Louisiana State University

Facility & Utility Operations

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ENERGY CONSERVATION PROGRAM

Energy Conservation Program

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Energy Conservation Policy

Louisiana State University strives to conserve energy by automatically and manually optimizing the operation of equipment that consumes energy, by improving energy consuming equipment documentation, by inspection of systems, by modifying existing systems to reduce consumption and by implementing design concepts that reduce energy consumption. Energy conservation is the responsibility of all students, faculty and staff given the multimillion dollar expenditure by the University on energy each year. Facility Services procures the energy, manages the utility budget and operates the major utilization equipment but requires the help of students, faculty and staff to control consumption.

The goal of the energy conservation program is to optimize energy consumption while balancing the energy needs and comfort levels for students, faculty, and staff. Achieving the goal also requires improving energy efficiency, reducing utility cost and reducing operating costs for the University. This program addresses operational guidelines, identifies operational concepts, defines maintenance improvements and conservation opportunities during system replacements or new construction.

Energy Conservation History

LSU has been successful in a number of energy conservation efforts. LSU has participated in the Institutional Conservation Program (ICP) which funded fifty percent of Energy Audits and the Energy Conservation Measures recommended with Federal funds. Over $6 million in grants have been awarded.

LSU used ACT 762 to fund a major upgrade of the Central Plant. A natural gas fired Turbine driving a 6,000 ton Chiller with heat recovery is the heart of this project. ACT 762 allows for private financing of projects with financing to be repaid through energy savings. This project has been “bought out” and refinanced at a lower interest rate to reduce costs.

LSU has also examined ways to reduce utility costs other than through the reduction in consumption. Beginning in 1981, natural gas purchases were bid; saving the University approximately $600,000 per year. In July 1985 the local government began charging for Sanitary Sewer Service. We performed a study which reduced the volume of sewerage billed, save $480,000 per year.

In 1987 and in 1990 cogeneration studies were performed. The 1987 study resulted in a reduction of $720,000 per year through 1990. The second study resulted in a reduction of $270,000 per year which expired at the end of 1996.

Typical energy usage on campus is 60% Heating, Ventilation, and Air Conditioning (HVAC), 15% lighting and 25% other. The university has had flat consumption per square foot for the last 5 years. This was accomplished despite the substantial increase of computer facilities, cooling equipment for these facilities and increase in high energy consuming research facilities.

Given these levels of consumption, the energy conservation effort has been tailored to concentrate on operating the HVAC systems as energy efficient as possible. The primary objective of this program is to ensure optimization of all systems at any given time which typically requires the utilization of larger central equipment which led to LSU creating a large central steam and chilled water plant. LSU has invested in two cogeneration projects at the Central Plant. One consists of a turbine driven chiller and the other a turbine driven electric generator. Each captures waste heat and returns that energy into the process to enhance efficiency.

The increased cost of energy has also increased focus on lighting energy conservation with the addition of automatic switches, manual intervention of turning lights off and the modifications of light type, ballast type and bulb type.

A key element for campus operations is the utilization of a Building Automation System (BAS) to monitor and control the HVAC systems, as well as provide limited lighting control campus wide. The BAS improves the efficiency and effectiveness of the existing operational resources, processes, and systems by providing continuous monitoring and automated adjustment of building HVAC system parameters thereby optimizing performance.

Energy conservation has been a continual process that continues to require the attention of all faculty, staff and students. Advancements in technology will continue to provide new opportunities for conservation efforts. The program’s operational focus is maintained by a weekly energy meeting held with key Facility Services administrative and operational personnel to review operational procedures, to discuss energy saving projects, to review issues associated with energy savings and to plan strategies to lower energy costs for the University.

Cogeneration Overview

In 2003 construction was begun on the LSU Cogeneration Plant. The Plant consists of a G.E. LM 2000 gas turbine during a 20 mw generator. The waste heat from the gas turbine is recovered by a 150,000 pounds per hour waste heat boiler. Steam from this boiler is used on campus or in 3 – 2000 ton steam turbine chillers provided in this project. The campus electrical distribution system was upgraded to distribute the electricity generated by this project.

