DOE Fan System Assessment Tool (FSAT) and Qualified FSAT Specialist Training: A Model for Increasing Industrial Fan System Energy Efficiency

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ABSTRACT

A 1998 report for the U.S. Department of Energy (DOE) found that in 1994, industrial electric motor systems consumed 747 billion kWh, equivalent to 25 percent of all U.S. electricity sales or 63% of the net industrial electricity used in the U.S. This report estimated that, in the manufacturing sector, the potential motor system energy savings using mature, proven, and cost-effective technologies range from 11-18 percent (Xenergy, 1998).

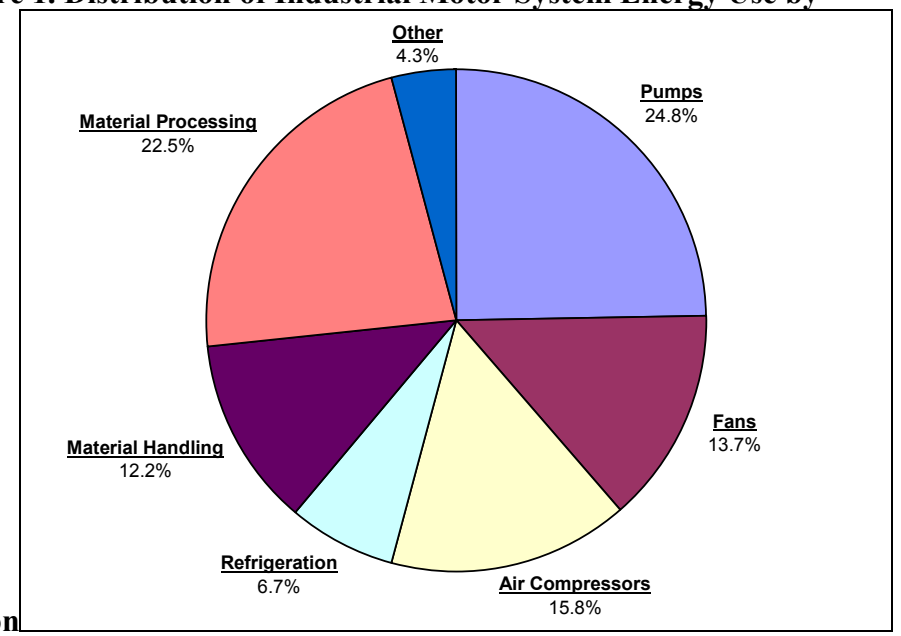
To help end users of industrial fan systems realize these energy savings opportunities, the DOE's Office of Energy Efficiency and Renewable Energy (EERE) is developing a Fan System Assessment Tool (FSAT) and Qualified FSAT Specialist Training program, in collaboration with the Air Movement and Control Association International, Inc. (AMCA International). AMCA International is a non-profit trade association assisting manufacturers, end-users, and engineers with testing, system design, equipment directories, educational materials, seminars and services related air moving equipment. As of this writing, anticipated date for release of the beta version of the FSAT software is Fall 2003 and the pilot Qualified FSAT Specialist Training program may be available by end of 2003.

Introduction

As shown in the pie chart (Figure 1), industrial fan systems account for 13.7 percent of the annual U.S. industrial motor system energy consumption, equivalent to 102 billion kWh/yr (Xenergy, 1998). Significant energy savings opportunities exist with respect to industrial fan systems: 5-15 percent in equipment, 20-50 percent in speed control in variable flow systems, and 5-25 percent in system design at (National Market, May 1996).

The Fan System Assessment Tool (FSAT) and Qualified FSAT Specialist Training, is a software tool and training program being developed jointly by the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy (EERE) and Air Movement and Control Association International, Inc. (AMCA International) to help U.S. industry realize energy savings opportunities from their industrial fan systems. This paper will describe the basic features and functions of FSAT as well as the expected outcomes for the Qualified FSAT Specialist Training. The development and implementation strategies that EERE has successfully employed in launching its pumping, compressed air, process heating systems software tools and Qualified Specialist Training program will also be discussed.

