SCHOOLS AND HOSPITALS
ENERGY MANAGEMENT PROGRAM REPORT

For

CONROE INDEPENDENT SCHOOL DISTRICT
Committed to Excellence

3205 W. Davis
Conroe, Texas 77304

Administered By:

SECO
State Energy Conservation Office

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ENERGY STAR PARTNER

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Schools & Hospitals Energy Management Program
Conroe Independent School District
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1.0 EXECUTIVE SUMMARY

Conroe Independent School District, now referred to as the District, requested that Texas Energy Engineering Services, Inc. (TEESI) perform a Preliminary Energy Assessment (PEA) of their facilities. This report documents that analysis.

This service is provided at no cost to the District through the Schools and Hospitals Energy Management and Technical Assistance Program as administered by the Texas Comptroller of Public Accounts, State Energy Conservation Office (SECO). This program promotes and encourages an active partnership between SECO and Texas schools for the purpose of planning, funding, and implementing energy saving measures, which will ultimately reduce facility energy bills.

The annual cost savings, implementation cost estimate and simple payback for all building energy retrofit projects identified in this preliminary analysis are summarized below. Individual building projects are summarized in Section 8.0 of this report.

Implementation Cost Estimate:	$6,029,800
Annual Energy Cost Savings:	$656,300
Simple Payback:	9.2 years

Recommendations and information of interest to the District is provided in this report regarding Energy Consumption and Performance (Section 3.0), Energy Accounting (Section 4.0), Senate Bill 12 and House Bill 3693 Overview (Section 5.0), Sample Monitoring of Indoor Environment Conditions (Section 6.0), Recommended Maintenance & Operation Procedures (Section 7.0), Retrofit Opportunities (Section 8.0), Capital Improvement Projects (Section 9.0), Building Commissioning (Section 10.0), Funding Options for Capital Energy Projects (Section 11.0) and Energy Management Policy (Section 12.0). A follow-up visit to the District will be scheduled to address any questions pertaining to this report, or any other aspect of this program.

SECO is committed to providing whatever assistance the District may require in planning, funding and implementing the recommendations of this report. The District is encouraged to direct any questions or concerns to either of the following contact persons:

SECO / Ms. Glenda Baldwin	TEESI / Saleem Khan
(512) 463-1731	(512) 328-2533

2.0 FACILITY DESCRIPTIONS

This section provides a brief description of the facilities surveyed. The purpose of the onsite survey was to evaluate the major energy consuming equipment in each facility (i.e. Lighting, HVAC, and Controls Equipment). A description of each facility is provided below.

1. Woodland High School

Image Source: Microsoft® Virtual Earth™

Stories:	Three story
Area:	397,000 SF
Year Built:	1996
Bldg. Components:	Steel frame, brick exterior wall, flat build-up roof, slab on grade
Typical Lighting Fixtures:	T12 fluorescent fixtures with magnetic ballasts
HVAC:	Air cooled chiller system with hot water heating system
Controls:	Energy management system (EMS), Manufacturer Invensys (Barber-Coleman Network 8000) and Automated Logic Controls (ALC)

2. Oak Ridge Elementary School

Image Source: Microsoft® Virtual Earth™

Stories:	One story
Area:	74,088 SF
Year Built:	1973
Bldg. Components:	Steel frame, brick exterior veneer, flat modified bitumen roof, slab on grade
Typical Lighting Fixtures:	T8 fluorescent fixtures with electronic ballasts
HVAC:	Air cooled chiller system with hot water heating system
Controls:	Energy management system (EMS), Manufacturer ALC

3. Oak Ridge 9th Grade Campus

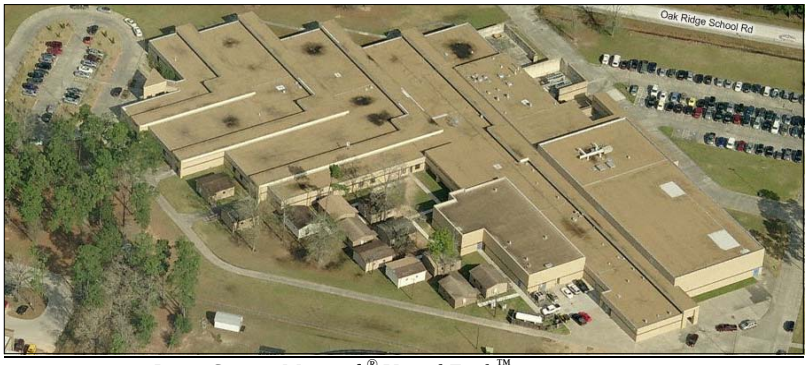


Image Source: Microsoft® Virtual Earth™

Stories:	One story
Area:	149,000 SF
Year Built:	1985
Bldg. Components:	Steel frame, brick exterior veneer, flat build-up roof, slab on grade
Typical Lighting Fixtures:	T12 fluorescent fixtures with magnetic ballasts and T8 fluorescent fixtures with electronic ballasts
HVAC:	Air cooled chiller system with hot water heating system
Controls:	Energy management system (EMS), Manufacturer ALC

4. Reaves Elementary School

Image Source: Microsoft® Virtual Earth™

Stories:	One story
Area:	84,358 SF
Year Built:	1974
Bldg. Components:	Steel frame, brick exterior veneer, flat built-up roof, slab on grade
Typical Lighting Fixtures:	T12 fluorescent fixtures with magnetic ballasts
HVAC:	Split DX system with hot water heating system
Controls:	Energy management system (EMS), Manufacturer Solidyne

5. Oak Ridge High School

Image Source: Microsoft® Virtual Earth™

Stories:	Two story
Area:	363,000 SF
Year Built:	1981
Bldg. Components:	Steel frame, brick exterior veneer, flat modified bitumen roof, slab on grade
Typical Lighting Fixtures:	T12 fluorescent fixtures with magnetic ballasts
HVAC:	Air cooled chiller system with hot water heating system
Controls:	Energy management system (EMS), Manufacturer ALC

6. Ford Elementary School

Image Source: Microsoft® Virtual Earth™

Stories:	One story
Area:	77,000 SF
Year Built:	1978
Bldg. Components:	Steel frame, brick exterior veneer, flat built-up roof, slab on grade
Typical Lighting Fixtures:	T12 fluorescent fixtures with magnetic ballasts
HVAC:	Water cooled chiller system with hot water heating system
Controls:	Energy management system (EMS), Manufacturer Solidyne

7. Wilkerson Intermediate School

Image Source: Microsoft® Virtual Earth™

Stories:	One story
Area:	82,884 SF
Year Built:	1974
Bldg. Components:	Steel frame, brick exterior veneer, flat built-up roof, slab on grade
Typical Lighting Fixtures:	T12 fluorescent fixtures with magnetic ballasts and T8 fluorescent fixtures with electronic ballasts
HVAC:	Packaged Rooftop-Units (RTUs)
Controls:	Energy management system (EMS),Manufacturer Solidyne

8. Hailey Elementary School

Image Source: Microsoft® Virtual Earth™

Stories:	One story
Area:	60,000 SF
Year Built:	1978
Bldg. Components:	Steel frame, brick exterior veneer, flat built-up roof, slab on grade
Typical Lighting Fixtures:	T12 fluorescent fixtures with magnetic ballasts
HVAC:	Water cooled chiller system with hot water heating system
Controls:	Energy management system (EMS), Manufacturer Solidyne

9. Washington Junior High School

Image Source: Microsoft® Virtual Earth™

Stories:	One story
Area:	144,966 SF
Year Built:	1988
Bldg. Components:	Steel frame, brick exterior veneer, flat built-up roof, slab on grade
Typical Lighting Fixtures:	T12 fluorescent fixtures with magnetic ballasts
HVAC:	Air cooled chiller system with hot water heating system
Controls:	Energy management system (EMS), Manufacturer Invensys (Barber-Coleman Network 8000)

10. Rice Elementary School

Image Source: Microsoft® Virtual Earth™

Stories:	One story
Area:	74,008 SF
Year Built:	1978
Bldg. Components:	Steel frame, brick exterior veneer, flat built-up roof, slab on grade
Typical Lighting Fixtures:	T12 fluorescent fixtures with magnetic ballasts and T8 fluorescent fixtures with electronic ballasts
HVAC:	Air cooled chiller system with hot water heating system
Controls:	Energy management system (EMS), Manufacturer ALC

3.0 ENERGY CONSUMPTION AND PERFORMANCE

A site survey was conducted at several of the District's facilities. The facilities surveyed comprised a total gross area of approximately 1.5 million square feet.

Annual electric and natural gas invoices for the buildings surveyed were $3,304,124 for the 12 month period ending May 2008. A summary of annual utility costs is provided in Appendix C, Base Year Consumption History.

To help the District evaluate the overall energy performance of its facilities TEESI has calculated their Energy Utilization Index (EUI) and Energy Cost Index (ECI). The EUI represents a facility's annual energy usage per square foot, it is measured as BTU's per square foot per year (BTU/SF/Year). Similarly, ECI is measured as cost per square foot per year ($/SF/Year). The EUI and ECI performance for selected facilities are listed on the next page:

Energy Cost and Consumption Benchmarks

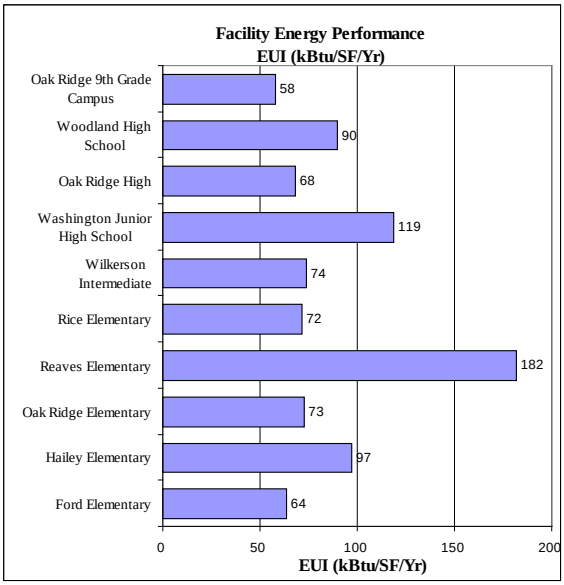
		Electric		Natural Gas		Total	Total	EUI	ECI	
	Building	KWH/Yr	$Cost/Yr	MCF/Yr	$Cost/Yr	$Cost/Yr	MMBTU/Yr	kBTU/SF/Yr	$/SF/Yr	SF
1	Ford Elementary	1,433,679	166,659	0	0	166,659	4,893	64	2.16	77,000
2	Hailey Elementary	1,711,040	141,914	0	0	141,914	5,840	97	2.37	60,000
3	Oak Ridge Elementary	1,580,500	136,069	0	0	136,069	5,394	73	1.84	74,088
4	Reaves Elementary	4,500,240	404,739	0	0	404,739	15,359	182	4.80	84,358
5	Rice Elementary	1,554,288	135,034	0	0	135,034	5,305	72	1.82	74,008
6	Wilkerson Intermediate	1,789,000	158,510	0	0	158,510	6,106	74	1.91	82,884
7	Washington Junior High School	5,054,672	435,085	0	0	435,085	17,252	119	3.00	144,966
8	Oak Ridge High	7,267,400	620,947	0	0	620,947	24,804	68	1.71	363,000
9	Woodland High School	10,456,800	882,286	0	0	882,286	35,689	90	2.22	397,000
10	Oak Ridge 9th Grade Campus	2,522,920	222,881	0	0	222,881	8,611	58	1.50	149,000
		KWH/Yr	$Cost/Yr	MCF/Yr	$Cost/Yr	$Cost/Yr	MMBTU/Yr	kBTU/SF/Yr	$/SF/Yr	SF
		37,870,539	3,304,124	0	0	3,304,124	129,252	86	2.19	1,506,304

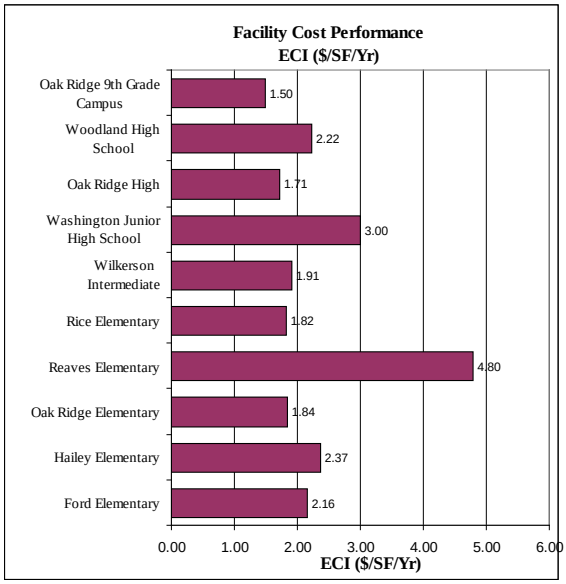
(1) Natural Gas utility data not including therefore EUI and ECI indices will increase if gas data is included.

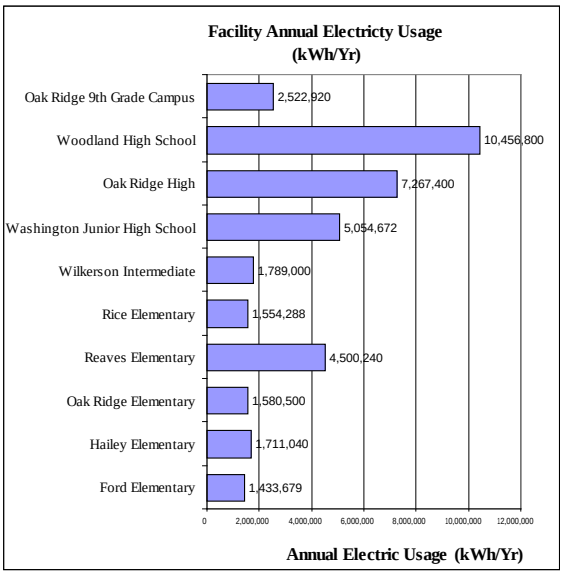
Knowing the EUI and ECI of each facility is useful to help determine the District's overall energy performance. The District's overall EUI value of 86 indicates potential for energy savings. Adoption of the energy reduction measures recommended in this report will aid the District in improving these indices.

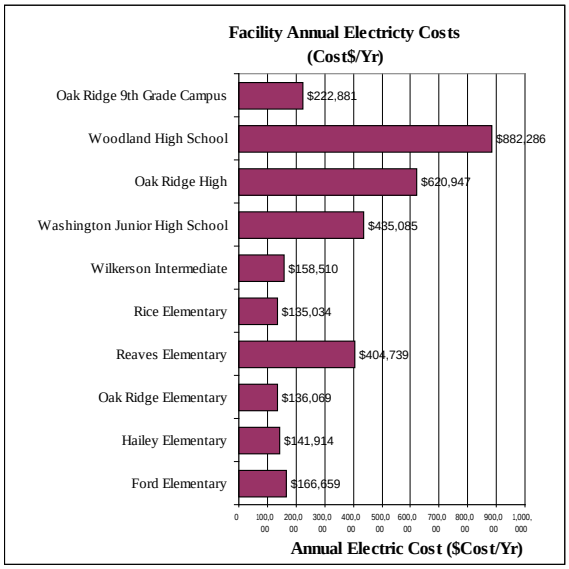
In addition, the District's EUI was compared to TEESI's database of Texas schools. See Appendix D to determine how each facility ranked.

The following charts summarize the data presented in the previous table. See Appendix C for further detail.









4.0 ENERGY ACCOUNTING

UTILITY PROVIDERS

Entergy and CenterPoint Energy provide electric services to the District.

MONITORING AND TRACKING

The District presently utilizes an electronic spreadsheet to track their utility data. Electronic spreadsheets are an essential tool by which an energy management program's activities are monitored. These spreadsheet can be used to track all utilities consumption and cost (i.e., Electric kWh & Cost$, Gas MCF & Cost$) on a monthly basis. The District uses this data to track utility consumption patterns and budget utility expenses. Having this historical data improves the District's awareness of their energy performance and will help in tracking their energy reduction goals.

The steps below are essential for an effective energy management tracking system:

1. Utility Meter Mapping: Develop a working document identifying meters, account numbers, and associated buildings served by the utility service. Due to large number of accounts and buildings served this step is recommended.

2. Bill Rate Analysis: Periodic spot checks of the applicable utility rates (TDSP Charges, demand ratchet clauses, power factor charges, etc.) to identify any abnormal situation.

3. Perform regular updates: An effective system requires current and comprehensive data. Monthly updates should be strongly encouraged.

4. Conduct periodic reviews: Such reviews should focus on progress made, problems encountered, and potential rewards.

5. Identify necessary corrective actions: This step is essential for identifying if a specific activity is not meeting its expected performance and is in need of review.

In addition, having this historical utility data would facilitate **House Bill 3693** and **Senate Bill 12** reporting requirements. Please see Section 5.0 for additional information regarding these requirements.

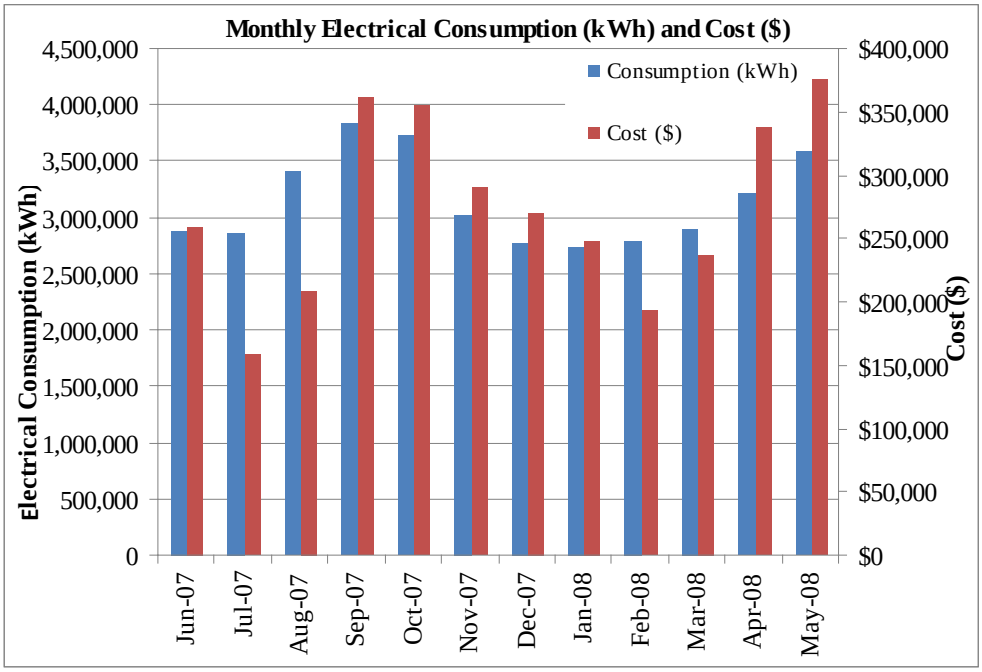
Furthermore, below in the following page is a sample format the District can customize to help summarize their overall utility usage and costs.

