Creating a Green and Profitable Work Environment

An informative guide to "green" cleaning and maintenance practices which provide efficient, productive and healthy operation of commercial buildings in Florida.

2003

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Chapter Highlights

- Use of energy efficient indoor and outdoor lighting.
- Developing building policy that targets supplemental loads.
- Building envelope maintenance.
- Effective control of building systems.
- Testing, adjusting, and balancing of building systems and controls.
- Heating and cooling system maintenance.
- Financing energy improvements.

Energy represents 30% of the typical office building's costs and is a property's single largest operating expense. Reductions in energy consumption of more than 35% are possible through changes in building operations and management strategies alone, along with increased asset value from energy performance improvements, and increased tenant satisfaction and retention. Employing strategies that effectively reduce the energy use of a facility will also have side benefits such as improving occupant comfort, improving indoor air quality, and improving building durability. Making low or no cost adjustments to a building will not only minimize current costs, but will also lower future maintenance costs. Such adjustments will also lower future equipment replacement costs for as energy savings measures are undertaken, the sizes and capacities of equipment necessary to maintain comfort are often reduced. Undertaking the process of uncovering opportunities will help the building manager and his staff understand the building's operational needs. Occupant comfort is generally paramount in terms of a building's operational needs, and occupants are prone to modify a space in order to achieve comfort, whether it involves bringing in devices from home, manually adjusting thermostats, or blocking vents, all of which can cause elevated energy use. Undertaking the process will also reveal how the building is intended to operate, and how current operation can be improved.

5.1 Lighting

Section Recommendations:

- Evaluate lighting requirements properly.
- Conduct a comprehensive lighting retrofit including bulbs, ballasts, and luminaries.
- Consider advanced lighting controls.
- Develop an integrated planned lighting maintenance program.
- Consider opportunities for exit lighting and exterior lighting.

Typical lighting upgrades result in payback periods of three to four years and can cut lighting electricity bills by 50% or more. Due to the low risk and high profitability of lighting upgrades in a commercial building, the energy savings gained from such efforts can assist with the financing of subsequent building upgrades.

Lighting consumes 25 – 30% of energy in commercial buildings, and is a primary source of heat gain and waste heat. Typical lighting upgrades result in payback periods of three to four years and can cut lighting electricity bills by 50% or more. Due to the low risk and high profitability of lighting upgrades in a commercial building, the energy savings gained from such efforts can assist with the financing of subsequent building upgrades.

Steven C. Spencer, FSEC

Figure 8. In this office, desks are positioned to take advantage of available daylight. Light shelves extend horizontally from the windows and help diffuse the natural light and control glare, as do interior blinds.

Upgraded lighting systems can also improve the quality of lighting in the building that can increase worker comfort, mood, safety (through effective emergency and exterior lighting), and productivity, as well as reduce absenteeism through a reduction in eye fatigue and an improvement in performance on visual tasks. Lighting also greatly affects the aesthetics and perception of the building, as well as the business conducted within. Although it may seem appealing to implement only the easiest and quickest payback opportunities when it comes to lighting upgrades, a more comprehensive upgrade will ensure that the other savings due to productivity will also be realized.

5.1.1 Indoor Lighting

When beginning to search for opportunities to conduct a lighting upgrade, one must first examine appropriate lighting needs of occupants, such as the quality and quantity of light, that depend on various tasks that are performed in the building. Such assessments must also take into account issues other than those attributed to artificial light sources, such as availability of daylight and glare. Therefore part of a lighting upgrade may involve relocation of desks and other task areas to take advantage of available natural light, or minimize glare. Lighting devices brought in by employees may indicate additional lighting needs.

As with many other conservation efforts, bigger is not always better. That is to say more light does not always lead to better functionality. Therefore the correct amount of light for the task to be completed must be determined, and achieving such target levels should involve a combination of available daylight and artificial light. Table 4 indicates average recommended levels for various tasks, as measured in footcandles. To conduct such an assessment oneself, a light meter will be necessary, available at most industrial and commercial equipment supply stores. Alternatively, resources for assistance are presented at the end of the Building Energy Use section. Analyzing lighting needs for various tasks, coupled with quantity of light available from the use of efficient bulbs and luminaries may reveal an instant savings opportunity where the number of bulbs in a particular fixture can be reduced, termed “delamping”.

Quality of light is also important, and involves taking into account glare, light color and light temperature. Lights are classified on the basis of the color rendering index (CRI) on a scale

Table 4. Recommended lighting levels for various activities.

