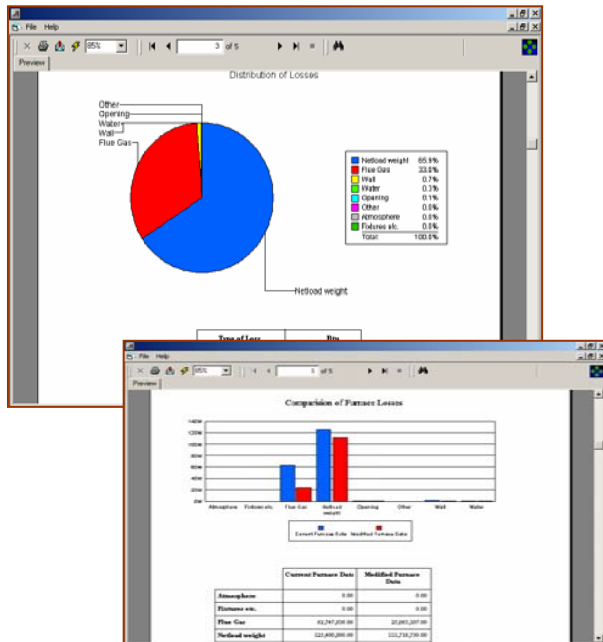
	Current	Modified
Furnace flue gas temp. (F)	900	900
% Oxygen in flue gases	6	2
% Excess air	35	10
Combustion air temperature (F)	100	500
Available Heat %	67	83
Gross Heat (Btu/hr)	190,144,958	135,677,098

Current Net Heat (Btu/hr) 127,337,122 Summary Enter/Edit Modified Data

Modified Net Heat (Btu/hr) 112,611,931 Close

- Use survey forms to collect data for each item listed in various Tabs of the form
- Use instructions given for each entry to collect the required data
- Review values of energy use or losses are for each major category of energy use

Process Heating Assessment and Survey Tool (PHAST)



The report shows

- Analysis of energy used in various parts of a furnace under a given operating condition
- Comparison of energy use for current operations and with possible changes (what-if analysis) in operating conditions for the furnace

Tips for Use of PHAST

Plant Survey

- Request plant to provide energy use information for all fired heating equipment if they have record of energy use by equipment
- If this information is not available then
 - Request them to complete the PHAST forms as much as possible
 - Or inform them about the type of information required for completion of the form and help them collect this information before the plant visit.
 - Or ask them to prepare a list of heating equipment prioritized by energy use-cost.

Tips for Use of PHAST

Plant Survey

- Make a note of burners and their rated capacity or model – supplier information to help selection of heating equipment for the assessment.
- It is very important to get information on the burner “loading”. This information is mostly subjective and can be provided by the operators or process engineers. Inform them that it is preliminary and has relatively small effect on energy savings recommendations.. It is mostly used for identifying the systems for assessment.
- Same comment applies for information on auxiliary equipment.

Current Version of PHAST

Plant Equipment Information

- Do NOT try to modify an existing case given in the data base to simulate your application. Always start out with a new case for your own application. You may change this by reopening the program.
- If you give a different name for the company and reopen the case, you will still see “XYZ Company” as company name but it will give you right name when you select your case from the plant name menu.
- The plant information section can be used for equipment using fuel firing, electric heat and steam heating equipment.

Current Version of PHAST

Plant Equipment Information

- For equipment such as electric arc furnaces (EAFs) that use oxygen lancing, use oxygen as a “new fuel” and give cost in terms of \$/cu.ft. to account for its cost.
- For use of alternate fuel during different periods of a year, use a separate zone with appropriate operating hours.
- The total energy cost (not individual equipment energy use cost) may include “double-dipping” if the steam used for heating equipment or processes is produced in-house and you consider boiler as one of the energy using equipment.

Current Version of PHAST

Furnace Analysis – Heat Balance

- General
 - Current version is straight forward for fuel fired systems using excess air or near-stoichiometric combustion.
 - One can use it for sub-stoichiometric fired systems by using equivalent available heat
 - For electrically heated system we have to use a “appropriate” temperature to adjust for electrical system efficiency. This allows its use for induction, resistance heating etc.
 - For steam heated system we have to use a “factitious” temperature to adjust for steam heating system efficiency. This allows its use for steam dryers, heat exchangers etc.

