Using ANSI/MSE 2000 to Enhance Energy Productivity

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ABSTRACT

While energy technology has shown vast improvement since the initial Arab oil embargo, commercial and industrial energy efficiency has not advanced as much as expected. In 1995, the energy index for commercial buildings averaged 90,500 Btu/sq.ft.-yr. This is an increase of 5.2 percent over the 1992 usage of 86,000 Btu/sq.ft.-yr (EIA, 2001). Manufacturing has seen the same growth in energy usage. In 1994, industries consumed 6,300 Btus per constant dollar (1992) value of shipments. This ratio has risen gradually from 6,100 Btus in 1985 (EIA, 2001). Year to year variance in energy type has not significantly impacted these results. The trend seems to indicate that, although significant technology improvements have been made, facilities are unable to manage technology effectively enough to achieve sustained improvement in energy efficiency.

The increase in energy use ratios while energy technology improves is an indication that the problem likely contains a significant management component and is not exclusively technical. While many organizations have independently formulated viable energy management schemes, a nationally recognized system that can be easily implemented at different sites has not been available to date. In April 2000 the Energy and Environmental Management Center (EEMC) at Georgia Tech completed the American National Standards Institute (ANSI) adoption process for a management system for energy, designated as ANSI/MSE 2000 (management system for energy). MSE 2000 provides the elements of an effective management system to assist organizations in achieving sustained improvements in energy efficiency. The elements of the system are described in a documented standard.

Elements of the standard that directly address organizational energy performance are management responsibility, an energy team, equipment and process control, energy monitoring and measuring, and energy purchasing. General elements including document control, corrective and preventive action, recordkeeping and internal audits establish a stable management structure that sustains and improves the management system.

Pilot implementations of the management system are underway at three organizations. Examples of how these organizations implemented the standard are provided. These initial results show the potential improvement from implementing MSE 2000 at other commercial, industrial, institutional, and government facilities.

Introduction

Dwindling demand, falling prices, and a movement in the economy away from energy intensive operations resulted in the decade of the 90s being one of little concern about energy. However as we begin the 21st century, energy price and supply is again approaching crisis proportions.

California and parts of the Midwest have experienced electrical shortages recently. In California, for example, the state's power reserves have fallen below 5 percent on several

occasions. This required the utility Independent System Operator (ISO) to mandate voluntary load curtailment programs for some customers of investor-owned utilities (Silicon Energy, 2001). The ISO said that power typically purchased from the Pacific Northwest wasn't available because of higher than expected heating demand in that region. Voluntary load reduction impacted large industrial, commercial, and agricultural customers who agreed to have their power temporarily interrupted in exchange for reduced rates.

