ENERGY EFFICIENT EQUIPMENT PURCHASING GUIDELINES FOR HOSPITALS – VERSION 1 (UPDATED January 2010)

Note: The information provided in this document is to be used for guidance only. Many of the types of equipment covered are complex, and purchasing decisions, including those that impact efficiency, are intimately related to the design, operation, and maintenance of the system as a whole. This table does not provide, and should not be used, as a substitute for exact specifications for purchasing, designing, operating, or maintaining equipment. Users are encouraged to retain the services of qualified engineers and other experts.

Below is a summary table of the equipment covered in these guidelines. To help users identify some of the best opportunities, the table "rates" the *relative* value of typical purchasing decisions for each equipment type. The ratings are GOOD MEDIUM NO CHANGE NEGATIVE for three areas: energy savings, maintenance savings, and return on investment (ROI). Note that these ratings are based on particular cases and might be different for different cases.

Equipment	Energy Savings	Maintenance Impact	Overall Return on Investment	Explanation (See Guidelines Following this Table for More Detail)	See Guideline Page…
Linear Fluorescent Lamps				At failure, replace older T-8s and T-12s with new, longer-life T-8s. In new installs use new longer-life T8s. Consider T5s in appropriate applications. For retrofit before failure, run the numbers.	3
Compact Fluorescent Lamps And LEDs				At or before failure, replace incandescents with CFLs or LEDs if existing fixture can accommodate them and desired lighting is provided. In new installations, linear T8s are often more cost-effective but some applications require light distribution that is only available from CFL or LEDs.	4
Electronic Fluorescent Ballasts				At or before failure of existing magnetic ballasts, and for new installations, use electronic ballasts.	5
Exit Signs				At or before failure of existing fluorescent or incandescent exit signs, and for new installations, use LED exit signs.	5
Lighting Controls				Complex, poorly constructed controls can increase maintenance costs. Avoid this & save energy by installing simple, durable sensors in appropriate locations (see Guideline for examples).	6
Lighting Fixtures				Selecting appropriate fixtures minimizes energy consumption, reduces maintenance costs and improves the ability to see and work comfortably. Cost is not is not always related performance.	6
Chillers				Variable speed chillers are more efficient than fixed speed but achieving these savings may require more adjustment/maintenance. However, overall ROI is still deemed "medium."	7
Cooling towers				Selecting the "best" cooling tower & operating it effectively will optimize efficiency; some of the best towers currently available are also easier to maintain.	8
Air filters				Replace old-style pleated filters with high capacity (extended surface) filters and old-style MERV 11 to 15 filters up to 12" deep with Purolator Dominator or equivalent.	9
Sterilizer Economizers				Retrofit older sterilizers with water economizers. All new sterilizers should have economizers.	9
Heating Water Producers				As appropriate, burner upgrades, condensing boilers, heat recovery chillers save substantial energy. More complex equipment needs more O&M attention to optimize efficiency.	10

Domestic Hot Water Heaters				At failure, convert tank-type water heaters to instantaneous unless you need the tank for storage of domestic water.	10
Electric Motors				At failure, purchase NEMA Premium except for limited duty applications. At or before failure, replace older, oversized motors with NEMA Premium.	11
Variable Frequency Drives				Properly applied VFDs save substantial energy & can extend equipment life. But good application is the key!!	12
Computers & Power Supplies				Save energy for little or no extra cost with ENERGYSTAR computers and 80+ power supplies.	13
Computer Monitors				Save energy for little or no extra cost with ENERGYSTAR 4.0 labeled PCs which include 80+ power supplies.	13
Network Computer Controls				Big savings potential for modest cost. Reduced PC runtime extends equipment life.	14
Televisions				Buy ENERGYSTAR televisions for non-patient room applications.	14
Printers, Fax, Copiers				Buy ENERGYSTAR rated equipment.	14
Ice Machines				Picking the right sized ice machine will save energy and increase reliability.	15
Refrigerators and Freezers				Lower cost refrigerators and freezers may have fewer “features”, cost less and use less energy.	15
Beverage Vending Machines				Occupancy equipped vending machines cost little more and save plenty of energy.	15
Medical Equipment	See Detailed Guideline.				16

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Equipment Type	Value to Hospitals of Purchasing Energy Efficient Equipment	Tips and Cautions on Purchasing and Applying This Equipment	Recommendations on Purchasing Specifications
LIGHTING			
General comments: Lighting is technically complex and new products are continually introduced to the marketplace. To keep up-to-date and get the best advice regarding purchasing, design, and installation, consult with multiple vendors and with the Lighting Design Lab http://lightingdesignlab.com/ 800-354-3864 **which provides low cost/no cost, unbiased advice and excellent training.**			
Linear Fluorescent Lamps Value Energy Savings Maint. Savings Return on Investment (ROI)	- New "3rd generation" T-8s use less energy and last longer than older T-12 & T8 lamps. - Longer life reduces maintenance and disposal costs. - T-5s may be an option, but see "Tips and Cautions." - Many utilities have incentives available.	- For many lighting applications, linear T8s are the most economical and efficient. - T-8 lamps and ballasts have undergone significant changes in efficiency and lamp life. Check with several manufactures to learn about the latest products. - Multiple manufactures have T-8s lasting 40,000 hours or more. - Lamp life depends on the number of starts and whether ballast is an instant or programmed start. - T-5s should be used judiciously. They cost more than T8s and are too bright for many fixtures. However, they can work very well in indirect and "architectural" applications such as wall washers and cove lighting. A 100,000 hour T5 lamp is now available. NO BRAINERS for Cost-Effectiveness: - When standard T8s fail, replace with longer life T8s RUN THE NUMBERS for your situation (vendors and the Seattle Lighting Lab can help): - Retrofit T-12s before failure with high performance T8s - Retrofit standard T8s before failure with high performance T8s	- Consult with multiple vendors and with the Seattle Lighting Design Lab http://lightingdesignlab.com/ 800-354-3864. - In general, information about the newest products is not included on the FEMP & ENERGYSTAR websites, and the cost effectiveness information is out of date. At the time of this publication, the "best available" described on the FEMP site had been superseded by more efficient technologies. - E-Source provides good background information on the technology; some of the info is slightly dated. http://www.esource.com/public/products/PA_Demo - BetterBricks provides a link to a manufacturer-developed software that helps owners, engineers and vendors select new lighting products and assess energy savings potential. On the following web page, scroll down to "Purchasing Tools": http://betterbricks.com/DetailPage.aspx?ID=943 Recommended Minimum Spec Content for High Performance T8s - T-8 lamp life should be rated for at least 30,000+ hrs. - Specify 40,000+ hrs if feasible for your hospital to buy from the manufacturer(s) currently offering these lamps.. - Color rendering index (CRI) should be greater than 80. - Many hospitals prefer 3,500 K color. - Lamps should be low-mercury.