The operational cost reduction philosophy each month is dependent on the relationship between purchased electricity cost and the cost of natural gas. When gas is inexpensive, relative to projected electricity fuel adjustment costs, the Cogeneration Plant is operated at maximum generation. Based on the cost of gas, duct firing may be used to generate additional steam for operating the steam chillers. When forecasted electrical fuel rates are comparable to gas rates, the plant is operated in a thermal following mode. This is where the generator is operated only enough to meet the steam needs of the campus. It is not uncommon to use the thermal following mode in the off peak demand months where peak electrical demand is charged at 66.6% if over the current contract power. Due to the cost of purchased electrical demand and associated debt service, it is currently unfeasible to shut down the generator operation.

Building Automation System Overview

LSU utilizes a Johnson Controls Metasys Building Automation System (BAS) to monitor and control the HVAC systems, as well as limited lighting systems throughout campus. The BAS is a highly scalable system that encourages upgrades and future system expansions. Currently, the BAS consists of over 20,000 points that are controlled or monitored.

Additionally, the BAS is compatible with other electro-mechanical systems such as fume hoods, variable frequency drives, and chillers which are utilized campus wide. This allows all of the systems equipped with Metasys to communicate over one network.

The BAS utilizes existing LSU networks and telecommunication systems to communicate with the systems deployed in the field. The BAS consists of (a combination of NAEs, NCMs) 64 Network Communication Modules (NCM) and 21 Operator Workstations that route information over the University's existing Ethernet system. This capability gives LSU the ability to monitor and control facility energy utilization as well as identify and prioritize those buildings with excessive energy consumption. In the event the campus network fails, each NCM will operate as a stand-alone controller. Each NCM connects up to 100 stand-alone Application Specific Controllers (ASC) which control individual systems such as air handling units and chilled water systems. Each performs the necessary programs to ensure that the system is operating as efficiently as possible.

Through the Operator Workstation, an operator can schedule air-handling units (AHU) to be started, stopped, and controlled individually. This allows for greater flexibility in scheduling only those areas of buildings that are being utilized. Schedules are set for classroom areas through data supplied by the Office of Records and Registration and office areas are scheduled with building use. Generally, office areas follow a 7:30 a.m. – 5:30 p.m. schedule during normal workdays and are off during weekends and holidays. Special use areas such as laboratories and libraries are scheduled with the user on an individual basis. Computer areas are generally scheduled to operate 24 hours per day. Scheduling is the single most important factor in controlling energy consumption.

Currently, the Metasys BAS is being converted to a web-based system thus enabling authorized personnel to access the BAS from any web browser. This will allow key users to access the BAS from a remote location to view the status of and make appropriate changes. This system is password protected to ensure that no unauthorized individual has access to the BAS.

The BAS provides continual monitoring of HVAC systems parameters, which allows the system to be used as a diagnostic tool for troubleshooting HVAC systems. The BAS will alert the operator of potential problems areas and allow problems to be corrected in a timely manner which helps to ensure all systems are running as efficiently as possible. With the data supplied by the BAS, it is often possible to diagnose problems prior to dispatching a technician.

The BAS allows control of chilled water and steam supplied to each building which ensures that each building receives the proper cooling or heating required to meet the given heat or cooling load within the building.

In the case of chilled water, the BAS modulates a building chilled water control valve based on the chilled water return temperature to maintain proper temperature differential temperature in each building. This allows the variable speed pumping system to adjust to meet the system needs. As flow is reduced to the buildings, a significant decrease in energy consumption is achieved. Building chilled water pumps are used only when pressure from the Central Plant is inadequate to meet the needs of the building HVAC system.

As with chilled water, the BAS also modulates a building steam valve based on hot water return temperature. Hot water pumps in buildings that utilize heat exchangers are also controlled. As the outside temperature drops below setpoint and the building is occupied, the building heat is automatically turned on.

The BAS is also responsible for monitoring and controlling the electrical demand on campus which accounts for more than 25% of the total electric bill. Electrical demand is limited typically during the months of August and September when the thermal loads and student loads are at their highest. In an attempt to flatten peak demand, the BAS will cycle HVAC equipment off for short periods of time (typically 5 to 10 minutes, per 30 minutes) throughout the day.

