The Steam System Scoping Tool: Benchmarking Your Steam Operations Through Best Practices

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Abstract

The U.S. Department of Energy Office of Industrial Technology (DOE-OIT) BestPractices efforts aim to assist U.S. industry in adopting near-term energy- efficient technologies and practices through voluntary technical-assistance programs on improved system efficiency. The BestPractices Steam effort, a part of the DOE-OIT effort, has developed a new tool that steam energy managers and operations personnel can use to assess their steam operations and improve their steam energy usage - the Steam System Scoping Tool. This paper describes how the tool was developed, how the tool works, and the status of efforts to improve the tool in the future.

Introduction

The U.S. Department of Energy (DOE) Office of Industrial Technology (OIT) BestPractices efforts aim to assist U.S. industry in adopting near-term energy-efficient technologies and practices through voluntary technical-assistance programs on improved system efficiency. There are nine industry groups - designated Industries of the Future (IOFs) - that are the focus of the OIT efforts. These IOFs include Agriculture, Aluminum, Chemicals, Forest Products, Glass, Metal Casting, Mining, Petroleum, and Steel. BestPractices efforts cover motors, compressed air, steam, and combined heat and power systems.

The overall goal of the BestPractices Steam effort is to assist steam users in adopting a systems approach to designing, installing, and operating boilers, distribution systems, and steam applications. BestPractices Steam is supported by a Steering Committee of steam system users, steam system service providers, and relevant trade associations. Within BestPractices Steam, a BestPractices and Technical (BPT) subcommittee works to develop tools and resources to promote the overall BestPractices Steam mission.

In the summer of the year 2000, the BPT subcommittee completed the development of and released a new tool called the Steam System Scoping Tool. This tool was developed for use by steam system energy managers and steam system operations personnel in IOF plants. The purpose of the Scoping Tool is to assist industrial users to:

- Evaluate their steam system operations against identified best practices.
- Develop a greater awareness of opportunities available for improving steam system energy efficiency and productivity.
- Compare their Scoping Tool self-evaluation results with those obtained by others.

This article describes how the Steam System Scoping Tool was developed, presents an overview of the major components of the tool, and discusses how the present version of the tools is being evaluated and used.

How The Steam System Scoping Tool Was Developed

In 1999, one of the goals the Steam BPT subcommittee set for itself was to develop a set of "Steam Assessment Guidelines" that steam users could apply to assess their steam operations. What the subcommittee initially envisioned as a set of guidelines ultimately became what is now the Steam System Scoping Tool. The authors of this paper (who co-chair the Steam BPT subcommittee) lead the activities of the subcommittee to develop the tool.

The major elements of the process that was used to develop the Steam System Scoping Tool consisted of the following:

1. An initial list of steam system best practice focus areas and questions was developed by the subcommittee co-chairs. This list was then circulated to BPT subcommittee members for com-

ment and addition. Subcommittee members have a variety of technical specialties - for example, boiler systems, water treatment systems, steam traps, etc. Based on subcommittee review comments the focus areas and questions were modified; this review and comment process was performed a number of times.

2. Once there was preliminary agreement on focus areas and questions, a set of possible responses to Scoping Tool questions and suggested scores for these responses were developed. Suggested scores were chosen to reflect how well a specific steam system best practice was followed in a facility. These suggested question responses and scores were again reviewed by members of the BPT subcommittee.

3. As key focus areas, questions, and score responses were developed, an approach for categorizing the focus areas and questions was developed. Based on subcommittee member input, it was ultimately decided that the main categories should be profiling, total steam system, boiler plant, and distribution/end use/ recovery.

Utilizing the expertise and input of the subcommittee members, the first evaluation version of the Steam System Scoping Tool was completed and released in August 2000.

Overview Of The Steam Scoping Tool

The present version (now called evaluation version 1.0c) of the Steam System Scoping Tool is in a Microsoft Excel spreadsheet format. The Scoping Tool includes seven individual worksheets:

1. Introduction
2. Steam System Basic Data
3. Steam System Profiling
4. Steam System Operating Practices: Total Steam System
5. Steam System Operating Practices: Boiler Plant
6. Steam System Operating Practices: Distribution, End Use, Recovery
7. Summary Results

The Steam System Scoping Tool is completed by answering the questions in Worksheets #2 through #6. When a steam user completes Worksheet #2, profiling information about the steam system is compiled. Some of the types of profiling information that can be entered into the Steam System Basic Data worksheet include:

- Total annual steam production.
- Total steam generation capacity.
- Average steam generation rate.
- Distribution of fuel sources used to make steam.
- Types of steam measurements made in the plant.
- Types of heat engines operated.

Answering the questions in Worksheets #3 through #6 assists steam users to perform self-evaluations of their steam systems. Table 1 illustrates the key improvement areas and the total scores available for those areas in the present version of the Scoping Tool. The present version of the Tool contains a total of 25 questions in the improvement areas listed in Appendix 1.

Appendix 2 shows an example screen from one of the Scoping Tool worksheets - the worksheet for Steam System Profiling. It also shows the actual questions asked in the Tool under the areas of steam costs, steam/product benchmarks, and steam system measurements, and the Tool scores available for different answers to these questions.

Once questions in Worksheets #2 through #6 are completed, the Tool automatically summarizes the answers that were provided. The user can see and print a summary of the Scoping Tool results using the Summary Results Worksheet #7.