Equipment Type	Value to Hospitals of Purchasing Energy Efficient Equipment	Tips and Cautions on Purchasing and Applying This Equipment	Recommendations on Purchasing Specifications
Compact Fluorescent Lamps & LED Value Energy Savings Maint. Savings ROI Note: LEDs are maturing quickly. Prices are going down while light quantity, quality and distribution improve. Unfortunately, many LED manufactures are not yet providing the light output that they claim. Consider LED as an option to CFL.	Note: Although quality CFLs are now widely available, they should be applied sparingly. For many applications, linear T8 lighting is still most economical and efficient - Retrofitting incandescent bulbs with CFLs even before failure is now cost effective because of available fixtures, lamps, and ballasts. - CFLs use 60-75% less energy than incandescent for the same light output and can last about five times longer, reducing maintenance costs. - A CFL operating 8760 hours per year can pay for itself in less than six months. - CFLs are constantly being improved. They come in all shapes and sizes, are reliable, and can be used in most incandescent applications. - Cost-effective and reliable CFL dimming is now available. Separate ballast dimming is excellent while screw-in ballast dimming still has limitations. - Initial flickering, buzzing, and on/off problems have been resolved, although there is still variation in quality. - Many utilities have incentives available.	*Tips and Cautions on CFLs* - As a rough guide, a 3:1 ratio of incandescent to CFL wattage yields equivalent light output. - Primarily use triple-tube CFLs of 18, 26, and 32 watts. - Pay attention to lamp life as well as size and wattage. Rapid start CFLs can last twice as long as instant start. Certain 40 watt twin tube PL lamps will outlast similar length/ wattage CFLs. - Use products with low (below 30%) total harmonic current distortion and displacement power factors greater than 0.9. - Some CFL products are rated for lower temperatures (0 and 32 degrees F) - In large installations, use lamps from a single manufacturer for uniform color. - Heat is a primary cause of premature failure. CFLs placed in too small a fixture or a totally enclosed fixture (e.g. ceiling globe) can fail prematurely and may not produce anticipated light output. Don't use more than 18 watt lamps in 6 inch down lights. - Screw-in CFLs can be used but may inadvertently be replaced with incandescent bulbs. Screw-in ballasts with locking devices and separate lamps will address this. Tips and Cautions on LEDs The "good stuff" is out there and cost effective in certain sizes and configurations but you'll need to do some searching and testing. Some tips: - Many LED manufacturers claim that you only need a 3 or 5 watt LED to replace a 50 watt incandescent lamp. However, you actually need 10 watts or more of LED lighting because LEDs provide less lumen output and different light distribution than incandescents. - Many of the LEDs we have evaluated don't appear to produce decent color rendering and reliable color despite the claims of manufacturers that they carry a range of colors including warm white, white and cool white. Look for a claim of >90 Color Rendering Index (CRI) in 3500K. - The author has not yet found a good MR-16 replacement for more than a 15 watt incandescent MR-16. The warranty should include no more than a 30% loss of light output after 50,000 hours of operation.	- Consult with multiple vendors and with the Lighting Design Lab http://lightingdesignlab.com/ 800-354-3864. - Note that the FEMP & ENERGYSTAR specifications only cover screw-in CFLs. - E-Source provides good background on CFL technology. Note that the application matrix is out of date (1993). http://www.esource.com/public/products/PA_Demo NO BRAINERS for Cost-Effectiveness: - When incandescent lamps fail, replace with LED or CFLs if application is appropriate and fixture can accommodate. - Retrofit incandescent bulbs before failure with LED or CFLs if application appropriate and fixture can accommodate. RUN THE NUMBERS for your situation (vendors and the Lighting Design Lab can help): - Assess cost-effectiveness if replacement or retrofit of the incandescent bulbs requires that fixtures also be changed out.

Equipment Type	Value to Hospitals of Purchasing Energy Efficient Equipment	Tips and Cautions on Purchasing and Applying This Equipment	Recommendations on Purchasing Specifications
Electronic Fluorescent Ballasts Value Energy Savings Maint. Savings ROI	- Electronic ballasts are more efficient than conventional magnetic ballasts. - They reduce room occupant stress by eliminating the flicker, audible noise, and poor light quality associated with older fluorescent lighting. - The latest high efficiency ballasts are about 95% efficient and probably use 5% to 15% less energy than the ballasts presently installed in your facility. They are available in instant start, and programmed start (improved rapid start). - Older instant-start T-8 ballasts created too much Radio Frequency Interference (RFI) for use in some hospital locations. Instant start T-8 ballast are now available that produce very little RFI. - Many utilities have incentives available.	- Fluorescent ballasts have recently undergone significant improvements in efficiency and lamp life. - For fixtures with many on/off cycles, use programmed start (improved rapid start) ballasts. If lamps have fewer than 3 starts per day, instant-start can be used. - Some older magnetic ballasts contain PCBs. Develop a procedure for handling and disposal. Recommended Article: *Get Your Light Right: Why Ballast Factor Matters* http://www.questline.com/newsletters/index.cfm?id=3576&userid=78409 A must read if retrofitting existing T12 magnetic ballasts with T8 electronic components NO BRAINERS for Cost-Effectiveness: - When magnetic ballasts fail, replace with the most efficient electronic T8 ballasts and lamps. - Retrofit magnetic ballasts before failure with the most efficient electronic ballasts. - When standard T-8 ballasts fail, replace with high performance T-8s. - Specify high performance electronic ballasts in new installations. RUN THE NUMBERS for your situation (vendors and the Lighting Design Lab can help): - Retrofit standard T-8s before failure with the more efficient T-8s.	- Consult with multiple vendors and with the Lighting Design Lab in Seattle http://lightingdesignlab.com/ 800-354-3864. - See above for information on FEMP & ENERGYSTAR. - E-Source provides good background information on the technology; some of the info is slightly dated. http://www.esource.com/public/products/PA_Demo Recommended Minimum Spec Content - Ballast efficiency should be >94%. - To minimize RFI, the Current Crest Factor (CCF) should be less than 1. 5 and greater than 1.35 - Use programmed start if there are more than three starts per day - Only buy two-lamp ballasts that can also operate one lamp. If one lamp fails, the fixture will not go dark. Also, if lower light is needed, just one lamp can be used. - For any new installation, the ballast factor should be between 0.85 and 1.2. - For retrofits, reduced ballast factors may be needed to maintain appropriate light levels without replacing existing fixtures.
Exit Signs Value Energy Savings Maint. Savings ROI	- Light Emitting Diode (LED) exit signs use less than 5 watts of power, cost less than $5 per year to operate depending on rates, and last at least 5 years. - Older exit signs use two incandescent or fluorescent lamps, use 10-40 watts of power, and cost more than $30/year to operate and maintain. - Fixing a failed exit sign can cost up to $150 in documentation and labor. - Some utilities will rebate the entire purchase price.	- Choose signs using the latest LED technology. - LED light output will diminish over time. To address this, write into the purchasing agreement, or get a certificate from the vendor/manufacturer, guaranteeing that *after five years of continuous use*, exit sign light output will comply with NFPA 101 and UL 924 requirements. Note: Long warranties do not address diminished light output. - It is not necessary to install exits signs with metal cases. Plastic LED exit signs are very durable and cost around $30. NO BRAINERS for Cost-Effectiveness: - When older exit signs fail, replace with LED exit signs. - Retrofit older exit signs before failure with LED exit signs. - In new installations, use LED exit signs.	- FEMP has a good spec, background information, a useful C/E example, and a life-cycle cost calculator. (ENERGYSTAR spec is not as complete.) http://www1.eere.energy.gov/femp/procurement/eep_requirements.html Recommended Minimum Spec Content: - Input power will be less than 5 watts per face and operate on dual voltage 120/277 VAC. - *After five years on continual use*, exit sign light output will comply with National Fire Association Protection (NFPA) 101, UL 924 and EPA EnergyStar requirement. - Manufacturer will replace all non-compliant and defective parts for five years from date of purchase. - Consult with multiple vendors and with the Seattle Lighting Design Lab http://lightingdesignlab.com/ 800-354-3864.