Activity	***Recommended Light Levels (footcandles)***
Average reading and writing	50 fc
Offices with computer screens Task lighting Ambient lighting	50 fc total 25 fc 25 fc
Hallways	10 fc
Stockroom storage	30 fc
Loading and unloading	10 fc
High-volume retail	100 fc
Low-Volume retail	30 fc
Roadway lighting	0.3 – 1.6 fc
Parking lots	0.8 – 3.6 fc
Building entrance	5 fc

Source: EPA / IESNA Lighting Handbook.

of 0 to 100. The higher the number, the more natural and bright people and objects appear, therefore it is recommended to use lights with the highest CRI that still meet energy use criteria. Light color is more of an aesthetic choice where lights with warmer sources (temperature below 3500° K) are generally preferred in lower illuminance environments and lights with cooler sources (temperature above 3500° K) are preferred in higher illuminance environments.

Although more prevalent in residential settings, many commercial buildings contain various fixtures (both installed and stand alone such as desk lamps) that use incandescent bulbs. Replacement of incandescent bulbs with compact fluorescents (CFLs) can produce 66%-75% savings from such lighting fixtures for CFLs use only 1/3 – ¼ the wattage of a comparable incandescent bulb, with the same, if not more light available, and at a comparable quality of light to that of the incandescent. CFLs are now available in a wide variety of shapes, sizes, and wattages to fit just about all incandescent fixtures. The rated life of CFLs also represents a dramatic improvement over incandescent fixtures, with many offering 10,000 hours or more compared to an average of approximately 1250 hours for incandescents. Care should be taken when selecting CFLs for use in incandescent recessed lighting fixtures (also known as "cans" or "high hats"). Although such fixtures often readily accept CFLs, the design of such fixtures does not directly lend themselves to achieving similar performance with CFLs as they do incandescents. On one hand, the design of such fixtures can shorten the service life of CFLs due to heat build-up. Secondly, installing a CFL in a standard recessed fixture may cause performance and optic problems such as glare. Accessories such as drop in reflectors and other optics are now on the market that solve many of these problems. Therefore, when selecting CFLs as a replacement for incandescents, it is important to keep the intended application in mind. Consulting with a lighting designer or the bulb's manufacturer will ensure optimum performance.

One of the most common light sources in commercial buildings is the linear (or sometimes circular) fluorescent lamp. The presence of T-12 type flourscent lamps, combined with magnetic ballasts, presents the greatest opportunity to reap large degrees of energy savings through the replacement of bulbs and ballasts. Without ballast replacement, standard T-12 lamps can be replaced with more energy efficient versions with the potential to produce 15% energy savings. Where both lamp and ballast replacement is feasible, T-8 lamps should be used along with electronic ballasts. Electronic ballasts have less audible noise and lamp flicker, have the ability to power 4 lamps rather than only 2 therefore increasing efficiency as well as first cost, and some have dimming capability. Electronic ballasts with instant start circuitry offer an additional 5% efficiency over rapid start ballasts, but may decrease lamp life under frequent on/off conditions. For such conditions, such as when the light is coupled to an occupancy sensor as soon to be discussed in this guide, programmable start ballasts should be used which "soft start" the lamp to maximize lamp life. Utilization of T-8 lamps in conjunction with electronic ballasts has the potential to save approximately 35% over standard T-12 lamps / magnetic ballast configurations.

Figure 9. Examples of fluorescent bulbs.

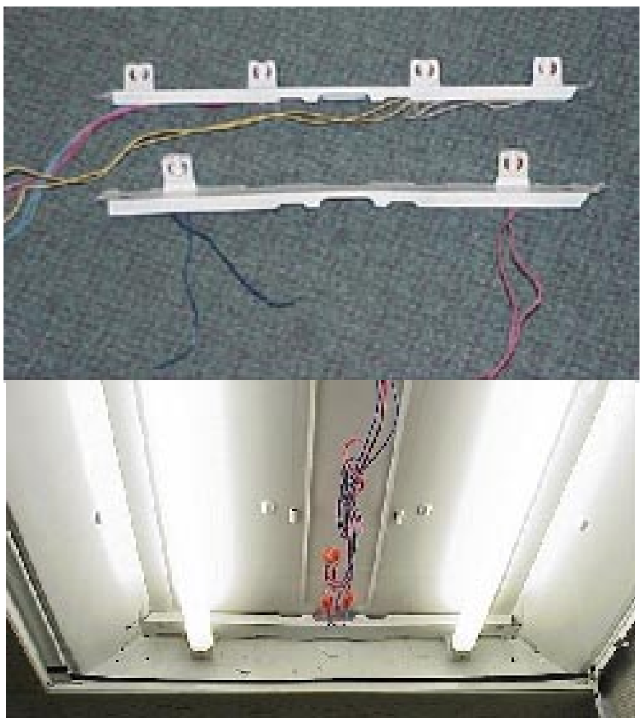
Further efficiency benefits can be gained through modification of a linear fluorescent fixture itself. A fixture, or luminary, is designed to direct light efficiently by getting the maximum amount of light to exit the fixture, while maintaining control over its distribution. A reflector is a device that can be added to existing fixtures that uses highly reflective surfaces to redirect light out of the fixture, thereby minimizing internal loss. Reflectors can improve the internal surface reflectance of newer fixtures by 17%, and even more in older fixtures, depending on how degraded the reflecting surfaces are. Consideration of reflectors is usually done in conjunction with an analysis of lighting quality and quantity as previously discussed, and aimed at improving lighting performance when delamping activities are undertaken.

