PITFALLS IN BUILDING AND HVAC AUDITS

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ABSTRACT

The purpose of an energy audit is to identify and analyze areas of energy consumption and to propose methods of conservation. In the process of completing an audit the following areas of consumption should be considered:

- Building Envelope
- Air-Handling Systems
- Chilled Water Systems
- Boiler Systems
- Lighting/Electrical Systems

Within these areas many potential conservation opportunities can be developed. Quite often opportunities are proposed without thorough analysis and as a result, they do not produce the desired results. When this happens, it is generally due to "pitfalls" or idiosyncrasies of the opportunity that were not considered in proposing the project.

The purpose of this paper is to point out some common pitfalls in each of the above areas and to propose some possible alternatives.

BUILDING ENVELOPE

The physical structure of a building presents a great many opportunities for energy savings. When performing a detailed energy audit, the following areas should be examined with respect to the building envelope:

- Walls
- Roofs
- Windows
- Doors
- Ceiling Height

In order to minimize energy losses through the building envelope it is important to minimize the negative effects of transmission, infiltration and radiation. Some standard, effective methods of saving energy loss through the building envelope are as follows:

- Insulation (Wall and Roof)
- Weatherstripping (Windows and Doors)
- Double-Glazing/Solar Film
- Destratification/Dropped Ceiling

Associated with these conservation opportunities are a number of "pitfalls" which, if not considered, seriously hamper their performance.

- Eliminate all major sources of infiltration. When applying weatherstripping, it is important to insure that all other sources of infiltration have been checked. Broken windows, holes in walls, poorly fitted doors and windows, and negative pressure in the conditioned space all result in infiltration, and will negate the positive effects of weatherstripping.

- Consider all aspects of solar film. In some parts of the country the negative effects seen in winter outweigh the summer savings.

- Consider all forms of savings, not just energy. Opportunities are often missed because only energy savings are considered. For example, the installation of exterior wall insulation or aluminum thermopane windows results in a substantial maintenance savings.

- Consider all effects of a dropped ceiling. When installing a dropped ceiling, substantial reductions must be made in both supply air quantity to the space and space lighting. Both reductions result in energy savings and lighting is often overlooked.

AIR HANDLING SYSTEMS

The opportunities for conservation in air handling systems are primarily based in system control. In order to minimize energy consumption in air handling systems, control systems which fine tune operations can be installed. Typical energy conservation opportunities for air-handling systems are:

- Enthalpy Cycle/Economizer Cycle
- Supply Air Reset
- Warm-up/Cool-down Cycle
- Thorough Maintenance on Control Systems
- Heat Recovery

In order to effectively incorporate these opportunities into an energy program the following "pitfalls" must be avoided:

- Choose the correct economizer system (dry-bulb or enthalpy). In dryer climates a single dry bulb temperature sensor can effectively make outside air decisions. Where enthalpy control (dry-bulb and wet-bulb sensors) is involved a penalty for increased maintenance should be considered.

- Supply-air reset is not appropriate for most constant temperature/constant humidity areas. In these areas over-cooling and reheating is necessary to produce room conditions as specified.

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- Heat recovery should not be considered in areas of potential fire hazard. This particularly applies to kitchen areas with high grease concentration.

- Address controls on a unit-by-unit basis. Operations of dampers and pneumatic control systems are seldom addressed on a unit-by-unit basis. As a result individual units that are seriously out of calibration are not identified and substantial savings are missed.

- "As-built" drawings are too often accepted as fact. In many cases the accuracy of these outdated drawings is poor.

CHILLED WATER SYSTEMS

The chilled water system in a commercial, industrial or institutional facility presents a number of potential conservation opportunities. The following are typical areas of concentration:

- Chilled Water Temperature Control
- Condenser Water Temperature Control
- Distribution System
- Chiller Operations
- Cooling Tower Optimization

Within these areas the following conservation opportunities are commonly investigated:

- Reset Chilled Water Temperature

- Reset Condenser Water Temperature

- Installation of 2-Way Valves and Variable Pumping or 3-Way Valves

- Computer Controlled Chiller Sequencing

- Free Cooling During Non-Design Days

- Installation of Additional Small Chiller

The following pitfalls are common mistakes when instituting the above opportunities:

- Resetting chilled water may not be an acceptable practice if any of the areas served by the system require strict temperature and humidity conditions. Computer rooms and clean rooms must be considered.

- Condenser water temperature reset savings has some very strict limitations. It can only realistically be reset to $7^{o}F$ above the outside air wet bulb temperature. Oftentimes, savings for larger ΔT is calculated.

- For the installation of 2-way valves with variable speed pumping to be successful system flow rates must be maintained above minimum velocity levels to avoid air entrainment. In many cases, this seriously limits the variable pumping range and therefore the savings.

- For retrofit to 3-way valve systems, the proximity of the supply and return piping must be considered in establishing feasibility.

- When establishing the potential for savings due to "free-cooling" it is important to do a complete evaluation of climatological data (specifically wet bulb temperature) vs. operating hours of the cooling system.

- Installation of additional small chiller. In order to optimize operation of a chilled water system, the summer and winter load profiles should be developed. The capacity and size of plant should be compared with load profiles. It has been found that in most cases addition of suitably sized small chiller will increase the efficiency of the plant considerably.

BOILER SYSTEMS

A boiler system/heating supply system presents a substantial number of opportunities for energy conservation. The following are typical areas of concentration:

- Boiler Plant Location
- Boiler Operations Optimization
- Distribution System

Within these areas the following opportunities consistently yield excellent energy savings:

- Automatic Continuous Boiler Blowdown
- Installation of Economizers
- Installation of Oxygen Trim Control
- Addition of a Small Boiler
- Insulation of Distribution System

There are a number of "pitfalls" associated with these opportunities that must be kept in mind when considering their implementation:

- The feasibility of installing a small boiler for summer operation is strongly dependent on the load profile of the system and the part load efficiency of the existing plant.

- When considering the installation of an economizer it is important to consider both heat recovery capacity and pressure drop across the economizer. Failure to consider pressure drop can result in difficulties maintaining a proper air/fuel ratio.

- To be most energy efficient, blowdown should be performed at the slowest rate possible to maintain an acceptable level of total dissolved solids (TDS). This minimizes blowdown and thereby minimizes make-up.

- Many of the inefficiencies of a steam or hot water system are a result of poor distribution. Detailed surveys of the distribution system, considering insulation, conditions of steam traps and condition of piping should be part of every audit.

LIGHTING/ELECTRICAL SYSTEMS

Lighting and electrical systems present our final area for both conservation opportunities and pitfalls. When considering lighting and electrical systems, the following areas of concentration are examined:

- Lighting
- Motors
- Demand Control/Load Shedding

In order to successfully implement these opportunities and achieve the projected energy savings, the following "pitfalls" must be avoided:

- Fluorescent lamp replacement with "Watt-misers" can result in accelerated ballast burnout. This is a result of incompatibility between ballast and lamp. To avoid this problem a burnout rate monitoring program should be instituted along with any relamping program.

- Nameplate data is not acceptable for determining motor consumption. Ampere readings should be taken where possible.

- Variable frequency drive (VFD) retrofits require taking a careful look at motor/drive compatibility. The harmonics resulting from full load operation of a standard motor with VFD can result in overheating.

- The energy effects of all characteristics of load shedding must be considered when defining sheddable loads. This includes the possibility of generating peaks during restart and start/stop wear on equipment.