Through the BAS, Facility Services personnel can access current and historical data to gain insight on performance of various mechanical systems on campus. Armed with this data, Facility Services personnel can optimize system performance and reduce campus energy consumption.

Energy Conservation Committee

Facility Services conducts s a weekly energy meeting with key administrators and supervisory personnel from the Energy Services, Utility Operations and Facility Maintenance departments.

At this meeting, the price of natural gas, storage reports and natural gas budget price is reported. Quarterly utility budget trends, daily steam condensate levels, daily steam usage and chilled water temperatures are reviewed. Operational performance of the main power house equipment is reviewed. Status of energy optimization projects is reported and potential projects are discussed. Integrity of data is addressed and reports on apparent abnormal operations are reviewed. Budget trends are reviewed and if over budget, reasons as to why this occurred are discussed as well as the measures that need to be taken to bring consumption within budget. Weekly updates are given on the status of current BAS operational programs and upcoming weather forecasts, special event related needs, and possible adjustments are also discussed each week.

Operational strategies are reviewed and discussed to ensure optimization of the cogeneration systems, central plant and all associated equipment. This ensures equipment is being operated in the most efficient manner in any given situation.

Energy conservation is a venture that must be constantly researched and analyzed. New strategies must be explored and implemented to ensure energy resources are being utilized to their fullest potential.

Operational Guidelines

The following summarizes key operational guidelines.

A. Optimized BAS schedules to meet classroom and office needs, specialized equipment needs, plant or animal needs, and laboratory needs. Schedules will not be permanently changed for the convenience of a small group of people and may require approval of the department dean or Director of Energy Services based on the cost to implement.

B. Classrooms in use after 5:00 p.m. and on weekends will be consolidated into night classroom buildings. Night classroom buildings are to be chosen based on efficiency and coordinated with the Department of Records and Registration. Facility services will identify low energy use night classroom buildings to Department of Records and Registration.

C. Ensure low usage areas, such as Field House, Maravich Assembly Center Union Ballrooms and Theater spaces, and large lecture hall lights, are turned off if not in use.

D. Maintain calibration on thermostats, instrumentation and controls.

E. All HVAC Systems will be turned off when not needed. Implement special routines for weekend, holiday and extended holiday schedules

F. General room temperature guidelines: Cooling Mode 72-76^{o}F Heating Mode 68-70^{o}F Appropriate clothing for students, faculty, and staff is recommended to provide the appropriate thermal comfort. Areas requiring temperature control during unoccupied times will be controlled by either raising the temperature of the space or by cycling the unit “on/off” several times during the unoccupied times.

G. General deck temperature guidelines: Cold deck 55^{o}F - 60^{o}F (Reset based on RA temperature) Cold deck (Humidity Control) 55^{o}F (when zone RH is above setpoint) Hot deck (During heating seasons only and exempting those buildings requiring reheat for moisture control, using reset schedule) Reset Schedule 80^{o}F at 72^{o}F outside dry-bulb temperature 140^{o}F at 20^{o}F outside dry-bulb temperature and 60^{o}F based on the return air temperature.

H. Where applicable, the BAS will reset supply air temperatures (typically between 55^{o}F and 60^{o}F) based on the return air temperature.

I. Heating season is to begin when low temperatures are projected to be in the thirties or when low temperatures are in the forties for at least three days and the high temperatures are less than 65°F (typically in mid to late November). The BAS will turn off heat to buildings automatically when outside air temperature reaches setpoint (typically 54°F degrees – 60°F).

J. Heating season is considered to end when the long range forecast predicts low temperatures in the 50's or higher for four consecutive days (typically in late March).

K. Steam and condensate leaks will be repaired on a priority basis (3 days) if located within the envelope of a building and within three weeks of discovery or damage if the utility system if free of access issues. Leaks with access issues will be isolated where possible and added to the summer steam heat project schedule.

L. Demand control may be used when the electrical demand creates a new threshold which could cost the University thousands of dollars per year.

M. Complete shutdown of residential life air conditioning systems during critical demand times and only during normal office hours. Residential Life to be advised of this condition.

