Steam System Tool Suite Introduction Guide

Alternate Text Narratives
and
Graphic Descriptions

October 6, 2009

Table of Contents

Welcome Module

9/30/2009

<u>Slide1</u>: Steam System Tool Suite - Welcome to the Steam System Tool Suite training.

<u>Slide 2</u>: There are eight different sections in this training. The navigational tutorial will provide you with a brief demonstration on how to navigate through the training. Then, you will learn how to use each one of the tools in the suite, including the Steam System Scoping Tool, the Steam System Assessment Tool, and the 3E Plus Insulation Tool. Each one of these trainings is called a module, and each module is followed by an interactive quiz, which will test your knowledge of the tools. Lastly, everything will be wrapped up with the conclusion.

<u>Slide 3</u>: Tool Capabilities - The U.S.DOE Steam Tools are designed to aid in assessing steam systems by identifying areas to investigate. The tools are most powerful in evaluating the opportunities to improve steam system operations by determining the energy and economic impact of specific projects. Steam assessments identify the performance characteristics of the system and identify opportunities to improve performance. Steam system modifications often affect the entire system requiring complicated calculations to accurately evaluate mass, energy, and economic impacts. The U.S.DOE Steam Tools complete these complicated calculations.

In this training you will learn the basics of how to use the tools to identify, analyze, quantify, and prioritize energy savings within your plant's steam system.

<u>Slide 4:</u> Example Steam System - The training will use an example steam system to demonstrate the use of the tools. The steam system used as the example represents a heavy industry site with typical components and common operating conditions. The evaluations and findings noted in this training represent opportunities commonly identified in industrial steam system investigations. This steam system is not extraordinary in any manner including fuel cost, steam production, and operating conditions.

The example system operates with three boilers—each boiler consumes a different fuel (natural gas, number 6 fuel oil, and green wood). The total fuel expenditure for the site is nominally 19 Million Dollars per Year. The cost of natural gas is ten dollars per Million BTU, the cost of number 6 fuel oil is five dollars per Million BTU, and the cost of green wood is 2 dollars per Million BTU (the blended fuel cost is five dollars and 80 cents per Million BTU). Typical steam production is 260,000 pounds per hour.

Slide 5: **Steam System -**

Schematic Visual Description:

Three boilers in parallel configuration produce steam to a multi-header steam distribution system with three pressure levels, high-pressure steam, medium-pressure steam, and low pressure steam. The schematic details are as follows:

Fuel is supplied to each boiler separately, as each has a separate fuel source.

A feedwater supply header provides feedwater to each of three steam boilers. Each boiler produces steam to supply a main high-pressure steam header.

The high-pressure steam header feeds a high-pressure distribution system with two backpressure turbines, one pressure reducing valve, and the high-pressure steam load (end users). The first backpressure turbine receives high-pressure steam and reduces it to low-pressure steam while generating electricity. The next item on the high-pressure distribution system schematic is the pressure reducing valve (PRV) which reduces the steam to medium-pressure. The second backpressure turbine receives high-pressure steam and reduces it to medium pressure steam while generating electricity. The final items on the high-pressure steam distribution system schematic are the end users, represented as a heat exchanger. Condensate discharged from the heat exchanger passes through a steam trap and is then directed to a flash-vessel allowing the condensate to from flash steam that is directed to the medium-pressure header. The remaining condensate exits the flash-vessel and is directed to the condensate recovery flash-vessel that discharges flash-steam to the low-pressure header.

The medium-pressure steam header supplies steam to one backpressure turbine which reduces steam to the low-pressure steam header while generating electricity. The medium-pressure header also supplies a pressure reducing valve which reduces steam to the low-pressure steam header. The medium-pressure header also supplied steam to the medium-pressure steam load, which is represented as a heat exchanger. This heat exchanger is represented similarly to the high-pressure unit. The heat exchanger discharges condensate through a steam trap to a flash-vessel that allows the condensate to form flash-steam that is directed to the low-pressure header.

The low-pressure distribution header receives steam from the turbine exhausts, the PRV station, and the flash steam generated from the condensate system. The low-pressure header supplies steam to the low-pressure load, which is also represented as a heat exchanger. This heat exchanger discharges condensate through a steam trap. The condensate enters an atmospheric pressure flash-vessel and is then pumped to the main condensate receiver where it combines with the condensate from the other end-use components. Low-pressure steam is also supplied to the deaerator through a control valve.

The main condensate tank pumps the combined collected condensate to the deaerator. Make-up water is mixed with the condensate prior to entering the deaerator. Feedwater is pumped from the deaerator to a header to supply the boilers, thus completing the schematic loop.

Cogeneration components are in place in the form of backpressure turbines. One of the backpressure turbines is in-place receiving high-pressure steam and discharging medium-pressure steam. This unit is rated to produce 3,500 kilowatts of power. Another backpressure turbine is in-place receiving medium-pressure steam and discharging low-pressure steam. This unit is rated to produce 4,200 kilowatts of power. The third backpressure turbine is a smaller capacity unit receiving high-pressure steam and discharging low-pressure steam. This unit is rated to produce 750 kilowatts of power. Steam is distributed to users at high, medium, and low pressures.

Slide 6:   **Results -** The example system was subjected to a steam system assessment using fundamental investigation techniques and the U.S.DOE Steam Tools. The assessment identified several projects that will result in significant energy savings that present economically attractive projects. The assessment identified more than 1,300,000 dollars per year of energy savings, which represents more than 7 percent of the fuel input cost to the site.

This Tool Introduction will walk you through this real-world example of a steam system to help illustrate how you can identify areas with potential for saving energy and for reducing costs.

Now, let's get started so you can learn how to utilize these tools at your site!

Navigational Tutorial

9/30/2009

Slide 1: Hello, and welcome to this interactive training on the Steam System Tool Suite. This training will show you a simulation of each software tool. In other words, you will see a movie that shows what you will see on screen, when you are using each software tool. You will be shown how to perform several actions in each tool, and a narrator will help you along the way by explaining. I would like to take a few minutes to show you how to navigate through the training. As you can see in the table of contents, it is separated into 3 different modules, each one demonstrating a different tool in the Steam System Tool Suite: The Steam System Scoping Tool, the Steam System Assessment Tool, and the 3E Plus Insulation Tool. Each module is followed by an interactive quiz, in which you complete a simulation of the tool that you just learned. Click on any module or quiz, in order to navigate to it.

Slide 3: Click on a module or quiz, and it will display each individual slide, as well as its title and its duration. You can click on any slide in order to navigate to it.

Slide 6: Under "Status," you will see a check-mark next to each module or slide that you have completed. At the bottom, you will see the total time of the training, as well as how much of that time you have completed. You can also utilize the bookmark feature. Select the small button on the left side of the slide title to bookmark a slide, to return to it later to complete the training session, or for reference or questions. You can click the button again to cancel the bookmark. At any time you have navigated the course with the sidebar or bottom control bar, and the audio does not begin, double-click on the highlighted sidebar slide title. The highlight identifies where you are, and the audio should restart.

Slide 7: Notice the toolbar below the main screen. "Rewind" will take you to the beginning of the module that you are viewing. Click "play" to continue,……

Slide 8: and "pause" to pause the training,

Slide 9: "Back" and "forward" will move back and forward between slides. If you want to go twice as fast, you can click on "2-times Fast Forward Speed."

Slide 10: Click on it again to get 4-times Fast Forward Speed. You must return to normal speed to hear the audio, as the audio is off during 2-times and 4-times Fast forward

Slide 11: Click on it one more time to go back to the normal speed.

Slide 12: You can also navigate to a particular section of the training by dragging the slider back and forward. Click it and hold down the mouse button.

Slide 13: It will display which slide you are on, out of the total number of slides in the module. As you reposition the slider cursor, you will notice the sidebar will highlight the slide corresponding to the cursor position. To restart the training, you may click on the corresponding slide (which is highlighted), or just hit the play button, as the pause button was automatically engaged when using the slider.

Slide 14: Also, You can choose to have the sound on or off.

Slide 15: “CC” allows the user to turn the closed-captioning on or off. Clicking the “X” will exit the program. Clicking “I” will display information about the program, including the author and the author’s e-mail address.

Slide 16: At the top right of the screen, you can click the left button to minimize the window.

Slide 17: Click on the middle button to maximize it, so that you can see it better.

Slide 18: Click on the X all the way on the right in order to close the training. If you are using Internet Explorer’s F11 Full-screen mode, you won’t be able to see the big “X” in the upper right corner until you hit F11 again. If you are using a browser other than Internet Explorer, these buttons will look different. Now, let’s get started!

SSST Module

9/30/2009

<u>Slide 1:</u> Hello, and welcome to this introduction on the Steam System Tool Suite.

<u>Slide 2:</u> In this tutorial, I will give you a basic overview of each Steam tool, including the Steam System Scoping Tool, the Steam System Assessment Tool, and the 3E Plus Insulation Tool. These tools are available for download from the DOE Industrial Technology Program's Technology Delivery website.

<u>Slide 3:</u> Technology Delivery is a program area within the Industrial Technologies Program (ITP) that supports ITP's mission to improve the energy intensity of the U.S. industrial sector through a coordinated program of research and development, validation, and dissemination of energy-efficient technologies and practices. One of the ways Technology Delivery keeps you in touch with the latest developments is through training, publications, and software tools. Let's get started to show how to begin to develop a list of potential projects at your site.

<u>Slide 4:</u> I will show you how to use the Steam tools, to identify, analyze, quantify, and prioritize energy savings within your plant's steam system. The first tool you should use is the Steam System Scoping Tool, which will help you develop a potential list of projects or areas of investigation for your plant.

<u>Slide 5:</u> Our example steam system utilized the SSST and identified these areas for further consideration:

Boiler efficiency improvements, feedwater economizers, blowdown thermal energy recovery, condensate recovery, and insulation improvements.

These projects were evaluated in the Assessment Tool and the Insulation Tool and identified nearly 1,300,000 dollars per year in energy savings.

Let's keep going to discover how these projects were developed using our Steam Tool Suite.

<u>Slide 6:</u> When assessing the condition of your steam system the first tool you should use is the scoping tool, SSST. It comes in two versions, a Visual Basic program and an Excel program. The Excel program is preferred and will be demonstrated here. The Scoping Tool requires you to enter information about your steam system pertaining to energy consumption, fuel type, unit costs, maintenance and energy monitoring practices. From this information the SSST identifies areas to investigate for potential energy savings. The SSST provides a weighting factor or score and compares it to a Best Practices score to help prioritize the areas to investigate first, with the highest potential of savings to the lowest potential areas for savings. This is not an "exact calculation" tool-there can be a range of appropriate scores that could be assigned to each question. Additionally, the weight assigned to a particular question may not precisely reflect the importance of that area for your facility. The tool is intended to aid in information gathering and to support investigation identification.

<u>Slide 7:</u> The first thing you will see is the 'Introduction' tab, which explains the audience for the tool, the purpose of the tool, the different sections of the tool, and so forth. Note that you can go back and forth between different sections in the tool by clicking on the tabs at the bottom of the worksheets.

<u>Slide 11:</u> Click on the next tab to visit the next section of the tool, '2', Steam System Basic Data.

Begin Tab 2- Steam System Basic Data

STEAM SYSTEM SCOPING TOOL, Version 1.0d **6/12/2002**

STEAM SYSTEM BASIC DATA

BASIC DATA ABOUT YOUR SYSTEM

<u>What To Do</u> Document some of the basic operating information about your steam system.

<u>Why Important</u> Documenting basic steam system data is important to help you to identify the current conditions of your steam system operations, and to establish a baseline/benchmark that you can refer to in the future.

QUESTION NUMBER	QUESTION	ANSWERS TO BASIC DATA QUESTIONS	
a	Briefly describe the type of production that your plant does in the column to the right. If you know the Standard Industrial Code (SIC) for your industry, please include that in your description.		
	IF YOU CONSUME STEAM BUT DO NOT GENERATE ANY OF YOUR OWN, PLEASE SKIP TO QUESTION "g"	**ANSWERS TO BASIC DATA QUESTIONS**	
b	What Is Your Total Annual Steam Production?		**Million lbs/year**
c	How Many Hours Per Year Is Your System In Operation?		**hours/year**
d	What Is Your Total Steam Generation Capacity?		**1000 lbs/hour, <u>or</u>**
			Boiler Horsepower
e	What Is Your Average Steam Generation Rate?		**1000 lbs/hour, <u>or</u>**
			Boiler Horsepower

	-CONTINUED-	ANSWERS TO BASIC DATA QUESTIONS	
f	What Is The % Distribution (On A Btu Basis) Of Your Fuel Sources For Steam Generation?		
	Coal		%
	Fuel Oil (#6)		%
	No. 2 Fuel Oil		%
	Natural Gas		%
	Process Waste Heat		%
	Biomass		%
	Solid Wastes		%
	Other		%
	TOTAL (Should add up to 100%)	0.0	%
-Steam System Basic Data (page 2)			
		ANSWERS TO BASIC DATA QUESTIONS	
g	Do You Have Any Heat Engines In Use On Site?		
	Back Pressure Steam Turbines		
	Number		
	Total Capacity		kW
	Condensing Steam Turbines		
	Number		
	Total Capacity		kW
	Combustion Gas Turbines Without Heat Recovery Steam Generators (HRSGs)		
	Total Capacity		kW
	Combustion Gas Turbines With HRSGs		
	Total Capacity		kW
	Other (specify type)		
	Total Capacity		kW
h	How Much Steam Do You Buy Annually From Others?		Million lbs/year
i	How Many Steam Traps Do You Have In Your Steam System?		
j	What is Your Average Boiler Blowdown Rate?		% of average feedwater flow rate

Slide 12: This section allows you to input some of the basic operating information about your steam system. For now, we'll answer Question 'a.', which asks for information for the type of production our 'plant' does. We'll just write 'Pulp and Paper' at Row 10.

QUESTION NUMBER	QUESTION	ANSWERS TO BASIC DATA QUESTIONS
a	Briefly describe the type of production that your plant does in the column to the right. If you know the Standard Industrial Code (SIC) for your industry, please include that in your description.	Pulp and Paper

Slide 15: Look at the text in red. Let's say that, for our plant, we generate our own steam. Therefore, we have to answer Questions "B" through "F". Total annual steam production will be 2,278 million pounds per year.

QUESTION NUMBER	QUESTION	ANSWERS TO BASIC DATA QUESTIONS	
b	What Is Your Total Annual Steam Production?	2,278	Million lbs/year

Slide 16: The system is in operation 8,760 hours per year.

QUESTION NUMBER	QUESTION	ANSWERS TO BASIC DATA QUESTIONS	
c	How Many Hours Per Year Is Your System In Operation?	8,760	hours/year

Slide 17: The site is equipped with three boilers with a combined total steam generation capacity of about 360,000 pounds per hour, so enter 360, as the units are in 1,000 pounds per hour.

QUESTION NUMBER	QUESTION	ANSWERS TO BASIC DATA QUESTIONS	
d	What Is Your Total Steam Generation Capacity?	360	1000 lbs/hour, or
			Boiler Horsepower

Slide 20: The average steam generation rate is about 260,000 pounds per hour, so again enter 260 to correspond to the units in 1,000 pounds per hour increments.

QUESTION NUMBER	QUESTION	ANSWERS TO BASIC DATA QUESTIONS	
e	What Is Your Average Steam Generation Rate?	260	1000 lbs/hour, or
			Boiler Horsepower

Slide 21: For question "F", let's say we consume 35 percent green wood, so enter 35 at biomass, row 30;

Slide 23: 37 percent natural gas,

Slide 24: and 28 percent Number 6 Fuel Oil.

QUESTION NUMBER	QUESTION	ANSWERS TO BASIC DATA QUESTIONS	
f	What Is The % Distribution (On A Btu Basis) Of Your Fuel Sources For Steam		
	Coal		%
	Fuel Oil (#6)	28	%
	No. 2 Fuel Oil		%
	Natural Gas	37	%
	Process Waste Heat		%
	Biomass	35	%
	Solid Wastes		%
	Other		%
	TOTAL (Should add up to 100%)	0.0	%

<u>Slide 27:</u> Question 'g' asks if we have any heat engines in use on site. Also, what kind, and what is their total capacity? Let's say that we have three backpressure steam turbines.

QUESTION NUMBER	QUESTION	ANSWERS TO BASIC DATA QUESTIONS	
g	Do You Have Any Heat Engines In Use On Site?		
	Back Pressure Steam Turbines		
	Number	3	
	Total Capacity		kW

<u>Slide 28:</u> The steam turbine generators are rated to generate 4,200 kW of power, 3,500 kW of power, and 750 kW of power. This makes for a total of 8,450 kW.

QUESTION NUMBER	QUESTION	ANSWERS TO BASIC DATA QUESTIONS	
g	Do You Have Any Heat Engines In Use On Site?		
	Back Pressure Steam Turbines		
	Number	3	
	Total Capacity	8450	kW
	Condensing Steam Turbines		
	Number		
	Total Capacity		kW
	Combustion Gas Turbines Without Heat Recovery Steam Generators		
	Total Capacity		kW
	Combustion Gas Turbines With HRSGs		
	Total Capacity		kW
	Other (specify type)		
	Total Capacity		kW

<u>Slide 29:</u> Now let's answer questions 'h' through 'j.' We do not purchase steam from other sources, so continue to question i. We have 3,550 steam traps in our steam system…….. and our average boiler blowdown rate is 6 percent (which is the percentage of the average feedwater flow rate that exits the boilers as blowdown.")

QUESTION NUMBER	QUESTION	ANSWERS TO BASIC DATA QUESTIONS	
h	How Much Steam Do You Buy Annually From Others?		Million lbs/year
i	How Many Steam Traps Do You Have In Your Steam System?	3550	
j	What is Your Average Boiler Blowdown Rate?	6	% of average feedwater flow rate

Slides 32 – 34: The next section is '3, Steam System Profiling.'

It poses a series of questions to determine what levels of steam and fuel consumption are being measured, monitored, trended and benchmarked against production levels. A score is assigned to each answer and totaled at the end of the tool. Higher levels of measuring, monitoring , trending and benchmarking will reflect in a higher score. This section is divided into three smaller sections, 'Steam Costs,' 'Steam/Product Benchmarks,' and 'Steam System Measurements.'

Begin Tab 3- Steam System Profiling

STEAM SYSTEM SCOPING TOOL, Version 1.0d 6/12/2002

STEAM SYSTEM PROFILING

STEAM COSTS

What To Do Identify what it costs at your facility to produce steam (in units of $/1000 lbs), and use this as a benchmark for evaluating opportunities for improving your steam operations. Start with determining what your fuel costs are to make steam, then add other costs associated with your operations (chemical costs, labor, etc).

Why Important Understanding the cost to make steam can be an eye-opener - producing steam is not free! Any opportunity that reduces the amount of steam generated saves money, so understanding the cost to make steam is a key step to being able to quantify improvement opportunities.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
SC1	Do you monitor your Fuel Cost To Generate Steam - in terms of ($) / (1000 lbs. of steam produced)?	yes	10	
		no	0	
SC2	How often do you calculate and trend your Fuel Cost To Generate Steam?	at least quarterly	10	
		at least yearly	5	
		less than yearly	0	

STEAM/PRODUCT BENCHMARKS

What To Do Identify how much steam it takes to make your key products. Then track this benchmark: a) with what other facilities in your company do; b) with what other similar plants in your industry do; and c) with how this benchmark varies in your operations over time.

Why Important The bottom line of your operation is how cost effectively you make your products, and steam use has an impact on your productivity. Steam/product benchmarking is an excellent way to monitor productivity and how steam improvements translate to improved productivity.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
BM1	Do you Measure your Steam/Product Benchmark - in terms of (lbs. of steam needed) / (unit of product produced)?	yes	10	
		no	0	
BM2	How often do you Measure and Trend your Steam/Product Benchmark - in terms of (lbs. of steam needed) / (unit of product produced)?	at least quarterly	10	
		at least yearly	5	
		less than yearly	0	

STEAM SYSTEM MEASUREMENTS

What To Do Identify key steam operational parameters that you should monitor and ensure that you are adequately measuring them.

Why Important You Can't Manage What You Don't Measure! Measurement of key steam system parameters assists you in monitoring your system, diagnosing potential system problems, and ensuring that system improvements continue to provide benefits to your operations.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
MS1	Do you measure and record Critical Energy Parameters for your Steam System?			
	Steam Production Rate (to obtain total steam production)	yes	10	
	Fuel Flow Rate (to obtain total fuel consumption)	yes	6	
	Feedwater Flow Rate	yes	6	
	Makeup Water Flow Rate	yes	4	
	Blowdown Flow Rate	yes	2	
	Chemical Input Flow Rate	yes	2	
		no to all of above	0	
MS2	How intensely do you meter your steam flows? - CHOOSE ONE OF FIVE ANSWERS	by major user/equip	20	
		by process unit	10	
		by area or building	5	
		by plant as a whole (i.e., total boiler output)	2	
		not at all	0	

Slide 35: At the beginning of each section, the 'What to do' part gives you suggestions on what and how to measure different aspects of your site, and the 'Why important' part explains how these measurements help you improve your steam site.

For each question, decide on your answer, look at the score to the right, and type this score in the grey box next to it, hit enter or tab to move forward.

'Steam Costs' asks you if you monitor the cost of fuel to generate steam, as well as how often you calculate that cost. We generate our own steam and receive bills that tell us the cost of fuel. We monitor our bills for a score of 10 at SC1.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
SC1	Do you monitor your Fuel Costs to Generate Steam – in terms of ($) / (1,000 lbs. o f steam produced)?	yes	10	10
		no	5	

Slide 36: We estimate our steam generation cost annually, so we can enter a score of 5 for SC2.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
SC2	How often do you calculate and trend your Fuel Cost To Generate Steam?	at least quarterly	10	
		at least yearly	5	5
		less than yearly	0	

Slide 39: 'Steam/Product Benchmarks' asks you to identify how much steam it takes to make your products, and to keep track of this benchmark over time and compare it with other facilities and plants. We estimate the amount of steam needed per pound of material produced and we trend this annually for scores of 10 for BM1 and 5 for BM2.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
BM1	Do you Measure your Steam/Product Benchmark - in terms of (lbs. of steam needed) / (unit of product produced)?	yes	10	10
		no	0	
BM2	How often do you Measure and Trend your Steam/Product Benchmark - in terms of (lbs. of steam needed) / (unit of product produced)?	at least quarterly	10	
		at least yearly	5	5
		less than yearly	0	

Slide 42: 'Steam System Measurements' asks you how often you measure and record various operational parameters of your system." We measure steam flow, feedwater flow rate and makeup water flow rate for a total of 20 points at MS1.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
MS1	Do you measure and record Critical Energy Parameters for your Steam System?			
	Steam Production Rate (to obtain total steam production)	yes	10	**10**
	Fuel Flow Rate (to obtain total fuel consumption)	yes	6	
	Feedwater Flow Rate	yes	6	**6**
	Makeup Water Flow Rate	yes	4	**4**
	Blowdown Flow Rate	yes	2	
	Chemical Input Flow Rate	yes	2	
		no to all of above	0	

Slide 44: We have steam flow meters on our major process equipment for a score for 10 on MS2.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
MS2	How intensely do you meter your steam flows? - CHOOSE ONE OF FIVE ANSWERS	by major user/equip	20	
		by process unit	10	**10**
		by area or building	5	
		by plant as a whole (i.e., total boiler output)	2	
		not at all	0	

Slide 45: The next three sections work the same way.

Begin Tab 4- Steam System Operating Practices

STEAM SYSTEM SCOPING TOOL, Version 1.0d **6/12/2002**

STEAM SYSTEM OPERATING PRACTICES

STEAM TRAP MAINTENANCE

What To Do Implement a comprehensive program to correctly select, test, and maintain your steam traps.

Why Important Steam traps play three important functions: a) prevent steam from escaping from the system before the heat is utilized; b) remove condensate from the system; and c) vent noncondensable gases. Poor steam trap selection, testing, and maintenance can result in many system problems including water hammer, ineffective process heat transfer, steam leakage, and system corrosion. An effective steam trap selection and maintenance program is often an excellent investment with paybacks of less than half a year.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
ST1	Does Your System Steam Trap Maintenance Program Include The Following Activities?			
	Proper Trap Selection For Application	yes	10	
	At Least Annual Testing Of All Traps	yes	10	
	Maintaining A Steam Trap Database	yes	10	
	Repairing/Replacing Defective Traps	yes	10	
		none of the above	0	

WATER TREATMENT PROGRAM

<u>What To Do</u> Implement and maintain an effective Water Treatment Program in your steam system.