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Lighting Controls Value Energy Savings Maint. Savings ROI	- Controls include automatic on/off controls (occupancy sensors) and dimmable controls. - They can provide good savings when applied judiciously in the hospital setting. See Tips and Cautions columns.	- Sensors that will be most cost-effective will be easy to install and maintain, require little adjustment, and are durable. For example, sensors installed in place of a standard light switch. - Automatic on/off lighting control should not be used in patient rooms and for safety reasons are generally not recommended for mechanical rooms. - Appropriate and cost-effective applications include: private offices (13-50% savings in the room's lighting energy), meeting spaces (22-65%), restrooms (30-90%), clean or soiled hold areas, pantries, and supply rooms. - Dimmable lighting controls can be used in daylit rooms. Consult with an architect and lighting designer experienced in daylighting. - In hospitals, because of variation in how spaces are used, occupancy sensors may be more cost effective than managing whole-building lighting control systems. - Occupancy sensors in spaces with 4 lamps or less are usually not cost effective, but do the calculation to be sure. - Consider using dual voltage sensors with no trim device that must go over the wires prior to connecting wires to the sensor. -Use combined ultrasonic and infrared sensors in meeting spaces and restrooms. NO BRAINERS for Cost-Effectiveness: - Retrofit private offices, meeting spaces, restrooms, clean and soiled hold areas, pantries, and supply rooms with simple, durable sensors. RUN THE NUMBERS for your situation (vendors and the Seattle Lighting Lab can help): - Retrofit of spaces with 4 lamps or less may not be cost-effective.	- Consult with multiple vendors and with the Seattle Lighting Design Lab http://lightingdesignlab.com/ 800-354-3864. The lab is also very knowledgeable about the application of controls in daylighting. - FEMP & ENERGYSTAR provide good background information but no specification or life-cycle cost calculator. - E-Source provides good background on controls, daylighting controls, and occupancy sensors. Some info slightly dated. http://www.esource.com/public/products/PA_Demo - The best approach is to test different products and see which ones work best.

Light Fixtures Value Energy Savings Maint. Savings ROI	This is a complex topic that cannot be adequately covered in this format. This table therefore has just a few comments that may help you choose between appearance and function. Purchasing the most efficient and functional fixture does not mean you must pay a high price.	- Fixtures with an indirect lighting component ("up light") should be capped with a clear dust cover in patient care areas to minimize dirt collection and simplify cleaning. However, keep in mind that the cover will increase heat and may reduce expected lamp and ballast life. - Many hospitals have started using recessed fixtures with a metal perforated curved "belly"" that hangs below the ceiling level. This may be architecturally appealing but the "belly" catches dirt and can be difficult to clean. This may not be a good choice for patient care areas. - Fixtures with clear pattern 12 lenses will distribute light in a similar pattern to the above recessed fixtures with less maintenance and lower initial cost. -Parabolic fixtures are relatively inefficient and hard to clean. - CFL fixtures look nice but are more expensive than linear T8; minimize use.	- Consult with multiple vendors and with the Seattle Lighting Design Lab http://lightingdesignlab.com/ 800-354-3864.

Equipment Type	Value to Hospitals of Purchasing Energy Efficient Equipment	Tips and Cautions on Purchasing and Applying This Equipment	Recommendations on Purchasing Specifications
HVAC AND OTHER EQUIPMENT			
General comments: HVAC and many of the other pieces of equipment in this section are complex. The information provided in this table is to be used for guidance only. Purchase decisions, including those that impact efficiency, are closely related to design and O&M of the system as a whole. This table should not be used as a substitute for exact specifications for purchasing, designing, operating, or maintaining equipment. Users are encouraged to retain the services of qualified engineers and other experts.			
Chillers (See below for Cooling Towers) Value Energy Savings Maint. Savings ROI	Operation & energy costs for chillers can far exceed the original purchase price in less than 5 years so their purchase, operation and maintenance deserve close attention.	- Focus equipment selection on total cost of ownership rather than first cost. - Have vendors provide ARI (Air-Conditioning and Refrigeration Institute) certified KW/ton in 10% load increments in a performance matrix so you can evaluate how the chiller will perform using your own load profile. Tips for specifying the Sequences of Operation: - Optimal operation depends not just on how you control your chiller, but also on how you control your pumps, cooling towers and air handling units. - Variable speed chillers have become well established and can be operated much more efficiently than fixed speed chillers in most facilities. Some utilities pay the entire incremental cost for upgrading a new chiller to variable speed. - If your plant has a mix of variable speed and fix speed chillers, choosing which chillers to run when and at what load is complex. - Resetting chilled water temperatures is complex, but can be a very cost-effective energy efficiency strategy. In plants without variable speed pumping, resetting the chilled water temperature upward in low load conditions is usually the best approach. In plants with variable speed pumping, some combination of	- Purchase decisions, including those that impact efficiency, are closely related to design and O&M of the system as a whole. Hospitals are encouraged to retain the services of qualified engineers and other experts. BetterBricks has developed a calculator that helps owners, engineers and vendors select chillers with the lowest Total Cost of Ownership: http://betterbricks.com/track.aspx?link=graphics/assets/documents/Chiller-Estimator-3.0.xls - FEMP has some excellent information on fixed speed chillers, but has not been updated for variable speed chillers and the latest rotary chillers. http://www1.eere.energy.gov/femp/procurement/eep_requirements.html - Another good source for information on chillers is the Air-Conditioning and Refrigeration Institute.