N. Utilize "duty cycling" of air units to reduce peak demands.

O. Operable windows are to be kept closed at all times. Windows will be sealed closed where allowed by Life Safety Code

P. Follow established Preventive Maintenance Schedules within budget. Ensure filters are changed, coils are cleaned, and all bearings are lubricated at scheduled intervals.

Q. Domestic hot water guideline is 140°F unless needed for food preparation or lab use.

R. Shift electrical chillers and pumps to steam driven machines when available.

S. Condenser water temperatures are to be kept as low as feasible down to 55°F (depending on chiller specifications).

T, Monitor chiller efficiencies at part load. Reconfigure operations where more efficient operation available.

Documentation Guidelines

A. Continuously identify and document all energy consuming equipment on campus, prioritize by level of consumption and monitor operation accordingly.

B. Plot chill water supply and return temperature at Power House daily. Review performance with Power House and HVAC managers.

C. Maintain list of steam and condensate leaks for prioritization, funding and scheduling to repair.

Inspection Guidelines

A. Units under BAS control will remain in the automatic position. Alarm summary reports are run weekly to identify those automatic operations in manual mode. These reports are assessed in the weekly energy meetings.

B. Check calibration of all chill water supply and return temperature instrumentation once per year. Critical instrumentation at Powerhouse will be calibrated quarterly.

C. Calibrate suspect instruments within three days of discovery.

D. Building Services Personnel will turn off classroom lights at the beginning of shift and lock doors.

E. Student workers will turn off classroom lights during daytime and identify candidates for motion detectors.

F. Electrical staff will assess voltage drop and retap transformers as required.

G. All Central Plant boilers are to be tuned annually to ensure optimal performance.

H. All condensate pumps are to be checked for leaks bi-weekly during the heating season.

I. The entire condensate system, including high-pressure steam traps, will be surveyed for leaks and restrictions monthly during the heating season.

Modification Guidelines

A. Damaged insulation on HVAC piping will be repaired within four weeks of damage or discovery within operations budget.

B. Damaged weather-stripping will be replaced as soon as discovered.

C. Broken windows will be repaired as soon as possible within operations budget.

D. Install motion detectors to control lights in classrooms, conference rooms and bathrooms.

E. Replace motors with energy efficient models in lieu of rewinding when using standard motors or any motor where rewind cost is greater than 50% of new motor cost of value.

F. Replace all incandescent lighting with florescent using T-8 lamps with electronic ballasts.

G. Replace failed ballasts with T-8 lamp electronic ballasts.

H. Replace burned out lamps with energy savings lamps.

I. Replace all exterior mercury vapor fixtures with high pressure sodium.

Construction Guidelines

General

A. Utilize equipment with the optimum efficiency for the situation.

B. A cost/energy analysis will be performed on all new facilities to determine the feasibility of connecting to the existing campus steam system or installing a local boiler.

C. Coordinate all utility interruptions and tie-ins with Facility Services. Minimum of 10 day notice will be given prior to interruption in order to protect equipment and conserve energy. Outages affecting multiple buildings will require more time to coordinate.

D. Meter electricity, steam, gas, water and chilled water to new facilities.

Heating, Ventilation, and Air Conditioning (HVAC) Guidelines

1. Starting of motors 40 HP and larger must be coordinated with Facility Services in order to keep peak electrical demand to a minimum.
2. Areas requiring special temperature and/or humidity control will be discussed with Facility Services on a case-by-case basis.
3. Group similar functions and activities on same air handling unit. Avoid mixing offices, labs, and classrooms on same air handling unit.
4. Design air conditioning systems to provide 72°F and 75% R.H. unless there is a special need.
5. Efficient use of energy is prime consideration in design.
6. Avoid using electric heat associated with AHU's and water heaters.
7. ASHRAE 90.1-2004 shall be used as a guide in the design of new buildings or the retrofitting of existing building.
8. Use power factor correction capacitors on all motors 15 HP and larger where power factor is less than 90%.
9. All motors are to be copper wound, high efficient type.
10. Motors located indoors should be open drip proof; outdoors should be total enclosed fan cooled.
11. Centrifugal chillers should have 4160 volt motors.
12. Motor starters to be provided with off-automatic switches of maintained contact type for use with energy management systems. All motor starters for pumps and exhaust fans are to be equipped with auxiliary contacts for use with energy management systems.
13. Locate grilles and diffusers to evenly distribute air to all parts of room; i.e. minimize drafts.
14. Provide opposed blade dampers at each supply register or grille that are adjustable from inside rooms.
15. Provide extractors or splitters on each take off or branch duct.
16. All air conditioning supply air ducts will be insulated.