<u>Why Important</u> An effective steam system Water Treatment Program: a) reduces the potential for waterside fouling problems in your boilers; b) is critical to minimizing boiler blowdown and the resulting energy losses; c) can reduce the generation of wet steam; and d) greatly reduces the potential for corrosion problems throughout your steam system. Most effective water treatment programs include both mechanical (filtration, softening, and deaeration) and chemical treatment. Problems in this area can lead to significant plant productivity issues related to equipment failure and downtime - be sure to consult with a chemical treatment specialist on an ongoing basis.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
WT1	How often do you ensure that your Water Chemical Treatment System is functioning properly?	at least daily	10	
		at least weekly	5	
		less than weekly	0	
WT2	How often do you NEED to clean Fireside or Waterside deposits in your Boiler?	every 5-10 years	10	
		every 1-5 years	5	
		once/year or more	0	
WT3	How often do you measure Conductivity (or Total Dissolved Solids [TDS]) in your Boiler and determine what your Steam and Mud Drum Blowdown Rate (or Top and Bottom Boiler Blowdown Rate) should be?	continuous, or at least once/shift	10	
		once/day	5	
		once/week or less	0	

SYSTEM INSULATION

What To Do Ensure that the appropriate major components of your steam system are well insulated. Determine the economic insulation thickness for your system components, and perform system insulation reviews to identify exposed surfaces that should be insulated and/or unrestored or damaged insulation.

Why Important Effective insulation - on piping, valves, fittings, and vessels - serves many important purposes. Insulation keeps steam energy within the system to be effectively used by processes, it can reduce temperature fluctuations in the system, it can reduce space conditioning requirements, and it can reduce the potential for personnel burns.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
IN1	Is your Boiler Plant equipment and piping system insulation (refractory, piping, valves, flanges, vessels, etc.) maintained and in good condition?	insulation excellent	10	
		insulation good, but can be improved	7	
		insulation inadequate	0	
IN2	Is your Steam Distribution, End Use, and Condensate Recovery equipment insulation (piping, valves, flanges, heat exchangers, etc.) maintained and in good condition?	insulation excellent	20	
		insulation good, but can be improved	14	
		insulation inadequate	0	

STEAM LEAKS

What To Do Identify and quickly repair steam leaks in your steam system.

Why Important Steam leaks can result from failures associated with such things as improper piping design, corrosion problems, and joint and valve seal failures. In high-pressure industrial steam systems, energy costs associated with steam leaks can be substantial. Identifying and repairing steam leaks is essential to properly balancing your steam system.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
LK1	How would you characterize Steam Leaks in your Steam System?	none	10	
		minor	8	
		moderate	3	
		numerous	0	

WATER HAMMER

What To Do Detect and quickly eliminate Water Hammer in your steam system.

Why Important Water Hammer is a serious concern - it can lead to failure and rupture of piping and valves, and in many cases significant personnel injury due to contact with steam and condensate. There are two main types of water hammer: one caused by accumulation of condensate in steam distribution piping and transport of this condensate by high-velocity steam; and the other caused by a pressure pulse resulting from steam collapse (rapid condensation) in condensate return lines and heat exchange equipment. Water Hammer in your steam system always says FIX ME!!

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
WH1	How often do you detect noticeable Water Hammer in your Steam and Condensate Recovery System?	less than once a month	10	
		monthly or weekly	5	
		daily or hourly	0	

MAINTAINING EFFECTIVE STEAM SYSTEM OPERATIONS

What To Do Establish and carry out a comprehensive steam system maintenance program.

Why Important Effective steam system operating practices and improvements can provide benefits to your steam operations year after year - IF you have an effective system maintenance program in place. Major areas of maintenance that will provide year-after-year benefits to your operations include: a) steam traps; b) boiler performance; c) water treatment; d) turbines, piping, heat exchangers, pumps, motors, and valves; and e) system insulation.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
MN1	Do you periodically - at least once a year - inspect the following important Steam Plant Operational Equipment?			
	Boiler Plant Equipment - boiler, deaerator, feedwater tank, chemical treatment equipment, blowdown equipment, economizer, combustion air preheater, insulation, etc.?	yes	5	
	Distribution System Equipment - piping (including design), steam traps (types, sizes, locations), air vents, valves, pressure reducing stations, insulation, etc.?	yes	5	
	End Use System Equipment - turbines, piping (including design), heat exchangers, coils, jacketed kettles, steam traps (types, sizes, locations), air vents, vacuum breakers, pressure reducing valves, insulation, etc.?	yes	5	
	Recovery System Equipment - piping (including design), valves, fittings, flash tanks, condensate pumps, condensate meters, insulation, etc.?	yes	5	
		no to all of above	0	

Slide 46: "Section 4, Steam System Operating Practices" contains six smaller sections. 'Steam Trap Maintenance' asks you whether you correctly select, test, and maintain your steam traps. We have a steam trap database, which assists us with an annual inspection of all our traps, and we verify the right trap for the application during the inspections for a total of 30 points for ST1.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
ST1	Does Your System Steam Trap Maintenance Program Include The Following Activities?			
	Proper Trap Selection For Application	yes	10	10
	At Least Annual Testing Of All Traps	yes	10	10
	Maintaining A Steam Trap Database	yes	10	10
	Repairing/Replacing Defective Traps	yes	10	
		none of the above	0	

Slide 51: We are a bit behind on repairing and replacing the traps, so we decided not to award any points for this activity.

Slide 53: 'Water Treatment Program' asks you how often you monitor your water treatment program and how often you need to clean deposits in your boiler." Our plant has a crew to inspect the Water Chemical Treatment system at the beginning of each shift, so we award 10 points to WT1. We have a third party maintenance contract to inspect the boilers and typically deposits are well controlled with the water treatment program and routine fire-side cleaning activities. As a result, a score of 10 is provided for WT2.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
WT1	How often do you ensure that your Water Chemical Treatment System is functioning properly?	at least daily	10	10
		at least weekly	5	
		less than weekly	0	
WT2	How often do you NEED to clean Fireside or Waterside deposits in your Boiler?	every 5-10 years	10	10
		every 1-5 years	5	
		once/year or more	0	

Slide 54: We continuously monitor boiler water conductivity so we award 10 points for WT3.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
WT3	How often do you measure Conductivity (or Total Dissolved Solids [TDS]) in your Boiler and determine what your Steam and Mud Drum Blowdown Rate (or Top and Bottom Boiler Blowdown Rate) should be?	at least daily	10	**10**
		at least weekly	5	
		less than weekly	0	

Slide 57: 'System Insulation' asks you how well your major steam system components are insulated and how your equipment insulation is maintained. Our boilers, auxiliary equipment, and the utilities piping are covered with appropriate insulation; only a few areas of missing insulation were noted. As a result, we award 7 points on IN1.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
IN1	Is your Boiler Plant equipment and piping system insulation (refractory, piping, valves, flanges, vessels, etc.) maintained and in good condition?	insulation excellent	10	
		insulation good, but can be improved	7	**7**
		insulation inadequate	0	

Slide 58: Our distribution piping insulation is very old and damaged in many spots, and valves are not insulated; therefore we will score 5 points for IN2.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
IN2	Is your Steam Distribution, End Use, and Condensate Recovery equipment insulation (piping, valves, flanges, heat exchangers, etc.) maintained and in good condition?	insulation excellent	10	
		insulation good, but can be improved	7	**7**
		insulation inadequate	0	

<u>Slide 61:</u> 'Steam Leaks' asks you how many steam leaks you have in your system." Our distribution system has leakage issues as well as the insulation problems. We will score 3 points for LK1.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
LK1	How would you characterize Steam Leaks in your Steam System?	none	10	
		minor	8	
		moderate	3	**3**
		numerous	0	

<u>Slide 63:</u> 'Water hammer' asks how often you find Water Hammer in your Steam and Condensate Recovery System." Our plant has little issues with water hammer, so we award 10 points for WH1.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
WH1	How often do you detect noticeable Water Hammer in your Steam and Condensate Recovery System?	less than once a month	10	**10**
		monthly or weekly	5	
		daily or hourly	0	

<u>Slide 66:</u> ‘Maintaining effective Steam System Operations” asks you whether you inspect, on a yearly basis, different operational equipment. Our third party maintenance contract does a thorough inspection of the boiler plant equipment and supporting equipment, piping system and its components, and many of our end user process equipment. We will award 15 points for MN1.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
MN1	Do you periodically - at least once a year - inspect the following important Steam Plant Operational Equipment?			
	<u>Boiler Plant Equipment</u> - boiler, deaerator, feedwater tank, chemical treatment equipment, blowdown equipment, economizer, combustion air preheater, insulation, etc.?	yes	5	**5**
	<u>Distribution System Equipment</u> - piping (including design), steam traps (types, sizes, locations), air vents, valves, pressure reducing stations, insulation, etc.?	yes	5	**5**
	<u>End Use System Equipment</u> - turbines, piping (including design), heat exchangers, coils, jacketed kettles, steam traps (types, sizes, locations), air vents, vacuum breakers, pressure reducing valves, insulation, etc.?	yes	5	**5**
	<u>Recovery System Equipment</u> - piping (including design), valves, fittings, flash tanks, condensate pumps, condensate meters, insulation, etc.?	yes	5	
		no to all of above	0	

Begin Tab 5 – Boiler Plant Operating Practices

STEAM SYSTEM SCOPING TOOL, Version 1.0d **6/12/2002**

BOILER PLANT OPERATING PRACTICES

BOILER EFFICIENCY

What To Do Measure, trend, and look for opportunities to improve the efficiency of your boilers.

Why Important One of the key boiler plant functions is to generate steam at the highest possible efficiency. Major sources of boiler efficiency losses include: a) combustion and flue gas energy losses [typically the largest]; b) blowdown losses; and c) refractory insulation losses. It is important to measure and trend boiler efficiency, flue gas temperature, flue gas oxygen content, and flue gas carbon monoxide content on a regular basis. Measurement and control of excess oxygen is critical to minimizing boiler combustion energy losses. Trending flue gas temperature can provide indications of other potential boiler problems, such as waterside or fireside fouling problems.

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
BE1	How often do you measure your overall Boiler Efficiency - [(heat absorbed to create steam) / (energy input from fuel)]?	at least quarterly	10	
		at least yearly	5	
		less than yearly	0	

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
BE2	Do you measure the following parameters as a function of boiler load and ambient temperature?			
	Flue gas temperature	yes	5	
	Flue gas Oxygen content	yes	5	
	Flue gas CO content	yes	5	
		no to all of above	0	

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
BE3	How do you control Excess Air in your Boiler to maximize Boiler Efficiency?	automatically	10	
		manually	5	
		not at all	0	

HEAT RECOVERY EQUIPMENT

What To Do Evaluate installation of Heat Recovery Equipment on your Boiler Plant.

Why Important In some boilers, high flue gas temperatures and high continuous blowdown rates can provide opportunities for installation of heat recovery equipment. Feedwater economizers and combustion air preheaters can, under appropriate conditions, be installed to extract excess flue gas energy and effectively increase the boiler efficiency. Blowdown heat recovery equipment can also, for some systems, be installed to extract otherwise lost heat from the blowdown system. For either potential opportunity, an economic analysis is needed to determine the feasibility of the opportunity, and the equipment should be designed and installed by qualified professionals.

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
HR1	Do you have any of the following Heat Recovery Equipment installed on your Boilers?			
	Feedwater Economizer and/or Combustion Air Preheater	yes	10	
	Blowdown Heat Recovery	yes	5	
		no to all of above	0	

GENERATING DRY STEAM

What To Do Ensure that you generate high-quality dry steam in your boiler plant.

Why Important Steam of 100% quality contains no liquid water; wet steam contains liquid droplets. Generating wet steam in your boiler can cause many system problems, including: a) inefficient process heat transfer; b) equipment failure by water hammer; c) equipment failure by corrosion and erosion; and d) steam trap failure by overloading. Some typical causes for creation of wet steam and boiler carryover are: a) wide swings in boiler water level; b) reduced operating pressure; c) boiler overload; and d) poor boiler total dissolved solids (TDS) control. A critical step to ensuring generation of high-quality steam is to measure the quality of steam leaving your boiler; this is typically done using steam calorimeters.

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
DS1	How often do you check the Quality of Steam that is output from your Boiler to the Distribution System, and ensure that you are generating Dry Steam?	at least quarterly	10	
		at least yearly	5	
		less than yearly	0	

GENERAL BOILER OPERATION

What To Do Ensure that your boilers perform their functions without large fluctuations in operating conditions.

Why Important How you control boiler operation can effect many elements of the steam system - including the operating life of the boiler, the quality of steam produced, and the effectiveness of steam use throughout your production operations.

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
GB1	Do you have an operational automatic blowdown controller on your Boiler?	yes	5	
		no	0	

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
GB2	What is the frequency of High Level Alarms (possibly indicating boiler undersized) or Low Level Alarms (possibly indicating boiler oversized) for your Boiler?	less than 1/month	10	
		1-5 per month	5	
		more than 5/month	0	

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
GB3	How often do you experience steam pressure fluctuations of greater than 10% of your Boiler Operating Pressure?	less than 1/month	5	
		1-5 per month	3	
		more than 5/month	0	

Slide 69: 'Section 5, 'Boiler Plant Operating Practices,' contains four smaller sections. 'Boiler efficiency' asks you about how often you measure boiler efficiency, what parameters you use to make those measurements and how you control excess air." Our plant estimates the boiler efficiency each month, so we can award 10 points to BE1.

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
BE1	How often do you measure your overall Boiler Efficiency - [(heat absorbed to create steam) / (energy input from fuel)]?	at least quarterly	10	**10**
		at least yearly	5	
		less than yearly	0	

Slide 70: We also measure flue gas temperature on each boiler, so we get a total of 5 points for BE2.

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
BE2	Do you measure the following parameters as a function of boiler load and ambient temperature?			
	Flue gas temperature	yes	5	5
	Flue gas Oxygen content	yes	5	
	Flue gas CO content	yes	5	
		no to all of above	0	

Slide 71: Periodically, we measure and tune the excess air in the boiler; therefore, we assign a total of 5 points for BE3.

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
BE3	How do you control Excess Air in your Boiler to maximize Boiler Efficiency?	automatically	10	
		manually	5	5
		not at all	0	

Slide 74: 'Heat recovery equipment' asks you about what kind of heat recovery equipment you have already installed on your boilers. One of our three boilers is equipped with a feedwater economizer. So what should we do? We don't want to give this a zero, but not award a full 10 points. We can consider 10 points divided by 3 boilers would give us a nominal 3 points for HR1 for the one feedwater economizer. This is a good time to mention that the scores suggested on the Scoping Tool are not fixed and you can use your best judgment to award the points for your specific configuration. You want this tool to help you identify areas of your system that can be improved. Low scores, of course, indicate areas that potentially could be improved. The scoping tool results should reflect the fact that potentially additional flue gas energy can be recovered.

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
HR1	Do you have any of the following Heat Recovery Equipment installed on your Boilers?			
	Feedwater Economizer and/or Combustion Air Preheater	yes	10	
	Blowdown Heat Recovery	yes	5	3
		no to all of above	0	

Slide 76: ' Generating dry steam' asks how often you check the quality of steam that is output and ensure that it is dry. We generate superheated steam and are not experiencing any carryover type issues; as a result, we award a score of 10 points for DS1.

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
DS1	How often do you check the Quality of Steam that is output from your Boiler to the Distribution System, and ensure that you are generating Dry Steam?	at least quarterly	10	10
		at least yearly	5	
		less than yearly	0	

Slide 78: 'General boiler operation' asks you about the blowdown controller, alarm frequency, and steam pressure fluctuations in your boiler. We utilize automatic blowdown control for 5 points on GB1.

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
GB1	Do you have an operational automatic blowdown controller on your Boiler?	yes	5	5
		no	0	

Slide 79: We rarely experience a high or low alarm, so we award 10 points for GB2.

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
GB2	What is the frequency of High Level Alarms (possibly indicating boiler undersized) or Low Level Alarms (possibly indicating boiler oversized) for your Boiler?	less than 1/month	10	10
		1-5 per month	5	
		more than 5/month	0	

Slide 80: Our boiler pressure remains stable so we award 5 points for GB3

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
GB3	How often do you experience steam pressure fluctuations of greater than 10% of your Boiler Operating Pressure?	less than 1/month	5	**5**
		1-5 per month	3	
		more than 5/month	0	

Slide 82: The next section, '6, Steam Distribution, End Use, Recovery Operating Practices' will ask questions concerning your methods to reduce steam pressure, and recover and utilize condensate and flash steam.

Begin Tab 6 – Steam Distribution, End Use, Recovery, Operating Practices

STEAM SYSTEM SCOPING TOOL, Version 1.0d   6/12/2002

STEAM DISTRIBUTION, END USE, RECOVERY - OPERATING PRACTICES

OPTIONS FOR REDUCING STEAM PRESSURE - MINIMIZE STEAM FLOW THROUGH PRVs

What To Do Investigate potential to use backpressure turbines in parallel with pressure reducing valves in your steam system.

Why Important In many steam systems, pressure reducing valves (PRVs) are used to provide steam at pressures lower than generated from the boiler. A potential opportunity for improving a steam system is to minimize the flow of steam through PRVs. One opportunity for doing this is to install backpressure turbines in parallel with PRVs in your steam system; in this way you can provide the low-pressure steam required and generate electricity or shaft power that can be utilized. A detailed economic analysis must be performed to evaluate this type of opportunity.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
PR1	How do you reduce steam pressure in your steam system?	steam generated at required pressure, or PRVs appropriately applied	10	
		backpressure turbines used in parallel with PRVs	10	
		boiler control used to reduce pressure	5	
		excess steam vented and/or used inefficiently	0	

RECOVER AND UTILIZE AVAILABLE CONDENSATE

What To Do Determine how much of your available condensate you recover and utilize.

Why Important Returning a substantial portion of your condensate to your boiler can have both energy and chemical treatment benefits: a) condensate is hotter than makeup water, so less energy is required to convert condensate to steam; and b) condensate requires significantly less chemical treatment than makeup water, so there may be savings in chemical treatment costs associated with returning condensate. Returning as much condensate as possible also can help to reduce boiler blowdown (because fewer impurities are resident in condensate), and so minimize blowdown energy losses.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
CR1	How much of your available Condensate do you recover and utilize?	greater than 80%	10	
		40% to 80%	6	
		20% to 40%	3	
		less than 20%	0	

USE HIGH-PRESSURE CONDENSATE TO MAKE LOW-PRESSURE STEAM

What To Do Investigate opportunity to utilize high-pressure condensate to produce useable low-pressure steam.

Why Important An opportunity for utilizing high-pressure condensate is to allow it to pass through a flash tank and utilize the flash steam in low-pressure steam applications. The remainder of the condensate, now at lower pressure and temperature, can then be sent back to the boiler for use in producing steam.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
FS1	How much of your available Flash Steam do you recover and utilize?	greater than 80%, or flash steam unavailable	10	
		40% to 80%	6	
		20% to 40%	3	
		less than 20%	0	

Slide 82 - continued: We generate steam at 400 psig for high pressure applications and primarily utilize steam turbines to achieve other useable pressures. However, we operate with additional steam turbine capacity and some steam flow through pressure reducing stations. Therefore we will award 7 points for PR1.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
PR1	How do you reduce steam pressure in your steam system?	steam generated at required pressure, or PRVs appropriately applied	10	
		backpressure turbines used in parallel with PRVs	10	7
		boiler control used to reduce pressure	5	
		excess steam vented and/or used inefficiently	0	

Slide 83: Once again, you can see flexibility when awarding a score. We use both steam turbines and PRVs to reduce the pressure. We have additional steam turbine capacity that could be used to manage low-pressure steam supply. The score of 7 helps capture this configuration.

Slide 84: We recover about 50 percent of the condensate for a score of 6 points for CR1.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
CR1	How much of your available Condensate do you recover and utilize?	greater than 80%	10	
		40% to 80%	6	6
		20% to 40%	3	
		less than 20%	0	

Slide 85: We recover about 50 percent of our flash steam, so we score 6 points for FS1.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
FS1	How much of your available Flash Steam do you recover and utilize?	greater than 80%, or flash steam unavailable	10	
		40% to 80%	6	**6**
		20% to 40%	3	
		less than 20%	0	

Begin Tab 7 – Summary Results

Slide 88: The 'Summary Results' section, '7.,' shows your total section score out of a possible maximum BestPractices score for each section of the scoping tool. Again, the more you measure, monitor, trend and benchmark, the higher your score. Your score is reported for each question, then summarized by area, from the profiling and operating practices sections. From the comparison, you can see which area or areas could be improved upon. Enter the date you completed this SSST so it can be compared to future evaluations of the system.

SUMMARY RESULTS

1. STEAM SYSTEM PROFILING	POSSIBLE SCORE	YOUR SCORE
STEAM COSTS		
SC1: Measure Fuel Cost To Generate Steam	10	10
SC2: Trend Fuel Cost To Generate Steam	10	5
STEAM/PRODUCT BENCHMARKS		
BM1: Measure Steam/Product Benchmarks	10	10
BM2: Trend Steam/Product Benchmarks	10	5
STEAM SYSTEM MEASUREMENTS		
MS1: Measure/Record Steam System Critical Energy Parameters	30	20
MS2: Intensity Of Measuring Steam Flows	20	10
STEAM SYSTEM PROFILING SCORE	90	60

2. STEAM SYSTEM OPERATING PRACTICES	POSSIBLE SCORE	YOUR SCORE
STEAM TRAP MAINTENANCE		
ST1: Steam Trap Maintenance Practices	40	30
WATER TREATMENT PROGRAM		
WT1: Water Treatment - Ensuring Function	10	10
WT2: Cleaning Boiler Fireside/Waterside Deposits	10	10
WT3: Measuring Boiler TDS, Top/Bottom Blowdown Rates	10	10
SYSTEM INSULATION		
IN1: Insulation - Boiler Plant	10	7
IN2: Insulation - Distribution/End Use/Recovery	20	5
STEAM LEAKS		
LK1: Steam Leaks - Severity	10	3
WATER HAMMER		
WH1: Water Hammer - How Often	10	10
MAINTAINING EFFECTIVE STEAM SYSTEM OPERATIONS		
MN1: Inspecting Important Steam Plant Equipment	20	15
STEAM SYSTEM OPERATING PRACTICES SCORE	140	100

3. BOILER PLANT OPERATING PRACTICES	POSSIBLE SCORE	YOUR SCORE
BOILER EFFICIENCY		
BE1: Measuring Boiler Efficiency - How Often	10	10
BE2: Flue Gas Temperature, O2, CO Measurement	15	5
BE3: Controlling Boiler Excess Air	10	5
HEAT RECOVERY EQUIPMENT		
HR1: Boiler Heat Recovery Equipment	15	3
GENERATING DRY STEAM		
DS1: Checking Boiler Steam Quality	10	10
GENERAL BOILER OPERATION		
GB1: Automatic Boiler Blowdown Control	5	5
GB2: Frequency Of Boiler High/Low Level Alarms	10	10
GB3: Frequency Of Boiler Steam Pressure Fluctuations	5	5
BOILER PLANT OPERATING PRACTICES SCORE	80	53

SUMMARY RESULTS (page 2)

3. STEAM DISTRIBUTION, END USE, RECOVERY OPERATING PRACTICES	POSSIBLE SCORE	YOUR SCORE
MINIMIZE STEAM FLOW THROUGH PRVs		
PR1: Options For Reducing Steam Pressure	10	7
RECOVER AND UTILIZE AVAILABLE CONDENSATE		
CR1: Recovering And Utilizing Available Condensate	10	6
USE HIGH-PRESSURE CONDENSATE TO MAKE LOW-PRESSURE STEAM		
FS1: Recovering And Utilizing Available Flash Steam	10	6
DISTRIBUTION, END USE, RECOVERY OP. PRACTICES SCORE	30	19

SCOPING TOOL RESULTS	POSSIBLE SCORE	YOUR SCORE
STEAM SYSTEM PROFILING	90	60
STEAM SYSTEM OPERATING PRACTICES	140	100
BOILER PLANT OPERATING PRACTICES	80	53
DISTRIBUTION, END USE, RECOVERY OP. PRACTICES	30	19
TOTAL SCOPING TOOL QUESTIONAIRE SCORE	340	232
TOTAL SCOPING TOOL QUESTIONAIRE SCORE (%)		68.2%
Date That You Completed This Questionnaire		3/04/09

Slide 92: Here is an example of using the results. Overall, the steam system scored 232 points, or 68 percent of the possible score, which leaves room for improvement. To determine where to start looking, you can divide "Your Score" by the "Possible Score" to calculate the percentage for each section. Let's begin by looking at the lowest score, Distribution, End Use, Recovery Operations from Section 6.