The data presented below is a summation of the data provided by the District. This data below includes only selected utility accounts and is for reference purposes only and does not represent the District's total utility data. See **Appendix C** for further detail regarding each utility account represented in the table below.

CONROE ISD UTILITY INPUT FORM

MONTH	ELECTRICITY			NATURAL GAS			WATER		
	KWH	COST $	$/KWH	MCF	COST $	$/MCF	GAL	COST $	$/GAL
Jun-07	2,893,632	$259,056	$0.090						
Jul-07	2,878,680	$159,157	$0.055						
Aug-07	3,427,028	$209,953	$0.061						
Sep-07	3,840,940	$362,474	$0.094						
Oct-07	3,742,959	$355,178	$0.095						
Nov-07	3,022,352	$291,953	$0.097						
Dec-07	2,789,160	$271,042	$0.097						
Jan-08	2,753,908	$248,336	$0.090						
Feb-08	2,795,548	$193,760	$0.069						
Mar-08	2,904,684	$237,848	$0.082						
Apr-08	3,228,540	$338,751	$0.105						
May-08	3,593,108	$376,616	$0.105						
Total	37,870,539	$3,304,124	$0.087						

Gross Building Area:	1,506,304	SF



5.0 SENATE BILL 12 AND HOUSE BILL 3693 OVERVIEW

In 2001, the 77th Texas Legislature passed Senate Bill 5 (SB5), also known as the Texas Emissions Reduction Plan, to amend the Texas Health and Safety Code. The legislation required ambitious, fundamental changes in energy use to help the state comply with federal Clean Air Act standards. It applied to all political subdivisions within 38 designated counties, later expanded to 41 counties.

In 2007, the 80th Texas Legislature passed Senate Bill 12 (SB 12) which among other things extended the timeline set in SB 5 for emission reductions. In the same period, the 80th Texas Legislature passed House Bill 3693 (HB 3693) which amended provisions of several codes relating primarily to energy efficiency.

The Bill requirements that are most relevant to this program are as follows:

- Establish a goal of reducing electric consumption by five percent (5%) each state fiscal year for six (6) years, beginning on September 1, 2007.

- Record electric, water, and natural gas utility services (consumption and cost) in an electronic repository. The recorded information shall be on a publicly accessible Internet Web site with an interface designed for ease of navigation if available, or at another publicly accessible location.

- Energy-efficient light bulbs for buildings, requires an institution to purchase commercially available light bulbs using the lowest wattages for the required illumination levels.

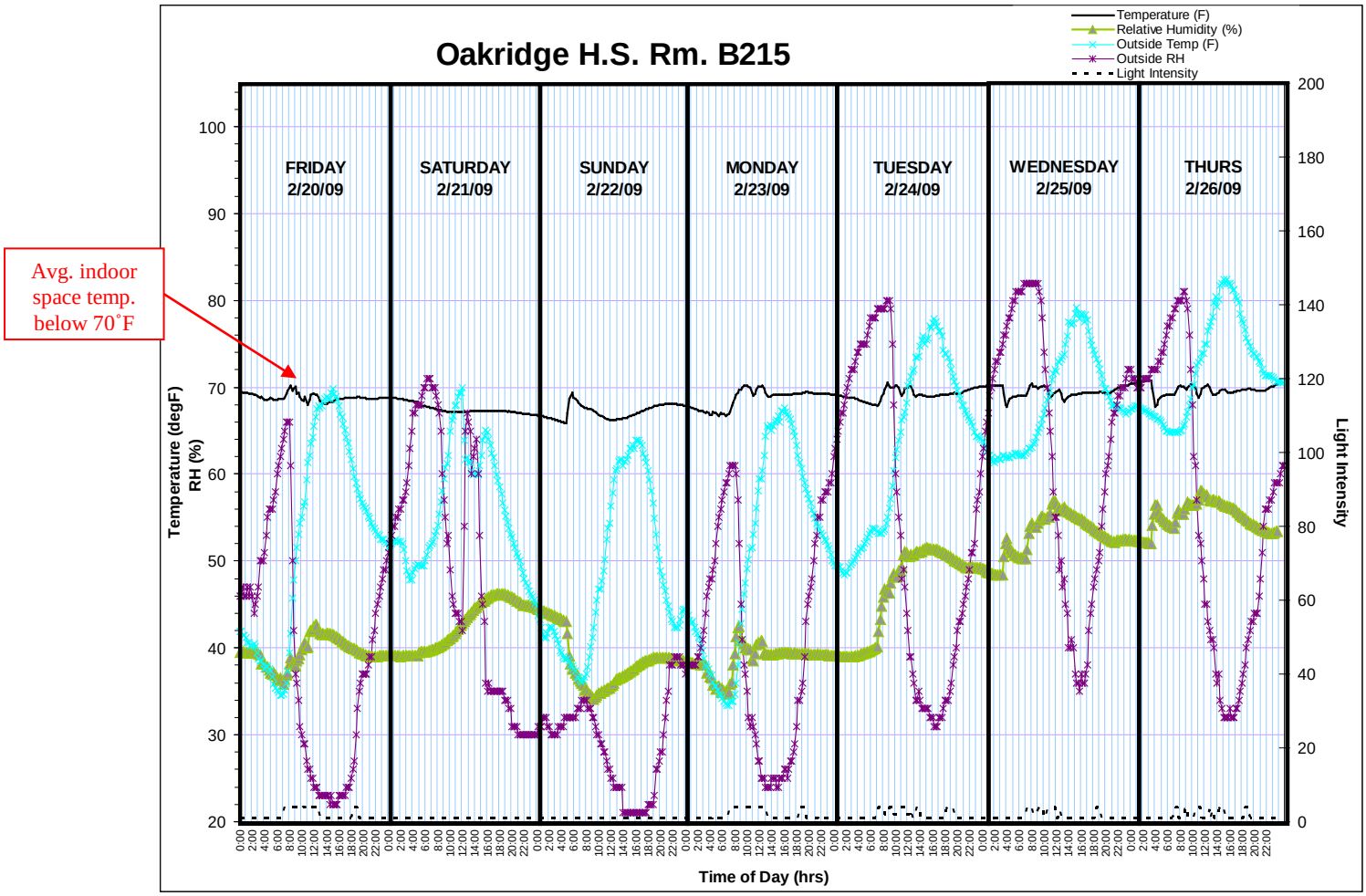
- Installation of energy saving devices in Vending Machines with non-perishable food products. **Not required by School Districts but highly recommended.**

A summary description of SB 12 and HB 3693 is available in Appendix A. Further detail regarding each bill can be found in the Texas Legislature website (http://www.capitol.state.tx.us/Home.aspx).

To help with the utility reporting process a sample input form can be found in the previous page and Appendix B of this report.

6.0 SAMPLE MONITORING OF INDOOR ENVIRONMENT CONDITIONS

During the onsite survey data-logging equipment was deployed at several locations throughout the District, to provide a snapshot of the indoor conditions. The data-logging equipment recorded the room's light intensity, space temperature and relative humidity. The data was analyzed to determine the average room temperatures throughout a typical weekday and weekend. In addition, the light intensity was recorded to determine if the lights remained on during unoccupied periods. Below is an example chart summarizing the data, see Appendix E for additional charts.



Furthermore, a cursory check of several facilities' Energy Management Systems (EMS) was conducted. Below are a few sample EMS screenshots taken during the preliminary walkthrough. The first example indicates excessive cycling of an Air Handling Units (AHU) Variable Frequency Drive (VFD). The VFD's primary function is to vary the AHU's fan speed in order to maintain a predetermined static pressure range in the supply air ducts. Many factors may be causing this excessive cycling. One possible solution is to calibrate the Proportional-Integral-Derivative (PID) loop of the controller. It is recommended a Commissioning (Cx) program be considered to address items such as these and to further investigate, verify and calibrate the District's EMS to ensure full optimization. Please see **Section 10.0** and **Appendix J** for further discussion regarding Building Commissioning (Cx).

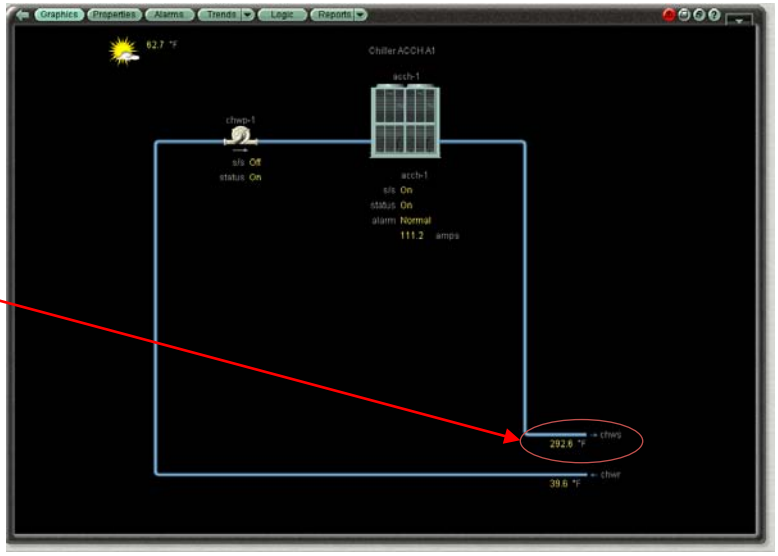
EMS Screenshots #1: Oakridge 9th Grade Campus – AHUs VFD Hunting

Example of excessive cycling "Hunting" of an AHUs VFD.

Calibrations of controller's PID Loop may be required.

EMS Screenshot #2: Rice Elementary – Inaccurate CHWS Temperature Reading

Chilled Water Supply (CHWS) temperature sensor reading is 292.6˚F. (Possible Faulty Sensor)



7.0 RECOMMENDED MAINTENANCE & OPERATION PROCEDURES

Sound Maintenance and Operation procedures significantly improve annual utility costs, equipment life, and occupant comfort. Generally, maintenance and operation procedural improvements can be made with existing staff and budgetary levels. Below are typical maintenance and operations procedures that have energy savings benefits. Please note that some of the recommendations noted below are currently being practiced by the District. With this in mind, the following maintenance and operation procedures should be encouraged/continued to ensure sustainable energy savings.

PUBLICIZE ENERGY CONSERVATION

Promote energy awareness at regular staff meetings, on bulletin boards, and through organizational publications. Publicize energy cost reports showing uptrends and downtrends.

IMPROVE CONTROL OF INTERIOR & EXTERIOR LIGHTING

Establish procedures to monitor use of lighting at times and places of possible/probable unnecessary use: Offices and classes at lunchtime, maintenance shops, closets, parking lots during daylight hours, etc. One or two friendly reminders for minor infractions will usually result in lower electric bills. **The picture on the below is a good example of effective lighting reduction practices and utilization of natural light through windows.** During the preliminary walkthrough of Geisinger Elementary, it was observed the hallway lights were switched off while sufficient natural light was entering through windows. This daylighting practice should be encouraged throughout the District (where appropriate).

Good Example of Daylighting
Geisinger Elem. Hallway

PRE-IDENTIFY PREMIUM EFFICIENCY MOTOR (PEM) REPLACEMENTS

Pre-identify supply sources and PEM stock numbers for all HVAC fan and pump motors so that as failures occur, replacement with PEM units can take place on a routine basis. As funding allows, pre-stock PEM replacements according to anticipated demand, i.e., motors in service more than 10 years, motors in stressful service, and particular motor types that are in service at several locations.

TYPICAL EQUIPMENT MAINTENANCE CHECKLISTS

Document schedules and review requirements for replacing filters, cleaning condensers, and cleaning evaporators. Include particulars such as filter sizes, crew scheduling, contract availability if needed, etc. Replace filters with standard efficiency pleated units. Generally appropriate service frequencies are as follows -- filters: monthly; condensers: annually; evaporators: 5 years.

Effective operation and maintenance of equipment is one of the most cost effective ways to achieve reliability, safety, and efficiency. Failing to maintain equipment can cause significant energy waste and severely decrease the life of equipment. Substantial savings can result from good operation and maintenance procedures. Initially these tasks can be overwhelming (if several deferred maintenance items are present) however with adequate resources and effective management, these procedures can be integrated into daily operations. Examples of typical maintenance checklists for common equipment are provided in **Appendix I**. These checklists from the Federal Energy Management Program (FEMP), a branch of the Department of Energy (DOE), are based on industry standards and should supplement, not replace those provided by the manufacturer. An effective maintenance program requires proper training in equipment-specific maintenance procedures.

MANAGE SMALL ELECTRICAL EQUIPMENT LOADS

Small electrical equipment loads consists of small appliances/devices such as portable heaters, microwaves, small refrigerators, coffee makers, stereos, cell phone chargers, desk lamps, etc. The District should establish a goal to reduce the number of small appliances and to limit their usage. For example, the use small space heaters should be discouraged; hence, all space heating should be accomplished by the District's main heating system. In addition, many small devices such as radios, printers, and phone chargers can consume energy while not in use. To limit this "stand-by" power usage these devices should be unplugged or plugged into a power strip that can act as a central "turn off" point while not in use. With an effective energy awareness campaign to encourage participation, managing small electrical loads can achieve considerable energy savings.

CONTROL OUTSIDE AIR INFILTRATION

Conduct periodic inspections of door and window weather-stripping, and schedule repairs when needed. Additionally, make sure doors and windows are closed during operation of HVAC systems (heating or cooling). Unintended outside air contributes to higher energy consumption and increases occupant discomfort.

REPLACE INCANDESCENT LAMPS WITH COMPACT FLUORESCENTS.

Replace existing incandescent lamps with compact fluorescent lamps as they burn out. Compact fluorescents use 50 to 75 percent less wattage for the same light output, with ten times the operating life of incandescents.

ENERGY STAR POWER MANAGEMENT

ENERGY STAR Power Management Program promotes placing monitors and computers (CPU, hard drive, etc.) into a low-power "sleep mode" after a period of inactivity. The estimated annual savings can range from $25 to $75 per computer. ENERGY STAR recommends setting computers to enter system standby or hibernate after 30 to 60 minutes of inactivity. Simply touching the mouse or keyboard "wakes" the computer and monitor in seconds. Activating sleep features saves energy, money, and helps protect the environment.

INSTALL ENERGY SAVING DEVICES ON VENDING MACHINE

Install energy saving devices on vending machines with non-perishable food items to reduce the equipment power usage. These devices shut the vending machines down during unoccupied periods. There are several commercially available devices that can be easily installed on existing vending machines. These devices typical have a motion sensor which powers down the equipment after periods of inactivity. For example if the motion sensor does not sense activity within 15 minutes the device will shutdown the vending machine and turn on once motion is sensed. These devices range in price from $100 to $250 and have a typical annual savings of $20 to $150 per vending machine.

WATT WATCHER PROGRAM

Watt Watchers of Texas is a FREE energy conservation program for Texas schools sponsored by the Texas State Energy Conservation Office/ Comptroller of Public Accounts and the Department of Energy. The program is designed for K-12 classrooms the help energy conservation awareness. The program encourages student and staff participation to help schools reduce energy waste. Information regarding this program in is found in **Appendix F**.

HAIL GUARDS ON CONDENSING AND PACKAGED ROOFTOP UNITS

When an HVAC unit is replaced the District should ensure the new unit be specified with hail guards. Hail guards protect the condensing unit's heat exchanger coils from hail damage. Damage to the condensing unit heat exchangers reduces the efficiency of the units. During the preliminary walk-through it was noted that several of the units did not have hail guards installed and showed signs of significant hail damage. It is recommended that unit(s) with damaged condensing fins be straightened using a fin comb. Below is an example of RTU without hail guards at Reeves Elementary.

Example of an RTU without
Hail Guards

CHILLED WATER RESET AS AN OPTIMIZING STRATEGY

Chilled Water Reset (CWR) is a strategy to reduce the chiller energy consumption by raising the chiller's control setpoint. When appropriately applied, CWR is relatively easy to implement and can achieve considerable energy savings. It is important to note that CWR should only be considered on a case-by-case basis, since there are adverse effects when raising the chilled water setpoint. Therefore the strategy of CWR, cannot be applied across the board and should only be considered as an optional strategy. During peak building loads, CWR may have adverse system effects than could interfere with control of space humidity and increase energy consumption of dependent system components (i.e. Pumps, Fan Coil Units, etc.). CWR should be limited to applications where the primary loads are predictable and the effects of outside conditions and operational loads are clearly understood. For example buildings that are lightly loaded at night and on weekends would benefit by this strategy. If CWR can be applied, a recommended chilled water setpoint range is between 44°F to 47°F. In addition, considering a control method based on system loads and outside condition should be considered.

8.0 RETROFIT OPPORTUNITIES

Energy retrofit projects identified during the preliminary analysis are detailed below. Project cost estimates include complete design and construction management services.

WOODLAND HIGH SCHOOL

RETROFIT INTERIOR LIGHTING

Replace T-12 fluorescent lamps and magnetic ballasts with high efficiency T-8 fluorescent lamps and electronic ballasts throughout the District's facilities. Typical four-foot, two-lamp magnetic ballast fixtures require 80 watts, while electronic ballasts and T-8 lamps in the same fixture configuration require only 50 watts. The cost and savings noted in the table below are based on preliminary observations of the facilities. Exact cost and quantities can be identified through a detailed energy audit.

INSTALLATION OF MOTION SENSORS FOR INDOOR LIGHTING CONTROL

It is recommended the District consider installing occupancy motion sensors to improve control of interior lighting. Occupancy sensors will help ensure lights are only on when the space is occupied. The following below provides an estimated cost and energy saving for the installation of these types of sensors. Please note this estimation is based on a preliminary assessment exact sensor location, technology (Infrared, Ultrasonic, and Dual Technology) and quantity can be determined during a detailed energy assessment or design phase. In general, enclosed areas with intermittent use, are typically good candidates for occupancy sensors (i.e. hallways, specific classrooms, conference rooms, break rooms, etc.).

UPGRADE EMS TO FULL DDC

Convert and upgrade all pneumatic control systems to full Direct Digital Control (DDC) Systems. The existing pneumatic devices/controllers have limited control options/capabilities and require frequent repairs to keep operational. Upgrading to a full DDC EMS system will improve system reliability, enhance control capabilities (i.e. chilled and hot water reset, remote room sensor and local override control, etc.) , and increase system efficiency.