Current Version of PHAST

Furnace Analysis – Heat Balance

- General

- It would be advisable **not** to use this section for Electric Arc Furnaces. The EAF has too many variables that are not accounted for in this version of PHAST.
- Dryers used for drying paint, ink etc. contain volatile vapors and require additional make-up air to meet safety or insurance requirements. Dryers used for drying of wet materials require additional make-up air to maintain allowable dew point or relative humidity in the exhaust air (or flue gases).
- In either case measurement of O₂ in exhaust air (flue gases) will give very high O₂ % in flue gases. The current version gives accurate relationship between O₂% (dry) and excess air used in the system for up to 16% to 17% O₂ or up to 350% to 400% “excess air”.
- In some cases you can use make-up air as additional atmosphere if you know the volume flow rate and air-gas flow for the burners to calculate excess air or equivalent O₂ in combustion products..

Current Version of PHAST

Furnace Analysis – Heat Balance

Net Heat for load

- Do not forget the heat of reaction or volatilization. For industries such as glass, petroleum, chemical, steel etc. this could have significant impact on the load heat requirement.
- It is hard to get heat of reaction. Ask the plant personnel (process engineer, metallurgist etc.) for this value.

Wall Heat losses

- Account for ALL losses for the system. If you include preheated combustion air, do not forget to include heat losses from the air-preheater and piping. Use total area and weighted average temperature. Hopefully in the next version we will allow entry of multiple sections with different temperatures.

Tips for Use of PHAST

Wall Losses

- Accuracy of the estimate is marginal if the wall surface temperature is below 150 deg. F. However you can use the actual wall temperature and get approximate value of wall losses even if the temperature is below 150 deg. F.

Opening losses

- It is necessary to insert a value of wall thickness. It should be more than 0.5 inch.
- For round holes use the opening length same as the diameter of opening.
- You can use the variable opening side for fixed opening by using open time as 100%

Opening Losses

Source of Data Information

File Help

Plant Name 082501 Aluminium Construction Furnace Name Melter no. 2

Net Load Weight Weight of fixtures, trays, baskets etc. Atmosphere

Other losses exposed hot parts Flue gas losses combustion conditions Heat Storage

Water-cooling Wall losses **Openings**

	Current		Modified	
	Fixed	Variable	Fixed	Variable
Furnace wall thickness (inches)	<input type="text" value="12"/>	<input type="text" value="12"/>	<input type="text"/>	<input type="text"/>
Length of openings (inches)	<input type="text" value="120"/>	<input type="text" value="120"/>	<input type="text"/>	<input type="text"/>
Diameter or Height of openings (inches)	<input type="text" value="2"/>	<input type="text" value="1.50"/>	<input type="text"/>	<input type="text"/>
Total opening area (ft ²)	<input type="text" value="10"/>	<input type="text" value="15"/>	<input type="text"/>	<input type="text"/>
Inside temp. (F)	<input type="text" value="1400"/>	<input type="text" value="1400"/>	<input type="text"/>	<input type="text"/>
Outside or Ambient temp.(F)	<input type="text" value="80"/>	<input type="text" value="80"/>	<input type="text"/>	<input type="text"/>
% of time open	<input type="text" value="100"/>	<input type="text" value="60"/>	<input type="text" value="100"/>	<input type="text"/>
Heat Btu/hr	101,245		<input type="text"/>	<input type="text"/>

Source of Data / Information
This is to be used for openings in the wall or doors etc. Use actual measurements if possible or information from the current furnace drawings.