Your results are:

67% for Steam System Profiling

71% for Steam System Operating Practices

66% for Boiler Plant Operating Practices

63% for Distribution, End Use, Recovery Operation Practices

We have room for improvement in all areas.

Slide 95: Where did you score less than the maximum score for a question? You utilize a combination of turbines and PRV, but perhaps additional turbine capacity could be incorporated to minimize the steam flow through pressure reducing valves.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
PR1	How do you reduce steam pressure in your steam system?	steam generated at required pressure, or PRVs appropriately applied	10	
		backpressure turbines used in parallel with PRVs	10	7
		boiler control used to reduce pressure	5	
		excess steam vented and/or used inefficiently	0	

-Additional turbine capacity for improvement!-

Slide 97: You could attempt to recover the remaining condensate and/or utilize more flash steam recovery for 8 more points for CR1 and FS1, respectively.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
CR1	How much of your available Condensate do you recover and utilize?	greater than 80%	10	
		40% to 80%	6	6
		20% to 40%	3	
		less than 20%	0	

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
FS1	How much of your available Flash Steam do you recover and utilize?	greater than 80%, or flash	10	
		40% to 80%	6	6
		20% to 40%	3	
		less than 20%	0	

Slide 98: Section 5, the Boiler Plant Operating Practices also has room for improvement at 66 percent.

Your results are:

67% for Steam System Profiling

71% for Steam System Operating Practices

66% for Boiler Plant Operating Practices

63% for Distribution, End Use, Recovery Operation Practices

We have room for improvement in all areas.

SCOPING TOOL RESULTS	POSSIBLE SCORE	YOUR SCORE
STEAM SYSTEM PROFILING	90	60
STEAM SYSTEM OPERATING PRACTICES	140	100
BOILER PLANT OPERATING PRACTICES	80	53
DISTRIBUTION, END USE, RECOVERY OP. PRACTICES	30	19
TOTAL SCOPING TOOL QUESTIONAIRE SCORE	340	232
TOTAL SCOPING TOOL QUESTIONAIRE SCORE (%)		68.2%
Date That You Completed This Questionnaire		3/04/09

Slide 101: You could monitor the flue gas oxygen and carbon monoxide content for 10 more points on question BE2 (rows 15-19).

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
BE2	Do you measure the following parameters as a function of boiler load and ambient temperature?			
	Flue gas temperature	yes	5	5
	Flue gas Oxygen content	yes	5	
	Flue gas CO content	yes	5	
		no to all of above	0	

-10 More Points!-

Slide 103: The lowest score is 3 of 10 for the heat recovery equipment HR1. (rows 30-33). In this case we only have one feedwater economizer. We could consider adding feedwater economizers to the other two boilers. This section also identifies that blowdown heat recovery could be added to the boilers. A possible 12 extra points is available in this question.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
HR1	Do you have any of the following Heat Recovery Equipment installed on your Boilers?			
	Feedwater Economizer and/or Combustion Air Preheater	yes	10	
	Blowdown Heat Recovery	yes	5	3
		no to all of above	0	

-Add Feedwater for More Points! -

These two sections can utilize the Steam System Assessment Tool, also known as the Assessment Tool, or SSAT, to help evaluate these potential projects to improve the scores as well as other areas. The Assessment Tool will be discussed in a subsequent module of this Introductory Training.

- Steam System Assessment Tool (SSAT)
-Evaluate Projects
-Improve Scores -

Slide 104: To look at one more area, return to Section 4 Steam System Operating Practices which scored 71 percent.

Slide 105: While this is the best of score for the sections the score indicates there is potential for improvement here as well. Beginning at question ST1 (rows 11-16), what things could you be managing better?

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
ST1	Does Your System Steam Trap Maintenance Program Include The Following Activities?			
	Proper Trap Selection For	yes	10	10
	At Least Annual Testing Of All	yes	10	10
	Maintaining A Steam Trap	yes	10	10
	Repairing/Replacing Defective	yes	10	
		none of the above	0	

-Repair/Replace Defective Traps for extra 10 points! -

Slide 107: Additional work on the System Insulation , questions IN1 and IN2 at rows 45 through 51, could have added up to 18 more points.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
IN1	Is your Boiler Plant equipment and piping system insulation (refractory, piping, valves, flanges, vessels, etc.) maintained and in good condition?	insulation excellent	10	
		insulation good, but can be improved	7	7
		insulation inadequate	0	
IN2	Is your Steam Distribution, End Use, and Condensate Recovery equipment insulation (piping, valves, flanges, heat exchangers, etc.) maintained and in good condition?	insulation excellent	20	
		insulation good, but can be improved	14	5
		insulation inadequate	0	

The 3EPlus Insulation Thickness Computer Program, also called the Insulation Tool, or 3EPlus can be used to help evaluate the energy and cost savings from various insulation projects, as well as the cost to implement those projects. This software tool will be discussed in a subsequent module of this Introductory Training.

- 3EPlus Insulation Tool (SSAT) **- Cost savings of projects** **-Cost to Implement those projects -**

Slide 110: The last section, 8, 'Next Steps', provides you with some resources to help you improve your steam system. It gives you links to downloads for a guide, a sourcebook, and the other 2 Steam tools that we will discuss later in this training.

Begin Tab 8 – Next Steps

STEAM SCOPING TOOL, Version 1.0d **6/12/2002**

NEXT STEPS - Additional DOE BestPractices Steam Resources

WHAT'S YOUR NEXT STEP? Your steam system self-assessment using this Tool may have identified some potential steam system improvement projects. BestPractices Steam has developed additional tools and resources to help you to go the next step in improving your steam system. These tools are identified below.

START AT THE BESTPRACTICES WEB SITE! This web site includes links to all of the major tools and publications developed by BestPractices Steam. The web site address is **http://www1.eere.energy.gov/industry/bestpractices/about_bestpractices.html**.

STEAM SYSTEM SURVEY GUIDE: This guide is a reference document developed for plant energy managers and steam system operations personnel. It provides a technical basis for identifying and assessing many potential steam system improvement opportunities. It is complementary to the Steam System Scoping Tool, and provides quantitative descriptions of how to quantify major steam system improvement opportunities. It is available from the BestPractices web site.

STEAM TIP SHEETS. BestPractices Steam has developed 26 energy tip sheets that provide concise descriptions of common steam system improvement opportunities. The tips are available for download from the BestPractices web site. The topics for these tip sheets are listed below, by major topic groups:

STEAM SYSTEM PROFILING

- ***Benchmark the Fuel Costs of Steam Generation***

STEAM SYSTEM OPERATING PRACTICES

- ***Inspect and Repair Steam Traps***
- ***Insulate Steam Distribution and Condensate Return Lines***
- ***Install Removable Insulation on Uninsulated Valves and Fittings***

BOILER PLANT OPERATING PRACTICES

- ***Improve Your Boiler's Combustion Efficiency***
- ***Use Feedwater Economizers for Waste Heat Recovery***
- ***Clean Boiler Waterside Heat Transfer Surfaces***
- ***Minimize Boiler Blowdown***
- ***Recover Heat from Boiler Blowdown***
- ***Minimize Boiler Short Cycling Losses***
- ***Deaerators in Industrial Steam***

DISTRIBUTION, END USE, RECOVERY OPERATING PRACTICES

- ***Replace Pressure-Reducing Valves with Backpressure Turbogenerators***
- ***Consider Steam Turbine Drives for Rotating Equipment***
- ***Return Condensate to the Boiler***
- ***Flash High-Pressure Condensate to Regenerate Low-Pressure Steam***
- ***Use a Vent Condenser to Recover Flash Steam Energy Use Low Grade Waste Steam to Power Absorption Chillers***
- ***Use Vapor Recompression to Recover Low-Pressure Waste Steam***
- ***Cover Heated, Open Vessels***

NEXT STEPS - Additional DOE BestPractices Steam Resources (cont.)

IMPROVING STEAM SYSTEM PERFORMANCE: A Sourcebook for Industry. BestPractices Steam has developed a Sourcebook that is designed to provide steam system users with a reference that describes basic industrial steam system components, outlines opportunities for energy and performance improvements, and provides a comprehensive list of steam system contacts, resources, tools, software, videos, and training courses and technical services. This Sourcebook should be available on the BestPractices web site in June 2002.

3E-PLUS INSULATION APPRAISAL SOFTWARE. 3E-Plus was developed by the North American Insulation Manufacturer's Association (NAIMA) to increase awareness among steam system operations and management personnel of the benefits of insulation, and to allow these personnel to assess insulation improvement opportunities. The present version of 3E-Plus can be downloaded from the BestPractices web site.

STEAMING AHEAD WEB SITE. The Alliance to Save Energy "Steaming Ahead" web site publicizes the activities and information products developed by the DOE BestPractices Steam effort. This web site is also the source for a "Steaming Ahead" bi-monthly e-mail newsletter. This newsletter promotes best-in-class practices and technology applications in steam system design and management. The "Steam Digest" - a yearly compilation of articles and papers on steam efficiency measures - is also available from the Steaming Ahead web site. The web site address is **www.steamingahead.org.**

Slide 112: **I**t also provides you with links to download energy tip sheets, with concise descriptions of common projects that can be implemented to improve your steam system."

"Look under Steam Tip Sheets for the Steam System Operating Practices rows 15-18 and you can see two tip sheets for "Insulate Steam Distribution and Condensate Return Lines" and "Install Removable Insulation on Uninsulated Valves and Fittings' may help improve your score for the distribution piping insulation, include valves and fittings. Your example score was 5 for questions IN2, so opportunities may exist. Review the other resources listed and visit the BestPractices website for more publications to improve your score, as well as additional tools to help estimate savings potentials. "

http://www1.eere.energy.gov/industry/bestpractices/index.html

http://www1.eere.energy.gov/industry/bestpractices/publications.asp

http://www1.eere.energy.gov/industry/bestpractices/techpubs_steam.html

http://www1.eere.energy.gov/industry/bestpractices/software.html#ssat

When you are finished, you can save your information as an Excel file. Go to 'File',

Slide 114: 'Save as,'

Slide 116: choose a name for your file, then click 'save.'

Slide 118: Your filename will be whatever you chose, followed by 'dot XLS'.

Slide 119: You can also print out individual sections. Just navigate to (or group) whatever section(s) you want to print out, go to the file menu,

Slide 121: click print,

Slide 123: select 'active sheet or sheets, and click 'OK'.

Slide 125: You can also print the entire workbook by selecting ……

Slide 126: **'**entire workbook' then clicking 'OK'.

Slide 129: The Steam System Scoping Tool can be considered a score card for your steam system performance. The scoping tool is a good first order look at your steam system, utilizing a minimum amount of information without the need for actual data collection, to determine where to begin looking for areas of improvement, so you can develop a potential project list.

Slide 130: By knowing where areas of improvement are, we can use the other tools to determine the impact of making changes to our system in order to select the best projects, or combination of projects, to consider for implementation. Insulation improvements are best evaluated with the 3E Plus Insulation Thickness Program. Steam System improvements are best evaluated with the Steam System Assessment Tool. Both of these tools can be used to make estimates of energy and cost savings.

Slide 131: To begin a further look into potential projects for feasibility, let's look at the Steam System Assessment Tool, or simply the Assessment Tool, or its acronym, SSAT. The Assessment Tool can help you further your investigation by modeling your system with site-specific details and then looking at selected projects for their impact on system efficiency, energy savings and cost savings.

SSAT Module
9/30/2009

<u>Slide 1:</u> Hello, and welcome to this introduction to the Steam System Assessment Tool.

<u>Slide 2:</u> Technology Delivery is a program area within the Industrial Technologies Program (ITP) that supports ITP's mission to improve the energy intensity of the U.S. industrial sector through a coordinated program of research and development, validation, and dissemination of energy-efficient technologies and practices. One of the ways Technology Delivery keeps you in touch with the latest developments is through training, publications, and software tools. This tool, the Steam System Assessment Tool, also known as 'the Assessment Tool', or its acronym, SSAT, is one of the software tools to help you identify energy saving opportunities to achieve your energy reduction goals.

<u>Slide 3:</u> Now, we will show you the Steam System Assessment Tool. This is an Excel-based software tool designed to model the entire steam system. It allows you to do project investigations, by doing a before-and-after analysis of different real-life steam projects.

Using steam system investigation techniques and the U.S. DOE Steam tools, system improvements, or projects, are identified. The Assessment Tool will be used to calculate the energy and economic impacts for these projects. These projects include boiler feedwater economizer installation, blowdown thermal energy recovery, condensate recovery, and insulation.

The initial investigation of our example system identified several areas where modifications could reduce energy consumption. We will use the SSAT to evaluate the impact of potential projects in some of these areas. We will see that sustainable real-world projects have the potential to reduce fuel cost more than 7 percent. It should be noted that the site fuel cost is 19,000,000 per year; therefore, the savings potential is 1,300,000 dollars per year.

<u>Slide 4:</u> After you open the SSAT, the first thing you will see is a list of templates to start with. There are three different basic system arrangements based on the number of steam pressures in the system. SSAT is arranged to have 1, 2, or 3 different pressure levels, utilizing combinations of high pressure, medium pressure, and low pressure. The SSAT templates are each available in US units or metric units. For now, let's click on SSAT 3 Header v3 US and hit the select button.

Select SSAT Template

SSAT Templates allow you to calculate predefined systems.
The structure of each template is locked and cannot be changed

Select one of the locked templates below:

	FileName	Title	FullName
	SSAT 1 Header v3 Metric.xls	1 Pressure Header Model v3 Metric	C:\Program Files\LM\ProSteam\Templates\SSAT 1 Header v3 Metric.xls
	SSAT 1 Header v3 US.xls	1 Pressure Header Model v3 US	C:\Program Files\LM\ProSteam\Templates\SSAT 1 Header v3 US.xls
	SSAT 2 Header v3 Metric.xls	2 Pressure Header Model v3 Metric	C:\Program Files\LM\ProSteam\Templates\SSAT 2 Header v3 Metric.xls
	SSAT 2 Header v3 US.xls	2 Pressure Header Model v3 US	C:\Program Files\LM\ProSteam\Templates\SSAT 2 Header v3 US.xls
	SSAT 3 Header v3 Metric.xls	3 Pressure Header Model v3 Metric	C:\Program Files\LM\ProSteam\Templates\SSAT 3 Header v3 Metric.xls
	SSAT 3 Header v3 US.xls	3 Pressure Header Model v3 US	C:\Program Files\LM\ProSteam\Templates\SSAT 3 Header v3 US.xls

US Units are BTU per hour per square inch-gauge, and degrees Fahrenheit.
Metric Units are Kilowatts, bar-gauge, and degrees Celcius.

Slide 7: The SSAT is a sophisticated steam system modeling tool that is based in Excel. The tool allows the user to configure a model of their industrial steam system. SSAT completes comprehensive mass and energy balances on the system.

Steam System Assessment Tool 3 Header Model **Data Entry Form for Current System**			
The data entry form is split into two sections.			
"Quick Start" enables you to enter a minimum amount of information about your site and to start modeling your system right away.			
"Site Detail" allows you to provide more detailed information about your site to improve the accuracy of the model.			
Yellow shaded cells require user input.			
Where different options can be chosen by the user, the required supplementary data input cells are shaded green and are indicated by ***red arrows***.			
Quick Start			
Enter Case Description	SSAT Default 3 Header Model		
General Site Data	**Input Data**		**Notes/Warnings**
			Power import + site generated power = site electrical demand
Site Power Import (+ for import, - for export)	15000	kW	
Site Power Cost	0.0700	$/kWh	Typical 2003 value: $0.05/kWh
Operating hours per year	8760	hrs	
Site Make-Up Water Cost	0.0025	$/gallon	Typical 2003 value: $0.0025/gallon
Make-Up Water Temperature	70	F	
Note: Enter average values for the operating period being modeled			
Boiler fuel - Choose from this drop-down list			Natural Gas
Site Fuel Cost per 1000 s.cu.ft	10.00	$	Typical 2003 value: $5.78/(1,000 s cu.ft)

Built into SSAT are many of the energy management projects commonly addressed in industrial steam systems.

Slide 8: The user can turn these projects on or off and when fuel and electricity cost data are input the economic impacts of the projects can be determined. SSAT provides a side-by-side comparison of the original system and the system operating with the selected projects implemented.

Steam System Assessment Tool

3 Header Model

Projects Entry Form

Use this form to specify improvement projects. These projects will then be modeled and compared to the existing operation.

Project 1 - Steam Demand Savings (Changing the process steam requirements)

Current use - HP: 50 klb/h (40.22 MMBtu/h) MP: 100 klb/h (86.25 MMBtu/h) LP: 200 klb/h (179.82 MMBtu/h)

Do you wish to specify steam demand savings?			No
If yes, enter HP steam saving	0	klb/h	
If yes, enter MP steam saving	0	klb/h	
If yes, enter LP steam saving	1	klb/h	

Note: A negative saving can be entered to model an increase in steam demand

Note: The savings have been converted to heat duties of 0.00 MMBtu/h (HP), 0.00 MMBtu/h (MP) and 0.00 MMBtu/h (LP) based on current header enthalpies

Note: These heat duties are then used to determine the actual flow change in the Projects Model based on the calculated header enthalpies

Project 2 - Use an Alternative Fuel

Existing Boiler Fuel : Natural Gas Fuel Cost : $0.00578/s cu.ft

Do you wish to specify an alternative fuel?	No

Slide 9: This allows the energy and economic impacts of the system improvements to be identified.

Steam System Assessment Tool

3 Header Model

Results Summary

SSAT Default 3 Header Model

Model Status : OK

Cost Summary ($ '000s/yr)	**Current Operation**	**After Projects**	**Reduction**	
Power Cost	9,198	9,198	0	0.0%
Fuel Cost	33,575	31,976	1,599	4.8%
Make-Up Water Cost	361	361	0	0.0%
Total Cost (in $ '000s/yr)	**43,134**	**41,535**	**1,599**	**3.7%**

On-Site Emissions	**Current Operation**	**After Projects**	**Reduction**	
CO2 Emissions	390200 klb/yr	371619 klb/yr	18581 klb/yr	4.8%
SOx Emissions	0klb/yr	0 klb/yr	0 klb/yr	N/A
NOx Emissions	772 klb/yr	736 klb/yr	37 klb/yr	4.8%

Slide 10: Once you have selected the template for the number of pressure headers and units, you can begin to enter specific data for your site to build the model. Let's assume we have already entered the data into the three header template, saved it, and are re-opening the file for further use. Go to 'File',

Slide 12: 'Open',

Slide 15: Click on desktop or wherever you saved the file.

Slide 16: select the file you want to open. I will select the file I previously created and saved. Select the file SSAT - 'Introduction-Base EFF

Slide 17: and hit 'Open'.

Slide 19:Click OK.

Slide 20: We will use this model for our example throughout this course.""We are already looking at the first tab, 'Input.' It contains the Data Entry Form for your steam system. It is broken into two sections, 'Quick Start

Quick Start

Enter Case Description	SSAT Default 3 Header Model		
General Site Data	**Input Data**		**Notes/Warnings**
Site Power Import (+ for import, - for export)	15000	kW	Power import + site generated power = site electrical demand
Site Power Cost	0.0700	$/kWh	Typical 2003 value: $0.05/kWh
Operating hours per year	8760	hrs	
Site Make-Up Water Cost	0.0025	$/gallon	Typical 2003 value: $0.0025/gallon
Make-Up Water Temperature	70	F	
Note: Enter average values for the operating period being modeled			
Boiler fuel - Choose from this drop-down list			Natural Gas
Site Fuel Cost per 1000 s.cu.ft	10.00	$	Typical 2003 value: $5.78/(1,000 s cu.ft)
Note: Fuel HHV is 1,000 Btu per s cu.ft (23,311 Btu/lb)			
For user defined fuels, enter HHV	20000	Btu/lb	
Note: Emissions cannot be calculated for user defined fuels			
Steam Distribution	**Input Data**		**Warnings**
High Pressure (HP)	400	psig	
Medium Pressure (MP)	150	psig	
Low Pressure (LP)	20	psig	
HP Steam Use by Processes	20	klb/h	
MP Steam Use by Processes	40	klb/h	
LP Steam Use by Processes	170	klb/h	
Note: Enter process steam use at each pressure level. Excludes turbines, letdowns, leaks, trap losses, deaeration steam and vents			

Slide 21: and 'Site Detail.' '

Site Detail			
Boiler			
Method for specifying boiler efficiency			Option 2 - Enter User Defined Value
Note: Model default efficiencies represent Best Practice values assuming good operation and the installation of an economizer			
Option 2 - Enter efficiency (%)	80	%	
Note: Boiler efficiency is defined as 100% - Stack Loss (%) - Shell Loss (%). The "Stack Loss" sheet gives more information on heat losses Note: Efficiency is based on Higher Heating Value. Economizers are included in the boiler efficiency. Boiler blowdown losses are excluded			
Blowdown Rate (% of feedwater flow)	6	%	
Do you have blowdown flash steam recovery to the LP system?			No
Please select how you wish to define your HP generation condition and then provide supplementary information below if required:			
Method for specifying HP generation condition			Option 2- User-defined superheated Conditions
Note: As a default, the model will use HP steam with 100 F of superheat. At HP pressure (600 psig), this corresponds to a temperature of 589 F			
Option 2 - Enter temperature	700	F	
Option 3 - Enter thermodynamic quality	99	% dry	
Note: Saturation temperature at specified HP pressure (600 psig) is 489 F Note: Steam quality is an expression of the percentage dryness (or vapor fraction) of the steam			

Slide 22: Quick Start' allows you to enter general information for your site.

Slide 24: 'Site Detail' allows you to give more detailed information about your site and how the steam system operates.

Slide 26: "Under 'Quick Start,' you can input basic information such as the site's utility rates (electrical, water, and fuel),

General Site Data	Input Data		Notes/Warnings
Site Power Import (+ for import, - for export)	15000	kW	Power import + site generated power = site electrical demand
Site Power Cost	0.0700	$/kWh	Typical 2003 value: $0.05/kWh
Operating hours per year	8760	hrs	
Site Make-Up Water Cost	0.0025	$/gallon	Typical 2003 value: $0.0025/gallon
Make-Up Water Temperature	70	F	
Note: Enter average values for the operating period being modeled			
Boiler fuel - Choose from this drop-down list			Natural Gas
Site Fuel Cost per 1000 s.cu.ft	10.00	$	Typical 2003 value: $5.78/(1,000 s cu.ft)

the generated steam pressure, the process steam consumption,

Steam Distribution	Input Data		Warnings
High Pressure (HP)	400	psig	
Medium Pressure (MP)	150	psig	
Low Pressure (LP)	20	psig	
HP Steam Use by Processes	20	klb/h	
MP Steam Use by Processes	40	klb/h	
LP Steam Use by Processes	170	klb/h	

as well as steam-to-electric generation configurations.

Steam Turbines	
Do you have a steam turbine installed between HP and LP?	No
Do you have a steam turbine installed between HP and MP?	Yes
Do you have a steam turbine installed between MP and LP?	Yes
Do you have an HP to condensing turbine installed?	No

Slide 28: and the number of steam traps in the distribution system.

Steam Traps	Input Data	Warnings
Number of traps at each pressure level		
Traps on HP header	50 traps	
Traps on MP header	500 traps	
Traps on LP header	3000 traps	
Select the approximate timing of your last trap testing and maintenance program		3-5 years ago

All of these help the Assessment Tool make calculations that will show up in the 'Models' and the 'Results' tabs, which we will show you in a minute.