DETAILED BUILDING COMMISSIONING (Cx)

Detailed HVAC & controls commissioning in an existing building involves analysis of existing systems to ensure compliance with original set-up/design conditions and where feasible to adjust operating parameters to enhance comfort and reduce energy consumption. Further description on detailed Cx is presented in Section 10. Based on the preliminary examination (utility data review, discussion with staff, and walkthrough) of the District's facilities indicated potential for energy cost savings primarily in the HVAC systems operations. **This type of commissioning is contingent upon the upgrade of existing EMS to a full DDC system.**

The following estimates are based on a preliminary walkthrough and available utility data analysis. Please note, not included in the estimate are the anticipated costs for items such as software & hardware upgrades and deferred maintenance items.

WOODLAND HIGH SCHOOL - RETROFIT OPPORTUNITIES				
ECRM	**Description**	**Estimated Implementation Cost**	**Estimated Annual Savings**	**Payback (years)**
Retrofit Lighting System	T12 to T8 Lamp Replacement	$258,000	$57,300	4.5
Motion Sensors	Installation of Motion Sensors	$44,000	$8,800	5.0
Upgrade EMS	Upgrade to 100% DDC	$515,000	$42,900	12.0
Detailed Cx	Detailed Bldg. Sys. Commissioning	$179,000	$39,700	4.5
TOTAL		**$996,000**	**$148,700**	**6.7**

OAK RIDGE ELEMENTARY

INSTALLATION OF MOTION SENSORS FOR INDOOR LIGHTING CONTROL

It is recommended the District consider installing occupancy motion sensors to improve control of interior lighting. Occupancy sensors will help ensure lights are only on when the space is occupied. The following below provides an estimated cost and energy saving for the installation of these types of sensors. Please note this estimation is based on a preliminary assessment exact sensor location, technology (Infrared, Ultrasonic, and Dual Technology) and quantity can be determined during a detailed energy assessment or design phase. In general, enclosed areas with intermittent use, are typically good candidates for occupancy sensors (i.e. hallways, specific classrooms, conference rooms, break rooms, etc.).

REPLACE AIR HANDLING UNIT (AHU) MOTORS

Replace seven (7) Air Handling Unit (AHU) motors with new high efficiency motors. The AHU motors to be replaced serve the K-3rd Grade Classrooms, Library, Cafeteria, and Main Office. Replacement these motors with new high efficiency motors will improve the systems performance and reduce energy consumption.

INSTALL VAV TERMINAL BOXES

Install Variable Air Volume (VAV) Terminal Boxes in the areas served by AHU-2 and AHU-4 (K – 3rd classrooms). Installing VAVs will allow for improved control, modulate cooling to meet system demand, and improve occupant comfort.

UPGRADE EMS TO FULL DDC

Convert and upgrade all pneumatic control systems to full Direct Digital Control (DDC) Systems. The existing pneumatic devices/controllers have limited control options/capabilities and require frequent repairs to keep operational. Upgrading to a full DDC EMS system will improve system reliability, enhance control capabilities (i.e. chilled and hot water reset, remote room sensor and local override control, etc.) , and increase system efficiency.

OAK RIDGE ELEMENTARY - RETROFIT OPPORTUNITIES				
ECRM	**Description**	**Estimated Implementation Cost**	**Estimated Annual Savings**	**Payback (years)**
Motion Sensors	Installation of Motion Sensors	$27,000	$4,500	6.0
AHU Motor Replacement	Replace 7-AHU Fan Motors	$14,000	$2,300	6.1
Install VAVs	Install VAV Terminal units in Classroom Areas	$280,000	$18,600	15.1
Upgrade EMS	Upgrade to 100% DDC	$110,000	$7,800	14.1
TOTAL		**$431,000**	**$33,200**	**13.0**

OAK RIDGE 9TH GRADE CAMPUS

RETROFIT INTERIOR LIGHTING

Replace T-12 fluorescent lamps and magnetic ballasts with high efficiency T-8 fluorescent lamps and electronic ballasts throughout the District's facilities. Typical four-foot, two-lamp magnetic ballast fixtures require 80 watts, while electronic ballasts and T-8 lamps in the same fixture configuration require only 50 watts. The cost and savings noted in the table below are based on preliminary observations of the facilities. Exact cost and quantities can be identified through a detailed energy audit.

INSTALLATION OF MOTION SENSORS FOR INDOOR LIGHTING CONTROL

It is recommended the District consider installing occupancy motion sensors to improve control of interior lighting. Occupancy sensors will help ensure lights are only on when the space is occupied. The following below provides an estimated cost and energy saving for the installation of these types of sensors. Please note this estimation is based on a preliminary assessment exact sensor location, technology (Infrared, Ultrasonic, and Dual Technology) and quantity can be determined during a detailed energy assessment or design phase. In general, enclosed areas with intermittent use, are typically good candidates for occupancy sensors (i.e. hallways, specific classrooms, conference rooms, break rooms, etc.).

UPGRADE EMS TO FULL DDC

Convert and upgrade all pneumatic control systems to full Direct Digital Control (DDC) Systems. The existing pneumatic devices/controllers have limited control options/capabilities and require frequent repairs to keep operational. Upgrading to a full DDC EMS system will improve system reliability, enhance control capabilities (i.e. chilled and hot water reset, remote room sensor and local override control, etc.) , and increase system efficiency.

DETAILED BUILDING COMMISSIONING (Cx)

Detailed HVAC & controls commissioning in an existing building involves analysis of existing systems to ensure compliance with original set-up/design conditions and where feasible to adjust operating parameters to enhance comfort and reduce energy consumption. Further description on detailed Cx is presented in Section 10. Based on the preliminary examination (utility data review, discussion with staff, and walkthrough) of the District's facilities indicated potential for energy cost savings primarily in the HVAC systems operations. **This type of commissioning is contingent upon the upgrade of existing EMS to a full DDC system.**

The following estimates are based on a preliminary walkthrough and available utility data analysis. Please note, not included in the estimate are the anticipated costs for items such as software & hardware upgrades and deferred maintenance items

OAK RIDGE 9TH GRADE CAMPUS - RETROFIT OPPORTUNITIES				
ECRM	**Description**	**Estimated Implementation Cost**	**Estimated Annual Savings**	**Payback (years)**
Retrofit Lighting System	T12 to T8 Lamp Replacement	$82,300	$16,400	5.0
Motion Sensors	Installation of Motion Sensors	$33,000	$6,000	5.5
Upgrade EMS	Upgrade to 100% DDC	$190,000	$13,500	14.1
Detailed Cx	Detailed Bldg. Sys. Commissioning	$67,000	$14,800	4.5
TOTAL		**$372,300**	**$50,700**	**7.3**

REAVES ELEMENTARY

RETROFIT INTERIOR LIGHTING

Replace T-12 fluorescent lamps and magnetic ballasts with high efficiency T-8 fluorescent lamps and electronic ballasts throughout the District's facilities. Typical four-foot, two-lamp magnetic ballast fixtures require 80 watts, while electronic ballasts and T-8 lamps in the same fixture configuration require only 50 watts. The cost and savings noted in the table below are based on preliminary observations of the facilities. Exact cost and quantities can be identified through a detailed energy audit.

INSTALLATION OF MOTION SENSORS FOR INDOOR LIGHTING CONTROL

It is recommended the District consider installing occupancy motion sensors to improve control of interior lighting. Occupancy sensors will help ensure lights are only on when the space is occupied. The following below provides an estimated cost and energy saving for the installation of these types of sensors. Please note this estimation is based on a preliminary assessment exact sensor location, technology (Infrared, Ultrasonic, and Dual Technology) and quantity can be determined during a detailed energy assessment or design phase. In general, enclosed areas with intermittent use, are typically good candidates for occupancy sensors (i.e. hallways, specific classrooms, conference rooms, break rooms, etc.).

UPGRADE EMS TO FULL DDC

Convert and upgrade all pneumatic control systems to full Direct Digital Control (DDC) Systems. The existing pneumatic devices/controllers have limited control options/capabilities and require frequent repairs to keep operational. Upgrading to a full DDC EMS system will improve system reliability, enhance control capabilities (i.e. chilled and hot water reset, remote room sensor and local override control, etc.) , and increase system efficiency.

DETAILED BUILDING COMMISSIONING (Cx)

Detailed HVAC & controls commissioning in an existing building involves analysis of existing systems to ensure compliance with original set-up/design conditions and where feasible to adjust operating parameters to enhance comfort and reduce energy consumption. Further description on detailed Cx is presented in Section 10. Based on the preliminary examination (utility data review, discussion with staff, and walkthrough) of the District's facilities indicated potential for energy cost savings primarily in the HVAC systems operations. **This type of commissioning is contingent upon the upgrade of existing EMS to a full DDC system.**

The following estimates are based on a preliminary walkthrough and available utility data analysis. Please note, not included in the estimate are the anticipated costs for items such as software & hardware upgrades and deferred maintenance items

REAVES ELEMENTARY - RETROFIT OPPORTUNITIES				
ECRM	**Description**	**Estimated Implementation Cost**	**Estimated Annual Savings**	**Payback (years)**
Retrofit Lighting System	T12 to T8 Lamp Replacement	$54,800	$12,100	4.5
Motion Sensors	Installation of Motion Sensors	$30,000	$5,000	6.0
Upgrade EMS	Upgrade to 100% DDC	$215,000	$15,900	13.5
Detailed Cx	Detailed Bldg. Sys. Commissioning	$46,000	$11,500	4.0
TOTAL		**$345,800**	**$44,500**	**7.8**

OAK RIDGE HIGH

RETROFIT INTERIOR LIGHTING

Replace T-12 fluorescent lamps and magnetic ballasts with high efficiency T-8 fluorescent lamps and electronic ballasts throughout the District's facilities. Typical four-foot, two-lamp magnetic ballast fixtures require 80 watts, while electronic ballasts and T-8 lamps in the same fixture configuration require only 50 watts. The cost and savings noted in the table below are based on preliminary observations of the facilities. Exact cost and quantities can be identified through a detailed energy audit.

INSTALLATION OF MOTION SENSORS FOR INDOOR LIGHTING CONTROL

It is recommended the District consider installing occupancy motion sensors to improve control of interior lighting. Occupancy sensors will help ensure lights are only on when the space is occupied. The following below provides an estimated cost and energy saving for the installation of these types of sensors. Please note this estimation is based on a preliminary assessment exact sensor location, technology (Infrared, Ultrasonic, and Dual Technology) and quantity can be determined during a detailed energy assessment or design phase. In general, enclosed areas with intermittent use, are typically good candidates for occupancy sensors (i.e. hallways, specific classrooms, conference rooms, break rooms, etc.).

UPGRADE EMS TO FULL DDC

Convert and upgrade all pneumatic control systems to full Direct Digital Control (DDC) Systems. The existing pneumatic devices/controllers have limited control options/capabilities and require frequent repairs to keep operational. Upgrading to a full DDC EMS system will improve system reliability, enhance control capabilities (i.e. chilled and hot water reset, remote room sensor and local override control, etc.) , and increase system efficiency.

DETAILED BUILDING COMMISSIONING (Cx)

Detailed HVAC & controls commissioning in an existing building involves analysis of existing systems to ensure compliance with original set-up/design conditions and where feasible to adjust operating parameters to enhance comfort and reduce energy consumption. Further description on detailed Cx is presented in Section 10. Based on the preliminary examination (utility data review, discussion with staff, and walkthrough) of the District's facilities indicated potential for energy cost savings primarily in the HVAC systems operations. **This type of commissioning is contingent upon the upgrade of existing EMS to a full DDC system.**

The following estimates are based on a preliminary walkthrough and available utility data analysis. Please note, not included in the estimate are the anticipated costs for items such as software & hardware upgrades and deferred maintenance items

OAK RIDGE HIGH - RETROFIT OPPORTUNITIES				
ECRM	**Description**	**Estimated Implementation Cost**	**Estimated Annual Savings**	**Payback (years)**
Retrofit Lighting System	T12 to T8 Lamp Replacement	$200,500	$44,500	4.5
Motion Sensors	Installation of Motion Sensors	$40,000	$8,000	5.0
Upgrade EMS	Upgrade to 100% DDC	$425,000	$34,000	12.5
Detailed Cx	Detailed Bldg. Sys. Commissioning	$163,000	$36,200	4.5
TOTAL		**$828,500**	**$122,700**	**6.8**

FORD ELEMENTARY

RETROFIT INTERIOR LIGHTING

Replace T-12 fluorescent lamps and magnetic ballasts with high efficiency T-8 fluorescent lamps and electronic ballasts throughout the District's facilities. Typical four-foot, two-lamp magnetic ballast fixtures require 80 watts, while electronic ballasts and T-8 lamps in the same fixture configuration require only 50 watts. The cost and savings noted in the table below are based on preliminary observations of the facilities. Exact cost and quantities can be identified through a detailed energy audit.

INSTALLATION OF MOTION SENSORS FOR INDOOR LIGHTING CONTROL

It is recommended the District consider installing occupancy motion sensors to improve control of interior lighting. Occupancy sensors will help ensure lights are only on when the space is occupied. The following below provides an estimated cost and energy saving for the installation of these types of sensors. Please note this estimation is based on a preliminary assessment exact sensor location, technology (Infrared, Ultrasonic, and Dual Technology) and quantity can be determined during a detailed energy assessment or design phase. In general, enclosed areas with intermittent use, are typically good candidates for occupancy sensors (i.e. hallways, specific classrooms, conference rooms, break rooms, etc.).

REPLACE WATER COOLED CHILLERS

Replace one (1) water-cooled chiller totaling approximately 100 tons with a new high efficiency water-cooled chiller. The existing unit is over 30 years old and has reached its useful life. The new high efficiency units will improve the HVAC system's performance and reliability.

REPLACE GAS FIRED BOILER

Replace one (1) 2,208 MBH gas fired boiler with a new high efficiency units. The existing boiler is over 30 years old and has reached its useful life. The new high efficiency boiler will improve the HVAC system's performance.

INSTALL VARIABLE FREQUENCY DRIVES TO REPLACE AHU INLET GUIDE VANES

Install two (2) 25 HP Variable Frequency Drives (VFDs) on two (2) Air Handling Units (AHU). The VFDs will replace the inlet guide vanes currently installed. The VFDs will allow the AHU's fan speed to modulate according to system demand. The application of VFDs will improve system operation and reduce energy consumption.

UPGRADE EMS TO FULL DDC

Convert and upgrade all pneumatic control systems to full Direct Digital Control (DDC) Systems. The existing pneumatic devices/controllers have limited control options/capabilities and require frequent repairs to keep operational. Upgrading to a full DDC EMS system will improve system reliability, enhance control capabilities (i.e. chilled and hot water reset, remote room sensor and local override control, etc.) , and increase system efficiency.

The following estimates are based on a preliminary walkthrough and available utility data analysis. Please note, not included in the estimate are the anticipated costs for items such as software & hardware upgrades and deferred maintenance items

FORD ELEMENTARY - RETROFIT OPPORTUNITIES				
ECRM	**Description**	**Estimated Implementation Cost**	**Estimated Annual Savings**	**Payback (years)**
Retrofit Lighting System	T12 to T8 Lamp Replacement	$50,000	$10,000	5.0
Motion Sensors	Installation of Motion Sensors	$28,000	$4,600	6.1
Replace Chiller	Replace 1 Chiller (100 tons)	$200,000	$12,500	16.0
Replace Boiler	Replace 1-2,208 MBH Gas Boiler	$88,000	$4,800	18.3
Install VFDs	Install VFDs on 2-25 HP AHUs	$30,000	$3,000	10.0
Upgrade EMS	Upgrade to 100% DDC	$165,000	$10,300	16.0
TOTAL		**$561,000**	**$45,200**	**12.4**

WILKERSON INTERMEDIATE

RETROFIT INTERIOR LIGHTING

Replace T-12 fluorescent lamps and magnetic ballasts with high efficiency T-8 fluorescent lamps and electronic ballasts throughout the District's facilities. Typical four-foot, two-lamp magnetic ballast fixtures require 80 watts, while electronic ballasts and T-8 lamps in the same fixture configuration require only 50 watts. The cost and savings noted in the table below are based on preliminary observations of the facilities. Exact cost and quantities can be identified through a detailed energy audit.

INSTALLATION OF MOTION SENSORS FOR INDOOR LIGHTING CONTROL

It is recommended the District consider installing occupancy motion sensors to improve control of interior lighting. Occupancy sensors will help ensure lights are only on when the space is occupied. The following below provides an estimated cost and energy saving for the installation of these types of sensors. Please note this estimation is based on a preliminary assessment exact sensor location, technology (Infrared, Ultrasonic, and Dual Technology) and quantity can be determined during a detailed energy assessment or design phase. In general, enclosed areas with intermittent use, are typically good candidates for occupancy sensors (i.e. hallways, specific classrooms, conference rooms, break rooms, etc.).

PACKAGED ROOFTOP UNIT (RTU) REPLACEMENT

Replace seventeen (17) Packaged Rooftop Units (RTUs) totaling approximately 300 tons. The existing units are over 25 years old and are beyond their useful life. Replacing the existing 17 RTUs with new high efficiency RTUs will improve the HVACs overall system performance and enhance occupant comfort.

UPGRADE EMS TO FULL DDC

Convert and upgrade all pneumatic control systems to full Direct Digital Control (DDC) Systems. The existing pneumatic devices/controllers have limited control options/capabilities and require frequent repairs to keep operational. Upgrading to a full DDC EMS system will improve system reliability, enhance control capabilities (i.e. chilled and hot water reset, remote room sensor and local override control, etc.) , and increase system efficiency.

The following estimates are based on a preliminary walkthrough and available utility data analysis. Please note, not included in the estimate are the anticipated costs for items such as software & hardware upgrades and deferred maintenance items

WILKERSON INTERMEDIATE - RETROFIT OPPORTUNITIES				
ECRM	**Description**	**Estimated Implementation Cost**	**Estimated Annual Savings**	**Payback (years)**
Retrofit Lighting System	T12 to T8 Lamp Replacement	$43,000	$9,500	4.5
Motion Sensors	Installation of Motion Sensors	$18,000	$3,200	5.6
Replace RTU	Replace 17 RTU (approx. 300 Tons)	$616,000	$34,200	18.0
Upgrade EMS	Upgrade to 100% DDC	$120,000	$7,500	16.0
TOTAL		**$797,000**	**$54,400**	**14.7**

HAILEY ELEMENTARY

RETROFIT INTERIOR LIGHTING

Replace T-12 fluorescent lamps and magnetic ballasts with high efficiency T-8 fluorescent lamps and electronic ballasts throughout the District's facilities. Typical four-foot, two-lamp magnetic ballast fixtures require 80 watts, while electronic ballasts and T-8 lamps in the same fixture configuration require only 50 watts. The cost and savings noted in the table below are based on preliminary observations of the facilities. Exact cost and quantities can be identified through a detailed energy audit.