Performing a steam system self-assessment using the Steam Scoping Tool can help users evaluate steam system operations against the best practices identified in the tool, and can help the users identify opportunities to improve steam system operations.

Through December 31, 2000, more than 100 requests have been made for the Scoping Tool.

The present version of the Tool is still being designated as an "evaluation" version because the subcommittee is attempting to obtain end user suggestions for improving it. One effort underway to get end user feedback is through a Steam Tool Benchmarking project being performed with six of the U.S. DOE Industrial Assessment Centers (IACs). There are 26 IACs, located at universities around the country, that perform comprehensive industrial assessments at no cost to small and medium-sized manufacturers. Six of these IACs - at the University of Massachusetts-Amherst, the University of Tennessee-Knoxville, Oklahoma State University, San Francisco State University, South Dakota State University, and North Carolina State University - are each performing three 1-day plant steam assessments utilizing the Steam System Scoping Tool. Feedback from these 18 steam assessments will be used to improve the present version of the Tool.

A web-based version of the Steam Scoping Tool is available through the IOF BestPractices website at www.oit.doe.gov/bestpractices/. Steam users can complete the Scoping Tool directly on line, print the results, and submit the results directly to an on-line database that is integrated with the web version of the Tool.

Future Development Efforts For The Steam System Scoping Tool

The overall vision for the continued development and usefulness of the Steam System Scoping Tool is as follows:

1. Over the next six months, user feedback will be obtained to confirm the usefulness of the Tool, and to obtain suggestions for improvements to the Tool.
2. Based on Scoping Tool results that users provide to BestPractices Steam, it will be possible to develop benchmarks of averages responses to the Scoping Tool questions.
3. Finally, the next step in the development of the Steam Scoping Tool is to expand its capabilities - so that, when steam users find areas where improvement is needed, the Tool will provide guidance to the users.

Conclusions

The Steam System Scoping Tool was developed to encourage steam system energy managers and operations personnel to evaluate their steam system operations and develop a greater awareness of opportunities that may be available for improving energy efficiency and productivity. In addition, steam users are encouraged to provide their Scoping Tool results to BestPractices Steam, so that results from the users can be summarized. All Scoping Tool results obtained from steam users will be held in strict confidence.

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APPENDIX 1. Summary Of Key Improvement Areas And Available Scores In The Steam System Scoping Tool

IMPROVEMENT AREA	WHAT TO DO	AVAILABLE SCORE
	STEAM SYSTEM PROFILING	
Steam Costs	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 by determining what your fuel costs are to make steam, then add other costs associated with your operations (chemical costs, labor, etc).	20
Steam/Product Benchmarks	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 your competitors do; and c) with how this benchmark varies in your operations over time.	20
Steam System Measurements	Identify key steam operational parameters that you should monitor and ensure that you are adequately measuring them.	50
	STEAM SYSTEM OPERATING PRACTICES	
Steam Trap Maintenance	Implement a comprehensive program to correctly select, test, and maintain your steam traps.	40
Water Treatment Program	Implement and maintain an effective water treatment program in your steam system.	30
System Insulation	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.	30
Steam Leaks	Identify and quickly repair steam leaks in your steam system.	10
Water Hammer	Detect and quickly eliminate water hammer in your steam system.	10
Maintaining Effective Steam System Operations	Establish and carry out a comprehensive steam system maintenance program.	20
	BOILER PLANT OPERATING PRACTICES	
Boiler Efficiency	Measure/trend/look for opportunities to improve your boiler efficiency.	35
Heat Recovery Equipment	Evaluate installation of heat recovery equipment in your boiler plant.	15
Generating Dry Steam	Ensure that you generate high-quality dry steam in your boiler plant.	10
General Boiler Operation	Ensure that your boilers perfrom their functions without large fluctuations in operating conditiions.	20
	STEAM DISTRIBUTION, END USE, RECOVERY OPERATION PRACTICES	
Minimize Steam Flow Through PRVs	Investigate potential to replace pressure-reducing valves with back-pressure turbines in your steam system.	10
Recover and Utilize Available Condensate	Determine how much of your available condensate you recover and utilize.	10
Use High-Pressure Condensate to Make Low-Pressure Steam	Investigate use of high-pressure condensate to produce useable low-pressure steam.	10
	TOTAL AVAILABLE STEAM SCOPING TOOL SCORE	340

APPENDIX 2. Steam Scoping Tool Example Screen - 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 by 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.

	ACTIONS	SCORE	YOUR SCORE
Do you monitor your fuel cost to generate steam in terms of ($) / (1000 lbs. of steam produced)?	yes	10	
	no	0	
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 your competitors do; and c) with how this benchmark varies in your operations over time.

Why Important The bottom line of your operation is how 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.

	ACTIONS	SCORE	YOUR SCORE
Do you measure your steam/product benchmark in terms of lbs. of steam needed/unit of product produced?	yes	10	
	no	0	
How often do you measure 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.

	ACTIONS	SCORE	YOUR SCORE
Do you measure and record critical energy?			
Steam Production Rate (to obtain total steam)	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 above	0	
How intensely do you meter your steam flows? CHOOSE ONE OF FIVE ANSWERS	by major user/ equipment	20	
	by process unit	10	
	by area or bldg.	5	
	by entire plant	2	
	not at all	0	