Figure 1. Distribution of Industrial Motor System Energy Use by Application



Source: Xenergy, Inc., 1998.

EERE BestPractices and Allied Partnership Initiatives

EERE encourages the energy-intensive sectors of the economy (including buildings, industrial, transportation and power generation) to work together to: 1) create broad, sector/industry-wide goals for the future, 2) identify specific needs and priorities through sector/industry-led roadmaps, and 3) form cooperative alliances to help attain those goals through public-private partnerships.

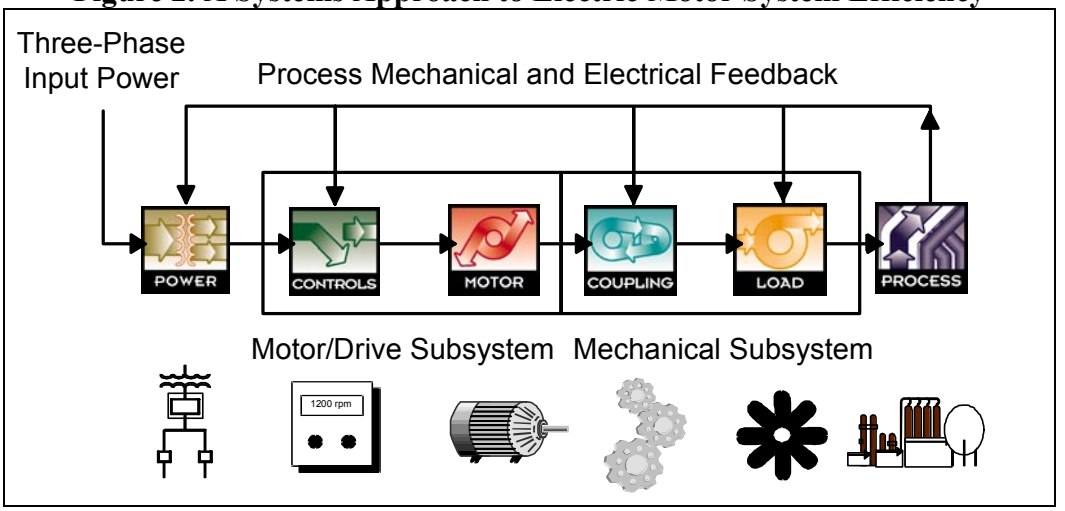
The BestPractices and Allied Partnership initiatives are two successful outreach activities, through which EERE offers near-term technical assistance to U.S. industry. As part of this technical assistance effort, BestPractices has been developing software tools and training that are designed to assist plants in assessing the energy efficiency and optimization potential of their industrial systems (motors, pumps, compressed air, fans, process heating, steam). Allied Partnerships are voluntary agreements that play a key role in market transformation, and have enabled EERE to work with industry experts, key associations, and industrial manufacturers and suppliers to develop software tools and Qualified Specialist Trainings to ultimately help industrial end users identify and assess the relative importance of system improvement opportunities.

Software Tools and Qualified Specialist Training

While there are gains to be made by improving the efficiency of the system components, the most significant energy savings opportunities are found at the *system* level in a *Systems Approach*. A *system* refers to the entire energy delivery process, from energy feed to finished product. A *Systems Approach* integrates the design, specification and installation of motor-driven equipment (e.g., fans) system in meeting the process (e.g., airflow) requirements. As shown in Figure 2 below, a system approach accounts for all the

parameters and efficiencies involved from the point where power enters the motor drive system, to where the work is done on the fluid.

Figure 2. A Systems Approach to Electric Motor System Efficiency



Source: U.S. Department of Energy (DOE). April 2003. Fan Sourcebook.