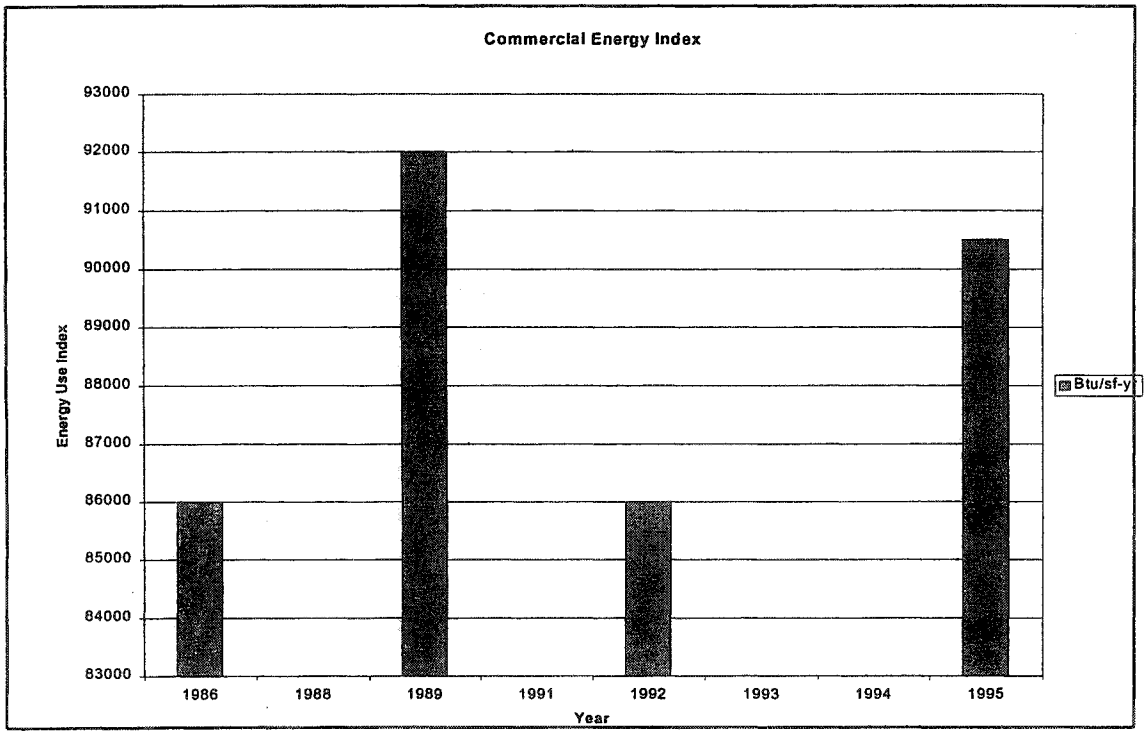

Figure 1. Commercial Energy Use Index, 1986-1995

Growing electrical demand has caused a surge in natural gas consumption as utilities scramble to find clean sources of energy. The increase in gas demand coupled with limited development of new gas supplies has resulted in rapid price escalation. Natural gas was selling for $2.50-$3/million Btus through the mid-to late 1990s, but experts predict that prices will remain above $5 in 2001.

Data on commercial energy efficiency from the Energy Information Agency, shown in Figure 1, indicates no consistent gain in energy productivity. While there are competing factors at work (for example improved energy systems and building materials versus increased use of office computers), the lack of a national emphasis on energy efficiency and divergent opinions about what constitutes an effective energy management program have resulted in little real improvement in energy management during the past decade.

Table 1. Industrial Energy Usage, Energy Efficiency, and Electricity Percentage of Total Energy Used*

Year	Industrial Energy Usage in Quads (10^{15} Btus)	Btu/Constant Dollar of Shipments	Electricity Percent of Total Energy Used
1985	17.24	6,100	24.9
1988	18.34	6,000	24.3
1991	20.12	6,200	24.6
1994	21.66	6,300	24.8

*-from DOE, Energy Information Agency

Industrial energy efficiency, Table 1, shows a similar erratic variance. Since 1985, unit energy use (Btu/$ output) has increased slightly, although not steadily. To account for changes in the type of energy used, electricity's percentage of total industrial energy is presented in the third column. While there is some variance in energy type year to year, this variation is not sufficient to explain the change in unit energy use. The total energy used by industry grew at a faster rate that the energy per constant dollar of output.

Because heavy, energy-intensive manufacturing is a smaller component of the national economy than in the past, efficiency should be expected to improve. However, the higher demand for energy, increases in cost and decreases in efficiency for both the commercial and industrial sectors suggest that more emphasis must be focused on energy management.

Management System Definition

While technology is crucial in effectively addressing energy problems, reliance on technology alone has not proven sufficient to solve our energy crisis. To reach its full potential, technology must be matched with effective management. The Management System for Energy, ANSI/MSE 2000, is modeled after other standardized management systems based on Deming's Plan-Do-Check-Act cycle (PDCA), Figure 2. PDCA systems define an ordered structure essential to avoid management chaos without becoming bureaucratic and sacrificing organizational innovation.

MSE 2000 is defined by an ANSI standard that prescribes elements necessary to institute P-D-C-A style management. Implementing MSE 2000 at a facility requires a strong commitment from executive management because, to be most effective, the system must be certified by an independent registrar at its inception and renewed every three years. One of the primary objectives of the management system is to foster continual improvement in energy management. Organizations implementing the system should expect to substantially reduce energy cost and improve sustainability. Another consequence of improved energy management is an increase in energy productivity. Energy productivity is defined by the indices of in energy use per unit and energy cost per unit.