		variable speed pumping and chilled water temperature reset is optimum. You will also need to balance cooling tower fan energy consumption against the benefits of reducing the condenser water temperature. Detailed analysis is required to optimize this combination. - Cooling towers have a substantial impact on the efficiency of chillers and should be evaluated as part of a package. See Cooling Tower section below. RUN THE NUMBERS for your situation: Use the BetterBricks Chiller Comparison tool to help identify the most cost effective chiller selection.	http://www.ari.org Recommended Article: *System Part Load Value: A Case for Chiller System Optimization,* Carrier HVAC Analysis, Volume 3, Number 3 http://www.carrieraircon.com.au/products/pdf/anly0303.pdf This article discusses the specific loadings of a plant, the weather data of the location, and the energy use of pumps and fans associated with the chillers. This is the level of analysis to look for from your designers. The article makes a strong case that a well developed system approach will result in an optimized chiller system. Ideas for Chiller Specification Language: - "The chiller shall be chosen based on the lowest Total Cost of Ownership (TCO) as determined by the BetterBricks Chiller Comparison Tool. The owner has already filled out the chiller load profile and other minimum requirements in the Chiller Comparison Tool and will provide the tool to all bidders upon request (contact xxx) for completion with Air Conditioning and Refrigeration Institute (ARI) certified KW/ton values. The bidders are encouraged to experiment with various chiller selections in order to provide the lowest TCO. Often, the best offer will be a variable speed chiller that is 20% or 30% larger than the minimum required capacity. Multiple compressor chillers may be most successful when there are many operating hours at low load. Additional requirements might include: refrigerant, glycol, installation limitations, etc."

Equipment Type	Value to Hospitals of Purchasing Energy Efficient Equipment	Tips and Cautions on Purchasing and Applying This Equipment	Recommendations on Purchasing Specifications
Cooling Towers Value Energy Savings Maint. Savings ROI	As with chillers, cooling towers (CT) are often selected for minimum size, lowest weight and lowest initial cost. This approach may not serve hospitals well because: - CTs can be difficult to place – get the most benefit from the limited available locations. - CTs will be used for a long time so you may later wish you had more capacity. - Minimally sized CTs can significantly limit the capacity and efficiency of your entire chilled water system. A generous cooling tower selection will improve chiller efficiency and help preserve chilled water system capacity.	- Sizing and Efficiency: An "oversized" cooling tower may be your best purchase because the initial cost of the larger tower is more than offset by the chiller power savings due to the cooler condenser water provided by the tower. - Type and Efficiency: Propeller-type fan cooling towers may use half of the fan energy used by a centrifugal (squirrel cage) fan cooling tower. - Sizing and noise: Designers tend to be cautious about noise so they add noise attenuation to towers…which require more fan power…which requires more noise attenuation…The designer might instead start with a bigger tower that could meet requirements with lower fan speeds requiring little if any sound attenuation. Low noise propeller fans can also be purchased at a modest cost. - VSDs: The use of variable speed drives for cooling tower fans can reduce energy consumption, the need for make-up water (and its related treatment), and system maintenance (due to reduced mechanical stress on the system). - VSDs: When a variable speed drive is used to control the speed of a cooling tower's fan, it is important to consider the lowest speed that the fan's drive train can tolerate. Drive trains using gear boxes may be able to tolerate only a 3:1 operating speed range due to lubrication requirements. - Controls: Include a conductivity controller to determine when "blow down" is required. Be sure and calibrate conductivity controller at least at the beginning of each season and more frequently if needed. - Sensors: Electronic basin water level sensors tend to be more reliable than traditional float valves. - Controls: Condenser pump speed control can be cost effective but requires careful control based on several limitations. Stick with fixed speed unless all of the dynamics are fully understood. - Controls: When controlling a multiple cell cooling tower, energy can often be saved by running multiple cells at a reduced capacity rather than by running fewer cells near full capacity. This approach may be limited by spray heads. - Spray Heads: Most brands of cooling towers use spray heads that only spray properly within a limited range of water flow. Work closely with the vendor to select appropriate spray heads based on your intended control applications. This is particularly important if you purchase a "larger than required" cooling tower. - Maintenance: Pay close attention to maintenance access requirements of towers. Performance of towers and the chillers they serve can deteriorate greatly if not maintained properly.	- Purchase decisions, including those that impact efficiency, are closely related to design and O&M of the system as a whole. Hospitals are encouraged to retain the services of qualified engineers and other experts. Recommended Article: *Selecting Cooling Towers for Efficiency* https://www.trane.com/commercial/library/vol34_1/ADMAPN014EN_0105.pdf