EERE has developed a portfolio of software tools for motor, pumping, compressed air, process heating, and steam systems (DOE, March 2003, *Decision Tools*). The purpose of these software tools is to create awareness of system improvement opportunities and to identify energy efficiency opportunities at the system level. These tools can be highly effective when properly used, but experience with MotorMaster+, the first software developed, has shown that a high level of specialized systems expertise and time to understand the tools and collect necessary input data is required.

To achieve broad use of the BestPractices system optimization software and insure that U.S. Industry gains the maximum possible benefit from these tools, an extensive network of skilled users (50 and greater), which has existing relationships with industrial customers, must be developed. Skilled users are individuals that already have an extensive background in optimizing the system being assessed, as well as a thorough grounding in the software itself. To this end EERE trains Qualified Specialists and recognizes them as skilled users of the software with a signed, numbered certificate, and listing on the EERE BestPractices website, where callers interested in the software and training are referred. Additional benefits to becoming a Qualified Specialist include the opportunity to become qualified to offer EERE software training classes to customers, access to quantities of software, ongoing technical support, and the invitation to participate in the review of proposed changes to software.

EERE has followed a similar development and implementation strategy, based on using Qualified Specialists as the deployment mechanism, to increase the use of the pumping, compressed air, and process heating software tools and training programs with and by industrial end users. This process is outlined as follows:

1. Identify software and training need (roadmap, assessment)

2. Engage the key industrial trade associations and their member companies to form a broad-based group to help in developing the software (if not available), and a Qualified Specialist Training and recognition program, and end user training;
3. Use the process of developing a Qualified Specialist Training program to fine-tune the software tool, test the End User Training curriculum and build ownership; and
4. Transfer long-term stewardship of the software tool and Qualified Specialist Training and End User Training program to the key industrial trade associations.

Below are the milestones and results to date for each of the existing pump, compressed air, and process heating Qualified Specialist Training programs.

Qualified Pump System Specialist training

EERE in cooperation with the Hydraulic Institute (HI), a trade association of U.S. pump manufacturers, launched in April 2001 the Qualified Pump System Specialist Training using the Pump System Assessment Tool (PSAT). The class involves one and a half (1-1/2) days training with a qualifying exam. To date there are 43 Qualified Specialists, from 5 workshops and 5 Qualified PSAT Instructors. A pump system end user training is also currently offered and taught by PSAT Instructors.

Qualified AIRMaster+ Specialist Training

EERE in cooperation with the Compressed Air Challenge (CA), incorporated as a not-for-profit in 2000, co-branded AIRMaster+, the compressed air system assessment and survey software tool, and launched in August 2001 the Qualified AIRMaster+ Specialist Training. The class involves two (2) days of classroom training, a practical exam, a take home exam, and a 4-1/2 hour qualifying exam. To date there have been 7 of these workshops held resulting in 53 Qualified AIRMaster Specialists. In September 2002, an End User Training was started to provide basic skills to end user for understanding and using the AIRMaster+ software. CAC is responsible for upgrades to AIRMaster+ software tool.

Qualified PHAST Specialist Training

EERE in cooperation with the Industrial Heating Equipment Association (IHEA), co-branded the Process Heating Assessment and Survey Tool (PHAST), and in September 2002 launched the Qualified PHAST Specialist Training. The class involves two (2) days of classroom training, a practical exam, a take-home exam, and a 3 hour qualifying exam. This training assumes a basic knowledge of process heating and participants must be able to apply systems knowledge to pass exam. To date there has been 1 workshop (pilot) resulting in 10 Qualified PHAST Specialists.

