Refresher for PHAST

By

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Masters
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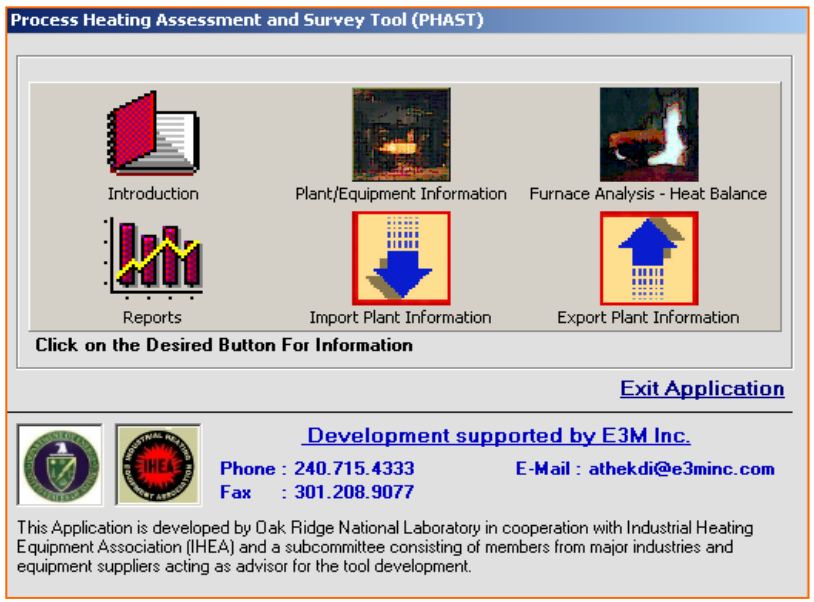
Process Heating Assessment and Survey Tool (PHAST)

Refresher



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)

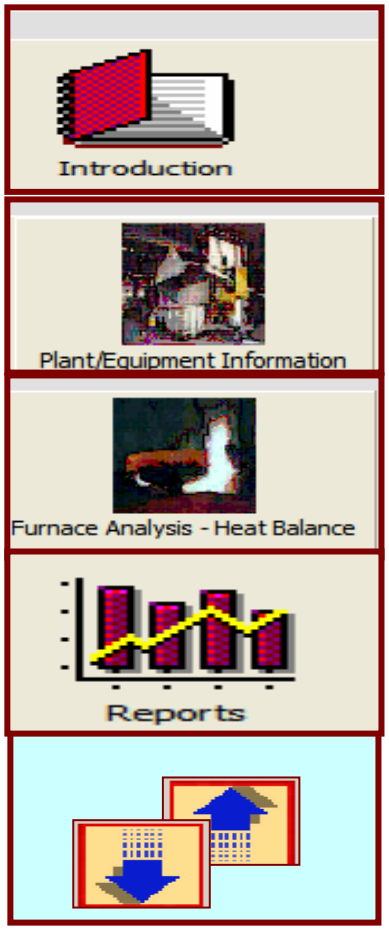
Download it from

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

It includes

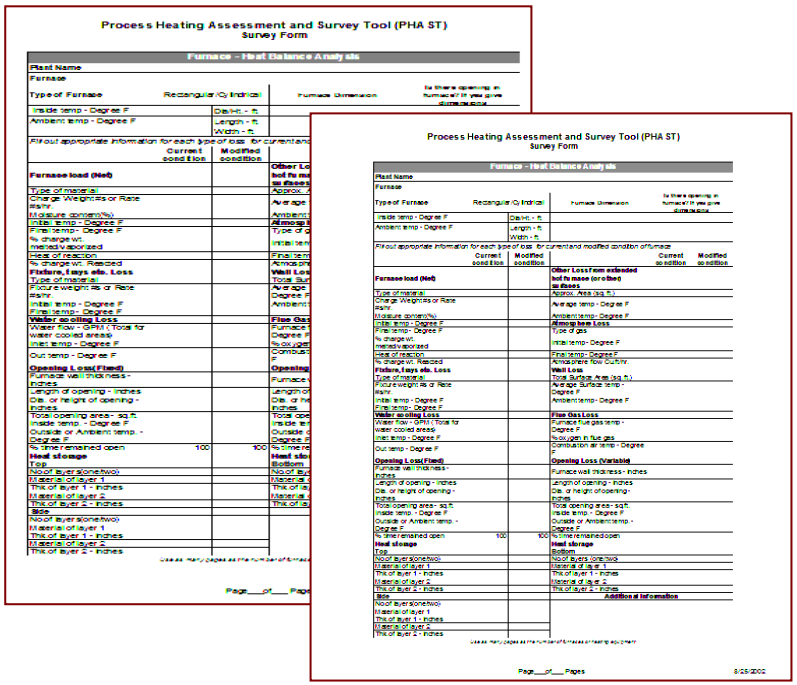
- Installation instructions for MS Windows 2000 and XP
- User manual
- Useful calculators
- Survey forms
- PHAST program