Many linear fluorescent fixtures contain a diffuser or louver primarily designed to block direct view of a lamp or to diffuse or redirect light. Diffusers (often semitransparent plastic sheets) do help spread light evenly across the face of the fixture but also tend to absorb a large quantity of light, rendering them somewhat inefficient. Clear plastic lenses with special surface texturing can be used instead to improve both efficiency and distribution of light. Louvers do a better job at controlling glare than diffusers, but louvers with small cubes (less than 1 inch) are quite inefficient. Larger "deep cell" louvers provide excellent efficiency and light control and are available for retrofit in most existing fixtures.

Along with reducing the fixture wattage of lighting through bulb and ballast replacement and improving the efficiency of light distribution through reflectors and louvers, an

Figure 10. In this example, a fixture containing four T-12 lamps is slated for delamping.

Figure 11. The fixture is stripped of its lamps.



Photos by: Dave Chasar, FSEC

Figure 12. Two T-8 lamps are used in place of the four T-12 lamps, and recentered.

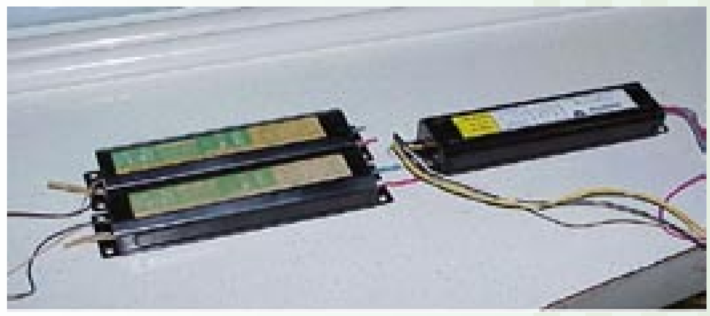


Figure 13. One electronic ballast replaces two magnetic ballasts.

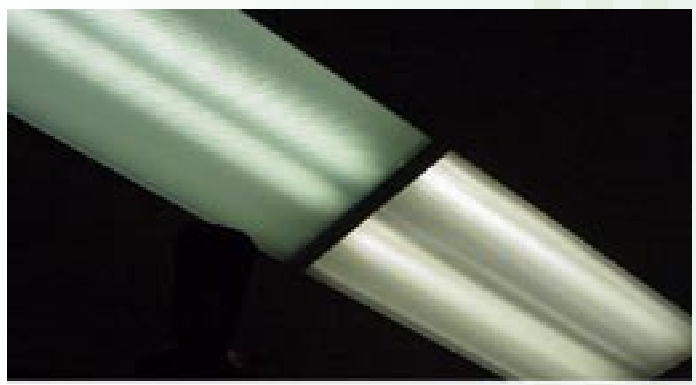


Figure 14. Comparison of the fourT-12 lamp fixture and the new two T-8 lamp fixture.

Steven C. Spencer, FSEC

Figure 15. Two examples of infrared motion sensors. The one on the left is a ceiling mount, and the one on the right is a wall mount.

equal potential for savings exists through the use of advanced controls. Advanced controls are designed to ensure that lights are active only when needed either through motion or timer control, or to ensure that the total light levels (artificial light + available daylight) are maintained at the minimum amount required. This is achieved through daylight sensing devices coupled with light dimming controls. Although extremely effective at achieving savings in lighting energy use, due to the potentially intensive and costly nature of retrofitting a building for advanced lighting control, details are not provided with this guide. Readers are suggested to consult the US EPA Building Upgrade Manual listed as a reference at the end of this chapter for further information. If advanced controls are not present in the building, a regular inspection should take place after hours to ensure lights do not remain on overnight. This can be part of a comprehensive lighting maintenance program, described next.