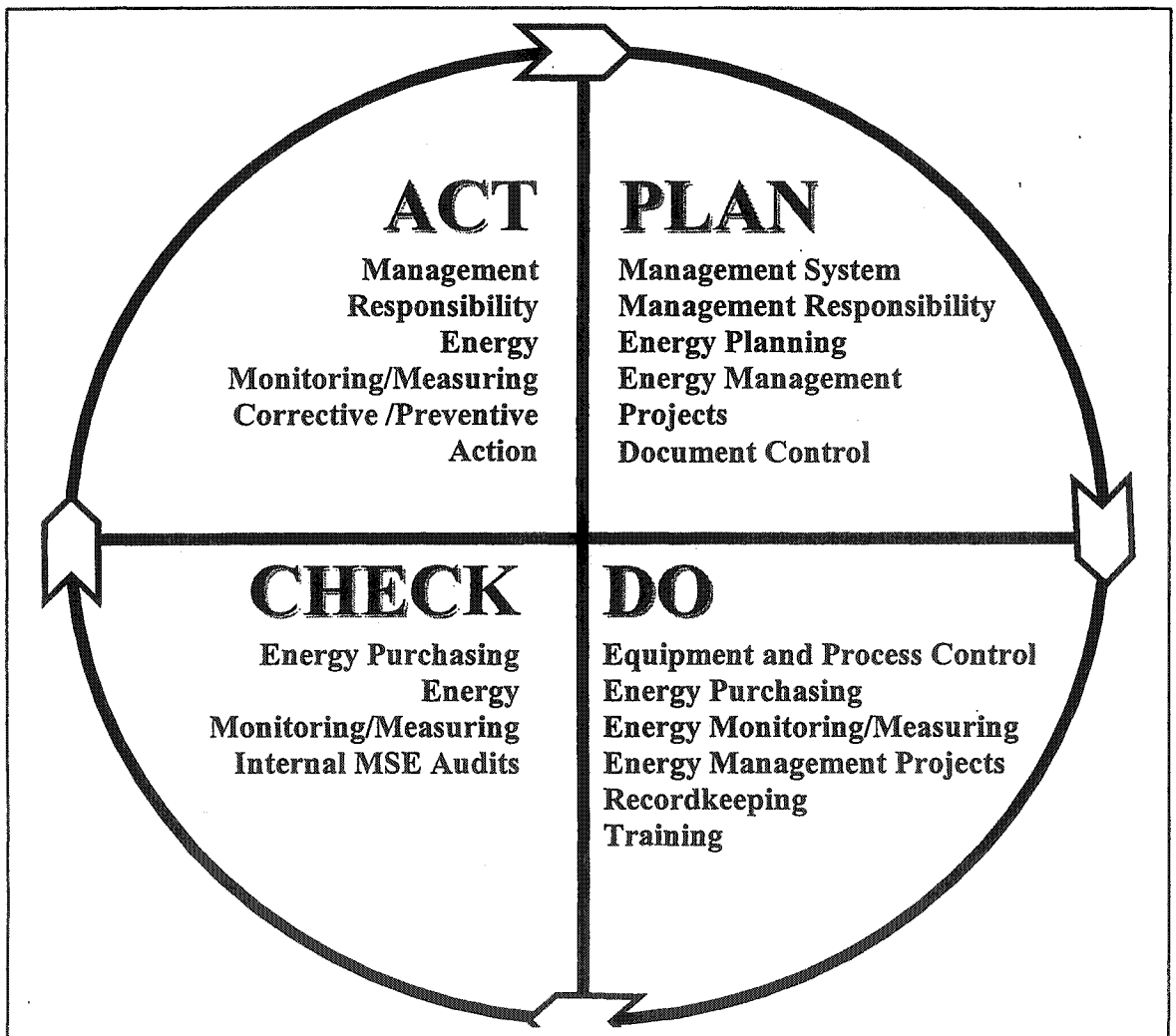

Figure 2. Plan-Do-Check-Act Cycle Showing MSE 2000 Elements

MSE 2000 Elements that Address Productivity

The MSE 2000 standard consists of twelve elements that define an effective management system. While all elements are needed to maintain effective management, not every element specifically addresses or affects the energy productivity at a facility. Table 2 presents a comprehensive list of all standard elements. Each of the elements listed in Table 2 contributes to the effective functioning of the management system. The elements described in detail below have the greatest impact on productivity.