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 (PHA ST)
Survey Form

Furnace - Heat Balance Analysis

Plant Name
Furnace
Type of Furnace | Rectangular (C) Indirect | Furnace Dimension | Is there opening in furnace? If yes give dimension below

Inside temp - Degree F | Dia/Ht. - ft.
Ambient temp - Degree F | Length - ft. | Width - ft.

Fill out appropriate information for each type of loss for current and modified condition of furnace

	Current condition	Modified condition
Furnace load (Net)		
Type of material		
Charge Weight/hr or Rate #s/hr.		
Moisture content(%)		
Initial temp - Degree F		
Final temp - Degree F		
% charge wt. melted/vaporized		
Heat of reaction		
% charge wt. Reacted		
Fixture, trays etc. Loss		
Type of material		
Fixture weight /lb or Rate #s/hr		
Initial temp - Degree F		
Final temp - Degree F		
Water cooling Loss		
Water flow - GPM / Total for water cooled areas		
Inlet temp - Degree F		
Out temp - Degree F		
Opening Loss(Fixed)		
Furnace wall thickness - Inches		
Length of opening - Inches		
Dia. or height of opening - Inches		
Total opening area - sq.ft.		
Inside temp. - Degree F		
Outside or Ambient temp. - Degree F		
% time remained open	100	100
Heat storage		
Top		
No.of layer s(one/two)		
Material of layer 1		
Thk.of layer 1 - Inches		
Material of layer 2		
Thk.of layer 2 - Inches		
Bottom		
No.of layer s(one/two)		
Material of layer 1		
Thk.of layer 1 - Inches		
Material of layer 2		
Thk.of layer 2 - Inches		

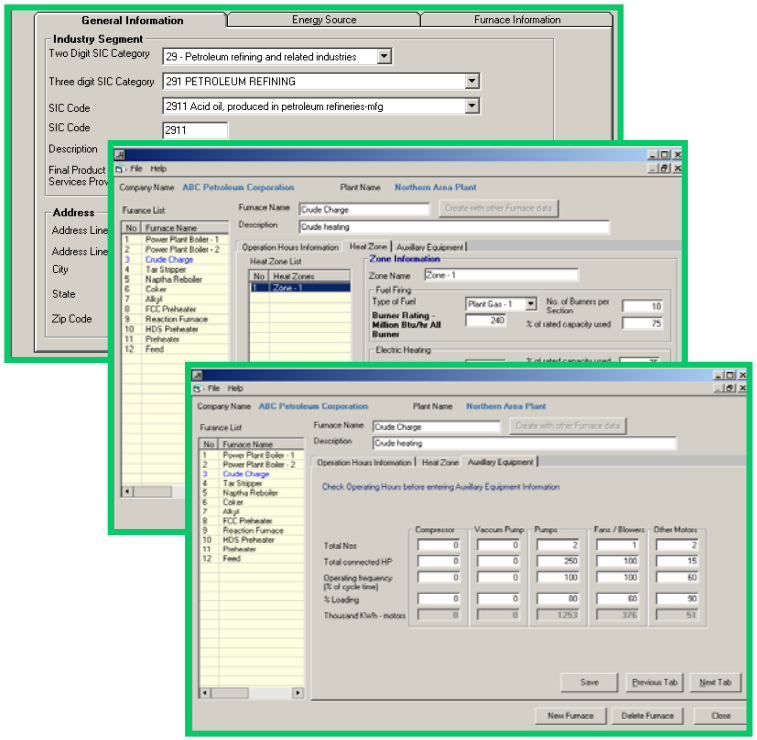
Use as many pages as the number of furnaces of heating equipment