Slide 30: Under 'Site Detail,' you can input more detailed information and operating parameters for the boiler,

Boiler		
Method for specifying boiler efficiency		Option 2 - Enter User Defined Value
Note: Model default efficiencies represent Best Practice values assuming good operation and the installation of an economizer		
Option 2 Enter efficiency (%)	80 %	
Note: Boiler efficiency is defined as 100% - Stack Loss (%) - Shell Loss (%). The "Stack Loss" sheet gives more information on heat losses Note: Efficiency is based on Higher Heating Value. Economizers are included in the boiler efficiency. Boiler blowdown losses are excluded		
Blowdown Rate (% of feedwater flow)	6 %	No
Do you have blowdown flash steam recovery to the LP system?		
Please select how you wish to define your HP generation condition and then provide supplementary information below if required:		
Method for specifying HP generation condition		Option 2- User-defined superheated Conditions
Note: As a default, the model will use HP steam with 100 F of superheat. At HP pressure (600 psig), this corresponds to a temperature of 589 F		
Option 2 Enter temperature	700 F	
Option 3 - Enter thermodynamic quality	99 % dry	
Note: Saturation temperature at specified HP pressure (600 psig) is 489 F Note: Steam quality is an expression of the percentage dryness (or vapor fraction) of the steam		

the steam turbines,

HP to LP Steam Turbine(s)	Input Data		Notes/Warnings
Isentropic efficiency	65	%	
Note: If multiple turbines are installed, the operation of the impact turbine (the turbine affected by changes to the system) should be modeled Note: A generator electrical efficiency of 100% is assumed by the model			
Select the appropriate turbine operating mode			Option 2 - Fixed Operation
Note: If Option 1 is chosen, the model will preferentially use the HP to LP turbine to balance the LP demand			
Option 2 - How should the fixed turbine operation be defined?			Specify fixed steam flow
Option 2 - Fixed steam flow	100	klb/h	
Option 2 - Fixed power generation	2000	kW	
Option 3 - How do you wish to define the operating range?			Option 3 not selected
Option 3 - Minimum steam flow	50	klb/h	
Option 3 - Maximum steam flow	150	klb/h	
Option 3 - Minimum power generation	1500	kW	
Option 3 - Maximum power generation	2500	kW	

Slide 31: the deaerator, feedwater heat recovery system, and process condensate.

Deaerator	Input Data		Warnings
Vent (as % of boiler feedwater flow)	0.1	%	
Note: Values of around 0.1% are typical			
Select the appropriate deaerator operating mode			Option 2 - User-defined pressure
Option 2 - Specify pressure	10	psig	
Note: Deaerator uses LP steam. Specified LP pressure is 20 psig			
Feedwater Heat Recovery System			
Heat recovery exchanger on the condensate tank vent?			No
If yes, enter approach temperature	20	F	
Note: Approach temperature is defined as the minimum allowable temperature difference in the heat exchanger			
Heat recovery exchanger on boiler blowdown?			No
If yes, enter approach temperature	20	F	
Process Condensate	**Input Data**		**Warnings**
Condensate return temperature to tank	180	F	
HP condensate recovery	0	%	
MP condensate recovery	70	%	
LP condensate recovery	50	%	
Note: Condensate recovery specified as the percentage of steam supplied to the processes at each level			
Do you flash condensate to MP steam?			No
Do you flash condensate to LP steam?			No

Slide 34: You can also allow the program to estimate steam losses such as the number of failed traps, the number of steam leaks,

Steam Trap Losses and Steam Leaks		
Choose a method for estimating steam losses		Option 2 - Losses calculated from user-defined data
Option 2 - Specify number of failed traps at each pressure level		**Warnings**
Trap failures on HP header	10 traps	
Trap failures on MP header	30 traps	
Trap failures on LP header	250 traps	
Option 2 - Specify number of steam leaks at each pressure level		**Warnings**
Steam leaks on HP header	0 leaks	
Steam leaks on MP header	0 leaks	
Steam leaks on LP header	0 leaks	

Note: Calculated values for current loss and leak rates based on current user inputs are:-
HP header - Trap failures: 25, Loss per trap 0.134 klb/h - Total trap loss = 3.36 klb/h. Steam leaks: 10, Loss per leak 0.033 klb/h - Total leaks = 0.33 klb/h.
MP header - Trap failures: 30, Loss per trap 0.038 klb/h - Total trap loss = 1.14 klb/h. Steam leaks: 12, Loss per leak 0.010 klb/h - Total leaks = 0.11 klb/h.
LP header - Trap failures: 50, Loss per trap 0.003 klb/h - Total trap loss = 0.13 klb/h. Steam leaks: 20, Loss per leak 0.001 klb/h - Total leaks = 0.01 klb/h.

Slide 35: and header heat losses.

Insulation Heat Losses	**Input Data**	**Notes/Warnings**
Choose a method for specifying heat losses		Option 1 - Losses automatically estimated by model (Model default)
Option 1 - Heat loss on HP header	0 MMBtu/h	
Option 1- H eat loss on MP header	0 MMBtu/h	
Option 1- H eat loss on LP header	0 MMBtu/h	
Option 2- % of heat lost on HP header	0.1 %	
Option 2 - %of he at lost on MP header	0.1 %	
Option 2 - %of he at lost on LP header	0.1 %	

Note: Losses calculated as the percentage of heat flow entering each header
Note: Current values for heat entering headers are: HP 533 MMBtu/hr, MP 122 MMBtu/hr, LP 295 MMBtu/hr - These may change when the model is updated

Slide 36: Users can enter more precise estimations of these losses if known.

"Now, we click on the 'Model ' tab to see what we have come up with.

Begin Model Tab

Slide 39: Model Tab – Visual Description of Schematic

Model Tab Schematic Visual Description

This schematic represents a three-pressure steam system, and all of its components.

On the top left, it says "Steam System Assessment Tool."

The top center will contain the descriptive title provided by the user, the initial template reads "SSAT Default 3 Header Model" or a similar title for whatever model you chose. Below it, you will see the Model Status, which should read "OK." The model status provides an indication of the calculation condition of the model.

To the left of the Model Status, you will see a chart in light blue, which indicates the emissions per year for carbon dioxide, sulfur oxide, and nitrogen oxide.

At the top right, it will say "Current Operation" if you are on the Model tab, or "Operation After Projects" if you are on the Projects Model tab.

The red graphic near the top left represents the boiler. From the left, there is a dotted line entering it, which represents the amount of feedwater entering the boiler from the deaerator.

Also to the left of the boiler, we see the following information highlighted in orange: the type of fuel being used in the boiler, the fuel input energy, the fuel flow rate, and the boiler efficiency.

To the right of the boiler, we see a dotted line pointing to the right and then down, with a number next to it, indicating the amount of boiler blowdown.

Below the boiler, we see the amount of steam that is entering the high-pressure header, the temperature of it, and the thermodynamic quality of the steam.

The steam exits the boiler and enters the high-pressure header, represented by a dark blue line. Under the line, to the far left, you will see a light-blue triangular graphic that represents a pressure-reducing station. The pressure reducing station is also equipped with a desuperheating station. The number at the top indicates the amount of steam entering the pressure reducing valve. The number at the center-left of the valve indicates the amount of desuperheating water entering the unit. The number below indicates the amount of desuperheated steam entering the medium-pressure header; as well as the temperature of the steam.

To the right of the pressure-reducing station, you will see light blue, cone-shaped graphics, that represent the steam turbines. The one nearest to the left is a high-pressure to condensing turbine. This turbine discharges to the condenser represented by the blue circle below the turbine. The turbine exhaust pressure is noted as the condenser pressure. The turbine in the middle receives high-pressure steam and exhausts low-pressure steam. The one to the right receives high-pressure steam and exhausts medium-pressure steam. Above each turbine is an indication of the amount of steam coming into the turbine from the header. To the right, in dark blue, you see the power generation of the turbine.

In the center of the medium-pressure and low-pressure headers, we see an arrow pointing downward, which indicates the amount of flash entering the header from the condensate collection flash vessels that are located at the far-right of the schematic.

Above the header, to the right, the amount of heat loss is expressed in orange. Below, there is a yellow box that indicates the pressure, temperature, and thermodynamic quality of the steam.

The arrow to the right of the header points to a dark blue circle with a line through it, indicating the steam end-use components. Below this symbol is an indication of the thermal energy supplied to the end-use components from the steam. The end-use components discharge condensate through a steam trap, represented by a blue circle with a "T" in it. Schematically, condensate passes to the right through the trap. Failed steam traps that are blowing steam to the atmosphere are represented with the red arrow exiting the top of the trap symbol. The condensate appropriately passing through traps, again represented as exiting to the right of the trap, can be recovered or lost. Lost condensate is represented as the unrecovered condensate discharging down from the traps and recovered condensate enters the condensate collection system further to the right.

The green figures to the far-right of the schematic represent condensate flash-vessels. The top flash-vessel receives condensate from the high-pressure end-users. Flash-steam is formed because the flash vessel operates at medium-pressure but it receives saturated liquid condensate at high-pressure. As equilibrium is reached flash-steam is formed. This flash-steam exits the vessel through the top and is directed to the medium-pressure steam header, which is shown in the center of the diagram. Condensate exits the flash vessel and enters the medium-pressure condensate collection system. The medium-pressure condensate system is equipped with similar equipment as the high-pressure system.

All of the collected condensate enters the main condensate receiver located in the lower-center of the schematic. Process condensate is mixed with turbine condensate and makeup water prior to entering the deaerator.

The steam system deaerator is represented at the lower-left of the schematic. The deaerator receives low-pressure steam to preheat the collected condensate and makeup water represented as entering from the bottom of the vessel. Boiler feedwater discharges from the deaerator to the left and up to the boiler. The line pointing out from the top of the deaerator and leading to the right shows the amount of steam escaping from the vent.

Below the condensate receiver are the makeup water system and the blowdown system. The blowdown system is the green vessel shown on the schematic. This unit receives the boiler blowdown and allows flash-steam to be generated. The flash-steam can be recovered to the low-pressure header, as shown on the schematic, or it can be lost from the system. The remaining liquid blowdown exiting the bottom of the blowdown flash tank becomes part of the makeup water stream. Flow rates are indicated for all of these streams. The makeup water passes through two heat recovery heat exchangers represented as red circles on the schematic. These heat exchangers allow thermal energy to be recovered from the condensate receiver flash steam and the blowdown liquid.

The table at the bottom right shows an economic summary for the steam system that is being modeled based on the input model conditions . On the right of the table, you see total operating cost in thousands of dollars per year.

'Power balance' shows the amount of power generated onsite, the amount of power imported, and the combined total site demand.

'Fuel balance' shows the amount of fuel consumed and the unit cost of the fuel.

'Make-up water' shows the flow of makeup water in gallons per hour, and the unit cost per gallon.

At the bottom, the total operating cost is in thousands of dollars per year.

Slide 39: As you can see, there is a visual representation of your site, including the boiler, turbines, pressure reducing stations, steam demands, and feedwater preparation components, including deaerator and the condensate tank.

The steam system model includes all of the major steam system components. However, it does not provide unlimited components and arrangements. The model is limited in extent for two primary reasons. First, the complexity is limited to allow it to be easily understood with minimal training. Second, the model is configured to ensure the users focus attention on the components that are impacted by changes in the steam system. In other words, the configuration forces the user to identify the components in their real system that will respond to changes in the steam system.

For example, a real steam system may include two boilers operating with different fuels. One boiler (and fuel) may serve as the base-load component while the other boiler responds to changes in steam system demand. If the base-load boiler is not impacted by changes in steam demand then there will be no difference (or impact) noted in the base-load boiler. As a result, only the impact boiler characteristics need to be modeled. Even though the model is limited in extent it serves as a powerful evaluation tool even for very complex steam systems.

Also note that the Economic Summary calculations at the bottom right of the 'Model' tab are made based on what was typed in the 'Input' tab. If you look at this table, you will see the annual cost results for power balance, fuel balance, and make-up water, based on the information you input. Keep in mind that the totals are in thousands per year. The total annual operating cost is at the bottom at 43,134,000 dollars.

Again, the results are based on the information provided to the 'Input' tab.

Begin Projects Input Tab

Slide 40: The 'Projects Input' tab is where you can start doing a what-if analysis, and calculate what kinds of savings you would get if you were to implement certain changes within the steam system at your site. The 'Input' reflects the conditions of your original steam system while the 'Projects Input' tab contains the changes you would like to make to improve performance of the original steam system. There is a list of 18 potential projects listed in the "Projects Input" tab.

Steam System Assessment Tool 3 Header Model Projects Entry Form		
Use this form to specify improvement projects. These projects will then be modeled and compared to the existing operation.		
Project 1 - Steam Demand Savings (Changing the process steam requirements) Current use - HP: 50 klb/h (40.22 MMBtu/h) MP: 100 klb/h (86.25 MMBtu/h) LP: 200 klb/h (179.82 MMBtu/h)		
Do you wish to specify steam demand savings?		No
If yes, enter HP steam saving	0 klb/h	
If yes, enter MP steam saving	0 klb/h	
If yes, enter LP steam saving	1 klb/h	
Note: A negative saving can be entered to model an increase in steam demand Note: The savings have been converted to heat duties of 0.00 MMBtu/h (HP), 0.00 MMBtu/h (MP) and 0.00 MMBtu/h (LP) based on current header enthalpies Note: These heat duties are then used to determine the actual flow change in the Projects Model based on the calculated header enthalpies		

Project 2 - Use an Alternative Fuel Existing Boiler Fuel : Natural Gas Fuel Cost : $0.00578/s cu.ft		
Do you wish to specify an alternative fuel?		No
Site Fuel Cost	0.67 $/MMBtu	Typical 2002 values: $2-6/MMBtu
Note: Example HHV values - Nat Gas 23,311 Btu/lb, No. 2 FO 19,400 Btu/lb, Typical Eastern Coal 13,710 Btu/lb, Green Wood 5,251 Btu/lb		
For user defined fuels, enter HHV	15000 Btu/lb	
Note: Emissions cannot be calculated for user defined fuels		

Project 3 - Change Boiler Efficiency Existing Efficiency : 85%		
Do you wish to specify a new boiler efficiency?		Yes
Note: An example use of this project option is to model the effect of installing an economizer by increasing the efficiency		
If yes, enter new boiler efficiency (%)	84 %	
Note: Typical Best Practice boiler efficiency for Natural Gas is 85%		

Project 4 - Change Boiler Blowdown Rate Existing Blowdown Rate : 2%		
Do you wish to specify a new boiler blowdown rate?		No
If yes, enter new rate (% of feedwater flow)	1 %	

Project 5 - Blowdown Flash to LP Not currently installed	
Do you wish to modify the blowdown flash system?	Option 2 - No change

Project 6 - Change Steam Generation Conditions Existing Conditions : 600 psig. Superheated steam at 589 F		
Do you wish to change the HP steam generation conditions?		Option 3 - No change
Option 1 - Enter temperature	600 F	
Note: Saturation temperature at specified HP pressure (600 psig) is 489 F		
Option 2 - Enter thermodynamic quality	99.9 % dry	

Project 7 - HP to LP Steam Turbine(s) Efficiency : 65% Operation : Balances LP Header			
Do you wish to modify the HP to LP turbine operation?			No
If yes, select the appropriate turbine operating mode			Option 1 – Balances LP header
Note: If Option 1 is chosen, the model will preferentially use the HP to LP turbine to balance the LP demand			
Specify a new isentropic efficiency (%)		70 %	
Note: A generator electrical efficiency of 100% is assumed by the model Note: Isentropic efficiency of existing turbine is 65%			
Option 2 - How do wish to define the fixed turbine operation?			Option 2 Not Selected
Option 2 - Fixed steam flow		100 klb/h	
Option 2 - Fixed power generation		2000 kW	
Option 3 - How do wish to define the operating range?			Option 3 Not Selected
Option 3 - Minimum steam flow		50 klb/h	
Option 3 - Maximum steam flow		150 klb/h	
Option 3 - Minimum power generation		1500 kW	
Option 3 - Maximum power generation		2500 kW	

Project 8 - HP to MP Steam Turbine(s) Efficiency : 65% Operation : Balances MP Header		
Do you wish to modify the HP to MP turbine operation?		No
If yes, select the appropriate turbine operating mode		Option 1 - Balances LP header
Specify a new isentropic efficiency (%)	70 %	
Note: A generator electrical efficiency of 100% is assumed by the model Note: Isentropic efficiency of existing turbine is 65%		

Option 2 - How do wish to define the fixed turbine operation?			Option 2 not selected
Option 2 - Fixed steam flow		100 klb/h	
Option 2 - Fixed power generation		2000 kW	
Option 3 - How do wish to define the operating range?			Option 3 not selected
Option 3 - Minimum steam flow		50 klb/h	
Option 3 - Maximum steam flow		150 klb/h	
Option 3 - Minimum power generation		1500 kW	
Option 3 - Maximum power generation		2500 kW	

Project 9 - MP to LP Steam Turbine(s) Not installed		
Do you wish to modify the MP to LP turbine operation?		No
If yes, select the appropriate turbine operating mode		Option 1 - Balances LP header
Specify a new isentropic efficiency (%)	70 %	

Note: A generator electrical efficiency of 100% is assumed by the model

Note: Isentropic efficiency of existing turbine is 65%

Option 2 - How do wish to define the fixed turbine operation?			Option 2 not selected
Option 2 - Fixed steam flow		100 klb/h	
Option 2 - Fixed power generation		2000 kW	
Option 3 - How do wish to define the operating range?			Option 3 not selected
Option 3 - Minimum steam flow		50 klb/h	
Option 3 - Maximum steam flow		150 klb/h	
Option 3 - Minimum power generation		1500 kW	
Option 3 - Maximum power generation		2500 klb/h	

Project 10 - HP to Condensing Steam Turbine(s) Not installed		
Do you wish to add an HP to condensing turbine?		No, maintain current operation
If yes, enter a new isentropic efficiency (%)	70 %	
Note: A generator electrical efficiency of 100% is assumed by the model		
If yes, select the units to specify the condenser pressure		psia
New condenser pressure (psia)	2	
If yes, select the new mode of operation		Option 1 – F ixed Power generation
Option 1 - Fixed power generation	1000 kW	
Option 2 - Fixed steam flow	50 klb/h	

Project 11 - Feedwater Heat Recovery Exchanger using Condensate Tank Vent Not currently installed	
Modify the condensate tank vent heat recovery system?	No
Note: An approach temperature of 20 F will be assumed for a new exchanger	

Project 12 - Feedwater Heat Recovery Exchanger using Boiler Blowdown Not currently installed	
Modify the boiler blowdown heat recovery system?	No
Note: An approach temperature of 20 F will be assumed for a new exchanger	

Project 13 - Condensate Recovery Currently recover 50% of HP, 50% of MP and 50% of LP at 150 F		
Do you wish to specify new condensate recovery rates?		No
If yes, enter new HP condensate recovery	75 %	
If yes, enter new MP condensate recovery	75 %	
If yes, enter new LP condensate recovery	75 %	

Note: Condensate return temperature will be assumed to be 150 F as for the current operation

Project 14 - Condensate Flash to MP Not currently installed	
Do you wish to modify the MP condensate flash system?	No

Project 15 - Condensate Flash to LP Not currently installed	
Do you wish to modify the LP condensate flash system?	No

Project 16 - Steam Trap Losses Losses estimated automatically by model - Last maintenance program 3-5 years ago		
Do you wish to model the impact of a maintenance program?		No

Note: For Option 1, the model estimates a new trap failure rate. The rate reported is for 6 months after the maintenance program is carried out

Option 2 - Trap failures on HP header	5	
Option 2 - Trap failures on MP header	5	
Option 2 - Trap failures on LP header	5	

Note: Calculated values based on current user inputs are:-
HP header - Trap failures: 25, Loss per trap 0.134 klb/h - Total trap loss = 3.36 klb/h.
MP header - Trap failures: 30, Loss per trap 0.038 klb/h - Total trap loss = 1.14 klb/h.
LP header - Trap failures: 50, Loss per trap 0.003 klb/h - Total trap loss = 0.13 klb/h.

Project 17 - Steam Leaks Losses estimated automatically by model - Last maintenance program 3-5 years ago		
Do you wish to model the impact of a maintenance program?		No

Note: For Option 1, the model estimates a new steam leakage rate. The rate reported is for 6 months after the maintenance program is carried out

Option 2 - Steam leaks on HP header	5	
Option 2 - Steam leaks on MP header	5	
Option 2 - Steam leaks on LP header	5	

Note: Calculated values based on current user inputs are:-

HP header - Steam leaks: 10, Loss per leak 0.033 klb/h - Total leaks = 0.33 klb/h.

MP header - Steam leaks: 12, Loss per leak 0.010 klb/h - Total leaks = 0.11 klb/h.

LP header - Steam leaks: 20, Loss per leak 0.001 klb/h - Total leaks = 0.01 klb/h.

Project 18 - Improved Insulation Currently modeled based on percentage heat loss on each header	
Do you wish to model the impact of improved insulation?	No

Note: Model will assume that heat losses are reduced to 10% of the current value by improving insulation

Slide 42: Only one of the 18 projects is selected at this time, and for the rest of them, "No" is selected after the question line, in yellow.

Project 3 - Change Boiler Efficiency Existing Efficiency : 80%		
Do you wish to specify a new boiler efficiency?		Yes
Note: An example use of this project option is to model the effect of installing an economizer by increasing the efficiency		
If yes, enter new boiler efficiency (%)	84 %	
Note: Typical Best Practice boiler efficiency for Natural Gas is 85%		

If you want to try a project, or a combination of several projects, click on the drop-down menu next to the question, and click "Yes."

Slide 43: *Drop Down Menu selected*

Project 16 - Steam Trap Losses Losses estimated automatically by model - Last maintenance program 3-5 years ago		
		Drop Down Menu:
		Option 1 – Yes, model to estimate new loss values
		Option 2 – Yes, enter new number of failed traps
		No
Do you wish to model the impact of a maintenance program?		Option 1 – Yes, model to estimate new loss values
Note: For Option 1, the model estimates a new trap failure rate. The rate reported is for 6 months after the maintenance program is carried out		
Option 2 - Trap failures on HP header	5	
Option 2 - Trap failures on MP header	5	
Option 2 - Trap failures on LP header	5	
Note: Calculated values based on current user inputs are:- HP header - Trap failures: 25, Loss per trap 0.134 klb/h - Total trap loss = 3.36 klb/h. MP header - Trap failures: 30, Loss per trap 0.038 klb/h - Total trap loss = 1.14 klb/h. LP header - Trap failures: 50, Loss per trap 0.003 klb/h - Total trap loss = 0.13 klb/h.		

Slide 44: Once you do that, you can change certain information.

Slide 48: For example, we can change the boiler efficiency using Project 3 Change Boiler Efficiency. As you can see, it is now 80 percent. Here, we can change it to 84 percent, which might model the impact of installing a feedwater economizer on the boiler, which we do not have in our current boiler system.

Project 3 - Change Boiler Efficiency Existing Efficiency : 80%		
Do you wish to specify a new boiler efficiency?		Yes
Note: An example use of this project option is to model the effect of installing an economizer by increasing the efficiency		
If yes, enter new boiler efficiency (%)	84 %	
Note: Typical Best Practice boiler efficiency for Natural Gas is 85%		

Begin Projects Model Tab

Slide 52: Now, let's take a look at the tab 'Projects Model.'

[Refer back to 'Slide 39: Model Tab – Visual Description of Schematic'. Changes between the "Projects Model" and "Model" tabs will be discussed in the next slides.]

Slide 55: The 'Projects Model' tab is just like the 'Model' tab that we showed you before, except for the fact that it shows how the values have changed after we made changes in the "Projects Input" tab.

Look up here, and you'll see that the boiler efficiency is 84 percent, because that is what we changed it to in the 'Projects Input' tab.

Natural gas →
364.7 MMBtu/h
364575.3 s cu.ft/h
eff = 84%

Boiler efficiency is 84%

So let's go back to the "Model" tab, which reflects our original boiler efficiency.