FSAT Software and Qualified FSAT Specialist Training

Many fan manufacturers have developed their own fan selection tools designed to help end users evaluate their present equipment and select as necessary new equipment. However, EERE recognized that there was a need for an unbiased fan system assessment tool capable of evaluating the performance of an entire fan system and providing directional

information toward system optimization choices. The primary purpose of the Fan System Assessment Tool (FSAT) software is ultimately to help end users and others assess the efficiency of their present fan systems and identify those that have significant system energy efficiency improvement opportunities. The Qualified FSAT Specialist training program is designed to train fan industry experts on the proper use and application of the FSAT software, who will in turn offer system optimization services and training to their customers.

Representatives from EERE, Lawrence Berkeley National Lab (LBNL), Oak Ridge National Lab (ORNL), and AMCA International have met several times to discuss the ongoing development of the FSAT tool. AMCA International's members have helped identify the important fan types and provided useful data on these fans for the FSAT database. Table 1 below shows the proposed list of fan types that the FSAT software will be able to analyze.

Table 1. Proposed List of Fan Types Analyzed by the FSAT Software

Fan Category	Impeller Design
Centrifugal	
SISW and DIDW	Airfoil, Backward Curved, Forward Curved, Radial, Radial Tip, Backward inclined
Industrial Exhausters	Air Handling, Material Handling, Long Shavings, Long Shavings Open
Pressure Blowers	
Axial	Vane Axial (adjustable and fixed), Propeller

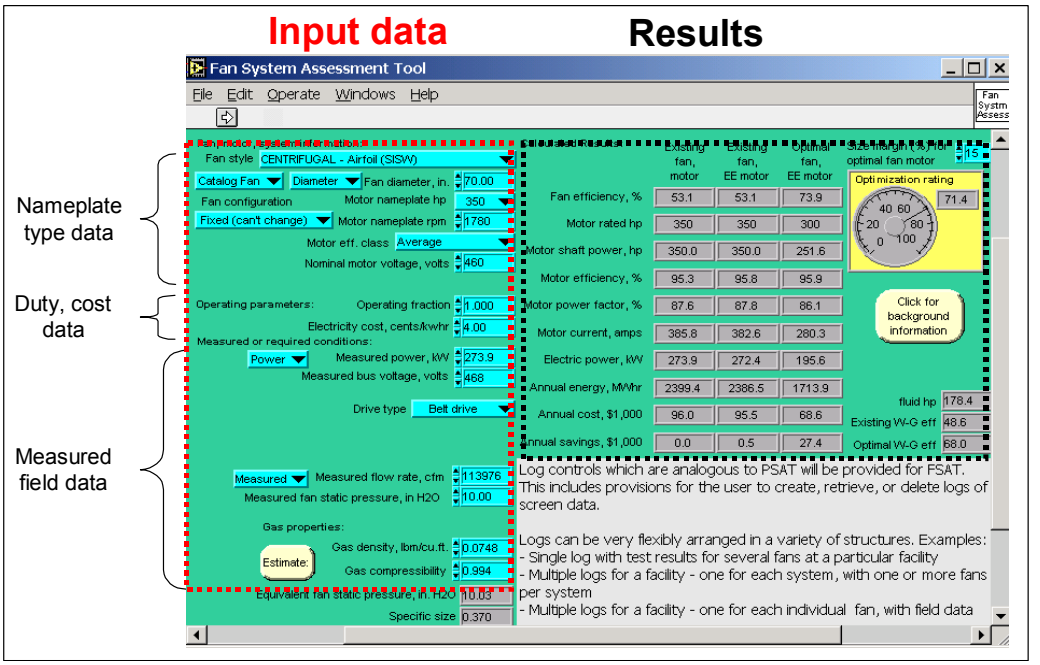
Source: Diagnostic Solutions, LCC. 2003. FSAT software beta 05 version.