Page ___ of ___ Pages

Process Heating Assessment and Survey Tool (PHA ST)
Survey Form

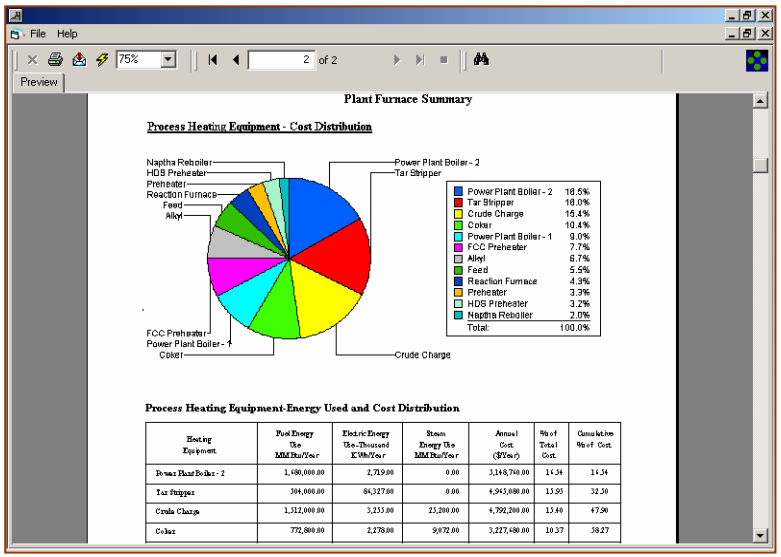
Use survey forms to collect energy use data for the furnaces, heaters, etc.

Process Heating Assessment and Survey Tool (PHAST)



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

Process Heating Assessment and Survey Tool (PHAST)

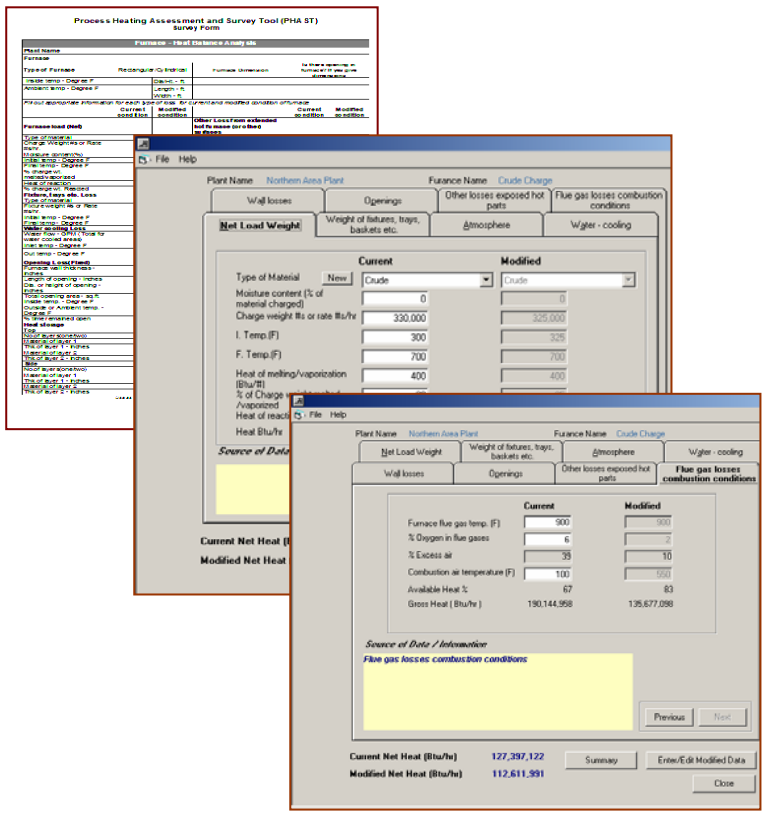


Heating Equipment	Fuel Energy Use MMBtu/Year	Electric Energy Use-Thousand KWh/Year	Steam Energy Use MMBtu/Year	Annual Cost ($/Year)	% of Total Cost	Cumulative % of Cost
Power Plant Boiler - 2	1,480,000.00	2,719.00	0.00	3,148,740.00	14.54	14.54
Tar Stripper	304,000.00	84,327.00	0.00	4,943,880.00	13.95	32.50
Crude Charge	1,312,000.00	3,233.00	23,200.00	4,792,200.00	13.40	47.90
Coker	772,800.00	2,278.00	9,072.00	3,227,480.00	10.37	58.27

The report shows:

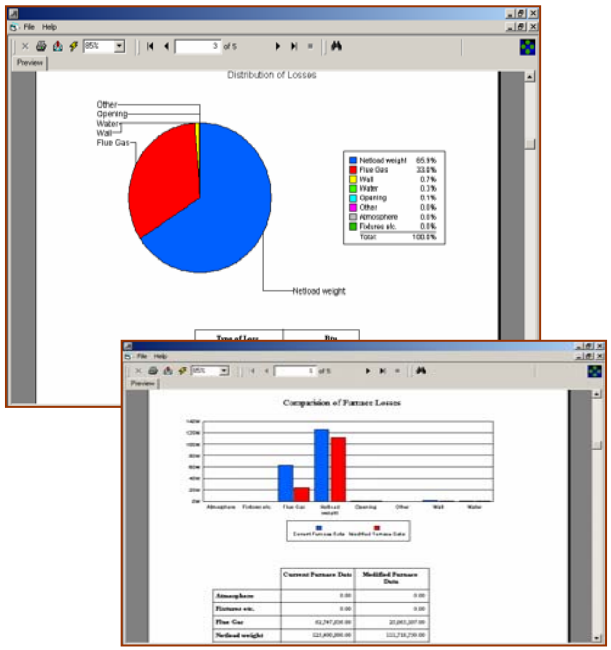
- **Estimated annual energy use and estimate annual cost of energy for heating equipment (furnaces, ovens etc.)**
- **List of heating equipment and % of total energy cost used for each equipment in order of annual cost of energy used**

Process Heating Assessment and Survey Tool (PHAST)