Back to Model Tab

Slide 56: Notice that the boiler efficiency was originally 80 percent.

Natural gas →
383.4 MMBtu/h
383278.3 s cu.ft/h
eff = 80%

So, by looking at both models, you can see the changes. OK, so let's look at a couple of other things. As you can see, the model calculates electricity impacts, fuel impacts, and economic impacts in the Economics Summary table.

Economic Summary based on 8760 hrs/yr		$ '000s/yr
Power Balance		
Generation	7513 kW	
Demand	22513 kW	
Import	15000 kW	
Unit Cost	$0.0700/kWh	9,198
Fuel Balance		
Boiler	383278.3 s cu.ft/h	
Unit Cost	$0.01/s cu.ft	33,575
Make-Up Water		
Flow	16469 gal/h	
Unit Cost	$0.0025/gal	361
Total Operating Cost		**43,134**

Slide 57: The projects also impact environmental emissions. Emissions impacts for the site are based on the selected fuel. Carbon dioxide and sulfur dioxide emissions are based on the selected fuel composition. Oxides of nitrogen emissions are estimates based on U.S.EPA data for typical boilers operating with the selected fuel.

Emissions	klb/yr
CO2	390200
SO2	0
NOx	772

To see a summary of the Current vs. Proposed Projects without flipping between the two tabs, you can click on the 'Results' tab.

Begin Results Summary Tab

Steam System Assessment Tool

3 Header Model

Results Summary

SSAT Default 3 Header Model

Model Status : OK

Cost Summary ($ '000s/yr)	**Current Operation**	**After Projects**	**Reduction**	
Power Cost	9,198	9,198	0	0.0%
Fuel Cost	33,575	31,976	1,599	4.8%
Make-Up Water Cost	361	361	0	0.0%
Total Cost (in $ '000s/yr)	**43,134**	**41,535**	**1,599**	**3.7%**
On-Site Emissions	**Current Operation**	**After Projects**	**Reduction**	
CO2 Emissions	390200 klb/yr	371619 klb/yr	18581 klb/yr	4.8%
SOx Emissions	0klb/yr	0 klb/yr	0 klb/yr	N/A
NOx Emissions	772 klb/yr	736 klb/yr	37 klb/yr	4.8%
Power Station Emissions		**Reduction After Projects**	**Total Reduction**	
CO2 Emissions		0 klb/yr	18581 klb/yr	-
Sox Emissions		0 klb/yr	0klb/yr	-
Nox Emissions		0 klb/yr	37 klb/yr	-

Note – Calculates the impact of the change in site power import on emissions from an external power station. Total reduction values are for site + power station

Utility Balance	Current Operation	After Projects	Reduction	
Power Generation	7513 kW	7513 kW	-	-
Power Import	15000 kW	15000 kW	0 kW	0.0%
Total Site Electrical Demand	22513 kW	22513 kW	-	-
Boiler Duty	383.4 MMBtu/h	365.1 MMBtu/h	18.3 MMBtu/h	4.8%
Fuel Type	Natural Gas	Natural Gas	-	-
Fuel Consumption	383278.3 s cu.ft/h	365027 s cu.ft/h	18251.3 s cu.ft/h	4.8%
Boiler Steam Flow	262.6 klb/h	262.6 klb/h	0.0 klb/h	0.0%
Fuel Cost (in $/MMBtu)	10.00	10.00	-	-
Power Cost (as $/MMBtu)	20.51	20.51	--	
Make-Up Water Flow	16469 gal/h	16469 gal/h	0 gal/h	0.0%

Turbine Performance	Current Operation	After Projects
HP to LP steam rate	Not in use	Not in use
HP to MP steam rate	22 kWh/klb	22 kWh/klb
MP to LP steam rate	28 kWh/klb	28 kWh/klb
HP to Condensing steam rate	Not in use	Not in use

Marginal Steam Costs	
(based on current operation)	
HP ($/klb)	----->
MP ($/klb)	----->
LP ($/klb)	----->

List of Selected Projects
Increase boiler efficiency

Gas Turbine Assessment
Your site is a good candidate for the installation of a gas turbine + waste heat boiler
Warnings - Any warnings listed below may impact on the validity of the simulation

Current Operation	**After Projects**

Slide 58: The energy costs/consumptions and emissions will be shown as well as the reduction in usage and the percentage reduction. Make sure this note indicates "Model Status: OK". The program is still calculating until this message appears. Please wait!

Model Status : OK

OK, now let's look at the difference in cost. As you can see, the Current total operating cost for our site is about 43,134,000 dollars per year. The cost went down to about 41,535,000 dollars. An improvement of 1,599,000 dollars per year or 3.7 percent of the operating costs! This is the impact of improving the efficiency of all steam generation at the site. If we were just targeting one boiler we could scale the results to estimate the individual boiler impact.

Cost Summary ($ '000s/yr)	**Current Operation**	**After Projects**		**Reduction**	
Power Cost	9,198	9,198		0	0.0%
Fuel Cost	33,575	31,976		1,599	4.8%
Make-Up Water Cost	361	361		0	0.0%
Total Cost (in $ '000s/yr)	**43,134**	**41,535**		**1,599**	**3.7%**

In our example, the Current Operation emissions indicate an estimated carbon dioxide emission is about 390,200 kilopounds per year, sulfur is 0, and nitrogen oxides are 772 kilopounds per year. The After Projects show a reduction of estimated carbon dioxide emissions to about 371,619, kilopounds per year, and nitrogen oxide emissions to 736 kilopounds per year. The percent reductions of 4.8% for each component are also calculated in the Results Summary table. So, you can see how much emissions are estimated to be reduced by increasing boiler efficiency a certain percentage!

On-Site Emissions	Current Operation	After Projects
CO2 Emissions	390200 klb/yr	371619 klb/yr
SOx Emissions	0klb/yr	0 klb/yr
NOx Emissions	772klb/yr	736 klb/yr

Reduction	
18581 klb/yr	4.8%
0 klb/yr	N/A
37 klb/yr	4.8%

I klbs = 1,000 pounds

Slide 60: Scroll down the Results Summary page and you will see a list of 'Selected Proj ects.' This is a list of the projects that you are considering to implement. As of now, we only tried increasing boiler efficiency.

List of Selected Projects
Increase boiler efficiency

Let's go back and do one more project to see what kind of difference it makes." Because in these examples we want to see the impact of each potential project individually we will turn the boiler efficiency project off.

We'll click on the 'Projects Input' tab

Begin Projects Example – Project Input Tab

Slide 61: and go to 'Project 3 – Change Boiler Efficiency'. We will select 'No' to turn this project off.

Drop Down Menu selected

Project 3 - Change Boiler Efficiency Existing Efficiency : 80%		
		Drop Down Menu:
		Yes
		No
Do you wish to specify a new boiler efficiency?		No
Note: An example use of this project option is to model the effect of installing an economizer by increasing the efficiency		
If yes, enter new boiler efficiency (%)	84 %	
Note: Typical Best Practice boiler efficiency for Natural Gas is 85%		

Slide 64: Then we will scroll down to 'Project 13 – Condensate Recovery.'

Project 13 - Condensate Recovery Currently recover 0% of HP, 70% of MP and 50% of LP at 180 F		
Do you wish to specify new condensate recovery rates?		No
If yes, enter new HP condensate recovery	75 %	
If yes, enter new MP condensate recovery	75 %	
If yes, enter new LP condensate recovery	75 %	
Note: Condensate return temperature will be assumed to be 150 F as for the current operation		

Slide 66: In the Project 13 title block, you can see the data you entered at the 'Input' tab. You will see the system originally recovered no condensate for the high pressure header, 70 percent for the medium pressure header, and 50 percent for the low pressure header system.

Let us assume we have identified a heat exchanger that discharges condensate to the sewer. Using a bucket and a stopwatch, we measure approximately 7 gallons per minute of condensate lost to the drain. This will result in an opportunity to increase condensate recovery from the low-pressure steam system by 2 percentage points for this system.

To evaluate this potential project, we need to select 'yes' to specify new condensate recovery rates.

Drop Down Menu selected

Project 13 - Condensate Recovery Currently recover 0% of HP, 70% of MP and 50% of LP at 180 F		
		Drop Down Menu:
		Yes
		No
Do you wish to specify new condensate recovery rates?		Yes
If yes, enter new HP condensate recovery	75 %	
If yes, enter new MP condensate recovery	75 %	
If yes, enter new LP condensate recovery	75 %	
Note: Condensate return temperature will be assumed to be 150 F as for the current operation		

Slide 68: We are only increasing the condensate collection from the low-pressure system; therefore, we enter 0 percent for the high-pressure header…….

Slide 70: and 70 percent for the medium pressure header.

Slide 71: For the low-pressure header, we will enter 52 percent.

Project 13 - Condensate Recovery Currently recover 0% of HP, 70% of MP and 50% of LP at 180 F		
Do you wish to specify new condensate recovery rates?		Yes
If yes, enter new HP condensate recovery	0 %	
If yes, enter new MP condensate recovery	70 %	
If yes, enter new LP condensate recovery	52 %	
Note: Condensate return temperature will be assumed to be 150 F as for the current operation		

Now, let's click on the 'Results' tab to see what a difference it made.

Back to Results Tab

Steam System Assessment Tool

3 Header Model

Results Summary

SSAT Default 3 Header Model				
Model Status : OK				
Cost Summary ($ '000s/yr)	**Current Operation**	**After Projects**	**Reduction**	
Power Cost	9,198	9,198	0	0.0%
Fuel Cost	33,575	33,534	42	0.1%
Make-Up Water Cost	361	352	9	2.5%
Total Cost (in $ '000s/yr)	**43,134**	**43,084**	**50**	**0.1%**
On-Site Emissions	**Current Operation**	**After Projects**	**Reduction**	
CO2 Emissions	390200 klb/yr	389717 klb/yr	483 klb/yr	0.1%
SOx Emissions	0 klb/yr	0 klb/yr	0 klb/yr	N/A
NOx Emissions	772 klb/yr	771 klb/yr	1 klb/yr	0.1%
Power Station Emissions		**Reduction After Projects**	**Total Reduction**	
CO2 Emissions		-8 klb/yr	475 klb/yr	-
SOx Emissions		0 klb/yr	0 klb/yr	-
NOx Emissions		0 klb/yr	1 klb/yr	-

Slide 74: This relatively small increase in condensate collection returns measurable benefits. If we can recover just 2 percent more of our low pressure condensate, our annual operating costs will be reduced 50,000 dollars. Our emissions will be reduced only slightly, yet saving 0.1 percent for carbon dioxide and nitrogen oxides. This project can also be relatively inexpensive to implement, so this is a good project to pursue.

Scroll down the 'Results tab' to the 'List of selected projects,'

Slide 76: and you will see that the project 'Increase LP Condensate Recovery' has been added to the list.

List of Selected Projects
Increase LP condensate recovery

Another feature of the tool is the Stack Loss Calculator. Click on the 'Stack Loss' tab.

Begin Stack Loss Tab

Slide 77: This calculator estimates the energy loss from the boiler stack. This tool could be used to determine the impact of improving combustion control, installing a feedwater economizer, or other exhaust gas related project. The previous boiler efficiency improvement example could have utilized this tool to evaluate the efficiency impact. To do this, it uses three inputs: stack gas temperature, ambient temperature, and stack gas oxygen content which you provide.

Steam System Assessment Tool Stack Loss Calculator			
Based on user inputs of Stack Temperature, Ambient Temperature and Stack Oxygen Content, an estimate will be provided of the heat loss from the boiler stack. Losses are expressed as a percentage of the heat fired.			
Stack losses are related to SSAT Boiler Efficiency as follows: **SSAT Boiler Efficiency = 100% - Stack Loss (%) - Shell Loss (%)** Shell Loss refers to the radiant heat loss from the boiler. Typically <1% at full load, 1-2% at reduced load.			
Input Data			
Stack Gas Temperature (°F)	450	°F	Stack Temperature - Ambient Temperature = 380°F
Ambient Temperature (°F)	70	°F	
Stack Gas Oxygen Content (%)	5	%	
Note: Stack gas oxygen content is expressed on a molar or volumetric basis			

Results

Estimated Stack Losses for each of the default fuels are as follows:

Natural Gas	**19.8**	**%**
Number 2 Fuel Oil	**15.5**	**%**
Number 6 Fuel Oil (Low Sulfur)	**15.0**	**%**
Number 6 Fuel Oil (High Sulfur)	**15.2**	**%**
Typical Eastern Coal (Bituminous)	**13.6**	**%**
Typical Western Coal (Subbituminous)	**15.1**	**%**
Typical Green Wood	**26.1**	**%**

For further information, scroll down for graphs of stack loss as a function of stack oxygen and temperature

Stack Loss Example

Determine the Stack Loss (Natural Gas)

Combustion analyzer data:

- Flue gas O2 content — 5% by volume
- Flue gas CO2 content — 6% by volume
- Flue gas CO content — ~0%
- Flue gas unburned fuel — ~0%
- Flue gas temperature — 450°F (380°F net)
- Intake air temperature — 70°F
- Stack Loss — 21.2%
- Combustion Efficiency — 78.8%

Slide 78: We have already entered out values of 450 degrees Fahrenheit Flue Gas Temperature, 70 degrees Fahrenheit ambient temperature and 5 percent oxygen content. Let's drop the Flue Gas temperature to 300.

Stack Gas Temperature (°F)	300 °F	Stack Temperature - Ambient Temperature = 380°F

Slide 79: Look down at 'Results' and you can see the percentages of estimated stack losses for each type of fuel. So if you were using natural gas, the stack loss would be 15.7 percent.

Results

Estimated Stack Losses for each of the default fuels are as follows:

Natural Gas	**15.7**	**%**
Number 2 Fuel Oil	**11.5**	**%**
Number 6 Fuel Oil (Low Sulfur)	**11.0**	**%**
Number 6 Fuel Oil (High Sulfur)	**11.2**	**%**
Typical Eastern Coal (Bituminous)	**9.5**	**%**
Typical Western Coal (Subbituminous)	**11.1**	**%**
Typical Green Wood	**22.4**	**%**

For further information, scroll down for graphs of stack loss as a function of stack oxygen and temperature

Let's change our value back to 450 Fahrenheit.

Stack Gas Temperature (°F)	450 °F	Stack Temperature - Ambient Temperature = 380°F

Slide 82: Look down at Results again. Stack loss is now 19.8 percent. Because the stack loss is generally the most significant loss, boiler efficiency could be estimated at 80.2 percent.

Results

Estimated Stack Losses for each of the default fuels are as follows:

Natural Gas	**19.8**	**%**
Number 2 Fuel Oil	**15.5**	**%**
Number 6 Fuel Oil (Low Sulfur)	**15.0**	**%**
Number 6 Fuel Oil (High Sulfur)	**15.2**	**%**
Typical Eastern Coal (Bituminous)	**13.6**	**%**
Typical Western Coal (Subbituminous)	**15.1**	**%**
Typical Green Wood	**26.1**	**%**

For further information, scroll down for graphs of stack loss as a function of stack oxygen and temperature

100% - 19.8% = 80.2% boiler efficiency

A feedwater economizer could recover thermal energy from the flue gas allowing the exhaust gas to discharge at 300°F. The Stack Loss Calculator indicates the stack loss will decrease to 15.7 percent, which translates into a boiler efficiency of approximately 84.3 percent.

100% - 15.7% = 84.3% boiler efficiency

These efficiencies could be used in Project 3 – Change Boiler Efficiency like we did previously.

You can see the stack loss values for the other fuels listed in the Results table.

Scroll down, and you will see a chart for each type of fuel.

Slide 83: *Slide in Motion to show charts for each fuel type.*

Visual Description of Stack Loss Charts

There is a graph for the stack loss results for each type of fuel: natural gas, number 2 fuel oil, number 6 fuel oil (low sulfur content), number 6 fuel oil(high sulfur content), typical eastern coal, typical western coal, and typical green wood.

Each graph shows you stack loss based on the flue gas oxygen content and the net stack temperature. Net stack temperature is the difference in the measured stack temperature and the ambient temperature.

The numbers on the left going up and down from 5 to 30, represent the stack loss percentage.

The numbers on the bottom, going from left to right from 0 to 600, represent the net stack temperature in degrees Fahrenheit.

The lines on the graph each represent a different percentage of stack oxygen content. Black is 11, Brown is 9, pink is 7, blue is 5, green is 3, and red is 1. The stack loss percentage increases as the net stack temperature increases.

Slide 84: Each chart shows the estimated percent of heat loss from the stack, or the Stack Loss.

As a last feature of the tool, click on the 'User calculations' tab for a sheet on which you can make your own personal notes and calculations.

Begin User Calculations Tab

<u>Slide 85:</u> This tab is basically blank when you first open the templates. You may want to include any assumptions or data references that are part of the Model or Projects Inputs. Here you can see we have listed the Steam Plant Point of Contact, the date the stack temperature measurements were taken and the resulting initial boiler efficiency. We have also listed a few ideas we want to evaluate with the Assessment Tool. You can also enter and perform side calculations and list assumptions used for the calculations and inputs.

User Calculations Sheet			
This is a blank sheet provided for the user to make notes, carry out calculations etc.			
This is a blank sheet provided for the user to make notes, carry out calculations etc.			
Steam Plant Contact:	I.M. Steam		
	123-456-7890		
Stack Temperature Measurements Taken	March 4, 2009		
Initial Boiler Efficiency	80.20	%	
Ideas for Projects:			
Feedwater Economizer			
	Current Flue Gas Temperature	450	F
	Estimated New Flue Gas Temperature	300	F
	Adjusted Boiler Efficiency	84.30	%
Condensate Recovery			
	Measured Condensate Flow Rate	7.00	gallons per minute
Blowdown Flash to Low Pressure			
Feedwater Heat Recovery Exchanger			

Begin Summary Example

Summary Example

Slide 86: Now I'm going to show you how you can use the Scoping Tool to identify a project; then use the Assessment tool to estimate the potential savings of that project.

So, let's go back to the Scoping tool and take a look at the Summary Results, which is Tab Number 7.

Begin SSST – Tab 7 - Summary

Slide 88: Near the bottom of the page, at row 71, you can see the summary results of the major topics.

SUMMARY OF STEAM SCOPING TOOL RESULTS

SCOPING TOOL RESULTS	POSSIBLE SCORE	YOUR SCORE
STEAM SYSTEM PROFILING	90	60
STEAM SYSTEM OPERATING PRACTICES	140	100
BOILER PLANT OPERATING PRACTICES	80	53
DISTRIBUTION, END USE, RECOVERY OP. PRACTICES	30	19
TOTAL SCOPING TOOL QUESTIONAIRE SCORE	340	232
TOTAL SCOPING TOOL QUESTIONAIRE SCORE (%)		68.2%
Date That You Completed This Questionnaire)		03/04/09

Let's try to see where we got a particularly low score. Well, we didn't do too great under Boiler Plant Operating Practices. There were 80 possible points, and our example scored 53, which would be 66 percent.

BOILER PLANT OPERATING PRACTICES	80	53

53-60 = 66%

Move up the spreadsheet to this topic, row 40.

3. BOILER PLANT OPERATING PRACTICES	POSSIBLE SCORE	YOUR SCORE
BOILER EFFICIENCY		
BE1: Measuring Boiler Efficiency - How Often	10	10
BE2: Flue Gas Temperature, O2, CO Measurement	15	5
BE3: Controlling Boiler Excess Air	10	5
HEAT RECOVERY EQUIPMENT		
HR1: Boiler Heat Recovery Equipment	15	3
GENERATING DRY STEAM		
DS1: Checking Boiler Steam Quality	10	10
GENERAL BOILER OPERATION		
GB1: Automatic Boiler Blowdown Control	5	5
GB2: Frequency Of Boiler High/Low Level Alarms	10	10
GB3: Frequency Of Boiler Steam Pressure Fluctuations	5	5
BOILER PLANT OPERATING PRACTICES SCORE	80	53

Slide 90: We can see how we performed by each sub-topic.

Let's go back and see how we got that result. Click on Tab Number 5- SSOP – Boiler Plant

Begin SSST – Tab 5 – SSOP – Boiler Plant

Slide 91: Now, go down to 'Heat Recovery Equipment', near row 25.

HEAT RECOVERY EQUIPMENT

What To Do Evaluate installation of Heat Re covery Equipment on your Boiler Plant.

Why Important In some boilers, high flue gas temperatures and high continuous blowdown rates can provide opportunities for installation of heat recovery equipment. Feedwater economizers and combustion air preheaters can, under appropriate conditions, be installed to extract excess flue gas energy and effectively increase the boiler efficiency. Blowdown heat recovery equipment can also, for some systems, be installed to extract otherwise lost heat from the blowdown system. For either potential opportunity, an economic analysis is needed to determine the feasibility of the opportunity, and the equipment should be designed and installed by qualified professionals.

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
HR1	Do you have any of the following Heat Recovery Equipment installed on your Boilers?			
	Feedwater Economizer and/or Combustion Air Preheater	yes	10	
	Blowdown Heat Recovery	yes	5	3
		no to all of above	0	

Slide 93: We only scored 3 of 15 points. No points were scored for the Blowdown Heat Recovery.

QUESTION NUMBER	QUESTION	ACTION	SCORE	YOUR SCORE
HR1	Do you have any of the following Heat Recovery Equipment installed on your Boilers?			
	Feedwater Economizer and/or Combustion Air Preheater	yes	10	
	Blowdown Heat Recovery	yes	5	3
		no to all of above	0	

The Assessment Tool includes projects that will calculate the impacts associated with boiler blowdown thermal energy recovery. Project 5 and Project 12 install the two most common blowdown thermal energy recovery components—a flash tank and a heat exchanger.

Return to the Assessment Tool's 'Project Inputs'.

Return to SSAT – Project Inputs Tab

Slide 94: Cancel Project 13 by selecting 'No'.

Drop Down Menu selected

Project 13 - Condensate Recovery Currently recover 0% of HP, 70% of MP and 50% of LP at 180 F		
		Drop Down Menu:
		Yes
		No
Do you wish to specify new condensate recovery rates?		No
If yes, enter new HP condensate recovery	0 %	
If yes, enter new MP condensate recovery	70 %	
If yes, enter new LP condensate recovery	52 %	
Note: Condensate return temperature will be assumed to be 150 F as for the current operation		

Slide 96: Go to Project 5 – Blowdown Flash to LP.

Slide 98: Select 'Option 1- Install Blowdown Flash' from the pull-down menu.

Drop Down Menu selected

Project 5 - Blowdown Flash to LP Not currently installed	
	Drop-down Menu:
	Option 1 - Install blowdown flash
	Option 2 – No change
Do you wish to modify the blowdown flash system?	Option 1 - Install blowdown flash

No flash steam recovery was in-place in the base case.

Slide 99: Continue down to 'Project 12 – Feedwater Heat Recovery Exchanger using Boiler Blowdown'.

Slide 101: Select 'Yes – install a new heat exchanger'.

Drop Down Menu selected

Project 12 - Feedwater Heat Recovery Exchanger using Boiler Blowdown Not currently installed	
	Drop-down Menu:
	Yes, install a new heat exchanger
Modify the boiler blowdown heat recovery system?	Yes, install a new heat exchanger
Note: An approach temperature of 20 F will be assumed for a new exchanger	

No heat recovery exchanger was in-place in the base case.

Slide 103: Return to the 'Results' tab and once again you will note additional reductions in annual operating costs. Check the List of Projects and you will see both projects identified in this calculation scenario.