The FSAT software is modeled after the Pumping Systems Assessment Tool (PSAT) developed for EERE by Don Casada of Diagnostic Solutions, LCC and under contract to ORNL. FSAT is being designed to use a minimal number of measured parameters to estimate how efficiently the fan is operating. FSAT compares this present efficiency value to the optimal efficiency that could be achieved, and calculates the associated operating costs and potential cost savings. In addition to providing a quick analysis-based method that can estimate cost savings, FSAT is also able to generate "What if" scenarios and their corresponding energy and cost savings opportunities. Looking at FSAT's Main Menu (Figure 4), the left third of the screen represents the input data. These inputs include general nameplate-type information (e.g., fan style, fan diameter or fan rpm, motor hp, and motor rpm), duty and cost data, and field measurements for the measured flow rate (cfm), static pressure, and electrical data (power or current). FSAT uses the fan affinity laws to calculate the fan static efficiency, specific size or specific speed.

The right side of the screen shows the calculated results in three columns listed as "Existing fan, and motor", "Existing fan and energy efficient motor", and "Optimal Fan and energy efficient motor". The first row shows the fan efficiency results, where the first and second columns are calculated from the data input on left hand side, the third column represents the efficiency of an optimal fan, and is based on the fan static efficiency vs. either specific speed or specific diameter curves that are built into FSAT. This information is obtained from published fan performance data available in catalogs and on CD's. The principal figure of merit at the bottom of the three columns is the potential cost savings, which can be used in life cycle cost or simple return on investment calculations. To the right

of the columns is the Optimization Rating, which represents the ratio of the power of the optimal configuration over the power required for the existing configuration. Like a grade, a rating of 100 is a "perfect" score indicating that the fan and motor combination are properly matched and doing as well as can be expected. A grade of 50 means that twice as much energy is being used as would be with an optimal configuration. Below the Optimization rating is the “Click for Background Info” button, which allows one to get further in-depth information on the various functions and menus.

Figure 4. FSAT Main Menu- Data Input Screen



Source: Diagnostic Solutions, LCC. 2003. FSAT software beta 05 version.

In this example, a centrifugal airfoil type fan is belt driven by a 350 hp motor at 1780 rpm and operating full time at 4 cents/kWh. Based on the measured flow rate and static pressure the calculated overall fan efficiency (top row) from replacing the existing fan with an optimal efficiency model increases from 53.1% to 73.9%, requires only a 300 hp motor vs. the existing 350 hp (second row) and results in a $27K savings (bottom row). These savings are significantly greater than the $0.5K savings realized from replacing the existing motor with an energy efficient motor alone.

Conclusion

Experience gained in developing the pumping, compressed air, and process heating software tools and associated Qualified Specialist Training programs have provided lessons learned with respect to the development and the effective widespread use of the Fan System Assessment Tool (FSAT) and Qualified FSAT Specialist Training. Namely, the importance of engaging industrial suppliers’ trade associations early in the software development process in order to build both a useful tool and training program, as well as sense of industry

ownership. Followed by the training of highly skilled individuals well-versed in the systems approach, that interact with customers, e.g., distributors and manufacturers' representatives.

In February 2003, EERE presented FSAT and the concepts for launching the tool at the AMCA International Marketing and Sales Executives meeting. There was strong interest by AMCA International's members to play an active role in beta testing the software, expanding the listing of fans to include commercial in addition to industrial fans, and developing the criteria for a Qualified FSAT Specialist program. Once FSAT software revisions are completed and near ready for release, a Pilot Qualified FSAT Specialist Training Workshop will be held. Industrial fan industry experts will be invited for a final review of the FSAT software and to test the curriculum and qualifying exam. Following final revisions, FSAT will be available for download from the EERE BestPractices website (http://www.oit.doe.gov/bestpractices/) or ordered at no cost through EERE's Clearinghouse (1.800.862.2086), as can the other software tools and many EERE publications.

Anticipating that the beta version of the FSAT software and the pilot Qualified FSAT Specialist Training program training program will be available in late 2003, EERE expects to have recognized 50+ Qualified FSAT Specialists by the end of 2005, as AMCA International gradually assumes stewardship over both the FSAT tool and Qualified Specialist training.

Acknowledgments

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