17. The use of flex duct will be kept to a minimum, less than 4 feet
18. Provide locking quadrants on all manual dampers.
19. All dampers will be of high efficiency, low leakage design.
20. Avoid mixing air streams (Hot and Cold Deck) and reheat type air handling systems.
21. Variable speed drives (VSD) will be used on all variable volume AHU's. All variable speed drives will be compatible with the BAS.
22. Fan speed will not to exceed 1200 RPM.
23. Coils are not to have more than 10 fins per inch.
24. Supply thermometers and pressure gauges in supply and return lines to water coils.
25. Avoid using high-pressure units.
26. Units using central campus chilled water (Powerhouse) will be designed for 48^{o}F entering chilled water.
27. Chilled water coil will be designed for a 12^{o}F rise.
28. Roof top units and window units are not allowed.
29. Minimum centrifugal chiller efficiency to be .55 Kw/Ton APLV.
30. Utilize variable speed chillers for loads over 100 tons.
31. Use water-cooled chillers for all systems larger than 100 tons.
32. Pump selection not to exceed 75% of rated capacity with all pumps.
33. Provide temperature and pressure gauges on supply and return lines of hot water, chilled water, and condenser water pumps.
34. Recommend using cross flow type cooling towers.
35. Utilize minimum quantities of outside air (OA) needed to meet ventilation requirements.
36. BAS Department will Implement the use of economizer mode, whenever possible, to take advantage of "free" cooling. Economizer modes shall be enabled by an enthalpy comparator. When OA enthalpy is lower than Return Air (RA) enthalpy, the economizer shall provide for maximum OA until the mixed air temperature reaches 57^{o}F for constant volume (CV) systems or 53^{o}F for variable air volume (VAV) systems.
37. Relative humidity control will be used for equipment protection, process control, or

research but not for personal comfort. Personal comfort will not be the primary reason for humidity control.

38. In non-humidity control conditions, return air will be used during the cooling season to control space temperatures instead of heated air.

39. Motor Efficiency at full load, as a minimum, should be as follows

	3600 RPM		1800 RPM		1200 RPM	
HP	Minimum Guaranteed	Nominal	Minimum Guarantee	Nominal	Minimum Guarantee	Nominal
1	78.5	81.5	81.5	84.0	75.5	78.5
1 1/2	78.5	84.0	81.5	84.0	85.5	87.5
2	81.5	84.0	81.5	84.0	85.5	87.5
3	84.0	86.5	88.5	90.2	87.5	89.5
5	87.5	89.5	87.5	89.5	87.5	89.5
7 1/2	87.5	89.5	90.2	91.7	90.2	91.7
10	88.9	90.2	90.2	91.7	90.2	91.7
15	89.8	91.0	91.7	93.0	91.0	92.4
20	91.0	92.4	92.4	93.6	91.0	92.4
25	91.7	93.0	93.0	94.1	92.7	93.6
30	92.4	93.6	93.0	94.1	92.7	93.6
40	92.4	93.6	93.7	94.5	93.3	94.1
50	92.0	93.0	93.7	95.4	93.3	94.1
60	92.7	93.6	94.7	95.4	94.3	95.0
75	93.7	94.5	94.7	95.4	94.7	95.9
100	93.7	94.5	95.7	96.2	94.7	95.4
125	94.3	95.0	94.7	95.4	94.7	95.4
150	93.7	94.5	95.7	96.2	95.2	95.8
200	94.3	95.0	95.7	96.2	94.7	95.4

Building Automation System Guidelines

All major HVAC equipment and all new HVAC equipment will be controlled by the existing Building Automation System. Existing HVAC equipment with non-electronic controls will be upgraded as systems are upgraded.