		NO BRAINERS for Cost-Effectiveness: -Many older cooling towers have bypass valves that maintain the chiller condenser water at a setpoint somewhere between 75 to 85 degrees. This may have been appropriate for old chillers but most chillers can run more efficiently with 68 degree or cooler water. Check with the chiller vendor to determine the lowest appropriate setpoint.	
Air Filters Value Energy Savings Maint. Savings ROI	- Nationally, the average total cost of ownership for air filters is about 80% fan energy and 20% materials and labor for periodic replacement so buying more energy efficient air filters is important. - New, improved air filters capture particulates just as well while providing less resistance to airflow. They can also have greater dirt holding capacity so they last longer. - Many hospitals replace air filters in-kind with what was originally specified and do not take advantage of recent air filter improvements that can reduce both maintenance and energy costs.	- The air filter market is dynamic and manufacturers are continually introducing new products and innovations. It can be challenging for hospital facility staff to keep up and will require getting advice from more than one source. For example, manufacturers of air filters that only capture particles mechanically may not accurately advise you on electrostatically enhanced filters. - If your supply air fans have modulating capability (e.g., inlet vanes or VFDs controlled to maintain discharge air pressure) then the fans will use less energy with improved air filters. - Pleated air filters are available in both purely mechanical capture and electrostatically enhanced capture. Note that while electrostatically enhanced filters can be more energy efficient, they may not capture particles as well as mechanical filters. However, if the air system has high performance final filters this may not be as important. - Manufacturers often recommend filter replacement at one inch pressure drop, but recent studies suggest the most economical replacement is at 0.75-0.8 in pressure drop. - Bag filters may be too long, and/or have too many cells per foot for your operating air velocity. This results in under inflated cells which can compromise energy efficiency, dirt capture efficiency, dirt holding capacity and filter durability. NO BRAINERS for Cost-Effectiveness: - Replace older style pleated filters with high capacity (extended surface) filters that are as deep as will fit. Typically you can replace 2" deep with 4" deep filters. - Replace older style MERV 11 to 15 filters up to 12" inches deep with Purolator Dominator or equivalent. RUN THE NUMBERS for your situation: - The BetterBricks Air Filter Calculator will help you select and justify the most cost effective air filters for your specific needs.	- FEMP & ENERGYSTAR do not cover filters. - Vendors have technical expertise and software tools to help you pick the best filters for your facility. BetterBricks has developed a calculator that helps owners, engineers and vendors estimate the relative costs of various air filters including first cost, labor and energy consumption. http://betterbricks.com/track.aspx?link=graphics/assets/documents/Air-Filter-Estimator-3.0.xls
Sterilizers Value Energy Savings Maint. Savings ROI	Some older sterilizers were not supplied with water economizers but can be retrofitted.	NO BRAINERS for Cost-Effectiveness: - Retrofitting older sterilizers with water economizers is simple and payback can be 6 months or less. "Just Do It". - All new sterilizers should have economizers.	Check out www.sterilizer.net for an example for a sterilizer economizer. Not all brands perform equally so compare water savings as a primary selection criteria.

Equipment Type	Value to Hospitals of Purchasing Energy Efficient Equipment	Tips and Cautions on Purchasing and Applying This Equipment	Recommendations on Purchasing Specifications
Hot Water Boilers Value Energy Savings Maint. Savings ROI	- Heating can consume up to 60% of total hospital energy use. As the costs of fossil fuels rise it is increasingly important for hospitals to pay careful attention to how boilers are purchased and operated. - Condensing boilers are getting attention these days because they have the potential to operate 10% more efficiently than other boilers. - Many hospitals no longer operate their own laundry. As a result, one or more of their boilers are too large for the year around load and are excellent candidates for replacement with a smaller condensing boiler. - Heat recovery chillers may provide most of the space heating needed by hospitals in the Pacific Northwest.	- Boilers are evolving. Replacing an older larger boiler is a design intensive process; seek the services of a highly qualified consultant. - Consider using a dedicated heat recovery chiller that is focused towards your process loads and can produce 130 degree heating water. This may allow you to use an even smaller 24/7 boiler. - Burner upgrade for an existing boiler can also produce excellent operational and energy saving benefits. - Consider the option of condensing boilers. They use return water coils to cool the flue gas below its condensing temperature of 130 degrees F. This condensing process extracts up to 10% more heat from the boiler. - It is essential that a condensing boiler have a large enough temperature differential so that the returning water temperature is less than 130 degrees F. - You may need to alter or replace heating control valves on a condensing boiler with pressure independent valves to reliably maintain a low return water temperature and optimize boiler operation. - The return water temperature on a condensing boiler can be reduced by reducing the supply heating water temperature.	FEMP & ENERGYSTAR provide good background information, a useful cost-effectiveness example, model specification language, and a life-cycle cost calculator. They do not specifically address condensing boilers. http://www1.eere.energy.gov/femp/procurement/eep_requirements.html Recommended Article**:** *Boilers For Today Types, Cost, And Controls*, Engineered Systems http://www.esmagazine.com/CDA/Articles/Feature_Article/6fece5d1ab6a9010VgnVCM100000f932a8c0____ Good discussion of selecting copper versus steel boilers and condensing versus non-condensing boilers, but not a complete analysis.
Domestic Hot Water Heaters Value Energy Savings Maint. Savings ROI	Large tank type water heaters are making some facilities nervous about legionella and are not as efficient as instantaneous water heaters. Instantaneous heaters may minimize concerns about Legionella and are more efficient.	Tips on water heating alternatives: - Instantaneous steam, gas and electric water heaters can be much more efficient than tank-type water heaters but be sure you have enough steam, gas or electric flow capacity to serve the instantaneous needs. - Although gas can be most efficient, steam units are becoming so efficient that they are a good alternative if steam is more readily available than gas. - Heat recovery chillers and DX AC units can satisfy or supplement domestic heating water needs. Two common concerns about converting from large tank type to instantaneous water heaters are the loss of domestic water storage capacity and dealing with asbestos insulation on the old hot water tanks. Consider keeping the old hot water tanks and allow cold city water to pass through the tanks before entering the new instantaneous water heaters.	http://www1.eere.energy.gov/femp/procurement/eep_requirements.html