INSTALLATION OF MOTION SENSORS FOR INDOOR LIGHTING CONTROL

It is recommended the District consider installing occupancy motion sensors to improve control of interior lighting. Occupancy sensors will help ensure lights are only on when the space is occupied. The following below provides an estimated cost and energy saving for the installation of these types of sensors. Please note this estimation is based on a preliminary assessment exact sensor location, technology (Infrared, Ultrasonic, and Dual Technology) and quantity can be determined during a detailed energy assessment or design phase. In general, enclosed areas with intermittent use, are typically good candidates for occupancy sensors (i.e. hallways, specific classrooms, conference rooms, break rooms, etc.).

REPLACE WATER COOLED CHILLERS

Replace one (1) water-cooled chiller totaling approximately 78 tons with new a high efficiency water-cooled chiller. The existing unit is over 30 years old and has reached its useful life. The new high efficiency unit will improve the HVAC system's performance.

REPLACE GAS FIRED BOILER

Replace one (1) 2,208 MBH gas fired boiler with a new high efficiency units. The existing boiler is over 30 years old and has reached its useful life. The new high efficiency boiler will improve the HVAC system's performance.

INSTALL VARIABLE FREQUENCY DRIVES TO REPLACE AHU INLET GUIDE VANES

Install two (2) 25 HP Variable Frequency Drives (VFDs) on two (2) air handling units (AHU). The units will replace the inlet guide vanes currently installed. The VFDs will allow the AHU's fan speed to modulate according to system demand. The application of VFDs will improve system operation and reduce energy consumption.

UPGRADE EMS TO FULL DDC

Convert and upgrade all pneumatic control systems to full Direct Digital Control (DDC) Systems. The existing pneumatic devices/controllers have limited control options/capabilities and require frequent repairs to keep operational. Upgrading to a full DDC EMS system will improve system reliability, enhance control capabilities (i.e. chilled and hot water reset, remote room sensor and local override control, etc.) , and increase system efficiency.

The following estimates are based on a preliminary walkthrough and available utility data analysis. Please note, not included in the estimate are the anticipated costs for items such as software & hardware upgrades and deferred maintenance items

HAILEY ELEMENTARY - RETROFIT OPPORTUNITIES				
ECRM	**Description**	**Estimated Implementation Cost**	**Estimated Annual Savings**	**Payback (years)**
Retrofit Lighting System	T12 to T8 Lamp Replacement	$39,000	$7,800	5.0
Motion Sensors	Installation of Motion Sensors	$22,000	$3,600	6.1
Replace Chiller	Replace 1 Chiller (78 tons)	$156,000	$8,600	18.1
Replace Boiler	Replace 1-2,208 MBH Gas Boiler	$88,000	$4,800	18.3
Install VFDs	Install VFDs on 2-25 HP AHUs	$30,000	$3,000	10.0
Upgrade EMS	Upgrade to 100% DDC	$160,000	$11,400	14.0
TOTAL		**$495,000**	**$39,200**	**12.6**

WASHINGTON JUNIOR HIGH

RETROFIT INTERIOR LIGHTING

Replace T-12 fluorescent lamps and magnetic ballasts with high efficiency T-8 fluorescent lamps and electronic ballasts throughout the District's facilities. Typical four-foot, two-lamp magnetic ballast fixtures require 80 watts, while electronic ballasts and T-8 lamps in the same fixture configuration require only 50 watts. The cost and savings noted in the table below are based on preliminary observations of the facilities. Exact cost and quantities can be identified through a detailed energy audit.

INSTALLATION OF MOTION SENSORS FOR INDOOR LIGHTING CONTROL

It is recommended the District consider installing occupancy motion sensors to improve control of interior lighting. Occupancy sensors will help ensure lights are only on when the space is occupied. The following below provides an estimated cost and energy saving for the installation of these types of sensors. Please note this estimation is based on a preliminary assessment exact sensor location, technology (Infrared, Ultrasonic, and Dual Technology) and quantity can be determined during a detailed energy assessment or design phase. In general, enclosed areas with intermittent use, are typically good candidates for occupancy sensors (i.e. hallways, specific classrooms, conference rooms, break rooms, etc.).

REPLACE AIR HANDLING UNITS (AHUs)

Replace fourteen (14) Air Handling Units (AHU), serving the building's original classroom wings, with new high efficiency units. The existing units are over 30 years old and are beyond their useful life. Replacing the existing 14 AHUs will improve the HVACs overall system performance and enhance occupant comfort.

UPGRADE EMS TO FULL DDC

Convert and upgrade all pneumatic control systems to full Direct Digital Control (DDC) Systems. The existing pneumatic devices/controllers have limited control options/capabilities and require frequent repairs to keep operational. Upgrading to a full DDC EMS system will improve system reliability, enhance control capabilities (i.e. chilled and hot water reset, remote room sensor and local override control, etc.) , and increase system efficiency.

DETAILED BUILDING COMMISSIONING (Cx)

Detailed HVAC & controls commissioning in an existing building involves analysis of existing systems to ensure compliance with original set-up/design conditions and where feasible to adjust operating parameters to enhance comfort and reduce energy consumption. Further description on detailed Cx is presented in Section 10. Based on the preliminary examination (utility data review, discussion with staff, and walkthrough) of the District's facilities indicated potential for energy cost savings primarily in the HVAC systems operations. **This type of commissioning is contingent upon the upgrade of existing EMS to a full DDC system.**

The following estimates are based on a preliminary walkthrough and available utility data analysis. Please note, not included in the estimate are the anticipated costs for items such as software & hardware upgrades and deferred maintenance items

WASHINGTON JUNIOR HIGH - RETROFIT OPPORTUNITIES				
ECRM	**Description**	**Estimated Implementation Cost**	**Estimated Annual Savings**	**Payback (years)**
Retrofit Lighting System	T12 to T8 Lamp Replacement	$94,200	$20,900	4.5
Motion Sensors	Installation of Motion Sensors	$32,000	$5,800	5.5
Replace AHUs	Replace 14 AHUs	$483,000	$25,400	19.0
Upgrade EMS	Upgrade to 100% DDC	$250,000	$25,000	10.0
Detailed Cx	Detailed Bldg. Sys. Commissioning	$65,000	$14,400	4.5
TOTAL		**$924,200**	**$91,500**	**10.1**

RICE ELEMENTARY

RETROFIT INTERIOR LIGHTING

Replace T-12 fluorescent lamps and magnetic ballasts with high efficiency T-8 fluorescent lamps and electronic ballasts throughout the District's facilities. Typical four-foot, two-lamp magnetic ballast fixtures require 80 watts, while electronic ballasts and T-8 lamps in the same fixture configuration require only 50 watts. The cost and savings noted in the table below are based on preliminary observations of the facilities. Exact cost and quantities can be identified through a detailed energy audit.

INSTALLATION OF MOTION SENSORS FOR INDOOR LIGHTING CONTROL

It is recommended the District consider installing occupancy motion sensors to improve control of interior lighting. Occupancy sensors will help ensure lights are only on when the space is occupied. The following below provides an estimated cost and energy saving for the installation of these types of sensors. Please note this estimation is based on a preliminary assessment exact sensor location, technology (Infrared, Ultrasonic, and Dual Technology) and quantity can be determined during a detailed energy assessment or design phase. In general, enclosed areas with intermittent use, are typically good candidates for occupancy sensors (i.e. hallways, specific classrooms, conference rooms, break rooms, etc.).

REPLACE GAS FIRED BOILER

Replace one (1) 2,208 MBH gas fired boiler with a new high efficiency units. The existing boiler is over 30 years old and has reached its useful life. The new high efficiency boiler will improve the HVAC system's performance.

INSTALL VARIABLE FREQUENCY DRIVES TO REPLACE AHU INLET GUIDE VANES

Install two (2) 25 HP Variable Frequency Drives (VFDs) on two (2) air handling units (AHU). The units will replace the inlet guide vanes currently installed. The VFDs will allow the AHU's fan speed to modulate according to system demand. The application of VFDs will improve system operation and reduce energy consumption.

UPGRADE EMS TO FULL DDC

Convert and upgrade all pneumatic control systems to full Direct Digital Control (DDC) Systems. The existing pneumatic devices/controllers have limited control options/capabilities and require frequent repairs to keep operational. Upgrading to a full DDC EMS system will improve system reliability, enhance control capabilities (i.e. chilled and hot water reset, remote room sensor and local override control, etc.) , and increase system efficiency.

The following estimates are based on a preliminary walkthrough and available utility data analysis. Please note, not included in the estimate are the anticipated costs for items such as software & hardware upgrades and deferred maintenance items

RICE ELEMENTARY - RETROFIT OPPORTUNITIES				
ECRM	**Description**	**Estimated Implementation Cost**	**Estimated Annual Savings**	**Payback (years)**
Retrofit Lighting System	T12 to T8 Lamp Replacement	$24,000	$4,800	5.0
Motion Sensors	Installation of Motion Sensors	$27,000	$4,500	6.0
Replace Boiler	Replace 1-2,208 MBH Gas Boiler	$88,000	$4,800	18.3
Install VFDs	Install VFDs on 2-25 HP AHUs	$30,000	$3,000	10.0
Upgrade EMS	Upgrade to 100% DDC	$110,000	$9,100	12.1
TOTAL		**$279,000**	**$26,200**	**10.6**

The following table summarizes the implementation costs, annual savings and payback for the above projects:

SUMMARY OF ENERGY COST REDUCTION MEASURES			
Campus	**Estimated Implementation Cost**	**Estimated Annual Savings**	**Payback (years)**
Woodland High School	$996,000	$148,700	6.7
Oak Ridge Elementary	$431,000	$33,200	13.0
Oak Ridge 9th Grade Campus	$372,300	$50,700	7.3
Reaves Elemenatary	$345,800	$44,500	7.8
Oak Ridge High School	$828,500	$122,700	6.8
Ford Elementary	$561,000	$45,200	12.4
Wilkerson Intermediate	$797,000	$54,400	14.7
Hailey Elementary	$495,000	$39,200	12.6
Washington Junior High	$924,200	$91,500	10.1
Rice Elementary	$279,000	$26,200	10.6
TOTAL:	**$6,029,800**	**$656,300**	**9.2**

The above projects implementation costs and annual savings are estimated based on a preliminary examination of the facilities. Final costs will be determined from detailed building assessments, engineering calculations, and contractor estimates.

Project design (drawings and specifications), if authorized, would normally be accomplished by professional engineers. Project acquisition (competitive bidding) would be in accordance with District requirements, and construction management would be provided by the engineering group who prepared the drawings and specifications.

9.0 CAPITAL IMPROVEMENT PROJECTS

This section is intended to describe capital improvement projects that have energy savings opportunities but cannot be justified solely based on the potential energy savings. However, these projects may be considered essential to ensure optimum system performance, enhance occupant comfort and to improve overall building efficiency. Capital Improvement Projects identified during the preliminary analysis are detailed below. Project cost estimates include complete design and construction management services.

Oak Ridge Elementary – Replace two (2) Air Cooled Chillers totaling approximately 200 tons in cooling capacity. These units serve the original section of the building. The existing chillers are over 15 years old and are reaching their useful life. Replacing the chillers with new high efficiency units will improve the systems efficiency and reliability. In addition, the new chiller water system can be upgrades to accommodate either a variable/primary or primary/secondary flow sequence.

Ford Elementary – Replace five (5) Air Handling Units (AHUs) totaling approximately 178 tons. The existing AHUs 30 years old and have reached their useful life. Replacing the AHUs with new units will improve the systems efficiency and reliability.

Replace one (1) water-cooled chiller totaling approximately 78 tons with a new high efficiency water-cooled chiller. The existing unit is over 30 years old and has reached its useful life. The new high efficiency units will improve the HVAC system's performance and reliability.

Hailey Elementary – Replace five (5) Air Handling Units (AHUs) totaling approximately 178 tons. The existing AHUs 30 years old and have reached their useful life. Replacing the AHUs with new high efficiency units will improve the systems efficiency and reliability.

Rice Elementary – Replace five (5) Air Handling Units (AHUs) totaling approximately 178 tons. The existing AHUs 30 years old and have reached their useful life. Replacing the AHUs with new high efficiency units will improve the systems efficiency and reliability.

CAPITAL RETROFIT PROJECT SUMMARY		
ECRM	**Description**	**Estimated Implementation Cost**
Oak Ridge Elementary	Replace 2-Chillers (approx. 200 Tons)	$400,000
Ford Elementary	Replace 5-AHUs	$370,000
Ford Elementary	Replace 1 Chiller (approx. 78 Tons)	$166,000
Hailey Elementary	Replace 5-AHUs	$370,000
Rice Elementary	Replace 5-AHUs	$370,000
	TOTAL	**$1,676,000**

10.0 BUILDING COMMISSIONING (Cx)

DETAILED COMMISSIONING

Detailed HVAC & controls commissioning in an existing building involves analysis of existing systems to ensure compliance with original set-up/design conditions and where feasible to adjust operating parameters to enhance comfort and reduce energy consumption.

Detailed or enhanced commissioning measures are typically characterized as fast payback, usually 24-60 months. Examples include chiller, boiler, air handler and terminal box service and/or adjustment, calibration of control systems and temperature settings, balancing conditioned air and/or chilled water flows etc. There are various degrees and types of commissioning programs. The cost and savings estimates presented here are for a detailed commissioning program. The project implementation duration may vary according to project complexity (12 to 14 month period is typical).

The goal of commissioning is to deliver a facility that operates as it was intended, meets the needs of the building owner and occupants, and provides training of facility operators. To reach this goal it is necessary for the commissioning process to provide documentation and verification of the performance of all building equipment and systems. For the process to work successfully it is equally important to have good communications between all participants (owners, operators and the commissioning agent) and to keep all parties involved and informed of all pertinent decisions.

At the building level, typical commissioning measures will look into opportunities to optimize the operations of HVAC equipment. Detailed commissioning measures at the building level may include the following:

1. Optimize the AHU operation
    - Develop optimal schedule for the AHUs.
    - Develop optimal reset schedules for single duct VAV unit discharge air temperature setpoints.
    - Develop optimal cold deck and hot deck temperature reset schedules.
    - Develop optimal duct static pressure reset schedules for VAV units.
    - Improve economizer cycle operation (if applicable).
    - Determine damper positions for minimum outside air intake.
    - Optimize air distribution where necessary.

2. Verify and calibrate the temperature and pressure sensors
    - Verify the accuracy of space temperature sensors, discharge air, cold deck and hot deck temperature sensors, as well as duct static pressure sensor and water differential pressure sensors. Calibrate the sensors if necessary.

3. Set up trends for major control parameters
    - Trending for major control parameters such as cold and hot deck temperatures, discharge air temperatures and static pressures.

4. Identify malfunctioning devices
    - Identify malfunctioning devices such as leaky valves. Reconnect damper linkages that are disconnected.

5. Reprogram control sequences where required

6. Optimize Central Plant Performance
    - Develop optimal start/stop schedules for chillers and boilers.
    - Develop optimal reset schedule for water supply temperature for chillers and boilers.

RETRO-COMMISSIONING (RCx)

Utility service provider's Retro-commissioning (RCx) process is a systematic documentation process that identifies low-cost operational and maintenance improvements in existing buildings. The commissioning process is applied to existing buildings to restore them to optimal performance. RCx typically focuses on energy-using equipment such as mechanical equipment, lighting and controls. The goal of a RCx program is to optimize the system performance to improve indoor air quality, comfort, controls, energy and resource efficiency. RCx typically consist of an audit of the entire building including a study of past utility bills and interview with facility personnel. Following, diagnostic monitoring and functional tests of building systems are executed and analyzed. Building systems are retested and re-monitored to fine-tune improvements. These processes help find and repair operational problems as well as identify problems that are more complex.

Facilities in the CenterPoint Energy's service territory are eligible to participate in their Retro-Commissioning Program. If the project is accepted, CenterPoint energy will help offset most of cost to implement RCx. For example if CenterPoint Energy's RCx Program accepts the project, the District's cost to implement RCx will be either $0 or $10,000 (see **Section 11.0** for further detail). Below is a list of schools that are in the CenterPoint Energy service territory.

List of Schools in CenterPoint Energy Service Territory:

1. Ford Elementary
2. Woodland High School
3. Vogel Intermediate
4. Tough Elementary
5. Kaufman Elementary
6. Broadway Elementary
7. York Jr. High
8. Cox Intermediate
9. Birnham Woods Elementary

11.0 FUNDING OPTIONS FOR CAPITAL ENERGY PROJECTS

Institutional organizations have traditionally tapped bond money, maintenance dollars, or federal grants to fund energy-efficient equipment change outs or additions such as energy-efficient lighting systems, high efficiency air conditioning units, and computerized energy management control systems. Today, a broader range of funding options are available. A number of these are listed below.

TEXAS LOANSTAR PROGRAM

The LoanSTAR (Saving Taxes and Resources) Program, which is administered by the State Energy Conservation Office, finances energy-efficient building retrofits at a current interest rate of 3 percent. The program's revolving loan mechanism allows borrowers to repay loans through the stream of cost savings realized from the projects. Projects financed by LoanSTAR must have an average simple payback of ten years or less and must be analyzed in an Energy Assessment Report by a Professional Engineer. Upon final loan execution, the School District proceeds to implement funded projects through the traditional bid/specification process. Contact: Theresa Sifuentes (512/463-1896).

INTERNAL FINANCING

Improvements can be paid for by direct allocations of revenues from an organization's currently available operating or capital funds (bond programs). The use of internal financing normally requires the inclusion and approval of energy-efficiency projects within an organization's annual operating and capital budget-setting process. Often, small projects with high rate of return can be scheduled for implementation during the budget year for which they are approved. Large projects can be scheduled for implementation over the full time period during which the capital budgets is in place. Budget constraints, competition among alternative investments, and the need for higher rates of return can significantly limit the number of internally financed energy-efficiency improvements.

PRIVATE LENDING INSTITUTIONS OR LEASING CORPORATIONS

Banks, leasing corporations, and other private lenders have become increasingly interested in the energy efficiency market. The financing vehicle frequently used by these entities is a municipal lease. Structured like a simple loan, a municipal leasing agreement is usually a lease-purchase arrangement. Ownership of the financed equipment passes to the School District at the beginning of the lease, and the lessor retains a security interest in the purchase until the loan is paid off. A typical lease covers the total cost of the equipment and may include installation costs. At the end of the contract period the lessee pays a nominal amount, usually a dollar, for title to the equipment.

PERFORMANCE CONTRACTING WITH AN ENERGY SERVICE COMPANY

Through this arrangement, an energy service company (ESCO) uses third party financing to implement a comprehensive package of energy management retrofits for a facility. This turnkey service includes an initial assessment by the contractor to determine the energy-saving potential for a facility, design work for identified projects, purchase and installation of equipment, and overall project management. The ESCO guarantees that the cost savings generated by the projects will, at a minimum, cover the annual payment due to the ESCO over the term of the contract.