Another aspect of maintaining efficient lighting within a commercial building is to develop and integrate a planned lighting maintenance program. Such a program will further enhance savings achieved from utilization of efficient equipment with savings achieved in labor. Lighting systems experience a decrease in system performance and efficiency over time as lamps age and their output decreases. Eventually the lamps will burn out. Over time dirt can also accumulate on reflective surfaces of fixtures that decreases their efficiency. Such factors can degrade a system's efficiency by 60%, consequently wasting energy, and compromising safety, productivity, and building aesthetics. Taking part in a maintenance practice called "group re-lamping" minimizes such problems and adds to lighting savings. Group re-lamping involves developing a plan whereby a large number of lamps are replaced at once, generally at about 70% of their expected life, which represents their maximum economic value. Depending on the number of fixtures in the building, re-lamping may be done throughout the entire building, or by developing a rotating schedule whereby only certain areas of the building are re-lamped at any one time. Regardless of the re-lamping schedule, proper waste fluorescent lamp management should always be practiced (consult the Resources and References section at the end of this chapter for information). Group re-lamping enables lighting systems to be right sized such that one does not need to compensate for differences in lighting levels between newer lamps and older lamps. In addition, even though group re-lamping involves replacing lamps before they burn out, it does reduce the amount of time spent replacing individual lamps and time spent responding to expired bulb situations, often reducing an overall lighting maintenance budget by 25%. Group re-lamping may also reduce the costs of bulbs themselves through bulk purchasing, and also reduces storage space necessary to keep a large amount of spare bulbs on hand at all times.

Another part of a planned lighting maintenance program is fixture cleaning. Fixtures should be cleaned during each group re-lamping. Generally fixtures only require a simple dusting, using the techniques presented earlier for soil control on elevated surfaces. If used, lenses and diffusers may need a washing (both sides) with mild detergent. Lenses and diffusers should be replaced less frequently than bulbs, and can be replaced during ballast replacement.

When each of the above mentioned strategies are carried out together in a comprehensive lighting maintenance program, considerable savings can be achieved. Table 5 presents an average performance comparison of fluorescent lighting retrofit options and maintenance practices.

David Floyd, FSEC

Figure 16. Regular fixture cleaning is an important part of a planned lighting maintenance program.

Along with ambient and task lighting inside commercial buildings, exit signs are another type of light fixture that have the potential to produce significant savings with a cost effective retrofit. Exit signs are available that utilize light emitting diodes (LED) and operate on 5 W or less per face, in lieu of conventional incandescent bulbs often operating on as much as 40 W per face. When installed throughout a building, LED exit signs can generate savings in both energy and maintenance costs. One sign alone can save approximately $15-$20 annually on electricity costs, and can last up to 25 years

Table 5. Performance comparison of fluorescent lighting retrofit options.

	Case1: T-12 Lamps w/ magnetic ballasts	Case 2: Energy Saving T-12 lamps	Case 3: T-8 lamps w/ electronic ballasts	Case 4: Case 3 + reflector lens and 50% de-lamping	Case 5: Case 4 + occupancy sensors	Case 6: Case 5 + maintenance program
Average Maintained footcandles	28	25	30	27	27	27
Input watts per fixture	184	156	120	60	60	50
Energy Savings	N/A	15%	35%	67%	80%	83%
Operating Cost Savings	N/A	15%	35%	67%	76%	80%
Simple payback (years)	N/A	2.4	4.7	2.7	2.9	2.8

Source: EPA / E Source, Lighting Technology Atlas, Table 3.1

without a lamp replacement, compared to approximately one year with an incandescent version.

Along with the savings in lighting energy a successfully implemented lighting retrofit and maintenance program offers, improving the efficiency and effectiveness of interior lighting also leads to savings in energy used to air condition the building. Lighting is a primary source of heat gain and waste heat in a commercial building resulting from the fact that energy consumed by the system that is not used to produce light (approximately 70%-80% of total energy consumed) is turned into heat. This heat places an additional load on a building's HVAC system, for in order to maintain the desired temperature in a building, the HVAC system must remove this heat. Efforts incorporated to reduce the electrical consumption and improve the effectiveness of lighting often involve the use of equipment such as bulbs and ballasts with higher efficiencies, and therefore produce less heat. Such a reduction in the heat load placed on the building's HVAC system results in a savings in the energy used for cooling. Magnitude of cooling saving vary depending on situations but for a typical 100,000 sqft office building that upgrades to T-8 lamps, electronic ballasts, and occupancy sensors achieving a 1 W/sqft lighting savings (equating to 300,000 kWh/year) a 14% savings in energy used for cooling (equating to 41,000 kWh/year) can also be achieved.


Eric Martin, FSEC

Figure 17. Light fixtures that direct light downward, where it is needed, minimize light trespass.