Previous Tab Next Tab

Current Net Heat (Btu/hr) 10,209,942 Summary Enter/Edit Modified Data

Modified Net Heat (Btu/hr) Report Close

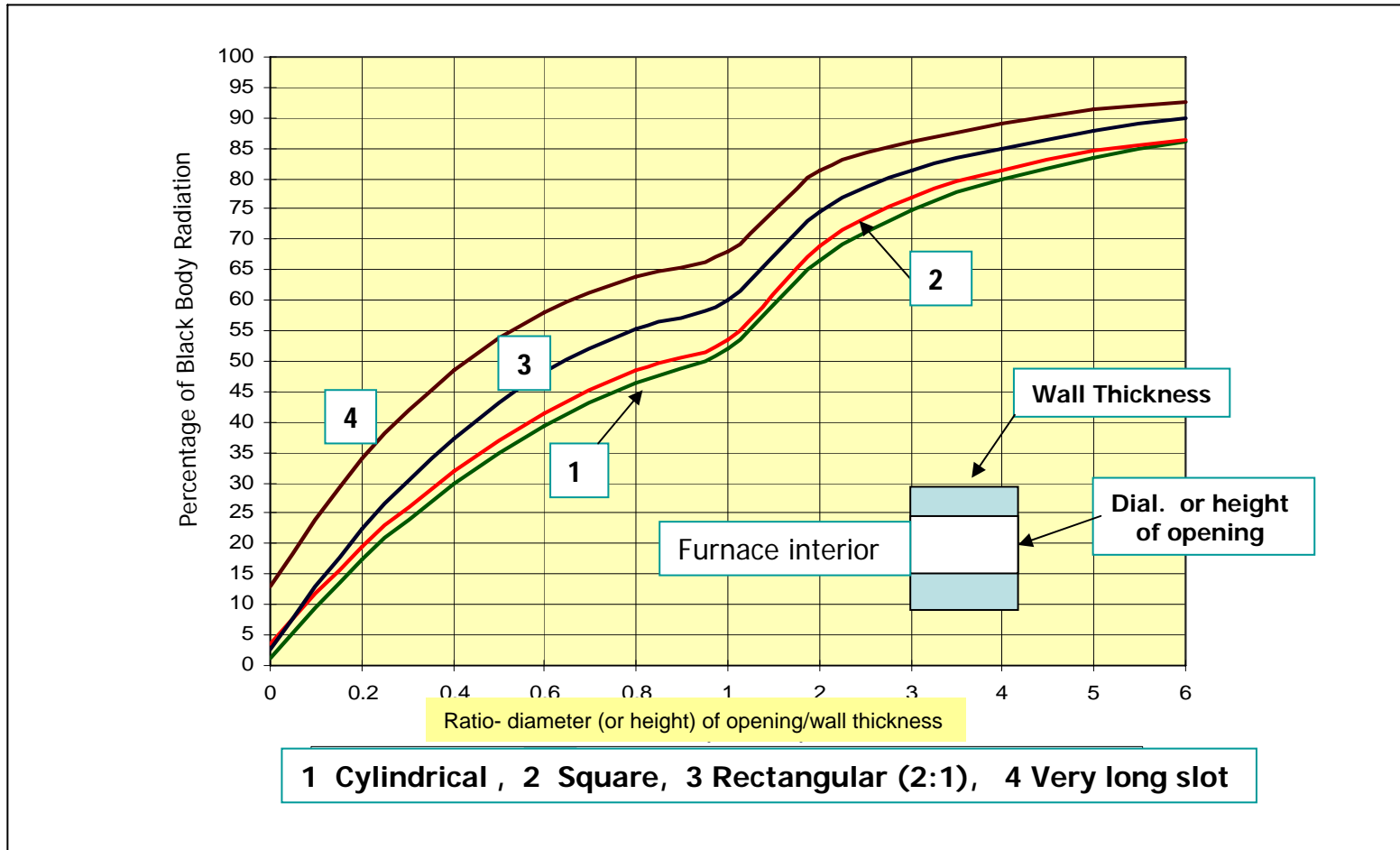
These calculations have been relatively difficult to understand use for many ESA experts as well as PHAST users.

Opening Losses

- The following dimensions are required for calculating radiation view factors
 - Furnace wall thickness
 - Diameter or height of the opening
- The actual dimensions have no effect on the final results. Only the ratio determines view factor.
- Use a finite (≥ 1) value for wall thickness. Do NOT use zero (0).
- Do not use a value of > 6 for this ratio. Otherwise you may get value of view factor of >1 . Obviously this cannot be right. We will correct this in the next version.
- For rectangular openings use slot length equal to or greater than the height of the slot. If this ratio is less than one then switch values of length to height and height to length. This does not affect the final results.
- You may use "0" for total area if there is no opening.
- For openings of different shapes/size use values for the largest opening.
- If you want to use two separate fixed openings then use one as fixed and another as variable with % opening value of 100%.

Radiation Heat Losses from Furnace Openings

an example of effect of radiation view factors



Tips for Use of PHAST

Available Heat

- The screen is designed for gas fired systems using air for combustion
- It only accounts for Stoichiometric or lean (excess air) combustion conditions
- The available heat values cannot be estimated if the flue gases include combustibles. Use charts given for “Available heat for sub-stoichiometric combustion” to estimate available heat and derive equivalent excess air number to get correct heat input values.
- For steam or electrically heated systems use value of excess air that gives electrical or steam heating system efficiency.