Results Tab

Steam System Assessment Tool

3 Header Model

Results Summary

SSAT Default 3 Header Model

Model Status : OK

Cost Summary ($ '000s/yr)	Current Operation	After Projects	Reduction	
Power Cost	9,198	9,204	-6	-0.1%
Fuel Cost	33,575	32,854	721	2.1%
Make-Up Water Cost	361	343	18	5.0%
Total Cost (in $ '000s/yr)	**43,134**	**42,401**	**733**	**1.7%**

On-Site Emissions	Current Operation	After Projects	Reduction	
CO2 Emissions	390200 klb/yr	381824 klb/yr	8376 klb/yr	2.1%
SOx Emissions	0klb/yr	0 klb/yr	0 klb/yr	N/A
NOx Emissions	772 klb/yr	756 klb/yr	17 klb/yr	2.1%

Power Station Emissions	Reduction After Projects	Total Reduction	
CO2 Emissions	-136 klb/yr	8240 klb/yr	-
SOx Emissions	0 klb/yr	0 klb/yr	-
NOx Emissions	0 klb/yr	16 klb/yr	-

Note - Calculates the impact of the change in site power import on emissions from an external power station. Total reduction values are for site + power station

Utility Balance	Current Operation	After Projects	Reduction	
Power Generation	7513 kW	7503 kW	-	-
Power Import	15000 kW	15010 kW	-10 kW	-0.1%
Total Site Electrical Demand	22513 kW	22513 kW	-	-
Boiler Duty	383.4 MMBtu/h	375.1 MMBtu/h	8.2 MMBtu/h	2.1%
Fuel Type	Natural Gas	Natural Gas	-	-
Fuel Consumption	383278.3 s cu.ft/h	375051 s cu.ft/h	8227.3 s cu.ft/h	2.1%
Boiler Steam Flow	262.6 klb/h	257.0 klb/h	5.6 klb/h	2.1%
Fuel Cost (in $/MMBtu)	10.00	10.00	-	-
Power Cost (as $/MMBtu)	20.51	20.51	-	-
Make-Up Water Flow	16469 gal/h	15642 gal/h	827 gal/h	5.0%

Turbine Performance	Current Operation	After Projects
HP to LP steam rate	Not in use	Not in use
HP to MP steam rate	22 kWh/klb	22 kWh/klb
MP to LP steam rate	28 kWh/klb	28 kWh/klb
HP to Condensing steam rate	Not in use	Not in use

Marginal Steam Costs	
(based on current operation)	
HP ($/klb)	----->
MP ($/klb)	----->
LP ($/klb)	----->

Calculate Marginal Costs

Press this button if marginal costs are not shown

List of Selected Projects
Install blowdown flash to LP
Install blowdown heat exchanger
Increase LP condensate recovery

Gas Turbine Assessment	
Your site is a good candidate for the installation of a gas turbine + waste heat boiler	
Warnings - Any warnings listed below may impact on the validity of the simulation	
Current Operation	**After Projects**

Slide 105: As you can see, you can easily perform several stand-alone project simulations as well as scenarios of combinations of projects to identify the impacts in fuel, electricity, and water consumption, as well as emissions impacts. This will help you select the best project configuration to improve your steam system.

Slide 106: The Assessment Tool has many useful features to evaluate steam system improvement projects by assisting the user in selection of individual *[stand alone]* and combination of projects in order to better determine system-wide benefits from implementing these steam improvement projects *[including energy and fuel savings, cost savings, and emissions savings. A final projects list to consider for implementation can also be developed.]*

Slide 107: We can continue to return to the Steam System Scoping Tool (SSST) to identify other opportunities to evaluate with the Assessment Tool.

For example, Tab Number 4 - Total Steam System indicated 'Moderate' Steam Leaks. You can look at several ways to address this in the Assessment Tool. You can repair the leaks and thus reduce the steam demand on the system. Use 'Project 1 – Steam Demand Savings', the preferred method in most situations, to evaluate this opportunity. However, you can look at implementing a Preventive Maintenance Program under Project 17 – Steam Leaks, and let the model estimate a new steam leakage rate as an estimate of its impact.

QUESTION NUMBER	QUESTION	ACTIONS	SCORE	YOUR SCORE
LK1	How would you characterize Steam Leaks in your Steam System?	none	10	
		minor	8	
		moderate	3	3
		numerous	0	

There are many combinations and stand- alone projects to consider. The user can continue to 'tweak' the project list to identify the best possible solution for your system. Further study may be needed before implementation can occur, in particular for large capital investment projects, however there are many quick maintenance-type activities that can potentially have significant savings for a relatively low cost to implement.

You can also use your scorecard (the Scoping Tool) to track your progress in improving the management of your steam system and to continue your focus on areas that need improvement. For example, if you remember insulation was an area of the Scoping Tool that that did not receive excellent marks.

Slide 108: To begin a further look into potential projects for feasibility, let's look at the 3EPlus Insulation Thickness Computer Tool, or simply the Insulation Tool, or its acronym, 3EPlus. The Insulation Tool can help you further your investigation by evaluating insulation projects, from the standpoint of energy savings, cost savings, and economic feasibility.

3E Plus Module

9/30/2009

Begin Introduction

<u>Slide 1:</u> Hello, and welcome to this introduction of the Steam System Tool Suite's 3E Plus Insulation Tool.

<u>Slide 2:</u> This tool is one of the Steam System Tool Suite, and is available for download from the DOE Industrial Technology Program's Technology Delivery website.

<u>Slide 3:</u> Technology Delivery is a program area within the Industrial Technologies Program (ITP) that supports ITP's mission to improve the energy intensity of the U.S. industrial sector through a coordinated program of research and development, validation, and dissemination of energy-efficient technologies and practices. One of the ways Technology Delivery keeps you in touch with the latest developments is through training, publications, and software tools.

Using the 3EPlus Insulation Tool, we can estimate the effects of insulating 20 feet of bare piping which was left off during a line repair.

We will show you how insulating this short section can save you 11,000 dollars and pay for itself in less than one month.

Slide 4: In order to see how the 3E Plus software tool can help us, let's take a look at one area of the Scoping Tool in which we may have opportunities for improvement.

STEAM SYSTEM SCOPING TOOL, Version 1.0d 6/12/2002

STEAM DISTRIBUTION, END USE, RECOVERY - OPERATING PRACTICES

OPTIONS FOR REDUCING STEAM PRESSURE - MINIMIZE STEAM FLOW THROUGH PRVs

What To Do Investigate potential to use backpressure turbines in parallel with pressure reducing valves in your steam system.

Why Important In many steam systems, pressure reducing valves (PRVs) are used to provide steam at pressures lower than generated from the boiler. A potential opportunity for improving a steam system is to minimize the flow of steam through PRVs. One opportunity for doing this is to install backpressure turbines in parallel with PRVs in your steam system; in this way you can provide the low-pressure steam required and generate electricity or shaft power that can be utilized. A detailed economic analysis must be performed to evaluate this type of opportunity.

QUESTION NUMBER	QUESTION	ACTIONS	POSSIBLE SCORE	YOUR SCORE
PR1	How do you reduce steam pressure in your steam system?	steam generated at required pressure, or PRVs appropriately applied	10	
		backpressure turbines used in parallel with PRVs	10	
		boiler control used to reduce pressure	5	
		excess steam vented and/or used inefficiently	0	

Go back to the Summary Results by clicking on the Section 7 tab.

SUMMARY RESULTS

1. STEAM SYSTEM PROFILING	POSSIBLE SCORE	YOUR SCORE
STEAM COSTS		
SC1: Measure Fuel Cost To Generate Steam	10	10
SC2: Trend Fuel Cost To Generate Steam	10	5
STEAM/PRODUCT BENCHMARKS		
BM1: Measure Steam/Product Benchmarks	10	10
BM2: Trend Steam/Product Benchmarks	10	5
STEAM SYSTEM MEASUREMENTS		
MS1: Measure/Record Steam System Critical Energy Parameters	30	20
MS2: Intensity Of Measuring Steam Flows	20	10
STEAM SYSTEM PROFILING SCORE	90	60

2. STEAM SYSTEM OPERATING PRACTICES	POSSIBLE SCORE	YOUR SCORE
STEAM TRAP MAINTENANCE		
ST1: Steam Trap Maintenance Practices	40	30
WATER TREATMENT PROGRAM		
WT1: Water Treatment - Ensuring Function	10	10
WT2: Cleaning Boiler Fireside/Waterside Deposits	10	10
WT3: Measuring Boiler TDS, Top/Bottom Blowdown Rates	10	10
SYSTEM INSULATION		
IN1: Insulation - Boiler Plant	10	7
IN2: Insulation - Distribution/End Use/Recovery	20	5
STEAM LEAKS		
LK1: Steam Leaks - Severity	10	3
WATER HAMMER		
WH1: Water Hammer - How Often	10	10
MAINTAINING EFFECTIVE STEAM SYSTEM OPERATIONS		
MN1: Inspecting Important Steam Plant Equipment	20	15
STEAM SYSTEM OPERATING PRACTICES SCORE	140	100

Slide 5: Look at Section 2, 'Steam System Operating Practices,' rows 28-30, under Steam Insulation. It looks like there is some room for improvement in insulation. You scored a 7 out of 10 for question IN1, and a 5 out of 20 for question IN2. So, how do we improve?

SYSTEM INSULATION	POSSIBLE SCORE	YOUR SCORE
IN1: Insulation - Boiler Plant	10	7
IN2: Insulation - Distribution/End Use/Recovery	20	5

Well, let's go back to that question by navigating to the tab for Section 4 – Total Steam System.

Slide 6: ***[slide in motion]***

STEAM SYSTEM SCOPING TOOL, Version 1.0d **6/12/2002**

STEAM SYSTEM OPERATING PRACTICES

STEAM TRAP MAINTENANCE

What To Do Implement a comprehensive program to correctly select, test, and maintain your steam traps.

Why Important Steam traps play three important functions: a) prevent steam from escaping from the system before the heat is utilized; b) remove condensate from the system; and c) vent noncondensable gases. Poor steam trap selection, testing, and maintenance can result in many system problems including water hammer, ineffective process heat transfer, steam leakage, and system corrosion. An effective steam trap selection and maintenance program is often an excellent investment with paybacks of less than half a year.

QUESTION NUMBER	QUESTION	ACTIONS	POSSIBLE SCORE	YOUR SCORE
ST1	Does Your System Steam Trap Maintenance Program Include The Following Activities?			
	Proper Trap Selection For Application	yes	10	
	At Least Annual Testing Of All Traps	yes	10	
	Maintaining A Steam Trap Database	yes	10	
	Repairing/Replacing Defective Traps	yes	10	
		none of the above	0	

Slide 6: We go down to System Insulation, beginning at row 40.

SYSTEM INSULATION

What To Do Ensure that the appropriate major components of your steam system are well insulated. Determine the economic insulation thickness for your system components, and perform system insulation reviews to identify exposed surfaces that should be insulated and/or unrestored or damaged insulation.

Why Important Effective insulation - on piping, valves, fittings, and vessels - serves many important purposes. Insulation keeps steam energy within the system to be effectively used by processes, it can reduce temperature fluctuations in the system, it can reduce space conditioning requirements, and it can reduce the potential for personnel burns.

QUESTION NUMBER	QUESTION	ACTIONS	POSSIBLE SCORE	YOUR SCORE
IN1	Is your Boiler Plant equipment and piping system insulation (refractory, piping, valves, flanges, vessels, etc.) maintained and in good condition?	insulation excellent	10	
		insulation good, but can be improved	7	
		insulation inadequate	0	
IN2	Is your Steam Distribution, End Use, and Condensate Recovery equipment insulation (piping, valves, flanges, heat exchangers, etc.) maintained and in good condition?	insulation excellent	20	
		insulation good, but can be improved	14	
		insulation inadequate	0	

<u>Slide 8:</u> Here you provided a response to the insulation questions. For IN1, on Row 45, you indicated that your boiler plant equipment and utilities piping system has appropriate insulation, but also a few areas in which insulation is missing. For IN2, on Row 49, you indicated that your distribution piping insulation is very old and damaged, and many valves are not insulated.

So, for insight on how to improve, look up at row 41, the 'What to do" section. This section asks you to perform system insulation reviews to identify exposed surfaces that should be insulated and/or unrestored or damaged insulation. Luckily, we have a tool that does exactly that!

SYSTEM INSULATION

<u>What To Do</u> Ensure that the appropriate major components of your steam system are well insulated. Determine the economic insulation thickness for your system components, and perform system insulation reviews to identify exposed surfaces that should be insulated and/or unrestored or damaged insulation.

Begin 3EPlus Insulation Tool software

<u>Slide 9:</u> So now, we will show you the 3E Plus, Insulation Thickness Computer Program. It is also called simply 3EPlus, or the Insulation Tool. This program is designed to calculate the energy impacts associated with thermal insulation projects. It will calculate the energy and cost savings from various thicknesses and types of insulation, as well as the conceptual installation costs. It will also estimate greenhouse gas emissions and reductions.

<u>3EPlus- Main Screen - Visual Description</u>

<u>Sections of the Program [buttons at top of page, descriptions on main screen]</u>

Energy

- Insulation Thickness
- Energy Loss/Gain
- Cost of Energy

Environment

- CO2 Reduction with Insulation Thickness

Economics

- Calculations for New Insulation Projects
- Calculations from Previous Projects

Options

Determining your insulation needs has never been easier.

3EPlus Insulation Thickness Computer Program

- Calculates Thermal Performance of Piping and Equipment
- Translates BTU Losses into Actual Dollars
- Calculates Greenhouse Gas Emissions and Reductions.

This is the main screen. Go up to the top and you will see 4 tabs for each one of the different sections of the tool. We'll start by clicking on 'ENERGY.'

Energy Tab

Energy Tab Inputs - Visual Description

Insulation Thickness (Data Entry Screen)

Item Description:*[blank]*
System Application: Pipe Horizontal
System Units: ASTM C585
Calculation Type: Personnel Protection
Process Temp: 350.0 ^{o}F
Ambient Temperature: 75.0 ^{o}F
NPS Pipe Size: 4
Wind Speed: 0.0 mph
Max Surface Temp: 140.0 ^{o}F

Insulation Layers
Add Button
Delete Button

#	Type	Name	Lock Thickness	Thickness, Inches
-	Base Metal	Steel		
1	Insulation	850F Mineral Fiber PIPE, Type I, C547-07	Vary	
-	Jacket Material	0.9 All Service Jacket		

<u>Slide 10:</u> You can also determine what the calculation type you are interested in. Use the pull down menus for the options, which also change the input parameters slightly.

<u>Slide 11:</u> For our overview, select 'heat loss per year' in the pull down menu.

Calculation Type: Heat Loss per Year

<u>Slide 12:</u> Here, you can enter different parameters regarding your insulation thickness, including the type of system application

Item Description: *[blank]*
System Application: Pipe Horizontal
System Units: ASTM C585
Calculation Type: Heat Loss per Year
Process Temp: 350.0 °F
Ambient Temperature: 75.0 °F
NPS Pipe Size: 4
Wind Speed: 0.0 mph
Annual Operation: 8000 hrs/yr

<u>Slide 13:</u> (pipes or ductwork, horizontal or vertical) you're working with. ***[use the pull down menu]***

System Application: Pipe Horizontal

<u>Slide 14:</u> Process temperature is the temperature of the fluid in the insulated component; this is often obtained by process measurement indications or surface temperature measurement.

Other parameters to enter include ambient temperature, wind speed, annual hours of operation, and, the nominal diameter of the pipe.

Pipe diameter is described in NPS pipe size, which stands for Nominal Pipe Size. Look under 'System Units.' *ASTM C585* is a document that identifies the standard insulation dimensions for typical piping in accordance with U.S. dimensions.

In addition to the critical inputs for process and ambient temperatures, wind speed also affects the results significantly. Piping located indoors typically experiences 0 to 2 mile per hour wind speed, while piping located outdoors can be subject to much higher values. However, for most applications 20 miles per hour would be considered a very high wind speed. Select the average wind speed for your region, or select a conservative value closer to indoor conditions.

<u>Slide 15:</u> You can also add information about your insulation layers. Select what type of material each layer is made of, including the base metal (the piping), the insulation itself, and the jacket material. The base and jacket materials are essential inputs in the 'Insulation Layers' section, but you can change the materials by using the pull down menus.

Slide 19: You must have at least one insulation layer as an input. The default entry insulation material can be changed by using the pull down menus for other selections.

You can use the 'Add/Delete' buttons to create the insulation configuration (such as multiple layers) to evaluate.

Insulation Layers
Add Button
Delete Button

There are 36 insulations to choose from.

#	Type	Name	Lock Thickness	Thickness, Inches
-	Base Metal	Steel		
		Pull-Down Menu Options ▪ Steel ▪ Stainless Steel ▪ Copper ▪ PVC		
1	Insulation	850F Mineral Fiber PIPE, Type I, C547-07	Vary	
		Pull-Down Menu Options ▪ MF Insulating Cement, C195-07 ▪ Insul + Finish Cement, C449-07 ▪ Calcium Silicate BLK+PIPE, Type I, C533-07 ▪ Elastomeric SHT+TUBE, Gr 1, C534-07 ▪ 850F Mineral Fiber PIPE, Type I, C547-07 ▪ 1200F Mineral Fiber PIPE, Types II and III, C547-07 ▪ 1000F Mineral Fiber PIPE, Type IV, C547-07 ▪ Cellular Glass, Type I, BLOCK, C552-07 ▪ Cellular Glass, Type II, PIPE and Tube, C552-07 ▪ 450F MF BLANKET, Type II, C553-02 ▪ 850F MF BLANKET, Type IV, C553-02 ▪ 1000F MF BLANKET, Type V, C553-02 ▪ 1200F MF BLANKET, Type VII, C553-02 ▪ Polystyrene PIPE, Type XIII, C578-07 ▪ Polystyrene BOARD, Type IV, C578-07 ▪ PIR, Gr 1, Types I,and II, C591-07 ▪ PIR, Gr 2, Type IV, C591-07 ▪ MF Metal Mesh BLANKET, Type II, C592-04	**Toggle:** Vary or Fix	If Fix:1.5 or Enter your specific value

#	Type	Name	Lock Thickness	Thickness, Inches
		▪ Perlite BLOCK+PIPE, C610-07 ▪ 450F MF BOARD, Type IB, C612-04 ▪ 850F MF BOARD, Type II, C612-04 ▪ 1000F MF BOARD, Type III, C612-04 ▪ 1200F MF BOARD, Type IVB, C612-04 ▪ 1800F MF BOARD, Type V, C612-04 ▪ High Temp Fiber Blanket, Gr 6, C892-05 ▪ Glass Fiber Felt, C1086-96(2004) ▪ Phenolic Sheet+TUBE, Gr 1, Type II and III, C1126 ▪ 650F Min. Fiber Pipe and Tank, Type II, C1393-00a ▪ 850F Min. Fiber Pipe and Tank, Type IIB, C1393-00a ▪ 1000F Min. Fiber Pipe and Tank, Type IVB, C1393-00a ▪ Melamine PIPE+FLAT, C1410-05a ▪ Polyolefin SHT+TUBE, C1427-04 ▪ Polyimide, Type I, C1482-04 ▪ Duct Wrap, 0.75 pcf, C1290 ▪ Duct Wrap, 1.0 pcf, C1290 ▪ Duct Wrap, 1.5 pcf, C1290		
-	Jacket Material	0.9 All Service Jacket		
		Pull-Down Menu Options ▪ 0.04 Aluminum, new, bright ▪ Aluminum, oxidized, in service ▪ 0.13 Stainless Steel, new, cleaned ▪ Stainless Steel, dull, in service ▪ 0.8 Iron or Steel ▪ 0.6 Copper ▪ 0.8 Painted Metal ▪ Galvanized steel, new, bright ▪ 0.28 Galvanized steel, dipped or dull ▪ 0.9 All Service Jacket ▪ 0.5 Aluminum Paint ▪ 0.9 Canvas ▪ 0.9 Roofing felt and black mastics ▪ 0.9 Colored mastics ▪ 0.9 PVC Jacketing		

You can use the 'Add/Delete' buttons to create the insulation configuration (such as multiple layers) to evaluate.

Insulation Layers
Add Button ***[click the Add Button]***
Delete Button

#	Type	Name	Lock Thickness	Thickness, Inches
-	Base Metal	Steel		
1	Insulation	850F Mineral Fiber PIPE, Type I, C547-07	Fix	1.5
2	Insulation	MF Insulating Cement, C195-07	Fix	1.5
3	Insulation	MF Insulating Cement, C195-07	Vary	
-	Jacket Material	0.9 All Service Jacket		

Insulation Layers
Add Button
Delete Button ***[click the Delete Button]***

#	Type	Name	Lock Thickness	Thickness, Inches
-	Base Metal	Steel		
1	Insulation	850F Mineral Fiber PIPE, Type I, C547-07	Fix	1.5
-	Jacket Material	0.9 All Service Jacket		

You cannot remove the jacket material.

Slide 27: Let's look at an example for a run of bare piping. As you see in this picture, there is approximately 20 feet of bare 10 inch diameter piping, possibly removed for repairs and never replaced.

Piping Photograph Visual Description

A photograph of an industrial pipe bridge is shown. The piping is somewhat congested but fairly typical of an industrial plant. One of the pipes, prominently displayed in the picture, is a steam header that has a section with no insulation. The un-insulated section has horizontal and vertical runs. This run has four 90-degree elbows which allow the pipe to avoid an obstruction. The piping distribution runs from left to right, engages an elbow to allow the piping to be raised, then an elbow to allow the piping to run toward the viewer and over a structural member, engage another elbow to turn down to the original elevation, then another elbow to continue to advance to the right. The pipe at the left of the picture is observed to be insulated with a metal jacket covering the assembly. However, in a very short distance the insulation and covering are removed leaving the pipe un-insulated through the turns and straight sections. Insulation and jacketing are in-place on the pipe as it leaves the picture to the right.

Let's enter the data for this system. There are vertical and horizontal sections, but for simplicity let's use horizontal as the input.

System Application: Pipe Horizontal

The steam temperature is 550 degrees Fahrenheit, enter this for the process temperature.

Process Temperature: 550.0 F

Ambient Temperature: 70.0 °F

Slide 31: The nominal pipe size is 10 inches. ***[Use the pull-down menu to select "10"]***

NPS Pipe Size: 10

33: Although this looks to be an outdoor application, there appears to be many opportunities to block wind, so let's enter a conservative 3 miles per hour for wind speed.

Wind Speed: 3 mph

<u>Slide 35:</u> Let's use the default steel piping, and change the insulation to calcium silicate ***[Use the pull-down menu to select]*** as we plan to replace it to match the existing insulation and an aluminum jacket, oxidized as the existing is in service ***[Use the pull-down menu to select]***.

#	Type	Name	Lock Thickness	Thickness, Inches
-	Base Metal	Steel		
1	Insulation	Calcium Silicate BLK+PIPE, Type I, C533-07	Fix	1.5
-	Jacket Material	0.1 Aluminum, oxidized in service		

<u>Slide 43:</u> Make sure the Lock Thickness toggle is set to 'vary'.

#	Type	Name	Lock Thickness	Thickness, Inches
-	Base Metal	Steel		
1	Insulation	Calcium Silicate BLK+PIPE, Type I, C533-07	Vary	
-	Jacket Material	0.1 Aluminum, oxidized in service		

<u>Slide 45:</u> Select the annual operation hours. Our system operates year round, so we'll select 8,760 hours per year.

Annual Operation: 8760 hours per year

There are 8,760 hours in a 365-day year.

<u>Slide 47:</u> Click on 'Calculate' to see your results.

Energy Tab – Calculate Option

Energy Tab Results - Visual Description

Heat Loss Per Year Report

Item Description: *[blank]*
System Units: ASTM C585
Geometry Description: Steel Pipe - Horizontal
Bare Surface Emittance: 0.8
Nominal Pipe Size: 10 in.
Process Temperature: 550 °F
Ave. Ambient Temperature: 70 °F
Ave. Wind Speed: 3 mph
Relative Humidity: N/A
Dew Point: N/A
Condensation Control Thickness: N/A
Hours Per Year: 8760
Outer Jacket Material: Aluminum, oxidized, in service
Outer Surface Emittance: 0.1
Insulation Layer 1: Calcium Silicate BLK+PIPE, Type I
Thickness: Varied

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/ft/yr)	Efficiency (percent)
Bare	547.8	50950000	-
0.5	207.0	10400000	79.59
1.0	149.2	5920000	88.39
1.5	121.4	3970000	92.21
2.0	109.8	3200000	93.73
2.5	102.4	2700000	94.69
3.0	97.2	2360000	95.36
3.5	93.3	2110000	95.86
4.0	90.4	1920000	96.24
4.5	88.1	1760000	96.54
5.0	86.2	1640000	96.78
5.5	84.7	1530000	96.99
6.0	83.4	1450000	97.16
6.5	82.3	1370000	97.31
7.0	81.3	1310000	97.43
7.5	80.5	1250000	97.55
8.0	79.8	1200000	97.64
8.5	79.2	1160000	97.73
9.0	78.6	1120000	97.81
9.5	78.1	1080000	97.88
10.0	77.7	1050000	97.95

Slide 48: At the top, it reviews all of the information that you input. At the bottom, you see the results for each insulation thickness, based on the 'vary' Lock Thickness, from bare pipe to 10 inches of insulation. As we would likely replace the insulation with a similar 3 inch thick insulation, go to the 3 inch row and you can see the results for a like-for-like replacement, as well as other insulation thicknesses that you could choose.