- **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

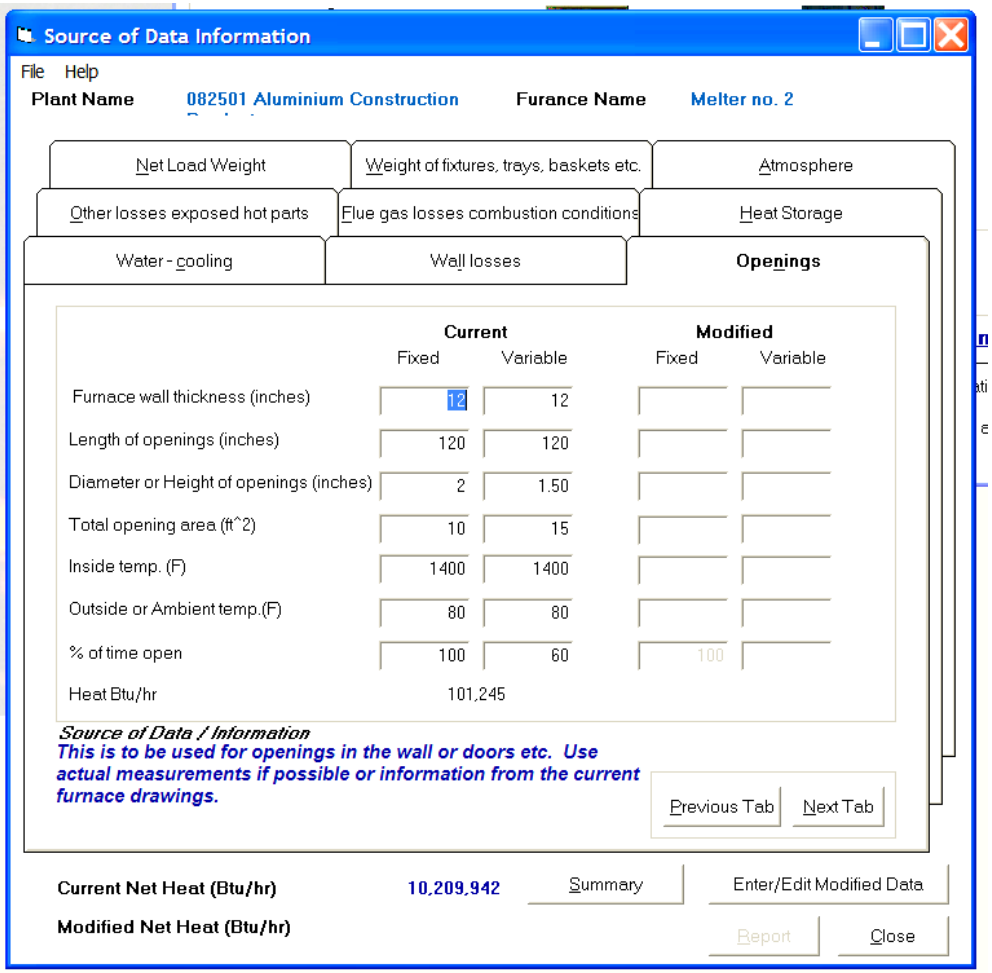
Wall Losses

- 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



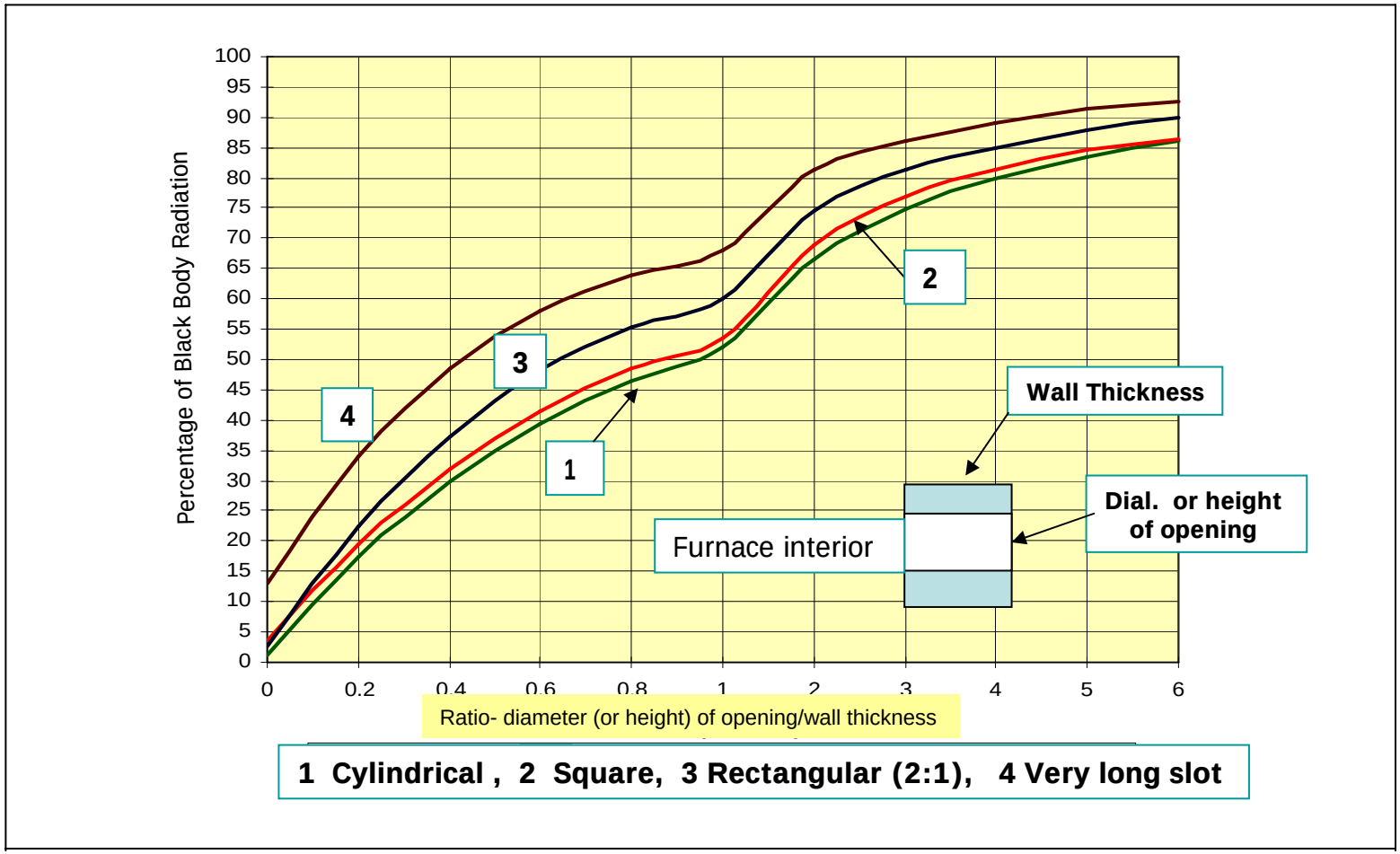
These calculations have been relatively difficult to understand use for many ESA experts as well as PHAST users.

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.