5.1.2 Exterior Lighting

Maintenance of exterior lighting for efficiency and effectiveness has many of the same concerns and recommendations as for interior lighting. Appropriate light levels should be maintained for tasks (see Table 4); efficient bulbs, ballasts, and fixtures should be utilized, and an appropriate and effective maintenance program should be developed. Fluorescent lights should be used where appropriate, however need for consistent operation through a wide variation in temperature regimes as well as need for high output lighting often calls for metal halide or high-pressure sodium lamps. With exterior lighting, advanced controls, whether motion, timer, or daylight sensing based, are extremely important to ensure light is only available when needed.

Exterior lighting does have some unique concerns of its own related to poor design. Light trespass, caused by the inappropriate selection, tilting, or aiming of outdoor luminaries for a particular lighting task, is light that strays from its intended target causing an annoyance or nuisance. Along with being an annoyance, it is an efficiency concern for light not falling on its intended target is wasted. Light trespass can result from uncontrolled light emitting horizontally from a fixture, emitting upwards towards the sky from a fixture, or light emitted from a fixture that is reflected from a surrounding surface. In order to control light trespass, outdoor lighting should only be located where it is needed. Use carefully aimed and directed fixtures that point downwards to illuminate signs and entrances. For ambient lighting such as in parking lots, place light fixtures below tree canopies rather than above. Cutoff lighting fixtures should be employed that emit no light above the plane of the horizon.

5.2 Building Policy and Supplemental Loads

Section Recommendations:

- Eliminate unnecessary supplemental loads.
- Utilize efficient office equipment.
- Implement office equipment power policies.

Supplemental loads in commercial buildings include office equipment and other plug loads that consume electricity. Along with consuming electricity, such equipment, similar to lighting, produces waste heat. One strategy is to seek out all "common use" supplemental loads and eliminate those that are unnecessary. Examples include disabling lights used for vending machines and illuminated signs during the daytime. Another strategy is to encourage or require the use of efficient office equipment such as computers and copiers. Efficient equipment standards and equipment are becoming more widely recognized and incorporated into the workplace, such as equipment certified under the US EPA Energy Star® program (for more information, visit www.energystar.gov). However, a building manager may not have control over the purchase decisions for such equipment. One thing the building manager can do is consult with those responsible for conduction of business within the building to jointly develop policies that are aimed at reducing the energy use of supplemental loads that are already present in the building. For example, policies can be incorporated that involve turning off equipment, such as computers, when the equipment is not in use for a long period of time, especially overnight.

Money Isn't All You're Saving

Analysis conducted by researchers at the Florida Solar Energy Center shows that 50 computers left on after hours each night without power management features operating consumes an unnecessary 41,000 kWh/year, costing a facility an unnecessary $2,000 - $4,000 per year depending on impact in peak demand. Vending machines and other non-essential equipment may also be unplugged or otherwise turned off. Energy efficient appliances should be selected where possible, such as those that qualify for the US EPA Energy Star® designation. Regular maintenance should be conducted on appliances so their efficiency can be maintained, for instance periodic and through refrigerator coil cleaning. If computers in the workplace are all equipped power management features, users may be instructed to enable them properly, for instance to take effect shortly after a screen saver has been activated. Excess heat is a leading cause of equipment failure, and power management features enable the equipment to generate less heat, leading to improved longevity and reliability.

Analysis conducted by researchers at the Florida Solar Energy Center shows that 50 computers left on after hours each night without power management features operating consumes an unnecessary 41,000 kWh/year, costing a facility an unnecessary $2,000 - $4,000 per year depending on impact in peak demand.

5.3 Building Envelope

Section Recommendations:

- Reduce uncontrolled infiltration of outside air.
- Examine ceiling plane for air barrier effectiveness.
- Implement effective window shading.

Energy efficient operation and maintenance strategies as applied to the building envelope generally involve reducing air infiltration. Reducing infiltration of hot humid air, as well as cold drafts, can greatly improve occupant comfort, as well as reduce energy use. Reducing infiltration can also improve indoor air quality, for uncontrolled air flows have no means of filtration, and often pick up additional dust and debris as they flow through building assemblies such as walls, roofs, and attics. Infiltration of outside air can also be exacerbated by other phenomena in the building causing excessive negative pressure such as duct leakage and unbalanced ventilation/exhaust. Developing a strategy to reduce infiltration will also reduce the amount of conditioned air that leaks out of the building. Energy savings available from "weatherizing" the building envelope vary widely, but can be on the order of 5% of heating and cooling costs for a large office building.

Steven C. Spencer, FSEC

Figure 18. T-bar ceilings, such as the one in this classroom, do not perform well as an air barrier.

