ENERGY SYSTEMS ANALYSIS AND MANAGEMENT MANUAL

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC.
www.smacna.org

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FOREWORD

This is the second edition of the Energy Systems Analysis And Management Manual with the first edition dating to 1997. In the years since the first edition many changes have been seen in the industry.

With the rising cost of fossil fuels and the increase of environmental concerns, reducing the energy consumption of HVAC systems is increasingly important. With these changes and with new changes coming on the horizon, the SMACNA contractor needs to be positioned to meet these challenges. New construction is only one part of the opportunities that are available for the contractor. Opportunities exist in other parts of the industry and the Energy Systems Analysis And Management Manual Task Force was formed to develop a revised and updated manual that addresses the variety of services which can be provided by the SMACNA contractor.

The intent of this manual is to provide the SMACNA contractor an overview of a variety of business opportunities, allowing the contractor to select those which might provide the greatest return on investment consistent with market forces in the local area. Topics presented in this manual include:

- Energy Conservation Management
- Air Systems
- Domestic Water Systems
- Electrical Systems
- HVAC System Maintenance And IAQ
- The Energy Audit
- Energy Management Maintenance And Monitoring
- Energy Estimating Procedures
- Economics Of Energy Reduction Projects
- CFC Refrigerant Regulation
- Energy Recovery Systems
- Evaporative Air Coolers
- Alternative Energy Systems
- Hydronic Recovery Systems
- Energy Recovery System Investment Analysis
- Energy Conservation Measures
- Legacy Systems
- Fundamentals Of Energy Transfer

It is not the intent of this manual to present these topics in depth. It is intended that manual present a general description of each topic with guidelines explaining the general knowledge or expertise required to pursue the various options. Once a reader determines that they wish to pursue a topic in more depth, they are directed to other SMACNA manuals or publications.

SMACNA wishes to thank the efforts and funding of the National Energy Management Institute in assisting in the development of the first edition, and their contribution towards the second edition for the industry. SMACNA also thanks the SMACNA contractors who, as members of the Energy Systems Analysis And Management Manual Task Force, volunteered their time and effort to the development of this manual. SMACNA appreciates their dedication and willingness to share their knowledge and experience.

SHEET METAL AND AIR CONDITIONING CONTRACTORS'
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CHAPTER 1

ENERGY CONSERVATION MANAGEMENT

Many of today's buildings include complex systems such as the following: security, stairwell pressurization, smoke purge, fire alarm, emergency lighting, building management system (BMS), building automation system (BAS), hot water heating piping, chilled water piping, domestic water piping, gas piping, exhaust air, emergency computer UPS, and computerized lighting control.

These systems have not only stretched the limits of the traditional facility maintenance department to keep them operating, but have greatly increased facility energy usage. When these complex systems are not maintained or controlled properly, the energy consumption can increase dramatically.

The accounting department in most facilities is usually responsible for receiving and paying all utility bills. Since most building owners do not consider utilities as a controllable cost, these bills are usually processed each month without any management review. The building maintenance or facility management department is usually judged by their ability in responding to trouble calls and keeping the heating and cooling systems operating, not in their ability to reduce energy usage. There are relatively few facilities which tie these functions together with the management and feedback overview needed to manage today's increasing utility costs.

When there is no direct accounting relationship between HVAC system maintenance and utility usage, there is no incentive to reduce utility costs. Maintenance staffing and supplies will continue to be cut to save costs as long as building managers do not have utility accounting controls that show the much higher utility costs that result from this short-sighted thinking.

In order to take control of utility costs, the energy relationship of the building systems must be understood. Understanding how the systems were intended to work will allow the creation of an energy and utility cost reduction plan. By using the energy auditing techniques in this text, you will learn how to identify the most cost effective system renovations to make and their relative priority. You will also learn how to set up the utility accounting procedures required to monitor the results of your new energy conservation program and justify future increased maintenance or renovation budget requests.

1.1 ENERGY USE INFLUENCE FACTORS

Nationwide, the systems that consume the most energy in order of decreasing magnitude are:

- Heating and Ventilating
- Lighting
- Air Conditioning
- Equipment and Process
- Domestic Hot Water

Requirements for the HVAC and electrical systems are controlled for the most part by building features listed in Table 1–1. The relative magnitude of each influence factor is suggested. In most cases the higher the magnitude, the greater the potential is for energy conservation.

1.2 BUILDING ENVELOPE

The building envelope is comprised of the roof, outside doors and windows, skylights, exterior walls, slab and all envelope joints. The building envelope protects the occupants from the outside elements and provides a protected thermal environment. It has a direct and significant impact on the building's energy use, and therefore, building energy codes have specific requirements for critical envelope components. The effectiveness of the building envelope depends on materials chosen, fenestration, installation, and environment and building purpose. See Figure 1–1 for the major components comprising the building envelope.

The building envelope is a significant portion of the building and building costs. See Table 1–2 for typical envelope costs as a percentage of the total building cost.

In regard to thermal losses through the building envelope, the performance depends on three variables: the area, the temperature difference between the inside and outside temperatures, and the material. The material properties dictate how easily heat transfer takes place and is quantified by the thermal conductivity, U. Equation 1–1 is used to calculation the thermal losses through the building envelope.

$$Q=U\times A\times \Delta T=U\times A\times (T_i-T_o) \qquad \textbf{Equation 1–1}$$

Where:

U = thermal conductivity = 1/R
R = thermal resistance
A = area of envelope component
T_i = temperature inside
T_o = temperature outside.