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/ft/yr)	Efficiency (percent)
Bare	547.8	50950000	-
3.0	97.2	2360000	95.36

The results include ‘Surface temperature,’ ***[the outer surface of the insulation jacket (the surface that is exposed to the ambient)],*** ‘Heat loss’ in BTU’s per year per linear foot, and efficiency ***[the portion of bare pipe heat loss that has been eliminated as a result of the proposed insulation installation]***,

You can see for bare pipe, {{the heat loss is 50,905,000 BTU per linear foot per year. For 3 inches of insulation, the heat loss is 2,300,000 BTU per linear foot per year. The difference between these values is the energy savings associated with installing the insulation. For the 20 foot length the savings is 973,000,000 BTU per year, or 111,000 BTU per hour.

Energy Savings – ((Energy Loss)$_{Bare}$ – (Energy Loss)$_{insul}$)) (Uninsulated Length)

Energy Savings = (50,950,000Btu per foot - year – 2,300,000 Btu per foot - year) (20 feet)

Energy Savings = (48,650,000 Btu per foot - year) (20 feet)

Energy Savings = (973,000,000 Btu per year) (1 year per 8,760 hours) = 111,000 Btu per

Click ‘Back’ to go back to the first screen, or select the menu tab ENERGY at the top of the screen.

Energy Tab Inputs

<u>Slide 49:</u> You can also specify the thickness of each insulation layer by selecting the toggle ‘fixed’ under Lock Thickness and entering the appropriate inches of the respective insulation material. For this example, put your cursor over the ‘vary’ Lock Thickness, and it will automatically turn to ‘fixed’ and ‘1.5’ will appear under Thickness, Inches for this layer indicating 1.5 inches of calcium silicate.

#	Type	Name	Lock Thickness	Thickness, Inches
-	Base Metal	Steel		
			Pull-Down Menu:	
			Fix	1.5
1	Insulation	Calcium Silicate BLK+PIPE, Type I, C533-07	Vary	
-	Jacket Material	0.1 Aluminum, oxidized in service		

<u>Slide 50:</u> You can change the default insulation thickness by manually changing the 1.5 to the desired thickness. For our example, let's change it to 3 inches.

#	Type	Name	Lock Thickness	Thickness, Inches
-	Base Metal	Steel		
1	Insulation	Calcium Silicate BLK+PIPE, Type I, C533-07	Fix	3
-	Jacket Material	0.1 Aluminum, oxidized in service		

<u>Slide 53:</u> Click on 'Calculate' ***[top of screen]*** to view the results.

Energy Tab – Calculate Option

<u>Energy Tab Results - Visual Description</u>

Heat Loss Per Year Report

Item Description: *[blank]*
Geometry Description: Steel Pipe - Horizontal
System Units: ASTM C585
Bare Surface Emittance: 0.8
Nominal Pipe Size: 10 in.
Process Temperature: 550 °F
Ave. Ambient Temperature: 70 °F
Ave. Wind Speed: 3 mph
Relative Humidity: N/A
Dew Point: N/A
Condensation Control Thickness: N/A
Hours Per Year: 8760
Outer Jacket Material: Aluminum, oxidized, in service
Outer Surface Emittance: 0.1
Insulation Layer 1: Calcium Silicate BLK+PIPE, Type I
Thickness: 3.085 in.

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/ft/yr)	Efficiency (percent)
Bare	547.8	50950000	
Layer 1	97.2	2360000	95.36

Slide 54: You will only see the results for this particular configuration, compared to the base case of bare pipe.

Slide 55: Click 'Back' to go back to the first screen, or select the menu tab energy at the top of the screen.

Energy Tab Inputs

Slide 56: Return the Lock Thickness to 'vary' to return to the default parameters.

#	Type	Name	Lock Thickness	Thickness, Inches
-	Base Metal	Steel		
1	Insulation	Calcium Silicate BLK+PIPE, Type I, C533-07	Vary	
-	Jacket Material	0.1 Aluminum, oxidized in service		

Slide 57: On the left-hand side of the screen, click on 'Cost of Energy' in order to estimate cost and savings of different insulation thicknesses.

Energy Tab – Cost of Energy Option

Cost of Energy Option Inputs - Visual Description

Insulation Thickness (Data Entry Screen)

Item Description: *[blank]*
System Application: Pipe Horizontal
System Units: ASTM C585
Fuel Type: Natural Gas
Heat Content – 1026 BTU/cubic foot
Fuel Cost – 10.00 $/Mcf
Efficiency: 75 %
Process Temperature – 550.0 ^{o}F
Ambient Temperature – 70.0 ^{o}F
NPS Pipe Size – 10
Wind Speed – 3 mph
Annual Operation – 8760 hours per year

Insulation Layers
Add Button
Delete Button

#	Type	Name	Lock Thickness	Thickness, Inches
-	Base Metal	Steel		
1	Insulation	Calcium Silicate BLK+PIPE, Type I, C533-07	Vary	
-	Jacket Material	0.1 Aluminum, oxidized in service		

Efficiency – a comparison of fuel energy input into the system required to produce the thermal energy loss at the point of investigation.

Slide 58: The information that you input is basically the same, actually carried over if you entered ENERGY data, except now you have the ability to select the type of fuel, cost of the fuel, and efficiency of the heating system. You can also enter the heat content, but for now we are just accepting the default.

Slide 59: As an example of this efficiency, assume 100,000 BTU's per hour of thermal energy is lost from a section of uninsulated pipe. More than 100,000 BTU's per hour of fuel energy had to be placed in the boiler to support the insulation loss. A large portion of the inefficiency resides in the inefficiency of the boiler. If boiler efficiency is 80 percent then at least 125, 000 BTU's per hour of fuel energy had to be provided to the boiler to accommodate the 100,000 BTU's per hour thermal loss.

Boiler Fuel Input Energy = Insulation Thermal Energy Loss / Boiler Efficiency

Boiler Fuel Input Energy = 100,000 Btu per hour / 0.80

Boiler Fuel Input Energy = 125,000 Btu per hour

Additional losses exist; such as, condensate losses that will make the total system energy loss increase further. Therefore, the efficiency value in 3EPlus is an expression of the comparison of thermal energy loss to fuel input energy. The efficiency will be less than boiler efficiency but boiler efficiency is a good approximation. It should be noted that the only calculations that rely on system efficiency are those related to fuel consumption. The primary calculation is the economic impact (fuel consumption) of adding insulation (*cost* and *savings*).

The units for the fuel's heat content and cost will change to reflect the typical units of measure for the fuel selected. Default values for the heat content, fuel cost, efficiency, and annual hours of operation **[keep in mind there are 8.760 hours in a 365-day year]** will be shown, but you can enter your specific values manually to reflect your site conditions.

Fuel Name	Cost Units	BTU
Natural Gas	$/Mcf	1026
Oil	$/gal	138700
LPG	$/gal	86310
Coal	$/ton	12500
Electricity	$/kWh	3415.3

For our example, enter natural gas for the fuel. The default values for natural gas heat content and cost of the fuel are shown. We will accept these values, but you can enter specific values for your application. For this example enter 80 percent for the boiler efficiency.

Efficiency: 80 %

Slide 61: "Click 'Calculate.'

Energy Tab – Cost of Energy – Calculate Option

Energy Tab Results - Visual Description

Cost of Energy Report

Item Description: *[Blank]*
Geometry Description: Steel Pipe - Horizontal
System Units: ASTM C585
Bare Surface Emittance: 0.8
Nominal Pipe Size: 10 in.
Process Temperature: 550 °F
Ave. Ambient Temperature: 70 °F
Ave. Wind Speed: 3 mph
Fuel Name: Natural Gas
Heat Content: 1026 BTU/cuft
Fuel Cost: 10.00 $/Mcf
Efficiency: 80 %
Hours Per Year: 8760
Outer Jacket Material: Aluminum, oxidized, in service
Outer Surface Emittance: 0.1
Insulation Layer 1: Calcium Silicate BLK+PIPE, Type I
Thickness: Varied

Variable Insulation Thickness	Cost ($/ft/yr)	Heat Loss (BTU/ft/yr)	Savings ($/ft/yr)
Bare	620.7	50950000	
0.5	126.7	10400000	494
1	72.07	5920000	548.6
1.5	48.38	3970000	572.3
2	38.95	3200000	581.7
2.5	32.94	2700000	587.8
3	28.78	2360000	591.9
3.5	25.71	2110000	595
4	23.35	1920000	597.4
4.5	21.48	1760000	599.2
5	19.96	1640000	600.7
5.5	18.7	1530000	602
6	17.63	1450000	603.1
6.5	16.72	1370000	604
7	15.93	1310000	604.8
7.5	15.24	1250000	605.5
8	14.62	1200000	606.1
8.5	14.08	1160000	606.6
9	13.59	1120000	607.1
9.5	13.15	1080000	607.5
10	12.75	1050000	608

<u>Slide 62:</u> Again, the top shows the information you input. The bottom table can be a bit confusing, but shows the results for different insulation thicknesses, including the cost of heat loss in dollars per foot per year **[The fuel-related operating costs associated with a 1-foot long section of pipe with the indicated insulation thickness]**. Also, heat loss in BTU per foot per year, **[even insulated pipe experiences some heat loss]** and savings in dollars per foot per year as compared to bare pipe are shown. It should also be noted that the *cost* and *savings* calculations associated with 3EPlus are based on the assumption that all thermal energy carries the same worth.

> **And as before, if you had left the Lock Thickness as 'fixed',**
> **you would have only seen the results for one configuration,**
> **3-inches of calcium silicate, compared to the bare insulation.**

<u>Slide 63:</u> Using the table, you will see the energy cost due to heat loss for bare pipe is 620.70 dollars per linear foot per year-12,400 dollars per year for the 20 foot section.

> **Heat Loss Cost of Bare Pipe = Cost $_{bare}$ (Uninsulated Length)**
>
> **Heat Loss Cost of Bare Pipe = $620.07 per linear foot – year) (20 feet) = $12,414 per year**

For our example, by adding the 3 inches of calcium silicate and the aluminum jacket the cost of the heat loss is calculated at 27.97 dollars per linear foot per year. So for the 20 foot length of piping, the estimated cost of heat loss of this configuration is 560 dollars a year.

> **Heat Loss Cost of Insulated Pipe = Cost $_{Insul}$ (Uninsulated Length)**
>
> **Heat Loss Cost of Insulated Pipe = $27.97 per linear foot – year) (20 feet) = $559 per year**

The Savings column indicates 592.70 dollars per year per linear foot, which is the difference of bare pipe at 620.70 dollars and 3 inches of insulation at 27.92 dollars, for the resulting savings of 592.73 dollars per foot per year. Therefore, to insulate 20 feet of bare piping, the total savings from this project are estimated at 11,854 dollars per year (about 11,000 dollars per year).

Savings = (Cost $_{bare}$ - Cost $_{Insul}$) (Uninsulated Length)

Savings = ($620.07 per linear foot – year - $27.97 per linear foot – year) (20 feet)

Savings = ($592.73 per linear foot – year) (20 feet) = $12,414 per year

Savings = $11,852 per year

<u>Slide 64:</u> 'Environment' is a model of the fuel based environmental emissions associated with reducing the thermal loss of a facility. Most of the information is carried over from the ENERGY/Cost of Energy configuration. You can change any information as you wish.

Environment is a model of the fuel-based environmental emissions associated with reducing the thermal loss of a facility.

Environment Tab

Environment Tab Inputs - Visual Description

Insulation Thickness (Data Entry Screen)

Item Description: *[blank]*
System Application: Pipe Horizontal
System Units: ASTM C585
Fuel Type: Natural Gas
Heat Content – 1026 Btu/cubic foot
Efficiency: 80 %
Process Temperature – 550.0 F
Ambient Temperature – 70.0 F
NPS Pipe Size – 10
Wind Speed – 3 mph
Annual Operation – 8760 hours per year

Insulation Layers
Add Button
Delete Button

#	Type	Name	Lock Thickness	Thickness, Inches
-	Base Metal	Steel		
1	Insulation	Calcium Silicate BLK+PIPE, Type I, C533-07	Vary	
-	Jacket Material	0.1 Aluminum, oxidized in service		

Click on 'Calculate' for your results.

Environment Tab – Calculate Option

Environment Tab Results - Visual Description

Pollutant Reduction Report

Item Description: *[blank]*
Geometry Description: Steel Pipe - Horizontal
System Units: ASTM C585
Bare Surface Emittance: 0.8
Nominal Pipe Size: 10 in.
Process Temperature: 550 °F
Ave. Ambient Temperature: 70 °F
Ave. Wind Speed: 3 mph
Fuel Name: Natural Gas
Heat Content: 1026Btu/cuft
Fuel Cost: 10.00 $/Mcf
Efficiency: 80%
Hours Per Year: 8760
Outer Jacket Material: Aluminum, oxidized, in service
Outer Surface Emittance: 0.1
Insulation Layer 1: Calcium Silicate BLK+PIPE, Type I
Thickness: Varied

Variable Insulation Thickness	CO2 (lb/ft/yr)	NOx (lb/ft/yr)	CE (lb/ft/yr)
Bare	7421	14.89	2022
0.5	1515	3.038	412.7
1	861.7	1.728	234.8
1.5	578.4	1.16	157.6
2	465.7	0.934	126.9
2.5	393.9	0.79	107.3
3	344	0.69	93.74
3.5	307.3	0.616	83.75
4	279.2	0.56	76.07
4.5	256.8	0.515	69.98
5	238.7	0.479	65.03
5.5	223.6	0.448	60.92
6	210.8	0.423	57.44
6.5	199.9	0.401	54.47
7	190.4	0.382	51.89
7.5	182.2	0.365	49.63
8	174.8	0.351	47.64
8.5	168.3	0.338	45.86
9	162.5	0.326	44.27
9.5	157.2	0.315	42.83
10	152.4	0.306	41.52

Slide 65: Here, we see the emissions for each gas: carbon dioxide (CO_2), nitrogen oxides (NOx), and carbon equivalent (CE), in pounds per foot per year. These amounts decrease as the insulation thickness increases.

Click on 'Economics' for a worksheet that calculates cost and thickness of different sizes of insulation.

Begin Economics Tab

Environment Tab Inputs – Job Information - Visual Description

Job Information (Data Input Screen)

Job Name: New Job
Project Name:
Project Number: 1
System:
Date: 03/10/2009
Location:
Engineer:
Contact:
Phone Number:
Will this analysis be for a hot surface, or a cold surface?
Radio buttons
[Selected] Hot
Cold
Is this a new application or a retrofit?
Radio buttons
[Selected] New
Retrofit
System Units: ASTM C585

Back Button
Next Button
Calculate Button

Slide 66: The first page asks for general information about this insulation job. You must enter a project number and date (which is provided) as a minimum to move forward. Enter '1' for project number; the current date is provided. Click the "next box" to forward to the next page

Slide 67: The next page asks for fuel information, including fuel type, cost, and heating system efficiency. Enter 80 percent for your system efficiency.

Environment Tab Inputs –Fuel Information - Visual Description

Fuel Information (Data Input Screen)

Fuel Type: Natural Gas
First Year Cost (Dollars/Mcf): 10.00; Question Box
Heating Value (BTU/cubic foot): 1,026
Efficiency (%): 75
Annual Fuel Inflation Rate (%): 3; Question Box

Back Button
Next Button
Calculate Button

[Enter '80' for efficiency]

Efficiency (%): 80

Slide 69: Defaults for these values are provided for the particular fuel type selected, as well as the heating value, all can be manually entered. The question mark beside the First Year Cost provides guidance to help you to calculate your fuel cost per the default unit. The Annual Fuel Inflation Rate default can be adjusted based on your particular economic analysis to perform. ……. Click the "next box" to forward to the next page.

Slide 70: 'Economic information' is where you will input discount rate, income tax rate, depreciation period in years, etc…again, according to the economic analysis you wish to review or accept the defaults.

Environment Tab Inputs – Economic Information - Visual Description

Economic Information (Data Input Screen)

Discount Rate (%): 8; Question Box
Effective Income Tax Rate (%): 35; Question Box
Physical Plant Depreciation Period (years): 7; Question Box
New Insulation Depreciation Period (years): 7; Question Box
Incremental Cost of Plant Capacity ($/MM BTU/hour): 3.47; Question Box
Percent of New Insulation Cost for Annual Insulation Maintenance: 2
Percent of Annual Fuel Bill for Physical Plant Maintenance: 1; Question Box
Annual Hours of Operation: 8320
Average Annual Ambient Temperature (F): 75
Average Annual Wind Speed (mph): 0
Reference Thickness for Payback Calculations: 0; Question Box

Back Button
Next Button
Calculate Button

To continue with this example, enter the data from the ENERGY tab inputs: 8,760 hours of operation, ………

Slide 72: 70 degrees ambient temperature, ……

Slide 73: wind speed of 3 miles per hour …….

Slide 75: and 0 inches of insulation thickness.

Environment Tab Inputs – Economic Information Entered - Visual Description

Annual Hours of Operation: 8760
Average Annual Ambient Temperature (F): 70
Average Annual Wind Speed (mph): 3
Reference Thickness for Payback Calculations: 0

[Click the "next box" to forward to the next page.]

Slide 76: 'Reporting Options ' is where you decide whether you want a report on all surfaces, or each surface individually, and whether you want a detailed engineering report, or a tabled report.

Environment Tab Inputs – Reporting Options - Visual Description

Reporting Options (Data Input Screen)
Select the number of Surfaces to Report On
Radio-buttons
Report on all surfaces, NPS or Tubing Sizes, and Top/Vertical/Bottom Flat Surfaces
[Selected] Select each surface individually
Select the Report Type
Radio-buttons
Detailed Engineering Report
[Selected] Tables Style Report
Cost Information Source
Radio-buttons
[Selected] Estimated Installation Cost by FEA Method
Cost Data from Previous Reports
User-supplied Thickness and Installed Cost Information for Each Surface
Starting Temperature: 100
Temperature Increment: 100

Back Button
Next Button
Calculate Button

We want to report on all surfaces.

[Select Radio Button]: Report on all surfaces, NPS or Tubing Sizes, and Top/Vertical/Bottom Flat Surfaces

[Click the "next button" to forward to the next page.]

Slide 78: In 'Insulation System,' specify the insulation to be installed, so select 'calcium silicate' and 'aluminum jacket oxidized in service' to continue with our example.

Environment Tab Inputs – Insulation System - Visual Description

Insulation System (Data Input Screen)

Insulation Material for Job: 1000F Min. Fiber Pipe and Tank, Type IVB, C1393-00a
Installation Complexity: Average
External Jacket Material: Aluminum, oxidized, in service
Material Price, dollar per foot for 2 by 2 pipe insulation, including jacket: 4.97; Question Box
Material Price, dollar per square foot for 2-inch thick board or block, including jacket: 1.71; Question Box
Labor Rate, dollar an hour. Including overhead: 38.25; Question Box
Regional Productivity Factor: Alabama; Question Box

Back Button
Next Button
Calculate Button

Insulation material – calcium silicate
Jacket – aluminum, oxidized, in service

Again, for an 'apples to apples' comparison

Slide 80: ***[Use the pull-down menu to select "Calcium Silicate BLK+PIPE, Type I, C533-07']***

Slide 82: You can also specify the price for the specific material selected, the cost of labor, and the location by state where the job is being done. Default costs should be adjusted for the specific insulation and labor. The baseline material cost adjustments should be based on the cost of 2 inch thickness of insulation covering pipe with a 2 inch nominal diameter. The program will ratio the cost for the various sizes of pipe or surfaces. The Question Marks can be checked to help you with the inputs. Click the "next box" to forward to the next page.

Slide 83: On the next page, you will see the 'Cost and Thickness Data' screen to estimate the cost (in dollars) for different insulation thicknesses.

Environment Tab Inputs – Cost and Thickness Data - Visual Description

Cost and Thickness Data (Results Screen)

Surface number: 1
Pipe Size: 0.5

Thicknesses are noted with units of inches.

Costs are noted with units of dollars per square foot for a flat surface.

Single Layer

Thick	Cost
1	7.24
1.5	8.19
2	9.84
2.5	11.05
3	12.35
4	17.64

Double Layer

Thick	Cost
3	15.57
4	21.32
5	26.96
6	32.75
0	0.00
0	0.00

Triple Layer

Thick	Cost
6	0.00
7	0.00
8	0.00
9	0.00
10	0.00
0	0.00

Back Button
Next Button
Calculate Button

Each pipe size is noted as a unique Surface Number with the corresponding Pipe Size. You will see options for single, double, and triple layers of insulation. You can scroll through every pipe size by clicking 'next' or 'back'.

Slide 87: As you scroll through, you will see that the cost per thickness of insulation increases with pipe size. Also, the cost increases with each layer; single, double, and triple.

For our example, we will select the pipe size "10."

As you scroll through, you will find Surface Number 17

Slide 88: which is for 10 inch diameter piping.

Environment Tab Inputs – Cost and Thickness Data Example - Visual Description

Cost and Thickness Data (Results Screen)

Surface number: 17
Pipe Size: 10

Single Layer

Thick	Cost
1	0.00
1.5	19.01
2	23.25
2.5	26.74
3	29.99
4	37.23

Double Layer

Thick	Cost
3	33.86
4	43.70
5	53.69
6	63.72
0	0.00
0	0.00

Triple Layer

Thick	Cost
6	72.24
7	84.39
8	96.51
9	103.70
10	119.84
0	0.00

You can see that a single layer of 3 inches of calcium silicate insulation and jacketing on a 10 inch diameter pipe for the default location Alabama and its default rates is 29.99 dollars per linear foot.

Single Layer

Thick	Cost
3	29.99

For 20 feet of piping, the estimated insulation costs, based on the economic inputs, is approximately 600 dollars.

Cost of Installing Insulation = (Cost $_{Install}$) (Uninsulated Length)

Cost of Installing Insulation = ($29.99 per linear foot) (20 feet) = $599.80

Our Costs of Energy calculation indicated an annual savings of approximately 11,000 dollars. The simple payback for insulating this 20 feet section is about 1 month, well worth the investment!

Simple Payback = Cost of Installing Insulation / Energy Savings

Simple Payback = $600 / $11,000 per year = 0.05 year = 1 month

Slide 89: Click on 'Calculate' to view the full report.

Pop Up Report– Visual Description

North American Insulation Mfg. Assoc.
NAIMA 3E Plus 4.0
Company Name
Address
City, State Zip
Phone Number

Project Name =
Project Number = 1
System =
Location =
Date = 03/10/2009
Engineer =
Contact =
Phone =

Slide 92: When you are ready to print a report, click on 'File.'

Slide 94: to print the report…… or save it as a rich text file.

Slide 96: If you choose to save it, type a filename, and click 'Save.'

Slide 98: To find the file in the future, the filename will be whatever name you chose, followed by Dot RTF.

[Click the "Options" at the top of the screen.]

Options Tab

Options Tab Inputs – General Options (Program Defaults) - Visual Description

User Information (Data Input Screen)

User Name: User Name
Company Name: Company Name
Address: Address
City, State, Zip: City, State, Zip
Phone Number: Phone Number

Save button

Slide 100: Under 'Options,' you can type general user information, add, delete,

Slide 101: or edit information about different insulation material……..