UTILITY SPONSORED ENERGY EFFICIENCY INCENTIVE PROGRAM

Many of the State's utilities offer energy efficiency incentive programs to offset a portion of the upfront cost associated with energy efficiency measures. The program requirements and incentives range from utility to utility. For example, CenterPoint Energy provides incentives for efficiency measures such as installation of high efficiency equipment, lighting upgrades, and building commissioning. These energy efficiency programs' incentives typically cover $0.06/kWh and $175/kW of verifiable energy and demand reductions, respectively. For further information, contact your utility provider to determine what programs are available in your area.

CENTERPOINT ENERGY RETRO-COMMISSIONING (RCx) INCENTIVE PROGRAM

The Retro-Commissioning is a energy efficiency program offered by CenterPoint Energy. The Retro-Commissioning Program is designed to achieve energy and peak demand savings in the CenterPoint Energy service territory. Savings are realized through the systematic evaluation of electric energy-using systems and subsequent implementation of low-cost measures. These measures target system operation and maintenance opportunities.

This program was designed to comply with Senate Bill 7 (SB7) passed by the Texas Legislature in 1999 which restructured the state's electric utility industry. Under this law, each investor-owned utility is to meet a 10% reduction in its annual system demand growth.

The CenterPoint Energy Retro-commissioning program involves a two-step process (Evaluation and Implementation):

Evaluation - The program subsidizes the costs to have a qualified RCx agent to evaluate the condition of the energy-using systems in a facility and identify opportunities to improve performance. The resulting recommendations are presented in a written report that details how to best improve the efficiency of the facility's systems.

Implementation – The District will review the evaluation and determine which RCx measures will be implemented. CenterPoint Energy's RCx Program will help offset the cost to have a qualified commissioning agent implement the RCx measures. In order to proceed with implementing the measures, the District will need to make a commitment to invest a minimum of $10,000 and have the project completed by year end.

For further information regarding this program please visit the following web address http://www.centerpointefficiency.com/recx/index.htm

12.0 ENERGY MANAGEMENT POLICY

Conroe ISD has undertaken a number of energy conservation initiatives. In 2008 an Energy Management (EM) Division of the Maintenance & Operations Department was created. These Sub-departments have been actively taking steps to improve their energy efficiency. Recent bonds have helped fund renovation projects. Furthermore, the District adopted an Energy Management Plan to help organize their energy management activities. A District-wide energy management plan adopted by the governing board sends a strong signal that energy management is an institutional priority. Therefore, the District is developing the tools and framework to ensure an effective Energy Management Program to achieve sustainable energy savings.

The following are some of the District's recent Energy Management Activities:

- Developed an Energy Management Team
- Upgrading Energy Management Systems District-wide to achieve centralized monitoring
- Publish Energy Report Cards
- Assign Energy Coordinators in Each Campus
- Promote Energy Awareness
- Created an online Work Order and Facility Request Form System
- Identified preferred areas for after-hours activity based on energy efficiency
- Encourage participation from all Staff Levels and Students
- Establish Facility Operation Guidelines
- Publish Energy Conservation Guidelines

While some of the tools are in place for a successful energy management program, it is important to note that a clearly defined Energy Management Plan is essential to help establish effective framework. The success of the EM Plan is dependent upon commitment for the board, defined responsibilities, clear objectives and established timelines. With this in mind, TEESI reviewed the District's current Energy Management Plan, below are a few comments and recommendations that may compliment the present plan.

The following are essential items that should be stressed in an energy management plan:

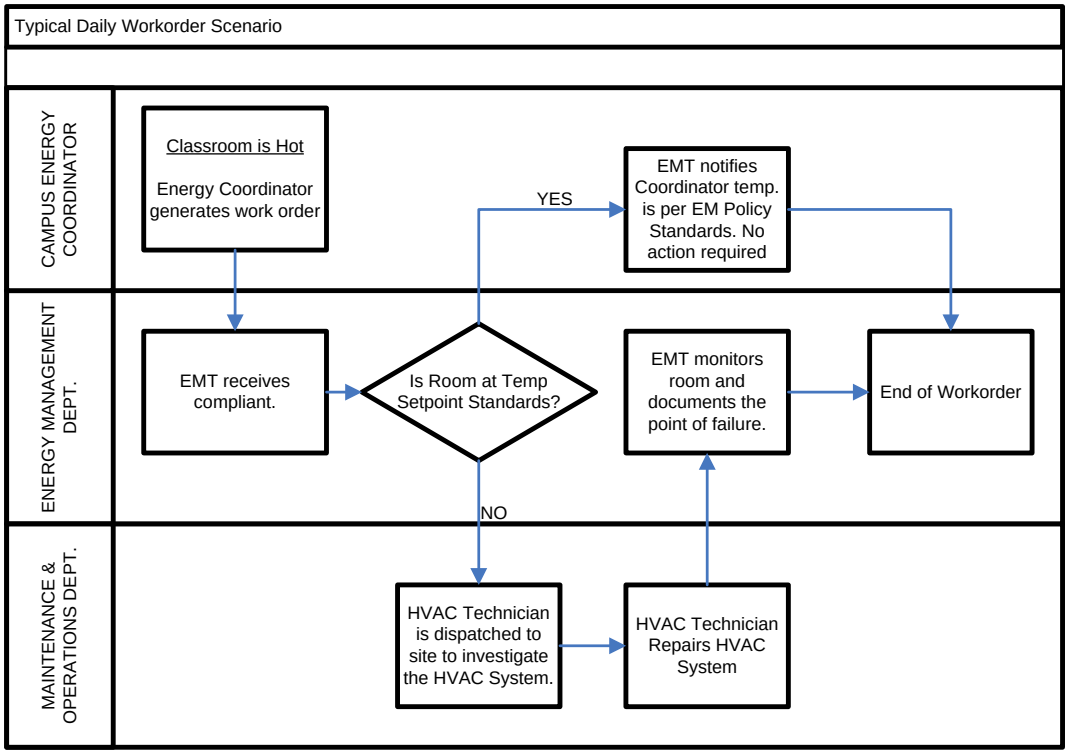
1. ESTABLISH AN ENERGY MANAGEMENT STEERING COMMITTEE The Energy Management Steering Committee will include representatives from a cross section of the District. The steering committee will serve as a review board to evaluate all energy management recommendations before adoption and implementation. The steering committee will meet **quarterly or semiannually** to review the District's energy cost and consumption. Regular meetings will ensure the Districts goals are being met prior to the end of the year.

2. PROMOTE ENERGY AWARENESS The energy management steering committee members shall establish a program to publicize the District's energy goals and progress on a **quarterly or semiannually** basis. For example, student drawn posters of the District's energy savings can be placed in hallways. This will encourage student involvement and act as an educational tool. Continuous promotion of the District's goals will ensure the sustainability of the energy management program and help achieve

further energy savings. In addition, further participation in the SECO sponsored Watt Watchers program will help accomplish this task, see **Appendix F** for further information regarding this program.

3. DEFINE DEPARTMENT ROLES AND RESPONSIBILITIES The core behind a strong energy management program is the personnel responsible for administering and enforcing a school board adopted Energy Management (EM) Plan. Due to the sheer volume and complexity of the tasks associated with effectively administering the program and enforcing such a policy, the District must consider the resources available to achieve the EM Plan's objectives. The objective of the Energy Management Plan is to define guidelines, procedures, responsibilities and establish authority. The key stakeholders primarily responsible for administering and enforcing the EM Policy are the Energy Management Department, Maintenance & Operations, and Planning & Construction Department. Effective coordination and communication among these departments is critical.

Below is an example of good coordination among departments. The EMT (Energy Management Technician) is defined as the staff member responsible for managing the Energy Management System (EMS). The HVAC Technician is the staff member responsible for maintaining and servicing the HVAC equipment.



The above chart describes the coordination with the Campus Energy Coordinator, the Energy Management Technicians (EMT) and HVAC Technicians.

Typical Work Order Scenario:

a) Energy Management Department receives a complaint indicating that a classroom is hot.

b) EMT does a quick check to see if the classroom temperature is within District standards.

c) If the classroom is being cooled according to District standards then the EMT will notify the user that the space meets standards and that no further action is required.

d) If the EMT confirms that the space is not being cooled to District standards, then HVAC Technician will be assigned to handle the problem.

e) EMT to follow-up and monitor the complaint for a short duration after corrective action is performed.

f) The EMT records the incident and determines if other units have similar problems.

This scenario exemplifies the desired relationship between the two sub-departments, and demonstrates the importance of teamwork and mutual understanding of the overall energy management goals of the District. Furthermore, in order for such a scenario to work smoothly, District's faculty and staff should be given adequate notice of the Energy Management Department's new service call procedures. Having the faculty and staff sufficiently prepared will ensure the newly adopted policy and procedures are supported. Such a promotional task could be considered as an Energy Awareness function of the Energy Management Department.

4. **RESOURCE ALLOCATION** Currently the Energy Management Division is comprised of two (2) Energy Managers responsible for the energy management activities of over 6 million square feet. In addition, there are approximately 8 to 12 HVAC Technicians responsible for the daily maintenance and operations of equipment. Based on the sheer size of the District and the number of responsibilities required to effectively manage an Energy Management and Maintenance Program, the District may consider allocating additional resources to ensure effective execution and administration. Additional resources (as budget permits) should be considered for the Energy and Maintenance & Operation Department. These additional resources could be used to acquire additional staff members, staff training, and receive outside consultation services. For example, the energy management department would be able to more effectively handle items such as perform field inspections, enforce policy compliance, gather utility information, and train support staff. In the Maintenance & Operations Department additional personnel would improve the effectiveness of the Energy Management Program and further enhance comprehensive Preventative Maintenance Program.

5. STAFF INCENTIVES AND RECOGNITION PROGRAM Establishing a student, staff, and campus incentive and recognition program would help promote and encourage support from staff and custodial members. The District may consider implementing a staff incentive and recognition program. Following are some program examples scenarios.

Scenario 1: The energy accounting system can be used to monitor cost savings and compare it to the base year consumption. An energy incentive plan consisting of a 50-50 sharing with the school campus and the Energy Management Program could be employed. The school would get 50% of the savings resulting from energy cost reduction. The school would be free to use the money for educational programs such as materials, supplies, etc. The other 50% would be used for continuing energy management efforts. The following is an example of the Building savings summary report.

EXAMPLE:

High School - Annual Total Electric Cost

Baseline (2006 - 07)	Current (2007 - 08)	Savings	50% Savings
$248,483	$240,483	$8,000	$4,000

In this example, the High School saved $8,000 where 50% ($4,000) will be assigned to the school. This money will be paid on October of the following fiscal year.

Scenario 2: An energy flag program will be implemented. There will be three energy flags, one flag per each grade level. These energy flags will be awarded to the schools exhibiting the greatest percentage reduction in energy costs. Energy flags will be awarded on a rotating basis each summer. In order to provide motivation, maintain enthusiasm, and recognize individuals doing their part to save the District taxpayers money through the Energy Management Program, the local media (including district newsletters) will be informed of the energy flag results. The energy flag will be awarded on January and August of each year based on the energy consumption of the previous four months.

The successes of the program should also be communicated to the public through the media to show what the District is doing to reduce costs to taxpayers.

6. NEW BUILDING AND CONSTRUCTION Ensure proper maintenance and operation of energy using equipment in new buildings by required adequate documentation of all systems and control strategies, specifying minimum content of M&O manuals; specifying contractor requirements for cleaning and adjusting equipment prior to occupancy; specifying on-site vendor training for M&O staff; and requiring as-built drawings.

7. ENCOURAGE ENERGYSTAR EQUIPMENT AND MATERIAL The District shall adopt a policy to purchase (when applicable) EnergySTAR certified equipment and building material. For example EnergySTAR certifies several types of products such as roofing material, HVAC and office equipment to ensure they meet certain energy efficiency requirements.

8. ADOPT AN ENERGY EFFICIENCY STANDARD The District may adopt an industry established building standard. Several industry establish building standards can be adopted by the District. For example, requiring buildings to achieve an EnergySTAR Label or meet LEED standards would provide guidance and set goals for future building design and existing building operation.

9. ESTABLISH A WATER MANAGEMENT PROGRAM Along with saving energy the District shall a establish a program to reduce water consumption. The following conservation measures shall be employed.

   a. Investigate the use of water conserving faucets, showerheads, and toilets in all new and existing facilities.
   b. Utilize water-previous materials such as gravel, crushed stone, open paving blocks or previous paving blocks for walkways and patios to minimize runoff and increase infiltration.
   c. Employ Xeriscaping, using native plants that are well suited to the local climate, that are drought-tolerant and do not require supplemental irrigation.
   d. Utilize drip irrigation systems for watering plants in beds and gardens.
   e. Install controls to prevent irrigation when the soil is wet from rainfall.
   f. Establish a routine check of water consuming equipment for leaks and repair equipment immediately.

13.0 ANALYST IDENTIFICATION

Texas Energy Engineering Services, Inc.
Capital View Center, Suite B-325
1301 Capital of Texas Highway
Austin, Texas 78746
(512) 328-2533

M. Saleem Khan, P.E., CxA
David Rocha, LEED-AP

APPENDICES

APPENDIX A

SENATE BILL 12 AND HOUSE BILL 3693

How to comply with SB12 & HB 3693

What you need to know about Texas Senate Bill 12

The passage of Senate Bill 12 (SB12) by the 80th Texas Legislature signified the continuance of Senate Bill 5 (SB5), the 77th Texas Legislature's sweeping approach in 2001 to clean air and encourage energy efficiency in Texas. SB12 was enacted on September 1, 2007 and was crafted to continue to assist the state and its political jurisdictions to conform to the standards set forth in the Federal Clean Air Act. The bill contains energy-efficiency strategies intended to decrease energy consumption while improving air quality.

All political subdivisions in the 41 non-attainment or near non-attainment counties in Texas are required to:

*1) Adopt a goal to reduce electric consumption by 5 percent each year for six years, beginning September 1, 2007**

2) Implement all cost-effective energy-efficiency measures to reduce electric consumption by existing facilities. (Cost effectiveness is interpreted by this legislation to provide a 20 year return on investment.)

3) Report annually to the State Energy Conservation Office (SECO) on the entity's progress, efforts and consumption data.

*Note: The recommended baseline data for those reporting entities will consist of the jurisdiction's 2006 energy consumption for its facilities and based on the State Fiscal Year (September 1, 2006 to August 31, 2007).

What you need to know about Texas House Bill 3693

The passage of House Bill 3693 (HB3693) by the 80th Texas Legislature is intended to provide additional provisions for energy-efficiency in Texas. Adopted with an effective date of September 1, 2007, HB 3693 is an additional mechanism by which the state can encourage energy-efficiency through various means for School Districts, State Facilities and Political Jurisdictions in Texas.

HB 3693 includes the following state-wide mandates that apply differently according to the nature and origin of the entity:

Record, Report and Display Consumption Data
All Political Subdivisions, School Districts and State-Funded Institutes of Higher Education, are mandated to record and report the entity's metered resource consumption usage data for electricity, natural gas and water on a publically accessible internet page.
Note: The format, content and display of this information are determined by the entity or subdivision providing this information.

Energy Efficient Light Bulbs
All School Districts and State-Funded Institutes of Higher Education shall purchase and use energy-efficient light bulbs in education and housing facilities.

Who must comply?
The provisions in this bill will apply to entities including: Cities and Counties; School Districts; Institutes of Higher Education; State Facilities and Buildings.

How do you define energy-efficiency measures?

Energy-efficiency measures are defined as any facility modifications or changes in operations that reduce energy consumption. Energy-efficiency is a strategy that has the potential to conserve resources, save money** and better the quality of our air. They provide immediate savings and add minimal costs to your project budget.

Examples of energy-efficiency measures include:

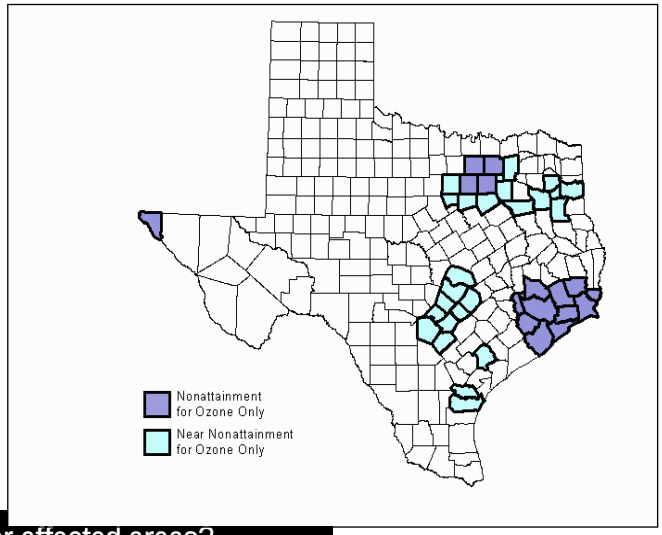
• installation of insulation and high-efficiency windows and doors • modifications or replacement of HVAC systems, lighting fixtures and electrical systems • installation of automatic energy control systems • installation of energy recovery systems or renewable energy generation equipment • building commissioning • development of energy efficient procurement specifications • employee awareness campaigns

***SECO's Preliminary Energy Assessment (PEA) program is an excellent resource for uncovering those energy-efficiency measures that can benefit your organization.*

What counties are affected?

All political jurisdictions located in the following Non-attainment and affected counties:

Bastrop Bexar Brazoria Caldwell Chambers Collin
Comal Dallas Denton El Paso Ellis Fort Bend
Galveston Gregg Guadalupe Hardin Harris Harrison
Hays Henderson Hood Hunt Jefferson Johnson
Kaufman Liberty Montgomery Nueces Orange Parker
Rockwall Rusk San Patricio Smith Tarrant Travis
Upshur Victoria Waller Williamson Wilson



What assistance is available for affected areas?

The Texas Energy Partnership is a partner with Energy Star©, who partners across the nation with the goal of improving building performance, reducing air emissions through reduced energy demand, and enhancing the quality of life through energy-efficiency and renewable energy technologies.

To assist jurisdictions, the Texas Energy Partnership will:

- Present workshops and training seminars in partnership with private industry on a range of topics that include energy services, financing, building technologies and energy performance rating and benchmarking

- Prepare information packages – containing flyers, documents and national lab reports about energy services, management tools and national, state and industry resources that will help communities throughout the region

- Launch an electronic newsletter to provide continuous updates and develop additional information packages as needed

Please contact Stephen Ross at 512-463-1770 for more information.