Equipment Type	Value to Hospitals of Purchasing Energy Efficient Equipment	Tips and Cautions on Purchasing and Applying This Equipment	Recommendations on Purchasing Specifications
Electric Motors Value Energy Savings Maint. Savings ROI	- As a rule of thumb, in a single year (8760 hrs.), a motor can consume energy costing about 10 times the motor's initial purchase cost so even small improvements in efficiency can yield good returns. - Replacing an existing motor that is still functioning with a NEMA Premium Efficient may not be cost effective unless the existing motor is very inefficient or more than 50% oversized. Utility rebates may improve the cost effectiveness.	- Choose the right sized motor. Motors operate at their highest efficiency at about 75% of their full-rated load and efficiency drops off sharply below 50% loading. - In hospitals, failed motors must often be replaced immediately. Design systems that use motors that are always available "off the shelf" from your motor service center to avoid rewinds or inappropriate replacements. - It may be difficult to find large NEMA Premium Efficient motors off the shelf. If systems are designed so motors are no larger than 75 HP, premium efficiency motors are usually more readily available (and easier to move because of their smaller size). - Try to use 1800 RPM motors, the most common off-the-shelf models. 3600 RPM motors don't last as long while 900 RPM and 1200 RPM motors are large and costly. - Specify and install VFDs in such a way that there is no requirement for inverter rated motors. - Note: NEMA Premium Efficient motors can run a little faster than standard motors. The energy required by many fixed-speed fan and pump applications varies with the cube of the rotational speed of the fan or pump. For example, increasing motor speed by only 2% can increase energy use by more than 6%. So, when replacing an old motor with a NEMA Premium Efficient motor in fixed-speed fan and pump applications, make sure the new motor's full-load speed is close to the old motor speed (while making certain it meets the minimum speed needed). If you discover you cannot closely match motor speeds, you must adjust fan sheaves or pump impeller diameters in order to realize energy savings. NO BRAINERS for Cost-Effectiveness: - Always purchase NEMA Premium Efficient motors except for very limited duty applications such as fire pumps and dedicated stair pressurization fans. - Older oversized motors (less than 50% loaded) are very inefficient and replacement with a NEMA Premium Efficient motor that is sized to be 75% to 85% loaded is easy to cost justify unless the related shutdown is a real problem. Some newer motors operate very efficiently at 50% load. RUN THE NUMBERS for your situation: - See column to the right for resources to help select and justify NEMA Premium Efficient motors.	- FEMP & ENERGYSTAR efficiency tables may be out of date. "NEMA Premium" is now the industry standard. NEMA Premium product specifications and associated language are at: http://www.nema.org/ - E-Source is an excellent resource for AC induction motors. http://www.esource.com/public/products/PA_Demo - DOE sponsors *MotorMaster+*, a useful selection software package that includes a database of motors and their efficiencies. Phone: (800) 862-2086 http://www1.eere.energy.gov/femp/procurement/eep_requirements.html Another software package that is easier to use for the evaluation of three phase motors is called em2006. Its development was funding by the Northwest Energy Efficiency Alliance's industrial program. http://www.em2solutions.com/software.htm

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Variable Frequency Drives Value Energy Savings Maint. Savings ROI	- The efficiency of VFDs themselves does not vary much from brand to brand. The efficiency results from proper application. - Properly applied VFDs can be one of the most valuable means of maximizing efficiency and reliability in your facility. By controlling motor speed so that it closely corresponds to varying load requirements, VFD installations can reduce energy consumption considerably, in some cases by more than 50 percent. However, most VFDs are not properly or optimally applied. Improperly installed VFDs can even cause motor damage. See "Tips and Cautions" for more information on application.	Good potential applications: (1) Fans that can vary (e.g. supply, return, exhaust, cooling tower, boiler burners) (2) Pumps that can vary (e.g. chilled water, hot water, condenser water and domestic water) (3) Air compressors and vacuum pumps can be purchased new with VFDs. (4) Variable speed chillers can be purchased new and old chillers can be retrofitted to variable speed by chiller manufacturers. - VFDs can be cost-effective in cases with average loadings as high as 90 percent, but an analysis should be performed for each individual case based on the time spent at part-load conditions and the efficiency with and without the VFD. - VFDs do not save energy if they are not operated below full 60 Hz speed. In fact, they waste 3% to 4% energy at full speed. - It is common to find that installed VFDs are not actually modulating. This indicates a problem and will likely require careful diagnosis as it can be related to complex system O&M issues - If the minimum recommended specifications (see right column) are followed such that VFDs are properly installed and specified, you may not need to install inverter rated motors. - For any retrofit situation with VFDs, harmonic vibration may be an issue. Part of the post-installation VFD start up routine should be running the VFD in manual through the anticipated speed range and seeing if there are vibration issues. (Manufacturers provide the ability to skip certain frequencies.) - When retrofitting with VFDs, evaluate the existing motor size. If the motor is substantially oversized, you will be able to cost-justify replacing the oversized motor with an appropriately sized NEMA Premium Efficient motor and a smaller VFD. See motor section above for descriptions of software packages to evaluate the cost effectiveness of using NEMA Premium Efficient motors. Note: - The IEEE 519 requirement should not be in the VFD spec but rather is an electrical system design issue related to making sure electrical noise does not affect other equipment.	FEMP and ENERGYSTAR have no VFD specs. - BetterBricks provides a link to a manufacturer-developed software that helps owners, engineers and vendors assess energy savings potential for VSDs. On the following web page, scroll down to "Purchasing Tools": http://betterbricks.com/DetailPage.aspx?ID=943 - E-Source is an excellent resource for VSDs. http://www.esource.com/public/products/PA_Demo Recommended Minimum Spec Content: - Keep wiring lengths between the motor and VFD as short as practical with a maximum length of 50 feet for 480 VAC applications. - Under no operating conditions should the line voltage at the motor be greater than 1000 Volts AC at any measurable frequency using a recording electronic meter or oscilloscope. - Under no operating conditions should the voltage from the motor shaft to ground exceed 3.5 Volts AC using a recording electronic meter or oscilloscope. - All bypass features shall start the driven equipment without slippage of belts. - These conditions should be verified and problems resolved as part of equipment start-up.