Management Responsibility

A common problem facing energy managers is the lack of organizational support. Because effective management of energy requires a facility-wide commitment, upper management must be involved or the effort is doomed. Long-term impact is never achieved by middle managers without upper management's commitment to make energy productivity a priority and to provide financial and manpower support.

Table 2. MSE 2000 System Elements

Element Number	Contents
4.0 Management System Requirements	Describes scope of MSE 2000
4.1 Management System	Basic MSE 2000 Objective and Procedures
4.2 Management Responsibility	Requirements for Executive Management, Energy Coordinator, and Energy Team
4.3 Energy Planning	Describes planning process, required planning information and contents of energy assessment
4.4 Equipment and Process Control	Presents management practices associated with equipment and processes that significantly affect energy usage
4.5 Energy Management Projects	Describes relation between goals, targets and projects
4.6 Document Control	Procedures to be followed with MSE 2000 controlled documents
4.7 Energy Purchasing	General purchasing practices including supplier evaluation, purchasing specifications, and bids and contracts
4.8 Energy Monitoring and Measuring	Procedures related to energy data collection
4.9 Corrective and Preventive Action	Describes processes associated with improving the management system
4.10 Record Keeping	Procedures related to records and retention
4.11 Internal MSE Audits	Requires for self audits of management system
4.12 Training	MSE 2000 training procedures

The MSE 2000 standard states, "Upper management shall develop and document its policy for managing energy, review and prioritize the goals developed, and state its commitment to continual improvement." This requires that energy management not be a "grassroots" operation but instead have the backing of upper management. Furthermore, management must not be a silent partner but must participate in the policymaking and be involved in implementing the policy by approving the goals of the program. By committing to continual improvement, management agrees to future participation and support.

A familiar problem with energy management is the lack of available resources to mount an effective program. MSE 2000 requires that "Upper management shall provide adequate resources to establish and maintain the management system for energy, including the personnel needed." While an energy management system at first appears to be an expense, the resources dedicated by executive management are really an investment. The result of improved energy management will be cost savings, reduced downtime/interruption of production, and increased energy productivity.

Energy Team

A lack of communication between different departments and functions is common in most organizations. Because energy is purchased in one area, consumed in another, and energy systems are maintained and operated by still another, the responsibility for energy

management is spread among so many that effectively no one is in charge. MSE 2000 remedies this situation by requiring formation of an interdisciplinary team with "representatives from all functional areas dealing with the procurement, application, consumption, and related emissions of fuels and energy systems." Instead of losing energy management responsibility between departments, the team captures input from all relevant functional areas to arrive at workable solutions.

While the formation of an energy management team is important to meeting organization goals and objectives, adequate leadership and control is necessary to prevent the team from becoming cumbersome and unruly. MSE 2000 requires that upper management appoint an energy coordinator to head the team. The coordinator must ensure that the management system for energy is developed, executed, and maintained and periodically report system performance to executive managers.

Equipment and Process Control

Energy systems and production processes consume most of the energy in facilities. Therefore, one element of the standard is devoted specifically to equipment and process control. The organization is required to identify equipment and processes that significantly affect energy use and to develop and use documented operating procedures, monitor and control relevant operational parameters, and employ maintenance appropriate to ensure continued energy efficiency.

The development and use of approved procedures will assure uniform operation of energy equipment. This can eliminate differences between shifts and operators. Procedures should be based on accepted operating practice and updated to reflect improvements.

The monitoring and control of important supervisory parameters will help assure equipment and processes are operated at the most efficient condition. Equipment operation fundamentally affects energy efficiency. Effective maintenance of energy equipment is equivalent to operation in its importance in efficiency. The recommended equipment can be installed, relevant operating procedures followed, and proper operation achieved through active monitoring, but if the equipment is not adequately maintained it will never realize the desired operating efficiency. Even high efficiency equipment, if not maintained, will not achieve the expected benefit. The standard requires that appropriate maintenance practices be identified and followed. Maintenance offers not only energy savings but will improve workplace safety, appearance and healthiness and usually improves environmental performance.