In order to carry out this strategy leaks in the building envelope must be located via occupant complaints and by inspection. Utilizing services of outside contractors such as energy raters, utility companies, and energy performance contractors may enable a "blower door test" to be performed on the building to gauge the extent of infiltration and assist with identification of major leaks. Many leaks may be found around windows and doors, and can be attended to with items such as caulk and weather-stripping. Use of revolving doors should be encouraged if present, and automatic doors should be calibrated properly to ensure they don't remain open for extended periods of time. Roofs and attics are another concern for building infiltration, especially if an effective air barrier is not in place between the attic space and the conditioned environment. Many commercial buildings have been designed with a suspended t-bar ceiling that was intended to act as such an air barrier, however, studies have found that in most cases, such ceilings are not effective air barriers. Ceilings created from drywall on the other hand, as in many residential situations, are much more effective air barriers. If a suspended t-bar ceiling is suspected to be a major pathway for infiltration of outside air (as most are) energy savings can be achieved by sealing vents and other gaps in the building envelope above the plane of the ceiling.

Another low cost strategy for reducing energy consumption through building envelope measures is window shading. A significant amount of heat gain on a building in Florida is through the solar gain through windows, and is directly proportional to the amount of window area. Window solar gain also varies according to the direction each window faces, with east and west facing windows experiencing the largest gains as the sun rises and sets. Such time periods also typically coincide with more expensive utility "on-peak" rates. A number of strategies are available for reducing solar gain including the use of window films, interior shading devices such as blinds, and exterior shading devices such as awnings, and roller blinds. Strategically placed trees also perform quite well for shading purposes.

Savings from window shading vary widely depending on a number of issues, but large degrees of savings can be achieved in buildings with any of the following characteristics:

- The window to floor area ratio is large (greater than 15%).
- The building is in a sunny location with little natural shade for windows on south, east, and west sides.
- Windows in the building are single pane.
- Windows in the building are clear, and not tinted or colored.

5.4 Building System Controls

Section Recommendations:

- Periodically check calibration of building sensors and controls.
- Analyze equipment schedules for applicability to building use.

If not checked periodically, controls that operate in conjunction with a building's HVAC system can cause the system to operate inefficiently and unexpectedly. Poorly calibrated sensors can cause increased heating

Steven C. Spencer, FSEC

Figure 19. Window shading devices can be incorporated into the architecture of a building, such as these exterior light shelves at the Florida Solar Energy Center in Cocoa.

and cooling loads, and can lead to occupant discomfort. Wall thermostats may be adjusted by occupants so comfort can be maintained, leading to further energy consumption. Savings from review and correction of problems associated with building system controls vary widely depending on individual situations, but average approximately 30% of heating and cooling costs.

Calibration of indoor and outdoor building sensors such as thermostats and humidistats should be checked periodically to ensure they are operating within original design specifications. Such activities may require specialized knowledge or equipment however, and may require outside professional assistance. Resources for such assistance are given at the end of the Building Energy Use section of this guide. Mechanical type controls such as those operating dampers and valves should also be inspected to ensure proper functionality. Pneumatic or pressure activated controls can develop system leaks, and dampers may become stuck in either the "open" or "closed" position. Such inspections may reveal controls that have been previously disconnected for any number of reasons.

While analyzing control functions, it is important to also analyze equipment schedules, a process that may uncover further opportunity for savings. Since occupancy schedules and building uses change frequently over the life of a building, an analysis of HVAC control operation may reveal a control scheme that reflects a previous building schedule, or one that does not account for daylight savings time. HVAC controls must be adjusted to properly condition the building for optimum comfort during occupied times, but thermostats and other controls can be set to modify operation to achieve energy savings during unoccupied times, when comfort is not a concern. This includes ventilation air, of which the amount required is directly dependant on occupancy. Ventilation air often consists of unconditioned outside air that puts extra heat and moisture loads on HVAC systems. Controls should be set such that the building is returned to a comfortable and safe environment by the time occupancy resumes at the beginning of each day, to avoid discomfort. The utility rate schedule should also be reviewed in conjunction with control operation. Utilities typically have varying rates for energy depending on the time of day it is used, termed "on-peak" and "off-peak". Such an analysis may uncover the possibility to operate certain equipment during "off-peak" times, resulting in direct savings. Analysis and correction of HVAC control related problems can be conducted by in-house qualified individuals, but in some cases may require outside expertise. If this is the case, and comfort problems have been reported, it may be beneficial to enlist a contractor to conduct testing, adjusting, and balancing of the HVAC system that generally includes controls analysis. This is discussed in the following section.

Since occupancy schedules and building uses change frequently over the life of a building, an analysis of HVAC control operation may reveal a control scheme that reflects a previous building schedule, or one that does not account for daylight savings time.