SECO Program Contact Information

LoanSTAR;
Preliminary Energy Assessments:
Theresa Sifuentes - 512-463-1896
Theresa.Sifuentes@cpa.state.tx.us

Schools Partnership Program:
Glenda Baldwin - 512-463-1731
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Engineering (Codes / Standards):
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Energy / Housing
Partnership Programs:
Stephen Ross - 512-463-1770
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Alternate Fuels / Transportation:
Mary-Jo Rowan - 512-463-2637
Mary-Jo.Rowan@cpa.state.tx.us

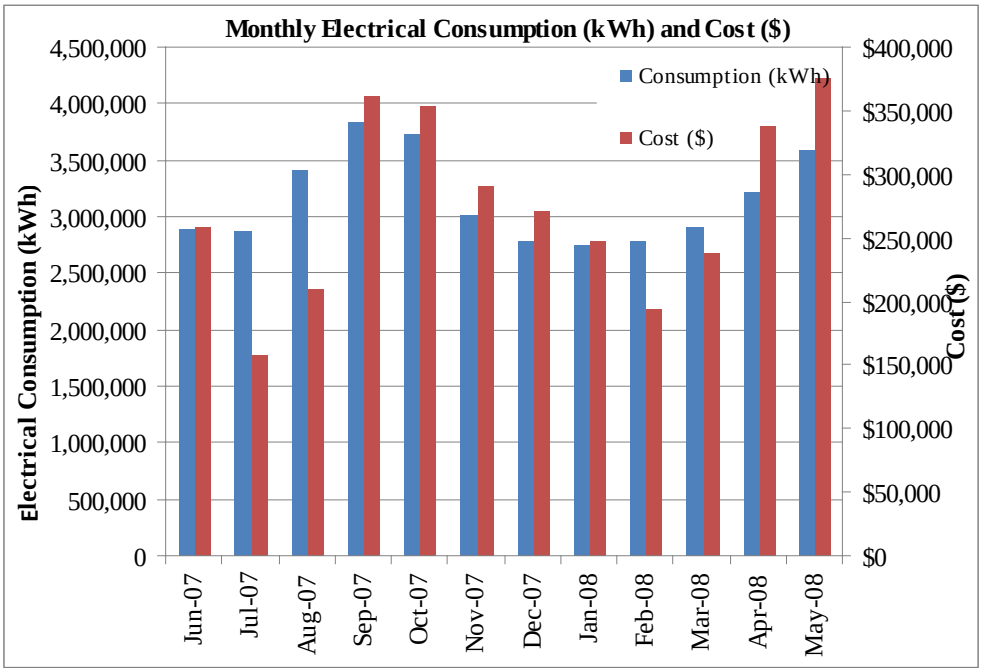
APPENDIX B

SAMPLE ENERGY REPORTING FORM

CONROE ISD UTILITY INPUT FORM

MONTH	ELECTRICITY			NATURAL GAS			WATER		
	KWH	COST $	$/KWH	MCF	COST $	$/MCF	GAL	COST $	$/GAL
Jun-07	2,893,632	$259,056	$0.090						
Jul-07	2,878,680	$159,157	$0.055						
Aug-07	3,427,028	$209,953	$0.061						
Sep-07	3,840,940	$362,474	$0.094						
Oct-07	3,742,959	$355,178	$0.095						
Nov-07	3,022,352	$291,953	$0.097						
Dec-07	2,789,160	$271,042	$0.097						
Jan-08	2,753,908	$248,336	$0.090						
Feb-08	2,795,548	$193,760	$0.069						
Mar-08	2,904,684	$237,848	$0.082						
Apr-08	3,228,540	$338,751	$0.105						
May-08	3,593,108	$376,616	$0.105						
Total	37,870,539	$3,304,124	$0.087						

Gross Building Area:	1,506,304	SF



APPENDIX C

BASE YEAR CONSUMPTION HISTORY

Energy Cost and Consumption Benchmarks

		Electric		Natural Gas		Total	Total	EUI	ECI	
	Building	KWH/Yr	$Cost/Yr	MCF/Yr	$Cost/Yr	$Cost/Yr	MMBTU/Yr	kBTU/SF/Yr	$/SF/Yr	SF
1	Ford Elementary	1,433,679	166,659	0	0	166,659	4,893	64	2.16	77,000
2	Hailey Elementary	1,711,040	141,914	0	0	141,914	5,840	97	2.37	60,000
3	Oak Ridge Elementary	1,580,500	136,069	0	0	136,069	5,394	73	1.84	74,088
4	Reaves Elementary	4,500,240	404,739	0	0	404,739	15,359	182	4.80	84,358
5	Rice Elementary	1,554,288	135,034	0	0	135,034	5,305	72	1.82	74,008
6	Wilkerson Intermediate	1,789,000	158,510	0	0	158,510	6,106	74	1.91	82,884
7	Washington Junior High School	5,054,672	435,085	0	0	435,085	17,252	119	3.00	144,966
8	Oak Ridge High	7,267,400	620,947	0	0	620,947	24,804	68	1.71	363,000
9	Woodland High School	10,456,800	882,286	0	0	882,286	35,689	90	2.22	397,000
10	Oak Ridge 9th Grade Campus	2,522,920	222,881	0	0	222,881	8,611	58	1.50	149,000
		KWH/Yr	$Cost/Yr	MCF/Yr	$Cost/Yr	$Cost/Yr	MMBTU/Yr	kBTU/SF/Yr	$/SF/Yr	SF
		37,870,539	3,304,124	0	0	3,304,124	129,252	86	2.19	1,506,304

District: Conroe ISD

ACCOUNT# 1008901021549517069100 Electric

Gas

BUILDING: Ford Elementary

FLOOR AREA: 77,000

		ELECTRICAL					NATURAL GAS / FUEL	
			DEMAND			TOTAL ALL		
		CONSUMPTION	METERED	CHARGED	COST OF	ELECTRIC	CONSUMPTION	TOTAL
MONTH	YEAR	KWH	KW	KW	DEMAND ($)	COSTS ($)	MCF	COSTS ($)
June	2007	95,904		518		11,806		
July	2007	97,920		461		11,734		
August	2007	104,544		432		12,242		
September	2007	162,432		490		18,181		
October	2007	155,823		461		17,342		
November	2007	106,560		461		12,620		
December	2007	131,328		461		15,024		
January	2008	91,584		432		11,007		
February	2008	112,032		490		13,130		
March	2008	107,712		446		12,588		
April	2008	118,944		516		14,005		
May	2008	148,896		533		16,980		
TOTAL		1,433,679				166,659	0.0	0

Energy Use Index:

Annual Total Energy Cost = 166,659 $/year

Total site BTU's/Yr ÷ Total Area (SF) = 64 kBTU/SF/year

Total KWH/yr x 0.003413 = 4,893.15 MMBTU/year

Total MCF/yr x 1.03 = 0.00 MMBTU/year

Total Other x _____ = 0.0 MMBTU/year

Total Site MMBTU's/yr = 4,893 MMBTU/year

Energy Cost Index:

Total Energy Cost/Yr ÷ Total Area (SF) = 2.16 $/SF/year

Electric Utility: Entergy

Gas Utility: _____

District: Conroe ISD

ACCOUNT# 143200 143276 Electric

Gas

BUILDING: Hailey Elementary

FLOOR AREA: 60,000

		ELECTRICAL					NATURAL GAS / FUEL	
			DEMAND			TOTAL ALL		
		CONSUMPTION	METERED	CHARGED	COST OF	ELECTRIC	CONSUMPTION	TOTAL
MONTH	YEAR	KWH	KW	KW	DEMAND ($)	COSTS ($)	MCF	COSTS ($)
June	2007	150,880		336		13,860		
July	2007	126,400		211		6,122		
August	2007	129,360		230		6,326		
September	2007	159,680		336		14,739		
October	2007	182,800		298		16,506		
November	2007	108,960		298		10,375		
December	2007	121,920		264		11,327		
January	2008	136,160		278		12,595		
February	2008	147,200		288		9,150		
March	2008	141,360		288		10,122		
April	2008	144,000		288		14,550		
May	2008	162,320		288		16,243		
TOTAL		1,711,040				141,914	0.0	0

Annual Total Energy Cost = 141,914 $/year

Total KWH/yr x 0.003413 = 5,839.78 MMBTU/year

Total MCF/yr x 1.03 = 0.00 MMBTU/year

Total Other x _____ = 0.0 MMBTU/year

Total Site MMBTU's/yr = 5,840 MMBTU/year

Energy Use Index:

Total site BTU's/Yr ÷ Total Area (SF) = 97 kBTU/SF/year

Energy Cost Index:

Total Energy Cost/Yr ÷ Total Area (SF) = 2.37 $/SF/year

Electric Utility: Entergy

Gas Utility: _____

District: Conroe ISD

ACCOUNT# 657782 Electric

Gas

BUILDING: Oak Ridge Elementary

FLOOR AREA: 74,088

		ELECTRICAL					NATURAL GAS / FUEL	
			DEMAND			TOTAL ALL		
		CONSUMPTION	METERED	CHARGED	COST OF	ELECTRIC	CONSUMPTION	TOTAL
MONTH	YEAR	KWH	KW	KW	DEMAND ($)	COSTS ($)	MCF	COSTS ($)
June	2007	124,000		460		11,949		
July	2007	147,000		450		7,673		
August	2007	145,000		440		7,554		
September	2007	163,000		485		15,373		
October	2007	124,000		480		12,136		
November	2007	134,500		480		13,002		
December	2007	100,000		420		9,922		
January	2008	111,500		380		10,715		
February	2008	128,500		390		8,378		
March	2008	105,000		390		8,073		
April	2008	140,500		460		14,721		
May	2008	157,500		535		16,574		
TOTAL		1,580,500				136,069	0.0	0

Energy Use Index:

Annual Total Energy Cost = 136,069 $/year

Total site BTU's/Yr ÷ Total Area (SF) = 73 kBTU/SF/year

Total KWH/yr x 0.003413 = 5,394.25 MMBTU/year

Total MCF/yr x 1.03 = 0.00 MMBTU/year

Total Other x _____ = 0.0 MMBTU/year

Total Site MMBTU's/yr = 5,394 MMBTU/year

Energy Cost Index:

Total Energy Cost/Yr ÷ Total Area (SF) = 1.84 $/SF/year

Electric Utility: Entergy

Gas Utility:

District: Conroe ISD

ACCOUNT# 425856 3246650 321625 Electric

Gas

BUILDING: Reaves Elementary

FLOOR AREA: 84,358

		ELECTRICAL					NATURAL GAS / FUEL	
			DEMAND			TOTAL ALL		
		CONSUMPTION	METERED	CHARGED	COST OF	ELECTRIC	CONSUMPTION	TOTAL
MONTH	YEAR	KWH	KW	KW	DEMAND ($)	COSTS ($)	MCF	COSTS ($)
June	2007	334,320		615		28,282		
July	2007	364,660		650		20,781		
August	2007	433,300		705		33,073		
September	2007	470,480		735		45,856		
October	2007	442,940		595		42,719		
November	2007	327,220		494		32,441		
December	2007	339,540		490		33,313		
January	2008	310,560		451		27,044		
February	2008	305,280		418		21,953		
March	2008	336,080		485		30,345		
April	2008	352,460		560		38,115		
May	2008	483,400		655		50,815		
TOTAL		4,500,240			0.00	404,739	0.0	0

Annual Total Energy Cost = 404,739 $/year

Total KWH/yr x 0.003413 = 15,359.32 MMBTU/year

Total MCF/yr x 1.03 = 0.00 MMBTU/year

Total Other x _____ = 0.0 MMBTU/year

Total Site MMBTU's/yr = 15,359 MMBTU/year

Energy Use Index:

Total site BTU's/Yr ÷ Total Area (SF) = 182 kBTU/SF/year

Energy Cost Index:

Total Energy Cost/Yr ÷ Total Area (SF) = 4.80 $/SF/year

Electric Utility: Entergy

Gas Utility: _____

District: Conroe ISD

ACCOUNT# 140707 11119 Electric

Gas

BUILDING: Rice Elementary

FLOOR AREA: 74,008

		ELECTRICAL					NATURAL GAS / FUEL	
			DEMAND			TOTAL ALL		
		CONSUMPTION	METERED	CHARGED	COST OF	ELECTRIC	CONSUMPTION	TOTAL
MONTH	YEAR	KWH	KW	KW	DEMAND ($)	COSTS ($)	MCF	COSTS ($)
June	2007	143,440		365		12,594		
July	2007	159,912		392		8,429		
August	2007	127,400		353		8,027		
September	2007	148,648		384		14,261		
October	2007	155,952		372		14,818		
November	2007	112,312		365		11,097		
December	2007	115,744		330		11,247		
January	2008	118,472		334		10,962		
February	2008	114,856		376		8,125		
March	2008	106,768		326		8,801		
April	2008	126,128		353		13,399		
May	2008	124,656		357		13,274		
TOTAL		1,554,288			0.00	135,034	0.0	0

Annual Total Energy Cost = 135,034 $/year

Total KWH/yr x 0.003413 = 5,304.78 MMBTU/year

Total MCF/yr x 1.03 = 0.00 MMBTU/year

Total Other x _____ = 0.0 MMBTU/year

Total Site MMBTU's/yr = 5,305 MMBTU/year

Energy Use Index:

Total site BTU's/Yr ÷ Total Area (SF) = 72 kBTU/SF/year

Energy Cost Index:

Total Energy Cost/Yr ÷ Total Area (SF) = 1.82 $/SF/year

Electric Utility: Entergy

Gas Utility: _____

District: Conroe ISD

ACCOUNT# 143279 Electric

Gas

BUILDING: Wilkerson Intermediate

FLOOR AREA: 82,884

		ELECTRICAL					NATURAL GAS / FUEL	
			DEMAND			TOTAL ALL		
		CONSUMPTION	METERED	CHARGED	COST OF	ELECTRIC	CONSUMPTION	TOTAL
MONTH	YEAR	KWH	KW	KW	DEMAND ($)	COSTS ($)	MCF	COSTS ($)
June	2007	162,000		550		15,401		
July	2007	111,000		500		6,427		
August	2007	159,000		530		8,466		
September	2007	196,000		610		18,583		
October	2007	186,000		620		17,797		
November	2007	139,000		620		13,919		
December	2007	124,000		490		12,175		
January	2008	117,000		500		11,636		
February	2008	124,000		450		8,373		
March	2008	112,000		430		8,664		
April	2008	148,000		500		15,566		
May	2008	211,000		540		21,503		
TOTAL		1,789,000				158,510	0.0	0

Annual Total Energy Cost = 158,510 $/year

Total KWH/yr x 0.003413 = 6,105.86 MMBTU/year

Total MCF/yr x 1.03 = 0.00 MMBTU/year

Total Other x _____ = 0.0 MMBTU/year

Total Site MMBTU's/yr = 6,106 MMBTU/year

Energy Use Index:

Total site BTU's/Yr ÷ Total Area (SF) = 74 kBTU/SF/year

Energy Cost Index:

Total Energy Cost/Yr ÷ Total Area (SF) = 1.91 $/SF/year

Electric Utility: Entergy

Gas Utility: _____

District: Conroe ISD

ACCOUNT# 2837120 2836432 178108 Electric

Gas

BUILDING: Washington Junior High School

FLOOR AREA: 144,966

		ELECTRICAL					NATURAL GAS / FUEL	
			DEMAND			TOTAL ALL		
		CONSUMPTION	METERED	CHARGED	COST OF	ELECTRIC	CONSUMPTION	TOTAL
MONTH	YEAR	KWH	KW	KW	DEMAND ($)	COSTS ($)	MCF	COSTS ($)
June	2007	352,208		675		18,312		
July	2007	357,588		580		18,270		
August	2007	421,624		850		39,865		
September	2007	491,780		815		45,628		
October	2007	526,444		864		48,660		
November	2007	447,280		802		41,406		
December	2007	361,308		768		34,146		
January	2008	390,632		611		24,431		
February	2008	367,520		707		27,055		
March	2008	382,724		729		39,341		
April	2008	433,068		804		44,596		
May	2008	522,496		887		53,375		
TOTAL		5,054,672				435,085	0.0	0

Energy Use Index:

Annual Total Energy Cost = 435,085 $/year

Total site BTU's/Yr ÷ Total Area (SF) = 119 kBTU/SF/year

Total KWH/yr x 0.003413 = 17,251.60 MMBTU/year

Total MCF/yr x 1.03 = 0.00 MMBTU/year

Total Other x _____ = 0.0 MMBTU/year

Total Site MMBTU's/yr = 17,252 MMBTU/year

Energy Cost Index:

Total Energy Cost/Yr ÷ Total Area (SF) = 3.00 $/SF/year

Electric Utility: Entergy

Gas Utility: _____

563678 878477 478985 2753273

METER/ACCOUNT# _____ Electric
_____ Electric
_____ Gas

District: Conroe ISD

BUILDING: Oak Ridge High

FLOOR AREA: 363,000

		ELECTRICAL					NATURAL GAS / FUEL	
			DEMAND			TOTAL ALL		
		CONSUMPTION	METERED	CHARGED	COST OF	ELECTRIC	CONSUMPTION	TOTAL
MONTH	YEAR	KWH	KW/KVA	KW/KVA	DEMAND ($)	COSTS ($)	MCF	COSTS ($)
June	2007	535,280		801		52,465		
July	2007	545,760		866		28,301		
August	2007	710,720		903		33,599		
September	2007	832,560		997		74,951		
October	2007	672,960		1,007		63,795		
November	2007	578,040		919		55,360		
December	2007	485,400		867		48,474		
January	2008	513,760		803		49,011		
February	2008	540,360		840		36,074		
March	2008	572,840		865		43,356		
April	2008	636,760		963		67,065		
May	2008	642,960		1,030		68,496		
TOTAL		7,267,400				620,947	0.0	0

Annual Total Energy Cost = 620,947 $/year

Total KWH/yr x 0.003413 = 24,803.64 MMBTU/year
Total MCF/yr x 1.03 = 0.00 MMBTU/year
Total Other x _____ = 0.0 MMBTU/year
Total Site MMBTU's/yr = 24,803.64 MMBTU/year

Energy Use Index:
Total site BTU's/Yr ÷ Total Area (SF) = 68 BTU/SF/year

Energy Cost Index:
Total Energy Cost/Yr ÷ Total Area (SF) = 1.71 $/SF/year

Electric Utility: Entergy

Gas Utility: _____

METER/ACCOUNT# 2833962 2833977 2829025 Electric
Electric
Gas

District: Conroe ISD

BUILDING: Woodland High School

FLOOR AREA: 397,000

		ELECTRICAL					NATURAL GAS / FUEL	
			DEMAND			TOTAL ALL		
		CONSUMPTION	METERED	CHARGED	COST OF	ELECTRIC	CONSUMPTION	TOTAL
MONTH	YEAR	KWH	KW/KVA	KW/KVA	DEMAND ($)	COSTS ($)	MCF	COSTS ($)
June	2007	826,920		1,147		77,826		
July	2007	796,200		1,191		42,068		
August	2007	962,400		1,246		48,519		
September	2007	969,000		1,294		90,751		
October	2007	999,960		1,273		93,465		
November	2007	865,680		1,212		81,856		
December	2007	838,560		1,047		78,355		
January	2008	779,760		929		72,880		
February	2008	751,080		881		47,874		
March	2008	874,200		958		63,459		
April	2008	895,200		1,137		91,957		
May	2008	897,840		1,253		93,276		
TOTAL		10,456,800				882,286	0.0	0

Note: Utilities estimated.