Energy Monitoring and Measuring

The importance of energy monitoring and measuring is often overlooked in organizations because it is difficult, time consuming or inconvenient. MSE 2000 contains an element on monitoring and measuring because it is impossible to manage without first measuring. Two types of analysis are supported by this element. Monitoring refers to compiling and evaluating utility-supplied data from billing statements. Pertinent information available from the bill includes cost, consumption, peak demand, rate schedule, average unit cost, incremental cost and the time period covered. Energy monitoring provides an overall view of the facility.

Measuring, also known as sub-metering, provides information on individual processes within the facility. Measurement yields insight into equipment unit efficiency, use hours and load factor. Together, monitoring and measuring provide the data necessary to perform an energy balance of the facility. A completed energy balance is used to direct and prioritize energy management projects.

Energy Purchasing

As utilities in the United States are restructured, more, not less, pressure is placed on organizations to effectively manage their energy. The impact of restructuring on consumers was summarized by William Ramsden, a member of the New Hampshire Public Utilities Commission, "You might face lower rates. (*But in a restructured market*) the consumers have to do the work. Before, all they cared about was flipping on the light switch." The standard recognizes that as restructuring spreads, the consumer will become more responsible for selecting a utility and contracting for utility service. Activities involved in effective purchasing are included as an element of the standard.

In general, the standard requires organizations to document purchasing procedures. In the past, suppliers were often chosen based on favorable relations or on price alone. Formulating a written procedure will support decisions based on the organization's energy policy and goals.

MSE 2000 states that a user must formulate purchasing specifications and evaluate potential suppliers on their ability to satisfy these stated requirements. Adhering to the standard and developing energy supply specifications for the organization should facilitate the comparison of supplier bids and contracts. The goal of this activity is to allow a facility to evaluate supply options based on their best interest.

Corrective/Preventive Action

A critical component of effective management is the ability to improve. In the MSE 2000 management system, improvement is institutionalized by the corrective/preventive action element. Management system performance is regularly checked through internal audits and management reviews. Corrective and preventive actions are undertaken when system checks uncover problems.

Corrective actions are taken when a management system or energy related problem occurs. The standard requires that an effective solution to the problem be identified, controls used to ensure that the specified solution is effective, and information on the action and its results submitted at the management review.

Preventive actions are instituted before a problem situation occurs. When the management team identifies a potential problem situation, action is taken before the problem occurs. With both corrective and preventive actions, the objective is to improve the operation and performance of the management system; one that is adaptable instead of bureaucratic.

Field Experience

After adoption of the MSE 2000 standard, several organizations expressed interest in early implementation. Although the management system was new, experience with implementation of similar systems illustrated the basic process. Three firms are involved in implementation and expect to be completed by the end of the year. Progress at each location follows.

Delta Air Lines

The Delta Air Lines Technical Operations Center (TOC) in Atlanta provides maintenance and repair to the airliner fleet. The Atlanta center is Delta's largest with a building capacity of eighteen planes, paint booths large enough for four planes, and 13,000 employees. Energy cost at the facility is over $1 million per month. The high utility cost attracted Delta to MSE 2000.

Delta has completed the MSE 2000 gap analysis, selected an energy management team, completed their energy manual and posted it on-line, and finished some training. A gap analysis is the first step in implementing a management system. It compares present management practice in a facility to the ideal described in the standard and documents shortfalls or gaps. In 2001, Delta plans to complete staff training and to be registered to the standard.

After completing the selection of an energy team, Delta was ready to begin the technical aspects of the management system. First, an energy profile showing the energy usage by type, incremental cost, and rank ordering of the consumers was completed. To maximize impact, MSE 2000 recommends that the most effort be focused on the largest energy users within a facility. Following this MSE 2000 procedure, Delta prepared to focus on its largest energy user. The energy profile, completed earlier, verified that the largest energy user at the facility was air-compressors. Air is used for component testing, plating tank agitation, and personnel cooling.