5.5 Testing, Adjusting, and Balancing

Section Recommendations:

- In the absence of trained in-house personnel, seek outside assistance to test, adjust, and balance the HVAC system.

Testing, adjusting, and balancing (TAB) is a process whereby the current state of the HVAC system is evaluated or tested and air and water flows are regulated or adjusted for the purpose of balancing the system such that it can meet all applicable loads and provide adequate indoor air quality. TAB of the HVAC system should be carried out periodically when it appears as though the system is not functioning as designed. Indicators of such problems include occupant complaints about hot and cold spots in the building, and frequent adjustment of HVAC components and controls to maintain a comfortable environment. TAB should also be conducted after renovation of spaces for different uses or occupancy. Since this happens frequently in buildings, but TAB does not, chances are that carrying out a TAB on an older building will uncover opportunities for savings. Again, savings potential can vary widely from building to building, but range in upwards of 10% of heating and cooling costs. TAB is most often conducted through the use of trained contractors, but can also be conducted by qualified in-house individuals. Services

Testing, adjusting, and balancing (TAB) is a process whereby the current state of the HVAC system is evaluated or ***tested*** *and air and water flows are regulated or* ***adjusted*** *for the purpose of* ***balancing*** *the system such that it can meet all applicable loads and provide adequate indoor air quality.*

available from utility companies and energy performance contractors may be leveraged for this item, and such services are discussed in a later section.

A TAB program may include review of a building's original design documentation and will focus on a number of areas. Such areas include analyzing supply, return, exhaust, and outside air flow rates and temperatures through system components and ductwork. Focus will be on ensuring the correct amount of air is going where it is supposed to and is delivered at an appropriate temperature while minimizing the amount of ventilation air delivered and maintaining a slight positive pressure within the building. Ventilation air is primarily hot humid air from outside the building, and operating with the minimum amount necessary reduces heat and moisture loads on the HVAC system, while still maintaining adequate indoor air quality. Ductwork should also be inspected for leaks that can affect proper flow distribution and lead to building durability concerns through building depressurization. If present, the HVAC water system will be tested in a similar fashion. Flow control devices including fans, pumps, and dampers will be checked for correct speeds, pressures, and other proper functionality, and control settings and operation will be reviewed. Based on the TAB analysis, and the recommendations that result, the TAB activity may lead to HVAC system adjustments to achieve operation that satisfies current load conditions, as well as result in savings.

5.6 Heating and Cooling System Maintenance

Section Recommendations:

- Maintain heat exchange surfaces such that they are free of dust and debris.

Maintenance of heating and cooling systems needs to be performed on a regular basis, not only to maintain equipment efficiency for energy savings, but also to ensure that systems have the ability to maintain appropriate comfort levels in the building. Many routine maintenance items concerning heating and cooling equipment can be handled by in-house staff, however buildings with complicated systems or buildings with limited amount of knowledgeable maintenance staff may need to rely on outside contractors to maintain systems properly.

Relatively easy yet important maintenance of heating and cooling systems involves maintaining heat exchange surfaces such as heating and cooling coils to keep them free of dust and debris. Accumulated dust and debris reduces the amount of surface area available for heat transfer and adds to the pressure drop across the coils, both leading to decreased system efficiency. A regular maintenance program that involves inspection and replacement of all air and water filters is an important concern for preserving equipment life, efficient operation,


Steven C. Spencer, FSEC

Figure 20. Heating and cooling system maintenance needs to be performed regularly to maintain equipment life and occupant comfort.

and building indoor air quality. However, even with effective filter replacement regimes, heating and cooling coils eventually become dirty enough to require cleaning. The airside of coils may be cleaned with compressed air, dust rags and brushes, or via power washing. The waterside of coils is generally inaccessible for mechanical cleaning, and is generally maintained with chemical treatments added on a periodic basis to the water in order to prevent biological and mineral scale build up. The types of heating and cooling equipment in commercial buildings vary, but all require additional maintenance and tune-ups from time to time. For more information on other maintenance issues related to various types of heating and cooling equipment, consult the US EPA Buildings Upgrade Manual listed as a reference at the end of this chapter.

5.7 Resources and Assistance for Financing Energy Improvements

Section Recommendations:

- Consider leveraging one of the listed resources for technical and financial assistance with energy retrofits.