Annual Total Energy Cost = 882,286 $/year

Total KWH/yr x 0.003413 = 35,689.06 MMBTU/year
Total MCF/yr x 1.03 = 0.00 MMBTU/year
Total Other x _____ = 0.0 MMBTU/year
Total Site MMBTU's/yr = 35,689.06 MMBTU/year

Energy Use Index:
Total site BTU's/Yr ÷ Total Area (SF) = 90 BTU/SF/year

Energy Cost Index:
Total Energy Cost/Yr ÷ Total Area (SF) = 2.22 $/SF/year

Electric Utility: Entergy

Gas Utility: _____

District: Conroe ISD

ACCOUNT# 657789 657929 901787 Electric

Gas

BUILDING: Oak Ridge 9th Grade Campus

FLOOR AREA: 149,000

		ELECTRICAL					NATURAL GAS / FUEL	
			DEMAND			TOTAL ALL		
		CONSUMPTION	METERED	CHARGED	COST OF	ELECTRIC	CONSUMPTION	TOTAL
MONTH	YEAR	KWH	KW	KW	DEMAND ($)	COSTS ($)	MCF	COSTS ($)
June	2007	168,680		674		16,561		
July	2007	172,240		596		9,352		
August	2007	233,680		691		12,281		
September	2007	247,360		843		24,151		
October	2007	296,080		808		27,941		
November	2007	202,800		721		19,877		
December	2007	171,360		664		17,059		
January	2008	184,480		607		18,055		
February	2008	204,720		612		13,648		
March	2008	166,000		622		13,099		
April	2008	233,480		777		24,776		
May	2008	242,040		894		26,080		
TOTAL		2,522,920				222,881	0.0	0

Annual Total Energy Cost = 222,881 $/year

Total KWH/yr x 0.003413 = 8,610.73 MMBTU/year

Total MCF/yr x 1.03 = 0.00 MMBTU/year

Total Other x _____ = 0.0 MMBTU/year

Total Site MMBTU's/yr = 8,611 MMBTU/year

Energy Use Index:

Total site BTU's/Yr ÷ Total Area (SF) = 58 kBTU/SF/year

Energy Cost Index:

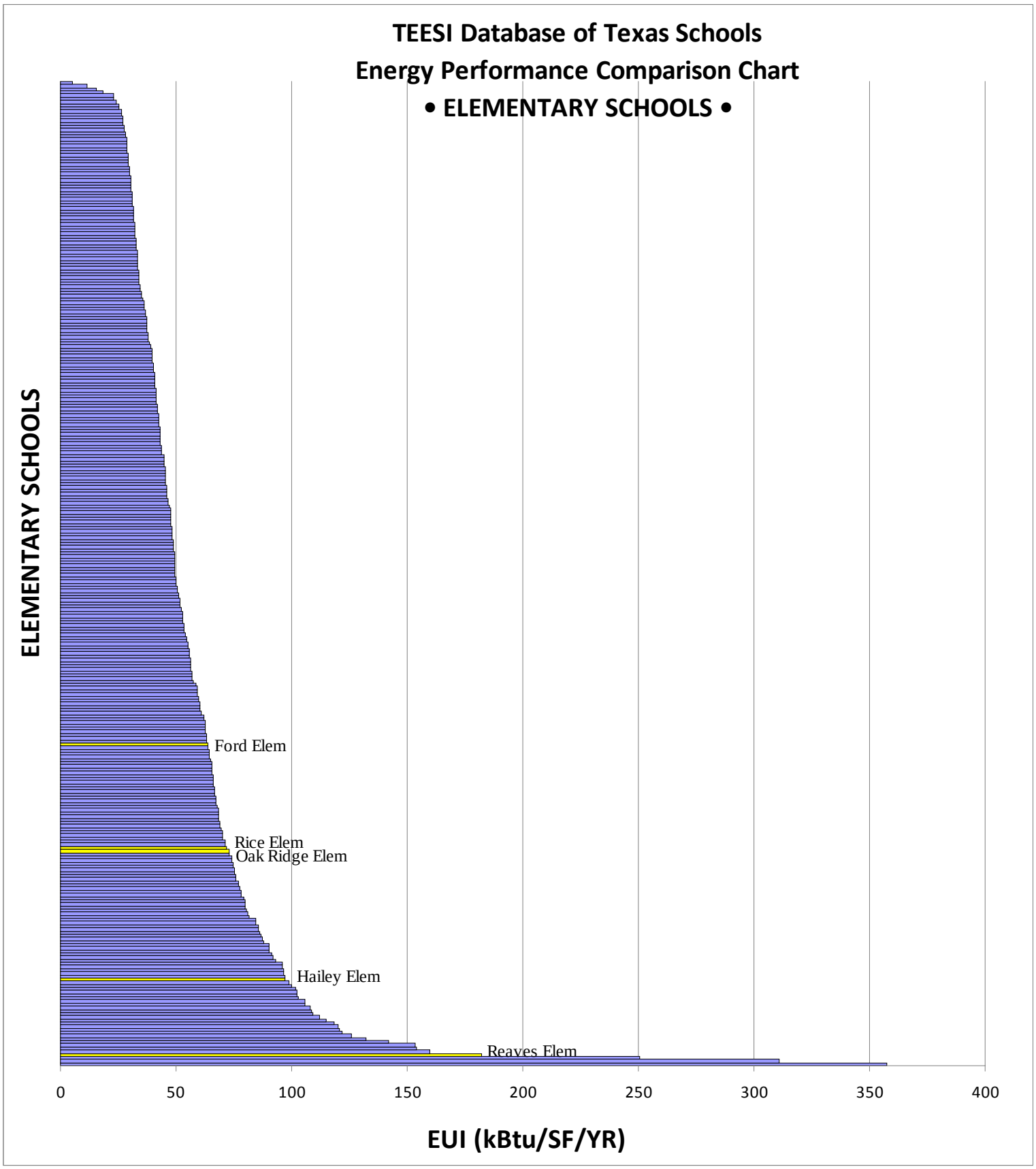
Total Energy Cost/Yr ÷ Total Area (SF) = 1.50 $/SF/year

Electric Utility: Entergy

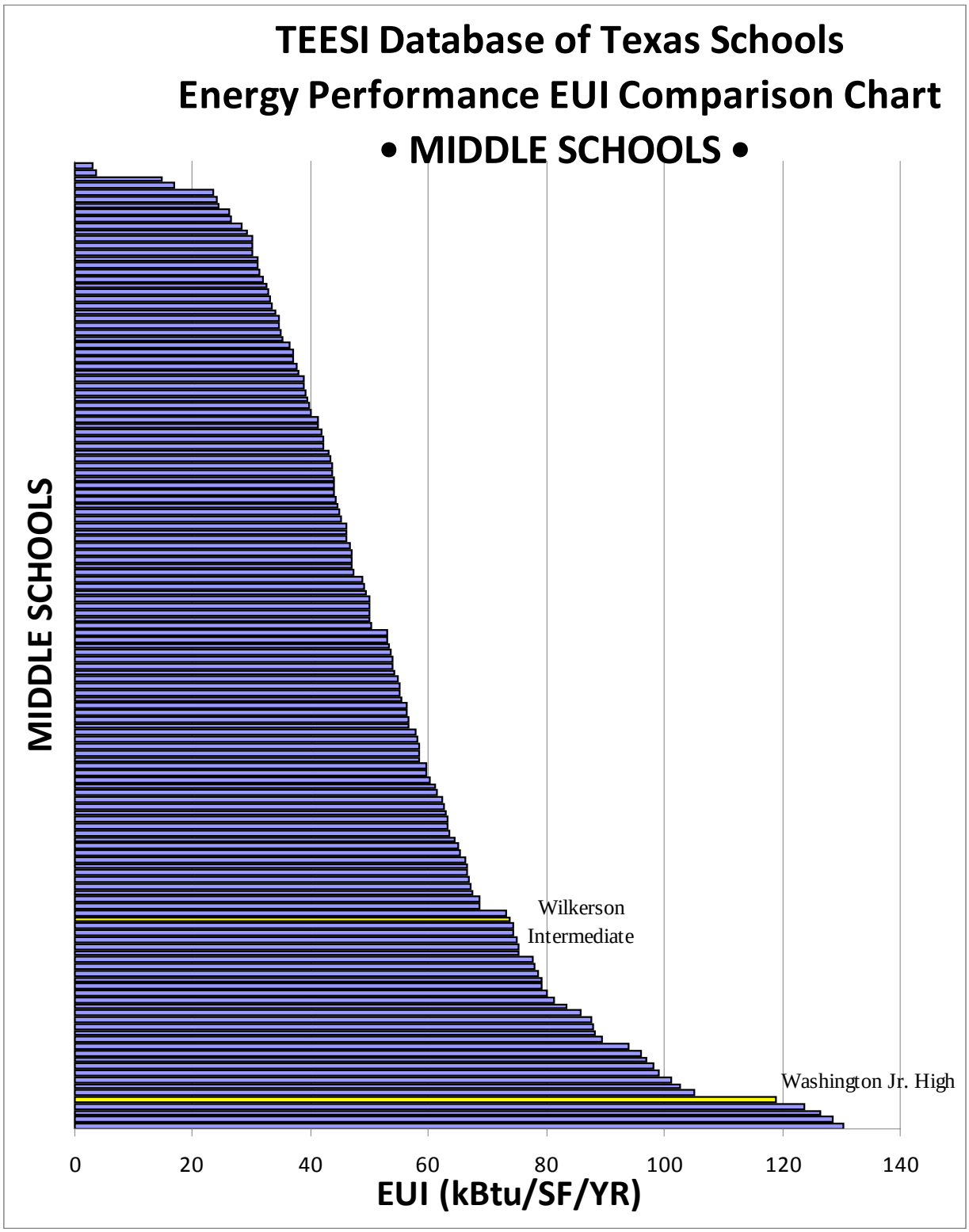
Gas Utility: _____

APPENDIX D

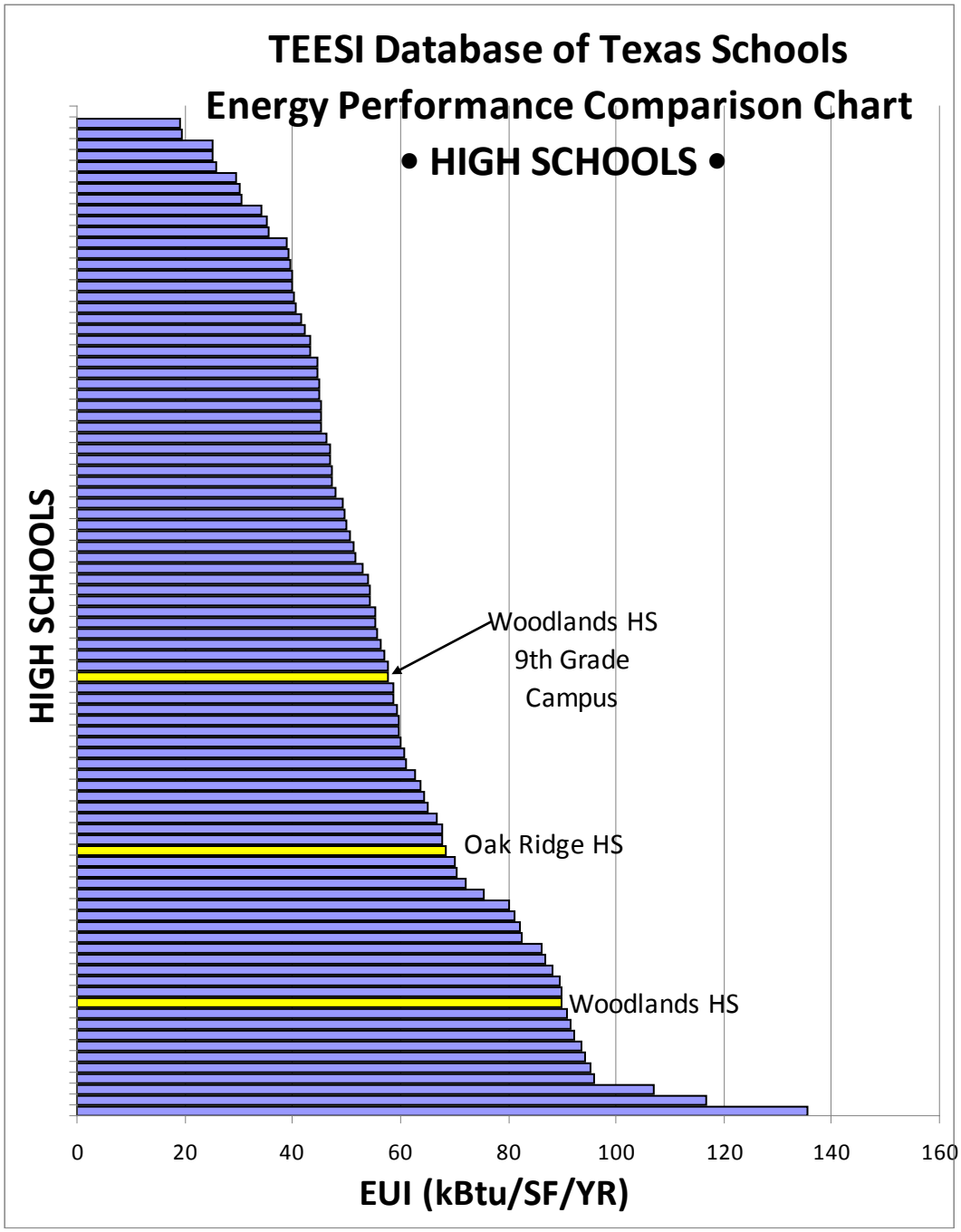
ENERGY PERFORMANCE COMPARISON CHARTS



(The chart above is a comparison of EUIs based on sample data from TEESI's database of Texas Schools)



(The chart above is a comparison of EUIs based on sample data from TEESI's database of Texas Schools)



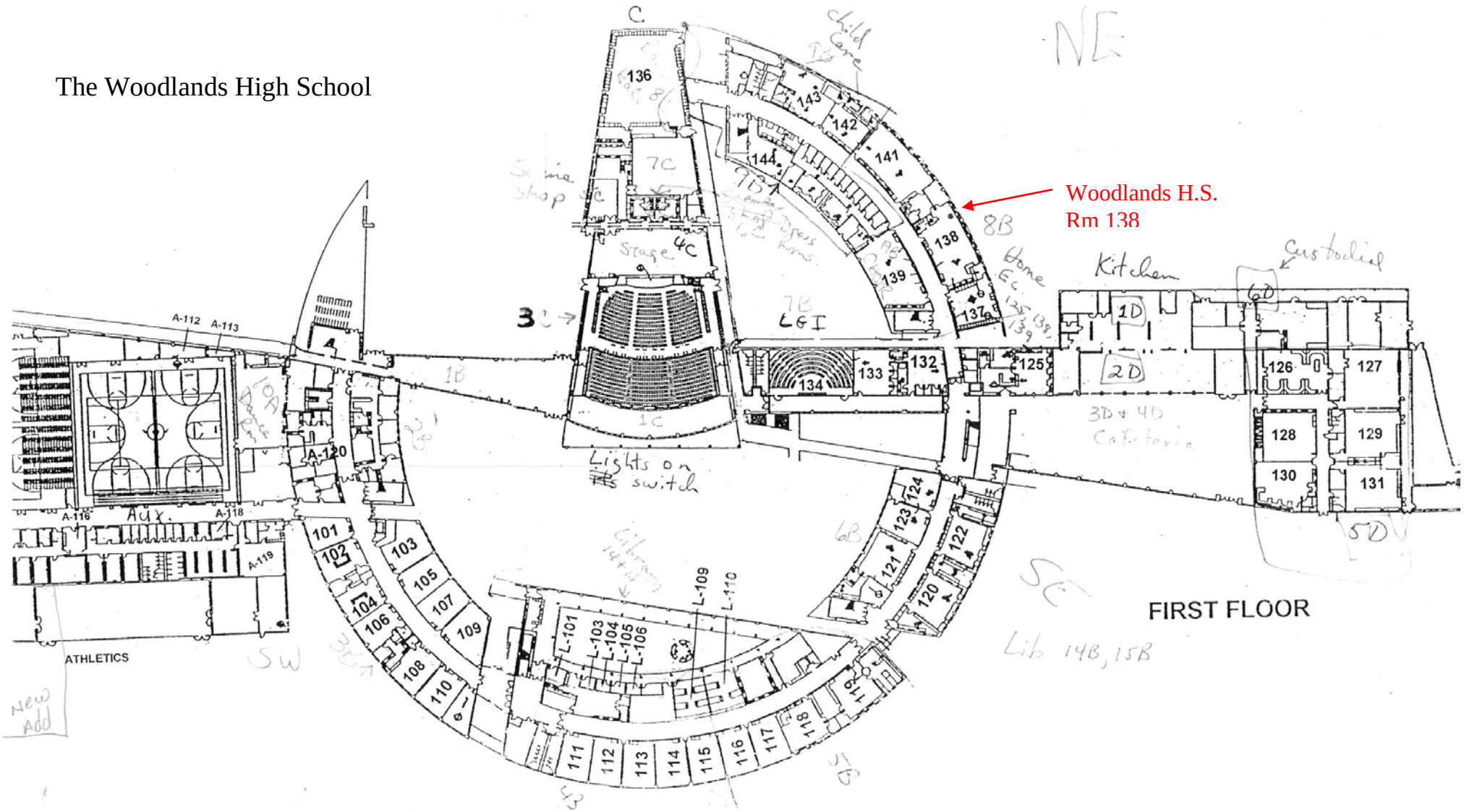
(The chart above is a comparison of EUIs based on sample data from TEESI's database of Texas Schools)