Delta completed an assessment of its compressed air system to establish usage patterns and applications. The assessment revealed that significant amounts of air are used for valve testing. Combining incremental pricing data from the energy profile with measurements of air usage determined that testing air valves during summer peak-cost times can increase the cost by almost $100/valve. Rescheduling air valve testing to off-peak periods can reduce electrical cost by approximately $230,000. By adhering to the principles outlined in MSE 2000, Delta ultimately achieved a significant energy cost savings with practically no investment.

Collins & Aikman

Collins & Aikman, a carpet manufacturer in Dalton, Georgia, is a leader in environmental management. They have reduced plant solid waste by over 80 percent and are committed to reducing energy waste as well. In the implementation of MSE 2000, they have selected an energy team, completed a gap analysis, begun their energy manual and written most of their energy-related work procedures. Collins & Aikman has completed some training with the remainder planned for early 2001. They plan to be conducting internal

audits of the management system by the end of the first quarter 2001 and will be poised for registration by mid-2001.

US Postal Service

The United States Post Service (USPS) was one of the initial clients to contact EEMC about MSE 2000. Driven by an executive order mandating a 35 percent reduction in energy usage by 2010, USPS was attracted to a structured management system. The Postal Service is initiating MSE 2000 at the Atlanta bulk mail operation. To date they have completed a gap analysis, selected an implementation team, and attended an initial round of training. After the Christmas 2000 rush, they plan to assemble an energy manual, complete energy process work procedures and instructions, and finish training necessary personnel. This will put them on track for a registration audit by 2001 third quarter.

Conclusion

In conclusion, ANSI/MSE 2000 includes the elements necessary to establish an effective system of energy management. The system includes sufficient structure to establish control, yet is flexible enough to encourage innovation and avoid bureaucratic rule. MSE 2000 institutes a broad management structure at the organizational level. Under the MSE 2000 management umbrella, other energy efficiency improvement tools may be integrated. Items that complement MSE 2000 include continuous commissioning, Certified Energy Manager training, the Energy Savings Analysis Protocol, and federally sponsored programs like ENERGY STAR® Buildings and ENERGY STAR® Products.

Continuous commissioning is a process developed by the Texas A&M Energy Systems Lab (ESL) to optimize the operation of existing building energy systems, guarantee continuous optimal operation in future years, and provide energy retrofit suggestions to minimize project costs (Liu, 1999). The continuous improvement aspect of continuous commissioning matches well with the intent of MSE 2000. Certified Energy Manager training developed by the Association of Energy Engineers encompasses the technical elements of energy management and can serve as essential grounding for persons appointed as MSE 2000 energy coordinator.

The Energy Savings Analysis Protocol (EASP) is a procedure defining how to conduct an energy assessment and evaluate energy savings opportunities at a facility (Simon, 2001). EASP describes data resources required, measurement procedures, site survey practice, analytical methods, and reporting.

ENERGY STAR® building and products are designations developed by the federal government to denote energy efficiency. ENERGY STAR® was introduced by the US Environmental Protection Agency in 1992 as a voluntary labeling program designed to identify and promote energy-efficient products, in order to reduce carbon dioxide emissions (EPA, 2001). EPA partnered with the US Department of Energy in 1996 to promote the ENERGY STAR® label, with each agency taking responsibility for particular product categories. ENERGY STAR® has expanded to cover new homes, most of the buildings sector, residential heating and cooling equipment, major appliances, office equipment, lighting, and consumer electronics. Incorporating ENERGY STAR® building guidelines and products into organizational energy management will make a positive impact on energy productivity.

During the past twenty-five years, quantum leaps in the efficiency of energy systems have been achieved and many innovative products introduced. But the improvement in energy efficiency nationwide is not stable. Apparently, technology alone is not sufficient to assure optimum energy productivity. Whatever the technology employed, people still use energy and often use it inefficiently. A documented system of management can provide the structure necessary to direct people in efficient energy use. A possible solution to improving national energy efficiency is combining improved management of energy resources *and* effective technology instead of just technology. MSE 2000 defines one approach to combine management with technology.

Though the final results and impacts are not yet completely visible from the initial MSE 2000 implementers, some goals of the system including a stable, proactive energy management structure, energy and cost savings, continual improvement, environmental impact mitigation, and improved sustainability will be achieved. Given the future uncertainty of energy price and supply, now is the time to embrace MSE 2000.

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