Equipment Type	Value to Hospitals of Purchasing Energy Efficient Equipment	Tips and Cautions on Purchasing and Applying This Equipment	Recommendations on Purchasing Specifications
OFFICE EQUIPMENT			
Comments and caveats: Overall, ENERGYSTAR office equipment will consume about half of the energy consumed by standard office equipment. The EnergyStar webpage is: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductCategory&pcw_code=OEF, Establishing new efficiency specs is not enough. A new purchasing process needs to be established at the same time. Anyone engaged in purchasing needs to be trained and if in doubt consult with the right person to review/authorize/guide the purchase.			
Computers and Power Supplies Value Energy Savings Maint. Savings ROI	- According to the EPA, an ENERGYSTAR personal computer with all its energy saving features activated consumes on average about 50% less energy than a standard PC. - Part of the 50% savings comes from more efficient power supplies, called "80+" that became part of the ENERGYSTAR specification 4.0 in 2007. - ENERGYSTAR 4.0 PCs are available from most manufacturers at prices comparable to standard PCs and with the features desired by consumers. - Reducing computer energy consumption will reduce the cooling requirement for your HVAC system. - Work has also begun on improving power supply efficiency for larger servers. -Uninterruptable Power Supplies are now available with 99% efficiency. This can save 20% or more of your server energy consumption and related cooling demand. - "Virtual Servers" and PCs with energy saving features of a Laptop are coming into the market but it will take 5 to 8 years before our existing stock of relatively inefficient PCs go away. Until then, EPA estimates a $40/year/PC savings is available with a $25/PC upfront cost and a lower annual cost.	- Many hospital Information Technology (IT) groups disable most or all of the energy savings features on PCs because they want to be able to update the PCs at any time. To make sure computer efficiency is optimized, but still give both individual users and IT the control they want and need, there are network-level software programs that may be appropriate for your facility (See "Automatic Controls for Computers" below.) - Uninterruptible power supplies (UPS) are often installed to protect important computer equipment from building power problems. UPSs can be more efficient if properly matched to the actual computer "load" (energy consumption). One medical center found 150 poorly loaded UPS in four locations. UPS use was consolidated so one UPS powered several "servers" with a target load of 80% for each UPS. This improved efficiency by 25%, saving $22,000 per year, and it improved reliability. NO BRAINERS for Cost-Effectiveness: Specify ENERGYSTAR 4.0 labeled PCs which include 80+ power supplies.	FEMP & ENERGYSTAR provide good background information and a list of qualified models. http://www1.eere.energy.gov/femp/procurement/eep_requirements.html Information on the 80+ power supplies can be found at www.80plus.org - Energy Star is evolving as a primary source of valuable information www.energystar.gov - The Eaton 9395 UPS offers 99% efficiency http://powerquality.eaton.com/About-Us/News-Events/2007/PR230307.asp

Monitors Value Energy Savings Maint. Savings ROI	- The older CRT (Cathode Ray Tube) monitors can use up to 250 watts while the new LCD (Liquid Crystal Display) monitors may use around 25 watts. LED displays are also coming to the market. - CRTs cause more eye strain, take up more desk space and produce much more heat. Putting an LCD monitor into the "sleep mode" can reduce energy consumption to around 2 watts.	- Some IT (Information Technology) groups require users to leave their personal computers on at all times; however, that does not mean the monitor must be left on. So…turn monitors OFF if your PC does not automatically go into a "sleep" or "hibernate" mode. - Also note that if a monitor is displaying a screen saver, this does not reduce monitor energy consumption; screen savers simply prevent the older CRT monitors from damage from displaying the same image. NO BRAINERS for Cost-Effectiveness: Specify ENERGYSTAR rated monitors. If your Information Technology department won't let you put the whole PC to sleep, at least turn the monitor OFF when not needed for a while.	For a list of qualifying ENERGYSTAR monitors and other information: http://www1.eere.energy.gov/femp/procurement/eep_requirements.html - Energy Star is evolving as a primary source of valuable information www.energystar.gov
Network-Level Computer Controls Value Energy Savings Maint. Savings ROI	- Software is available to put PCs into low-power states from the network level (*shutdown*, *standby* and *hibernate for PCs, and sleep for monitors)* when not in use. This software enables IT to access computers at all times for software upgrades, backups, etc). - This software can reduce PC energy consumption about 80%. If a typical hospital PC averages 130 watts for 8760 hrs/yr or 1,139 kWh, costs would be $62/yr. A reduction from 130 watts to 25 watts for 75% of the time would save 690 kWh and $38/year at $0.055/kWh. These savings justify the $25 per PC license and $3 per year for software maintenance & updating.	- Some older PCs are not appropriate for this software and will simply remain on 24/7. Their monitors can be automatically turned off using Windows 98 and later. Ask the software vendor. - Some IT (Information Technology) groups require users to leave their personal computers on at all times; however, that does not mean the monitor must be left on. So…turn monitors OFF if your PC does not automatically go into a "sleep" or "hibernate" mode. - Also note that if a monitor is displaying a screen saver, this does not reduce monitor energy consumption; screen savers simply prevent the older CRT monitors from damage from displaying the same image. Most screen savers actually increase PC energy consumption so select "None" in the screen saver section of your power management options unless you have a CRT. .	- The Northwest Energy Efficiency Alliance helped fund start-up of a company called Verdiem which carries the Surveyor software. Other software packages are also available. - Find Verdiem Surveyor at www.verdiem.com. - Also see E-Source for background information; some slightly dated. http://www.esource.com/public/products/PA_Demo - Energy Star is evolving as a primary source of valuable information www.energystar.gov
Televisions Value Energy Savings Maint. Savings ROI	- Televisions are found near every patient bed, in every waiting room, in conference rooms and in lounges. TVs in patient rooms may operate more than 4500 hours per year while TVs in other areas may operate full time (8760 hr/yr). Selecting the most efficient TV that meets your functional needs can save enough energy to pay for the entire TV purchase at least twice during the life of the TV.	- ENERGYSTAR rates TVs based on their power draw while "off". Energy Star rated TVs must draw less than one watt. Some TVs draw several watts. - Information on the efficiency while in use is not readily available. What we do know is that newer CRT TVs are more efficient than older CRT TVs. - LCD TVs are even more efficient but their higher cost may not make them cost-effective, depending on your hospital's criteria A 20" LCD is about $600 compared to $200 for a CRT. Given about $85/year in energy savings depending on rates, the payback would be about 4.7 years. - Pay attention to the rated life of TV screens. Ratings of 50,000 hours or more are now common for LCD and Plasma TVs. - At time of purchase have a plan for maintenance of TVs. Will they be repaired	- See http://www1.eere.energy.gov/femp/procurement/eep_requirements.html under "Other Technologies – Low Standby Power." - Purchase ENERGYSTAR for non-patient room applications. - At this writing, only 4 manufacturers make TVs for patient room use and they are not ENERGYSTAR listed. When soliciting large purchasing proposals, tell the vendor to provide power consumption information for ON and OFF conditions. Let them know that the cost of operation will be factored into the purchasing decision.

		in-house, by a contractor, exchanged with supplier, or discarded and replaced? NO BRAINERS for Cost-Effectiveness: Specify ENERGYSTAR for non-patient room applications.	
Printers, Fax Machines, Copiers Value Energy Savings Maint. Savings ROI	Energy Star office equipment saves about 50% of the energy consumed by more conventional products.	- Modern Energy Star desktop printers and "3 in 1" units do not use much energy. You may want to focus on choosing a unit with the lowest ink costs as a primary selection criterion.	Specify ENERGYSTAR machines. See: http://www1.eere.energy.gov/femp/procurement/eep_requirements.html