1. Start/Stop Controlling - A relay will be located remote from the BAS panel. This relay will be controlled by the BAS and will start and stop the controlled device when the “off-auto” switch is only in the “auto” position.

2. Status Monitoring - Status will be indicated by dry type contacts (no grounding, no voltage) with N.O. meaning “off”.
   a. Air handler status will be proven by a differential pressure switch across the fan or a current sensing relay.
   b. Toilet exhaust fan status will be proven by auxiliary contacts in the motor starter.
   c. Pump status will be proven by auxiliary contacts in the motor starter for less than 10 horsepower. For pumps 10 Horsepower or larger, status must utilize differential pressure sensors.

3. Alarm monitoring - Alarms will be indicated by dry type contacts (no grounding, no voltage) with N.O. meaning a normal condition and closed contacts meaning an alarm condition.

4. Sensors
   a. Chilled water temperature sensor: The sensor-transmitter combination will have± 0.7°F accuracy over a 35°F – 65°F range. These sensors will be mounted in immersion wells.
   b. Hot water temperature sensors: The sensor-transmitter combination will have ± 1 degree Fahrenheit accuracy over a 70°F – 200°F range. These sensors will be

mounted in immersion wells.

c. Cold deck, hot deck, and return air temperature sensors: The sensor-transmitter accuracy will be ± 1 degree Fahrenheit over a 40°F – 150°F range. These sensors will be duct mounted with the sensor extending a minimum of 12 inches into the airstream.

d. Space sensors: The sensor-transmitter accuracy will be ± 0.5 °F over (50°F – 100°F range). The sensor will be mounted in a heat enclosure approved by the Engineer.

e. Differential Pressure Sensors: They will be sized for the range intended with an accuracy of ± 0.5 pounds.

5. The equipment to be controlled and/or monitored is listed below.

a. All air handling units

i. Start/stop

ii. Status

iii. Supply air temperatures

b. Hot deck temperature-control and monitor

c. Cold deck temperature-control and monitor

iv. Monitor and control zone temperature

b. Exhaust fans control and monitor single zone units

i. Start/stop

ii. Status

d. Chilled Water System

i. Start/stop on each pump

ii. Status on each pump

iii. Chilled water supply temperature

iv. Chilled water return temperature

v. Building chilled water valve – control

e. Hot Water System

i. Start/stop on each pump

ii. Status on each pump

iii. Entering water temperature

iv. Leaving water temperature

v. Control and monitor

f. Control Air Supply

i. High temperature alarm

ii. Air pressure.

Electrical Guidelines

1. Use minimum 10 gauge wire on home runs 100 feet or longer.
2. Minimum 12 gauge wire for Distribution System.
3. Use Copper Wire, Buss Bars, Panel Boards Buss and Ground and Transformers windings.
4. Provide multiple lighting levels (with switching) in labs, and classrooms.
5. Do not use incandescent or mercury lamps. Avoid specialty lighting and bulbs
6. Use motion detectors to control lights.
7. Meter all new electrical service (both energy and power).
8. Fluorescent lamps shall be T-8 with energy efficient ballast.
9. Foot-candle (F.C.) design levels shall be submitted on new installations.
10. Use the following guidelines for lighting design.

Corridor	20-30 F.C.
Offices	30-50 F.C.
General	50–70 F.C.
Accounting (Close work)	70-90 F.C.
Classrooms General	50-70 F.C.
Auditorium Type Classroom	50-70 F.C. (have multi levels available)
Drafting	90-120 F.C.
Labs – General	50-70 F.C.
Labs – High Intensity	90-120 F.C.

11. Task lighting is recommended for individual work stations.
12. Lenses for fluorescent fixtures are to be injection molded acrylic prismatic lenses.
13. Flexibility in switching of lighting on new installation for energy conservation is required. (Halls vs Rooms)
14. Utilize “EXIT” signs that incorporate LED technology.
    a. Use task lighting instead of over lighting entire room
    b. Control corridor lighting via BAS.
    c. Apply AFDs to motor loads that can be reduced in speed during applicable conditions.