Although many operational and maintenance issues aimed at reducing energy costs are designed to eventually create a positive cash flow for the building through energy savings, some require an initial up front investment. For example, some lighting savings can be achieved through gradual replacement of bulbs and ballasts, however much larger savings can be achieved by undertaking fixture upgrades and installation of advanced controls, which represent an up front cost. Savings can be achieved through proper maintenance of existing HVAC equipment, but a much greater savings can be achieved in the long run by replacing aging and improperly designed systems with newer, properly designed systems. Initial cost of equipment, plus need for use of outside contractors to diagnose and suggest cost effective upgrade strategies often render the largest potential for savings and long term building durability out of reach of many building managers due to tight budgets and lack of additional funding. Avenues do exist however to assist building managers in such situations, two of which include utility company incentives and rebates and energy performance contractors.

Most electric and gas utility companies have incentive and rebate programs that building managers can take advantage of to achieve energy savings. Even though utility companies are in the business of "selling" energy, they have some stake in energy conservation to ensure that they can continue to satisfy all customers' needs with existing generation capacity. Utility companies have realized that conservation is much more cost effective than construction of new generation capacity, and offer assistance to customers with similar goals through "demand-side management." Incentive and rebate programs vary from utility to utility, but example programs include:

- Free business energy evaluations.
- Rebates for undertaking lighting upgrades.
- Rebates for replacing cooling systems with qualifying high efficiency models.
- Rebates for improving building envelopes through window treatments, insulation, and reflective roofing.
- Rebates for custom and innovative energy savings strategies.

Utility companies have realized that conservation is much more cost effective than construction of new generation capacity, and offer assistance to customers with similar goals through "demand-side management.".

To find out about available rebates and incentives, and to partner with the utility to take advantage of such programs, begin by contacting the utility's commercial/industrial/business solutions center.

Another avenue for building managers that can lead to assistance with financing energy improvements is by contracting with an energy performance contractor or energy service company (ESCO). Such companies provide turnkey services including opportunity analysis, and purchase and installation of equipment, improvements, and services, all at zero cost to the business or building owner. Contracts are based on guaranteed energy savings, of which the ESCO assumes all risk involved with the retrofit. Payment for ESCO provided services and equipment comes directly from energy savings, which are split between the ESCO and the business/building owner. Contracts are generally long term, and monitoring equipment is most often installed to assist with verification of savings.

Different ESCOs may focus on different strategies. Some are housed within utility companies and focus on conservation of a particular fuel use. Others are housed within equipment companies and focus on use of particular equipment. Different building situations call for different ESCO services, but often the largest opportunities for savings and performance are gained by utilizing an ESCO that considers all possible conservation strategies, including water conservation. For more information on energy performance contracting, visit www.escperform.org.

Rebuild America is a program of the U.S. Department of Energy (DOE) that focuses on energy-savings solutions as community solutions. Rebuild America began in 1994 with the mission to accelerate energy-efficiency improvements in existing commercial, as well as other, buildings through private-public partnerships created at the community level. Today, Rebuild America is helping commercial buildings and building managers across the country sort though an often overwhelming array of options for building improvements and develop and implement an Action Plan that meet their needs. Working on a local level, Rebuild America helps commercial building managers access innovative technologies, industry services, customized assistance, and a variety of business and technical tools needed to perform energy retrofit on buildings. Rebuild America can connect building managers with other community partnerships that are working on the same issues, businesses that provide efficient products and services, technical tools that can help expedite a project, and with information on energy audits, financing strategies and energy-efficient technologies. Rebuild America has an active partnership working in Florida, as well as smaller partnerships working at the local level. To date, the Florida partnership has retrofitted 6,084,352 square feet of building space to achieve a total annual energy savings of $11,006,219. To find out more about Rebuild Florida, or local partnerships, visit www.rebuild.org for contact information.

5.8 Resources and References

Building Energy Upgrades

"Building Upgrade Manual." US Environmental Protection Agency. http://www.energystar.gov/index.cfm?c=business.bus_upgrade_manual

Ceiling Air Barrier Integrity

"Best Practice for the Location of Air and Thermal Boundaries in Small Commercial Buildings." Cummings, James. B. and Charles R. Withers, Florida Solar Energy Center. Proceedings of 12th Annual Symposium on Improving Building Systems in Hot and Humid Climates, San Antonio, TX, May 2000.

Lighting and Equipment Disposal Information and Regulation

Florida Department of Environmental Protection - Hazardous Waste Division
http://www.dep.state.fl.us/waste/quick_topics/publications/shw/hazardous/fact/c&dwaste.pdf

http://www.dep.state.fl.us/waste/quick_topics/publications/shw/hazardous/fact_mcl.pdf

Technical and Financial Resources for Energy Upgrades

Florida Solar Energy Center – www.fsec.ucf.edu

Building Energy Raters – www.energygauge.com/search.htp

Rebuild America – www.rebuild.org

Energy Performance Contracting – www.escperform.org