Options Tab Inputs – Insulation Material (Maintenance) - Visual Description

Insulation Material (Data Input Screen)

Add button
Edit button
Delete button
Activate button

ID	Material Name	Active	Created By	Type	Max Temp.
1	MF Insulating Cement, C195-07	TRUE	System	5	1900
2	Insul + Finish Cement, C449-07	TRUE	System	5	1200
3	Calcium Silicate BLK+PIPE, Type I, C533-07	TRUE	System	3	1200
4	Elastomeric SHT+TUBE, Gr 1, C534-07	TRUE	System	5	220
5	850F Mineral Fiber PIPE, Type I, C547-07	TRUE	System	1	850
6	1200F Mineral Fiber PIPE, Types II and III, C547-07	TRUE	System	2	1200

ID	Material Name	Active	Created By	Type	Max Temp.
7	1000F Mineral Fiber PIPE, Type IV, C547-07	TRUE	System	2	1000
8	Cellular Glass,Type I,BLOCK, C552-07	TRUE	System	4	800
9	Cellular Glass,Type II,PIPE and Tube, C552-07	TRUE	System	4	800
10	450F MF BLANKET, Type II, C553-02	TRUE	System	1	450
11	850F MF BLANKET, Type IV, C553-02	TRUE	System	1	850
12	1000F MF BLANKET, Type V, C553-02	TRUE	System	2	1000
13	1200F MF BLANKET, Type VII, C553-02	TRUE	System	2	1200
14	Polystyrene PIPE,Type XIII, C578-07	TRUE	System	5	165
15	Polystyrene BOARD, Type IV, C578-07	TRUE	System	5	165
16	PIR, Gr 1, Types I,and II, C591-07	TRUE	System	5	300
17	PIR, Gr 2, Type IV, C591-07	TRUE	System	5	300
18	MF Metal Mesh BLANKET, Type II, C592-04	TRUE	System	2	1200
19	Perlite BLOCK+PIPE, C610-07	TRUE	System	3	1200
20	450F MF BOARD, Type IB, C612-04	TRUE	System	1	450
21	850F MF BOARD, Type II, C612-04	TRUE	System	1	850
22	1000F MF BOARD, Type III, C612-04	TRUE	System	1	1000
23	1200F MF BOARD, Type IVB, C612-04	TRUE	System	2	1200
24	1800F MF BOARD, Type V, C612-04	TRUE	System	2	1800
25	High Temp Fiber Blanket, Gr 6, C892-05	TRUE	System	1	3000
26	Glass Fiber Felt, C1086-96(2004)	TRUE	System	1	1200
27	Phenolic Sheet+TUBE, Gr 1, Type II and III, C1126	TRUE	System	5	257
28	650F Min. Fiber Pipe and Tank, Type II, C1393-00a	TRUE	System	1	650
29	850F Min. Fiber Pipe and Tank, Type IIB, C1393-00a	TRUE	System	1	850
30	1000F Min. Fiber Pipe and Tank, Type IVB, C1393-00a	TRUE	System	2	1000
31	Melamine PIPE+FLAT, C1410-05a	TRUE	System	5	350
32	Polyolefin SHT+TUBE, C1427-04	TRUE	System	5	200
33	Polyimide, Type I, C1482-04	TRUE	System	5	400

ID	Material Name	Active	Created By	Type	Max Temp.
34	Duct Wrap, 0.75 pcf, C1290	TRUE	System	1	250
35	Duct Wrap, 1.0 pcf, C1290	TRUE	System		250
36	Duct Wrap, 1.5 pcf, C1290	TRUE	System		250

Temperature Points (Data Input Screen)

Row	Temperature	Conductivity
1	-200	0.124
2	-150	0.152
3	-100	0.181
4	-50	0.203
5	-25	0.212
6	0	0.221
7	25	0.234
8	50	0.246
9	75	0.259
10	100	0.272

Slide 102: different types of fuel,

Options Tab Inputs – Fuel Types - Visual Description

Fuel Types (Data Input Screen)

Add button
Edit button
Delete button
Activate button

ID	Fuel Name	Active	Created By	Cost	Cost Units	BTU
1	Natural Gas	TRUE	System	10.00	$/Mcf	1026
2	Oil	TRUE	System	1.50	$/gal	138700
3	LPG	TRUE	System	0.90	$/gal	86310
4	Coal	TRUE	System	70.00	$/ton	12500
5	Electricity	TRUE	System	0.10	$/kWh	3415.3

Pollutants (Data Input Screen)

ID	Name	Lbs/10^6 BTU
1	CO2	425.5
2	NOx	0.9497
3	CE	116

Slide 103: jacket material,

Options Tab Inputs – Jacket Material - Visual Description

Jacket Material (Data Input Screen)

Add button
Edit button
Delete button
Activate button

ID	Material Name	Active	Created By	Emittance
1	Aluminum, new, bright	TRUE	System	0.04
2	Aluminum, oxidized, in service	TRUE	System	0.1
3	Stainless Steel, new, cleaned	TRUE	System	0.13
4	Stainless Steel, dull, in service	TRUE	System	0.3
5	Iron or Steel	TRUE	System	0.8
6	Copper	TRUE	System	0.6
7	Painted Metal	TRUE	System	0.8
8	Galvanized steel, new, bright	TRUE	System	0.1
9	Galvanized steel, dipped or dull	TRUE	System	0.28
10	All Service Jacket	TRUE	System	0.9
11	Aluminum Paint	TRUE	System	0.5
12	Canvas	TRUE	System	0.9
13	Roofing felt and black mastics	TRUE	System	0.9
14	Colored mastics	TRUE	System	0.9
15	PVC Jacketing	TRUE	System	0.9

Slide 104: or base metals.

Options Tab Inputs – Base Metals- Visual Description

Base Metals (Data Input Screen)

Add button
Edit button
Delete button
Activate button

ID	Material Name	Active	Created By	Emittance
1	Steel	TRUE	System	0.8
2	Stainless Steel	TRUE	System	0.3
3	Copper	TRUE	System	0.6
4	PVC	TRUE	System	0.9

Under 'Edit,' ***[at the top of the screen]***

Slide 106: click on 'Save as Default' in order to save this information as the default that will display whenever you open 3E Plus. If you change any information while using 3E Plus, click on "Load Defaults' to restore everything back to the default.

Slide 107: To cover the remaining menus, go to the File menu,

Slide 109: and click 'Save job" in order to save all of your information as a 3E Plus File.

Slide 114: Click on 'Open Job' to open a 3E Plus File you had previously saved. You can also print the report, or export it, which converts it into a rich text file."

Under 'Units,' you can select whether you want measurements to display in English or SI units.

Slide 115: ***[Conclusion]*** The 3EPlus Insulation Tool has many useful features to evaluate insulation projects by assisting the user in selection of appropriate types ***[insulation materials]*** and thicknesses through parametric runs, and by calculating the energy and cost savings, implementation costs, and emission reductions ***[savings]***.

Slide 116: We now know the potential projects and their energy and economic impacts ***[energy and cost savings]*** from using 3EPlus.

You can also return to the Steam System Scoping Tool (SSST) to revise your scorecard results for insulation to determine a projected new score pre-implementation or for a final score post-installation of the projects.

We can use this information for stand-alone projects as well as incorporate the data into the ***[Next Steps]***Steam System Assessment Tool (SSAT) for modeling the current configuration, in order to better determine system-wide benefits ***[system interactions]*** from implementing these insulation improvement projects***[resulting in a Final Projects List with estimates of energy and cost savings]***.

SSST Quiz

9/30/2009

<u>Slide 1:</u> "For the Steam Distribution Operating Practices, Section 6 of the scoping tool, type the numbers corresponding to the following answers, for each question, then hit enter for each question, and then the advance arrow at the bottom of the screen (at the control bar):

STEAM SYSTEM SCOPING TOOL, Version 1.0d

6/12/2002

STEAM DISTRIBUTION, END USE, RECOVERY - OPERATING PRACTICES

OPTIONS FOR REDUCING STEAM PRESSURE - MINIMIZE STEAM FLOW THROUGH PRVs

<u>What To Do</u> Investigate potential to use backpressure turbines in parallel with pressure reducing valves in your steam system.

<u>Why Important</u> In many steam systems, pressure reducing valves (PRVs) are used to provide steam at pressures lower than generated from the boiler. A potential opportunity for improving a steam system is to minimize the flow of steam through PRVs. One opportunity for doing this is to install backpressure turbines in parallel with PRVs in your steam system; in this way you can provide the low-pressure steam required and generate electricity or shaft power that can be utilized. A detailed economic analysis must be performed to evaluate this type of opportunity.

		ACTIONS	SCORE	YOUR SCORE
PR1	How do you reduce steam pressure in your steam system?	steam generated at required pressure, or PRVs appropriately applied	10	
		backpressure turbines used in parallel with PRVs	10	
		boiler control used to reduce pressure	5	
		excess steam vented and/or used inefficiently	0	

RECOVER AND UTILIZE AVAILABLE CONDENSATE

What To Do Determine how much of your available condensate you recover and utilize.

Why Important Returning a substantial portion of your condensate to your boiler can have both energy and chemical treatment benefits: a) condensate is hotter than makeup water, so less energy is required to convert condensate to steam; and b) condensate requires significantly less chemical treatment than makeup water, so there may be savings in chemical treatment costs associated with returning condensate. Returning as much condensate as possible also can help to reduce boiler blowdown (because fewer impurities are resident in condensate), and so minimize blowdown energy losses.

		ACTIONS	SCORE	YOUR SCORE
CR1	How much of your available Condensate do you recover and utilize?	greater than 80%	10	
		40% to 80%	6	
		20% to 40%	3	
		less than 20%	0	

USE HIGH-PRESSURE CONDENSATE TO MAKE LOW-PRESSURE STEAM

What To Do Investigate opportunity to utilize high-pressure condensate to produce useable low-pressure steam.

Why Important An opportunity for utilizing high-pressure condensate is to allow it to pass through a flash tank and utilize the flash steam in low-pressure steam applications. The remainder of the condensate, now at lower pressure and temperature, can then be sent back to the boiler for use in producing steam.

		ACTIONS	SCORE	YOUR SCORE
FS1	How much of your available Flash Steam do you recover and utilize?	greater than 80%, or flash steam unavailable	10	
		40% to 80%	6	
		20% to 40%	3	
		less than 20%	0	

PR1: " Your steam demands require 400psig, 150 psig, and 20 psig pressures. Your boiler generates 400 psig and PRVs are used to reduce to 150 psig.

Answer: Steam generated at required pressure, or PRV's appropriately applied"

*Type "**10**" points for your score at PR1, hit Enter.* "Correct"

Select Fast Forward Button on the tool bar.

		ACTIONS	SCORE	YOUR SCORE
PR1	How do you reduce steam pressure in your steam system?	steam generated at required pressure, or PRVs appropriately applied	10	**10**
		backpressure turbines used in parallel with PRVs	10	
		boiler control used to reduce pressure	5	
		excess steam vented and/or used inefficiently	0	

CR1: "Approximately 75% of condensate is recovered at your boiler plant.

Answer: 40% to 80%"

*Type "**6**" points for your score at CR1, hit Enter.* "Correct"

Select Fast Forward Button on the tool bar.

		ACTIONS	SCORE	YOUR SCORE
CR1	How much of your available Condensate do you recover and utilize?	greater than 80%	10	
		40% to 80%	6	**6**
		20% to 40%	3	
		less than 20%	0	

FS1: "Your steam system utilizes approximately 50% of flash steam for condensate heat recovery.

Answer: 40% to 80%"

*Type "**6**" points for your score at FS1, hit Enter.* "Correct"

Select Fast Forward Button on the tool bar.

		ACTIONS	SCORE	YOUR SCORE
FS1	How much of your available Flash Steam do you recover and utilize?	greater than 80%, or flash steam unavailable	10	
		40% to 80%	6	6
		20% to 40%	3	
		less than 20%	0	

Slide 7: "Nice job! It looks like you have grasped the concept of using the Steam System Scoping Tool."

SSAT Quiz

9/30/2009

Slide 1: For this quiz, you will investigate the impact of a very common steam system management activity—reducing steam consumption. We can assume we investigated a steam consuming process and have identified that the process could consume 1,000 pounds per hour less low-pressure steam through improved process control.

Implement a project that will make these estimations.

*Select "**Projects Input**" tab at the bottom of the screen.*

Steam System Assessment Tool			
3 Header Model			
Projects Entry Form			
Use this form to specify improvement projects. These projects will then be modeled and compared to the existing operation.			
Project 1 - Steam Demand Savings (Changing the process steam requirements)			
Current use - HP: 50 klb/h (40.22 MMBtu/h) MP: 100 klb/h (86.25 MMBtu/h) LP: 200 klb/h (179.82 MMBtu/h)			
Do you wish to specify steam demand savings?			*No*
If No, the following inputs are greyed out.			
If yes, enter HP steam saving	0	klb/h	
If yes, enter MP steam saving	0	klb/h	
If yes, enter LP steam saving	1	klb/h	
Note: A negative saving can be entered to model an increase in steam demand			
Note: The savings have been converted to heat duties of 0.00 MMBtu/h (HP), 0.00 MMBtu/h (MP) and 0.00 MMBtu/h (LP) based on current header enthalpies			
Note: These heat duties are then used to determine the actual flow change in the Projects Model based on the calculated header enthalpies			

At 'Project 1, Steam Demand Savings (Changing the process steam requirements)' section, the question asks "Do you wish to specify steam demand savings?". The default answer is "No".

*Use the Drop-down Menu to select "**Yes**".*

Several rows will now engage and allow you to enter the steam savings at each pressure heading.

*At row "If yes, enter LP steam saving" 0 klb/hr, change the "0" to "**1**" and hit Enter.* "Correct"

Steam System Assessment Tool			
3 Header Model			
Projects Entry Form			
Use this form to specify improvement projects. These projects will then be modeled and compared to the existing operation.			
Project 1 - Steam Demand Savings (Changing the process steam requirements)			
Current use - HP: 50 klb/h (40.22 MMBtu/h) MP: 100 klb/h (86.25 MMBtu/h) LP: 200 klb/h (179.82 MMBtu/h)			
			Drop-down Menu Options
			Yes
Do you wish to specify steam demand savings?			*No*
If Yes, enter the value of steam reductions, corresponding to the respective pressure, to the left in 1,000 pounds per hour (klbs/hr).			
If yes, enter HP steam saving	0	klb/h	
If yes, enter MP steam saving	0	klb/h	
If yes, enter LP steam saving	**1**	klb/h	
Note: A negative saving can be entered to model an increase in steam demand			
Note: The savings have been converted to heat duties of 0.00 MMBtu/h (HP), 0.00 MMBtu/h (MP) and 0.00 MMBtu/h (LP) based on current header enthalpies			
Note: These heat duties are then used to determine the actual flow change in the Projects Model based on the calculated header enthalpies			

*Now select the "**Results**" tab at the bottom of the screen.*

Slide 12: You will save about 128,000 dollars a year by implementing the new process control strategy.

Steam System Assessment Tool

3 Header Model

Results Summary

SSAT Default 3 Header Model

Model Status : OK

Cost Summary ($ '000s/yr)	Current Operation	After Projects	Reduction	
Power Cost	9,198	9,199	-1	0.0%
Fuel Cost	33,575	33,447	128	0.4%
Make-Up Water Cost	361	359	1	0.4%
Total Cost (in $ '000s/yr)	**43,134**	**43,006**	**128**	**0.3%**

On-Site Emissions	Current Operation	After Projects	Reduction	
CO2 Emissions	390200 klb/yr	388713 klb/yr	1487 klb/yr	0.4%
SOx Emissions	0 klb/yr	0 klb/yr	0 klb/yr	N/A
NOx Emissions	772 klb/yr	769 klb/yr	3 klb/yr	0.4%

Power Station Emissions	Reduction After Projects	Total Reduction	
CO2 Emissions	-24 klb/yr	1463 klb/yr	-
SOx Emissions	0 klb/yr	0 klb/yr	-
NOx Emissions	0 klb/yr	3 klb/yr	-

Note - Calculates the impact of the change in site power import on emissions from an external power station. Total reduction values are for site + power station

Utility Balance	Current Operation	After Projects	Reduction	
Power Generation	7513 kW	7511 kW	-	-
Power Import	15000 kW	15002 kW	-2 kW	0.0%
Total Site Electrical Demand	22513 kW	22513 kW	-	-
Boiler Duty	383.4 MMBtu/h	381.9 MMBtu/h	1.5 MMBtu/h	0.4%
Fuel Type	Natural Gas	Natural Gas	-	-
Fuel Consumption	383278.3 s cu.ft/h	381818.1 s cu.ft/h	1460.2 s cu.ft/h	0.4%
Boiler Steam Flow	262.6 klb/h	261.6 klb/h	1.0 klb/h	0.4%
Fuel Cost (in $/MMBtu)	10.00	10.00	-	-
Power Cost (as $/MMBtu)	20.51	20.51	-	-
Make-Up Water Flow	16469 gal/h	16407 gal/h	62 gal/h	0.4%

Turbine Performance	Current Operation	After Projects
HP to LP steam rate	Not in use	Not in use
HP to MP steam rate	22 kWh/klb	22 kWh/klb
MP to LP steam rate	28 kWh/klb	28 kWh/klb
HP to Condensing steam rate	Not in use	Not in use

Marginal Steam Costs	
(based on current operation)	
HP ($/klb)	----->
MP ($/klb)	----->
LP ($/klb)	----->

List of Selected Projects
Reduce LP steam demand

Gas Turbine Assessment
Your site is a good candidate for the installation of a gas turbine + waste heat boiler

Warnings - Any warnings listed below may impact on the validity of the simulation	
Current Operation	**After Projects**

New Slide: Nice job! It looks like you are ready to begin evaluating projects with the Steam System Assessment Tool.

3EPlus QUIZ

9/30/2009

<u>Slide 1</u>: For this quiz, go to the Energy tab, and calculate the Insulation Thickness for Insulation with the parameter below. Hit enter after each input, to advance the screen. Use "Heat Loss per Year' calculation type.

Parameters:
1.) a Process temperature of 450 F
2.) an Ambient temperature of 70 F
3.) a Nominal Pipe Size of 8 inches and length of 10 feet

*Select "**Energy**" Tab at the top of the first screen.*

Screen will change to these parameters:

Energy Tab

Insulation Thickness (Data Entry Screen)

Item Description *[blank]*
System Application: Pipe Horizontal
System Units: ASTM C585
Calculation Type: Personnel Protection
Use the Drop-down Menu to select "Heat Loss per Year" option.
Process Temp: 350.0 °F
Type" 450" in the space. Hit "Enter"
Ambient Temperature: 75.0 °F
Type" 75" in the space. Hit "Enter"
NPS Pipe Size: 4
Use the Drop-down Menu to select " 8". Hit "Enter"
Wind Speed: 0.0 mph
Max Surface Temp: 140.0 °F

Insulation Layers
Add Button
Delete Button

#	Type	Name	Lock Thickness	Thickness, Inches
-	Base Metal	Steel		
1	Insulation	850F Mineral Fiber PIPE, Type I, C547-07	Vary	
-	Jacket Material	0.9 All Service Jacket		

<u>Slide 6</u>: Now, calculate your results.

*Select "**Calculate**" Tab at the top of the screen.*

Screen will change to these parameters:

<u>Slide 7:</u> Here are your results for: insulation thickness, surface temperature, heat loss, and efficiency.

Heat Loss Per Year Report (Results Screen)

Item Description = [blank]
System Units = ASTM C585
Geometry Description = Steel Pipe - Horizontal
Bare Surface Emittance = 0.8
Nominal Pipe Size = 8 in.
Process Temperature = 450 °F
Ave. Ambient Temperature = 70 °F
Ave. Wind Speed = 0 mph
Relative Humidity = N/A
Dew Point = N/A
Condensation Control Thickness = N/A
Hours Per Year = 8000
Outer Jacket Material = All Service Jacket
Outer Surface Emittance = 0.9
Insulation Layer 1 = 850F Mineral Fiber PIPE, Type I, C547-07, Varied

Results for:
- -Surface Temperature
- -Heat Loss
- -Efficiency

Variable Insulation Thickness	Surface Temp (°F)	Heat Loss (BTU/ft/yr)	Efficiency (%)
Bare	448.8	23660000	
0.5	177.4	4760000	79.87
1.0	129.2	2530000	89.31
1.5	112.3	1840000	92.21
2.0	102.8	1470000	93.77
2.5	95.4	1200000	94.93
3.0	91.4	1060000	95.54
3.5	88.5	948900	95.99
4.0	86.2	866400	96.34
4.5	84.4	800700	96.62
5.0	82.9	747100	96.84
5.5	81.7	702500	97.03
6.0	80.7	664800	97.19
6.5	79.8	632300	97.33
7.0	79.1	604200	97.45
7.5	78.4	579500	97.55
8.0	77.8	557600	97.64
8.5	77.3	538000	97.73
9.0	76.9	520500	97.80
9.5	76.5	504600	97.87
10.0	76.1	490200	97.93

<u>Slide 8:</u> Now calculate the Cost of Energy for Fuel Oil at $1.90 per gallon and a boiler efficiency of 80 percent.

*On the left side of the screen, select "**Cost of Energy: Bare and Insulated Surfaces**" button.*

Insulation Thickness (Data Entry Screen)

Item Description *[blank]*
System Application: Pipe Horizontal
System Units: ASTM C585
Fuel Type: Natural Gas
Use the Drop-down Menu to select "Oil" for "Fuel Oil".
Notice the following inputs changed automatically:
Heat Content: 1026 BUT/cuft to 138700 Btu/gal
Fuel Cost: 10.00 $/Mcf to 1.50 $/gal
Type" 1.9" in the space. Hit "Enter"
Efficiency: 75%
Type" 80" in the space. Hit "Enter"
Process Temp: 450.0 °F
Ambient Temperature: 70.0 °F
NPS Pipe Size: 8
Wind Speed: 0.0 mph
Annual Operation: 8000 hrs/yr
Use the Drop-down Menu to select " 8". Hit "Enter"

Insulation Layers
Add Button
Delete Button

#	Type	Name	Lock Thickness	Thickness, Inches
-	Base Metal	Steel		
1	Insulation	850F Mineral Fiber PIPE, Type I, C547-07	Vary	
-	Jacket Material	0.9 All Service Jacket		

*Select “**Calculate**” Tab at the top of the screen.*

Screen will change to these parameters:

<u>Slide 9</u>: Here are your results for: Installation Costs, Heat Loss, and Cost Savings.

Cost of Energy (Results Screen)

Item Description = [blank]
System Units = ASTM C585
Geometry Description = Steel Pipe - Horizontal
Bare Surface Emittance = 0.8
Nominal Pipe Size = 8 in.
Process Temperature = 450 °F
Ave. Ambient Temperature = 70 °F
Ave. Wind Speed = 0 mph
Fuel Name = Oil
Heat Content = 138700 Btu/gal
Fuel Cost = 1.90 $/gal
Efficiency = 80%
Hours Per Year = 8000
Outer Jacket Material = All Service Jacket
Outer Surface Emittance = 0.9
Insulation Layer 1 = 850F Mineral Fiber PIPE, Type I, C547-07, Varied

Results for:
- -Installation Costs
- -Heat Loss
- -Cost Savings

Variable Insulation Thickness	Cost ($/ft/yr)	Heat Loss (BTU/ft/yr)	Savings ($/ft/yr)
Bare	405.10	23660000	
0.5	81.54	4760000	323.600
1.0	43.32	2530000	361.800
1.5	31.54	1840000	373.600
2.0	25.25	1470000	379.900
2.5	20.56	1200000	384.500
3.0	18.08	1060000	387.000
3.5	16.25	948900	388.900
4.0	14.83	866400	390.300
4.5	13.71	800700	391.400
5.0	12.79	747100	392.300
5.5	12.03	702500	393.100
6.0	11.38	664800	393.700
6.5	10.83	632300	394.300
7.0	10.35	604200	394.700
7.5	9.92	579500	395.200
8.0	9.55	557600	395.600
8.5	9.21	538000	395.900
9.0	8.91	520500	396.200
9.5	8.64	504600	396.500
10.0	8.39	490200	396.700

Slide 10: "Nice job! It looks like you are ready to evaluate your insulation improvement options with 3EPlus software tool!

Conclusion Module

9/30/2009

<u>Slide 1:</u> Thank you for participating in the Steam System Tool Suite Introduction. We hope you have learned some of the capabilities of the Tool Suite and how to use them to identify and evaluate projects for your Steam System. Please continue to check back with the BestPractices Technology Delivery website for additional resources, and other training opportunities. We wish you good luck as you work toward reducing your energy consumption and improving your system performance.