Equipment Type	Value to Hospitals of Purchasing Energy Efficient Equipment	Tips and Cautions on Purchasing and Applying This Equipment	Recommendations on Purchasing Specifications
FOOD SERVICE EQUIPMENT			
Comments: **- These types of equipment reject a lot of heat. Space must be adequately conditioned for them to operate at optimum efficiency.** **- Establishing new efficiency specs is not enough. A new purchasing process needs to be established at the same time. Anyone engaged in purchasing needs to be trained and if in doubt consult with the right person to review/authorize/guide the purchase.**			
Ice Machines Value Energy Savings Maint. Savings ROI	- The typical hospital has at least one ice machine per nursing wing so the energy consumption of ice machines is significant. - There is a lot of variation in the amount of electricity used by different models — anywhere from 4 to 22 kWh per 100 pounds of ice produced.	- Over-sizing of ice makers can increase energy consumption due to excessive standby losses. Consult with manufacturers on their sizing guidelines. - For reliability and easier servicing, choose equipment with fewer moving parts and controls with diagnostic capabilities; avoid augers. - To the extent possible, standardize makes and models across the hospital to streamline O&M. - Avoid installation in confined spaces. - Water-cooled ice makers can be used if space is poorly conditioned, but they use more water than air-cooled units.	Use the FEMP specifications http://www1.eere.energy.gov/femp/procurement/eep_requirements.html - E-Source has good background information on the choices, although does not provide enough quantitative information to choose between air cooled and water cooled machines. http://www.esource.com/public/products/PA_Demo Be sure that select units are NSF certified if required. http://www.nsf.org/
Refrigerators and Freezers Value Energy Savings Maint. Savings ROI	- Hospitals use lots of refrigerators and often put them in tight spaces. The more efficient units will produce less heat and last longer. - Moderately priced high efficiency units are available.	- There is substantial variation in energy use even among the ENERGYSTAR appliances; examine labels carefully and avoid unnecessary "features". - Develop minimum purchasing standards or develop purchasing contracts that all must be used rather than allow groups in the hospital to purchase units individually. - Sometimes, when a unit fails, it must be replaced immediately. Bigger facilities might consider keeping a few common units on site.	See ENERGYSTAR: http://www1.eere.energy.gov/femp/procurement/eep_requirements.html Be sure that select units are NSF certified if required. http://www.nsf.org/
Beverage Vending Machines Value Energy Savings Maint. Savings ROI	- Refrigerated vending machines operate 24/7 consume 2,500 to 4,400 kWh of energy per year, they add to cooling loads in the spaces they occupy. At $0.055/kWh, that amounts to about $135 to $240 per year. - Savings for vending machines equipped with occupancy sensors range from 24 to 76 percent, depending on usage patterns and ambient conditions.	- Occupancy sensing. At least one device now on the market uses a passive infrared occupancy sensor (PIR) to turn off the compressor & fluorescent lights. A temperature sensor turns on the compressor as needed to cool products. - Lighting: Units with low-temperature electronic ballasts & T8 lamps reduce power to about 80 watts. - The more traffic in the vending area, the lower the savings from occupancy sensors, Locations that are unoccupied during nights and on weekends present the best opportunities, but a significant amount of savings can be achieved even by machines in areas unoccupied for 15 minutes or more at a time.	Ask your vendor about energy efficient models including occupancy sensors, T-8 lamps, and electronic ballasts. You may have an agreement with a vending company. That agreement could specify efficiency standards. - E-Source is an excellent resource for vending machines and has useful numbers. http://www.esource.com/public/products/PA_Demo

LARGE MEDICAL EQUIPMENT

Comments:

- Medical equipment is typically selected by medical staff entirely for diagnostic and treatment capabilities rather than for energy efficiency.
- Further, there are no "ENERGYSTAR" models of complex medical equipment.
- HOWEVER: There are important energy efficiency opportunities in where the equipment is located and how it is integrated into a hospital's infrastructure.

Recommendations:

- Encourage the medical and administrative staff to notify facilities staff as early as possible of plans to buy and locate medical equipment (and other equipment as well such as refrigerators, ice machines, etc.). This should be part of staff education and awareness around purchasing.
- Facilities staff can then plan ahead carefully for the optimal location and integration of equipment based on the capabilities of the existing infrastructure (chilled water and ventilation) so that the initial cost of installation and the energy consumption over time can be minimized.
- Facilities staff also must be persistent in asking manufactures for legitimate numbers for energy consumption and required heat dissipation. Manufacturers do not commonly make that information available and tend to provide high numbers. Ask for the numbers before committing to purchasing so the manufacturer is more motivated to respond.
- If the standard medical equipment configuration does not integrate well with the hospital's existing infrastructure, the facility staff and design consultants should investigate possible modifications such as changes to the size or characteristics of the heat exchanger. Manufacturers are hesitant to alter heat exchangers, so again, do this before committing to purchase and allow for extra production time.
- It is usually better to remove heat and fumes rather than cooling and diluting them. If possible, locate new equipment near exhaust air ductwork and adequate chilled water piping.

Below are examples of missed opportunities:

EXAMPLE A

A new scanner was purchased by medical staff without conferring with the facilities group. The equipment manufacture installed a 24 GPM water-to-water heat exchanger that required 25 psi of water pressure from the hospital chilled water system. This hospital, like most, did not have a chilled water system designed for providing 25 psi on the other side of the facility (from the chillers) where the new scanner was to be located.

Unfortunately, the design consultant believed the scanner's stated cooling requirements were necessary and added a complex and expensive pumping system at the scanner. When the scanner was turned on, it became apparent that it only needed 17 GPM of water flow. At 17 GPM, the heat exchanger only needed half the chilled water pressure and this could have been provided directly from the primary chilled water system.

There are several ways this inefficiency could have been avoided:

- Medical/Administrative staff alerts facilities staff of planned purchase.
- Facilities staff tells the design consultants that the medical center's chilled water system is only going to provide a specified maximum pressure and chilled water temperature, and that the design consultants have to work within those restraints.
- Require reliable information on energy consumption and heat dissipation from the manufactures and, if necessary, require the manufacturer to provide a heat exchanger appropriate for the facility.

EXAMPLE B

A medical lab added new test equipment that produces fumes and heat. The lab located the equipment where it would most easily fit in the lab space. Once lab staff started using the equipment, they found that there was not enough ventilation to dilute the fumes and remove the heat. The best and most efficient resolution would have been to relocate the equipment right below a major exhaust air system and modify the exhaust ductwork. Instead, a mechanical design firm charged $75,000 to design a $750,000 system retrofit that would shut the lab down for several weeks.