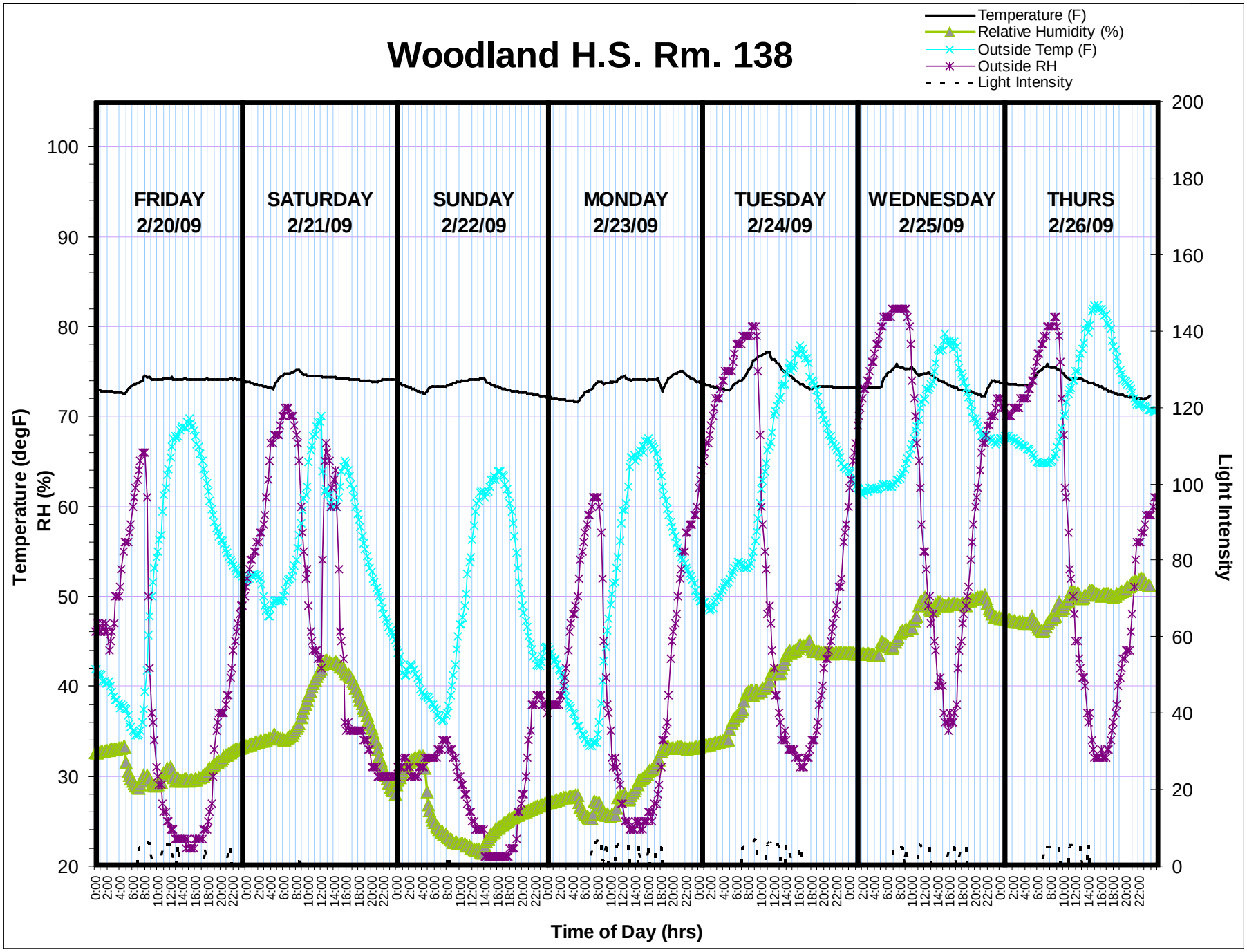
APPENDIX E

DATALOGGER CHARTS

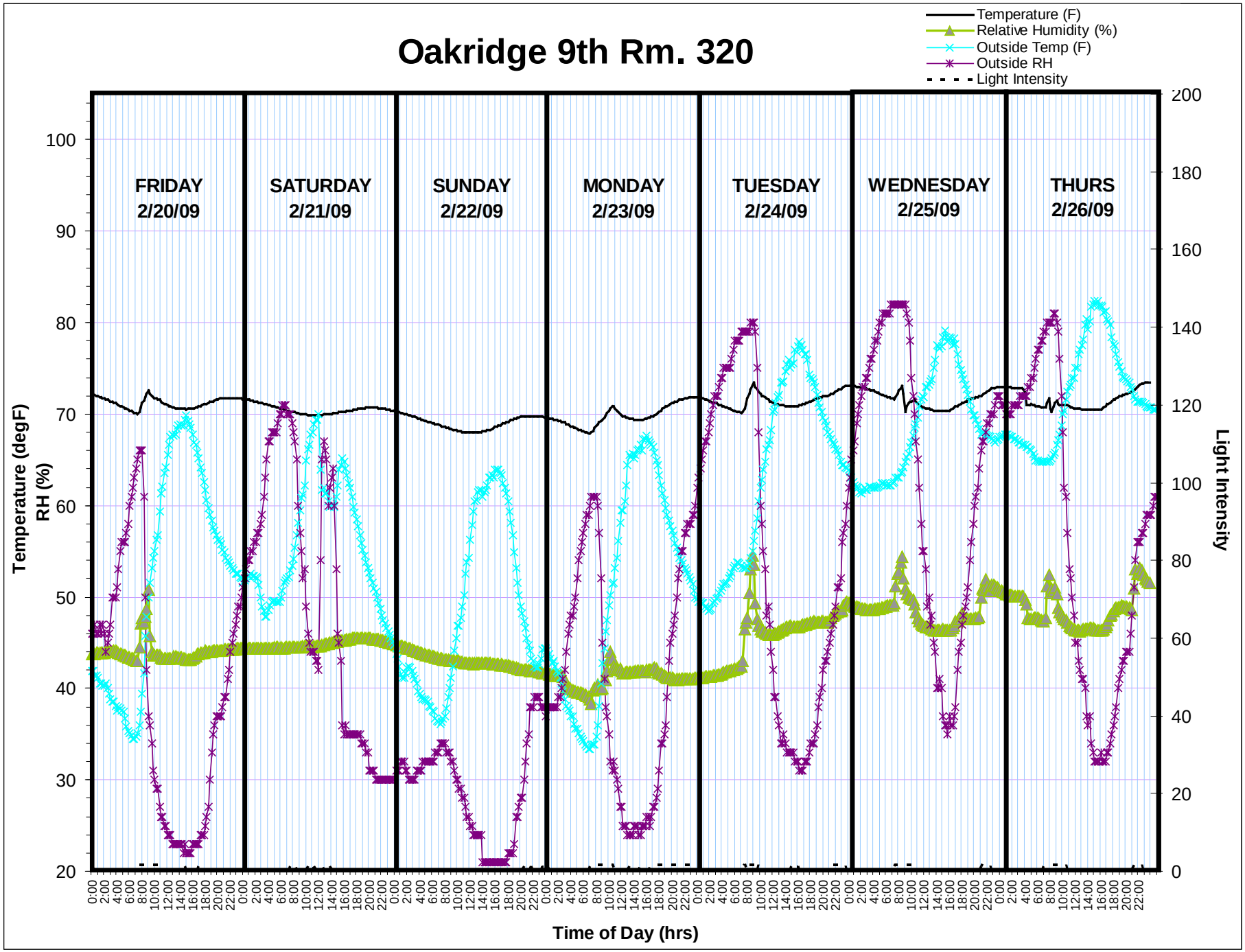
WOODLAND HIGH SCHOOL

The Woodlands High School

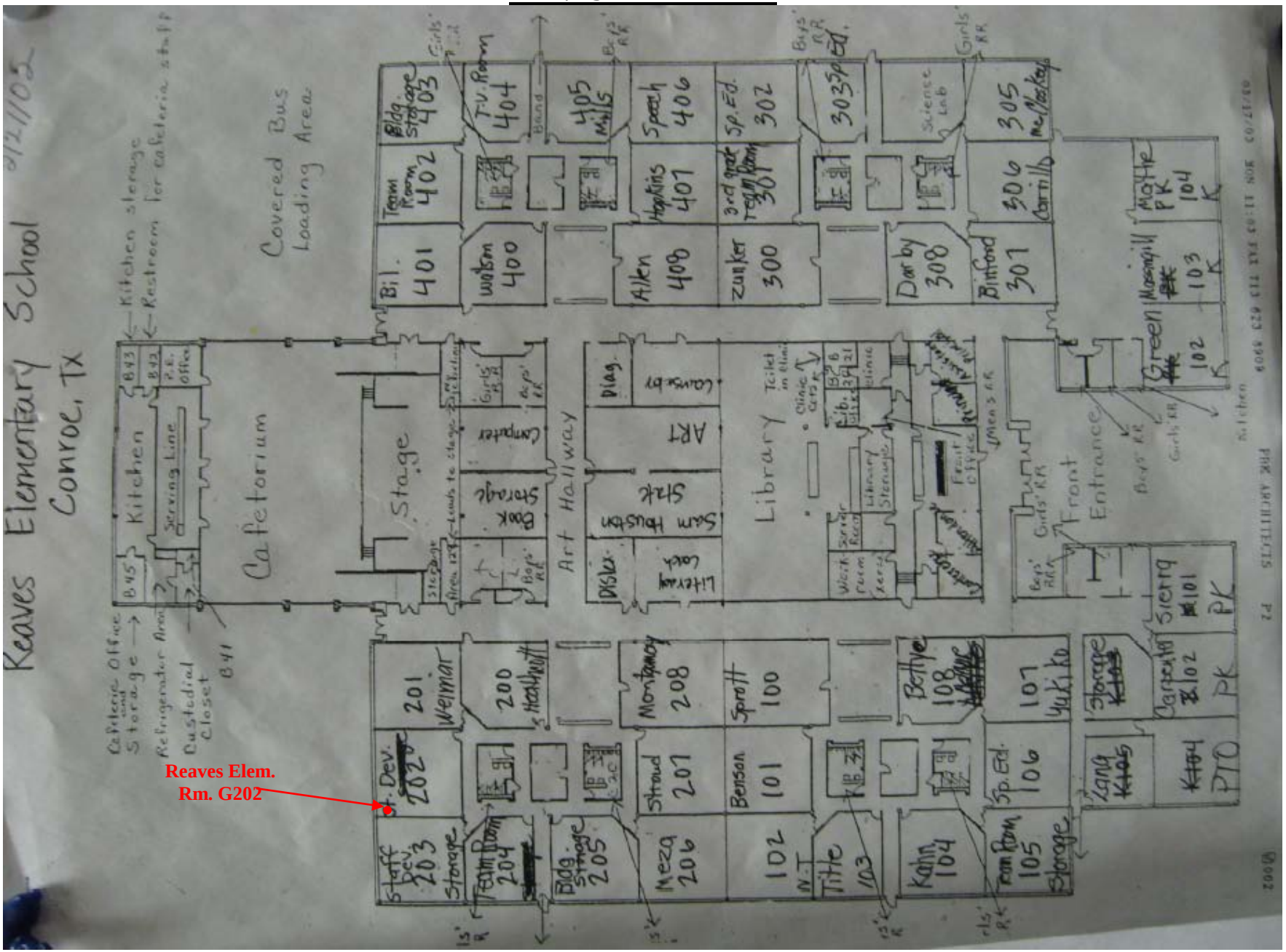


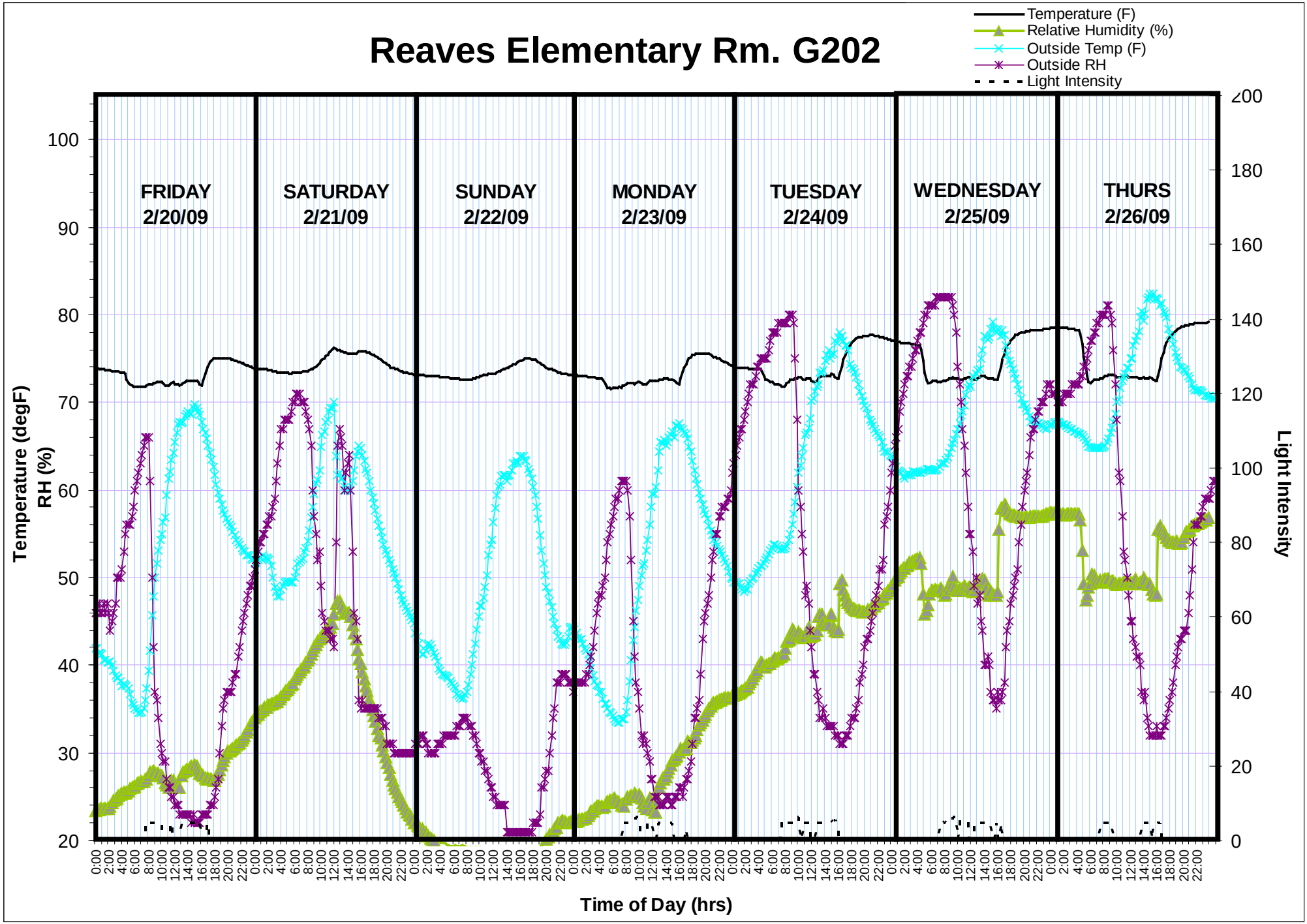

Woodland H.S. Rm. 138
Temperature (F)
Relative Humidity (%)
Outside Temp (F)
Outside RH
Light Intensity
FRIDAY 2/20/09
SATURDAY 2/21/09
SUNDAY 2/22/09
MONDAY 2/23/09
TUESDAY 2/24/09
WEDNESDAY 2/25/09
THURS 2/26/09
Temperature (degF)
RH (%)
Light Intensity
Time of Day (hrs)

OAKRIDGE 9TH GRADE

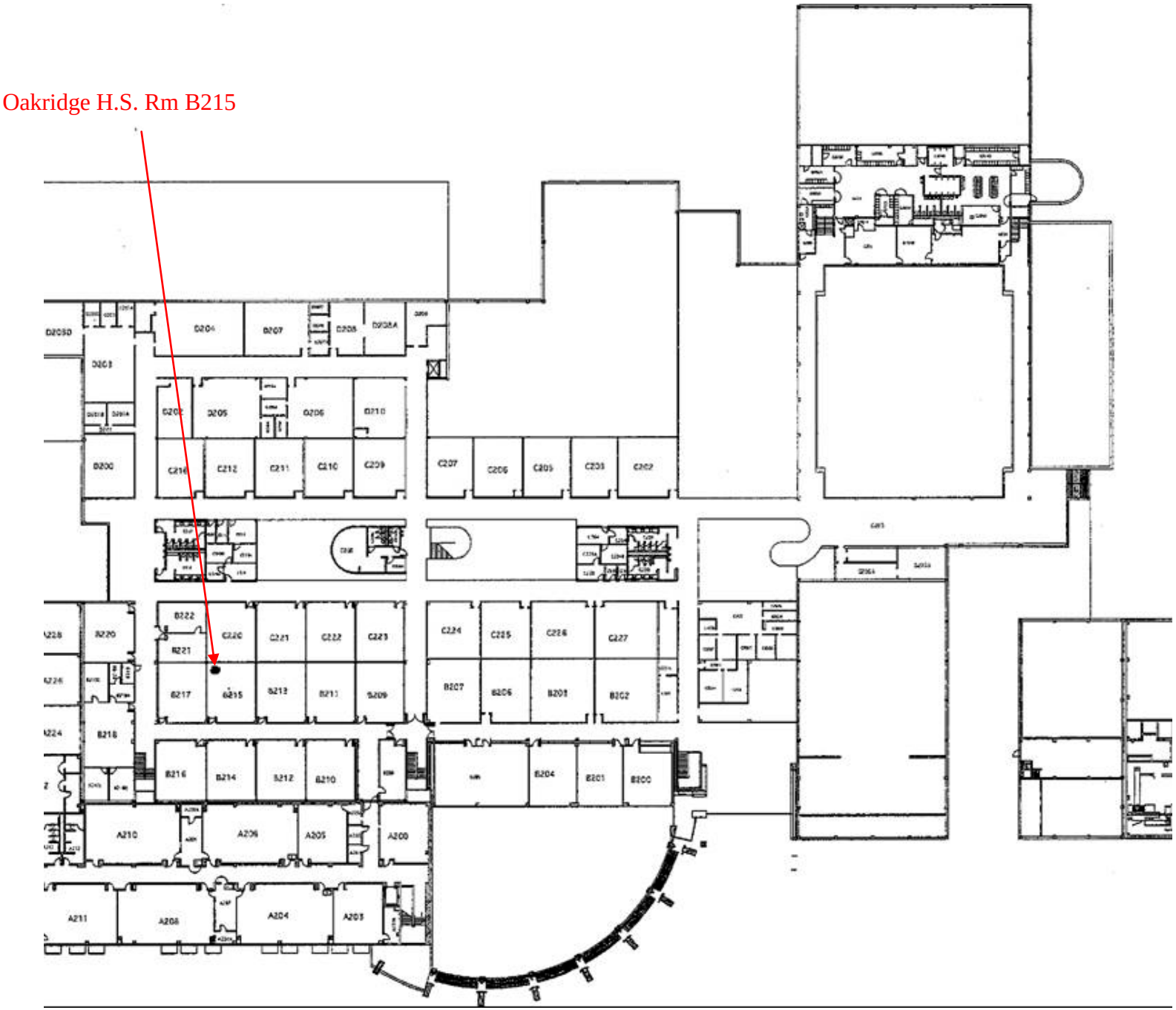

Oakridge 9th Rm. 320
Temperature (F)
Relative Humidity (%)
Outside Temp (F)
Outside RH
Light Intensity
FRIDAY 2/20/09
SATURDAY 2/21/09
SUNDAY 2/22/09
MONDAY 2/23/09
TUESDAY 2/24/09
WEDNESDAY 2/25/09
THURS 2/26/09
Temperature (degF)
RH (%)
Light Intensity
Time of Day (hrs)

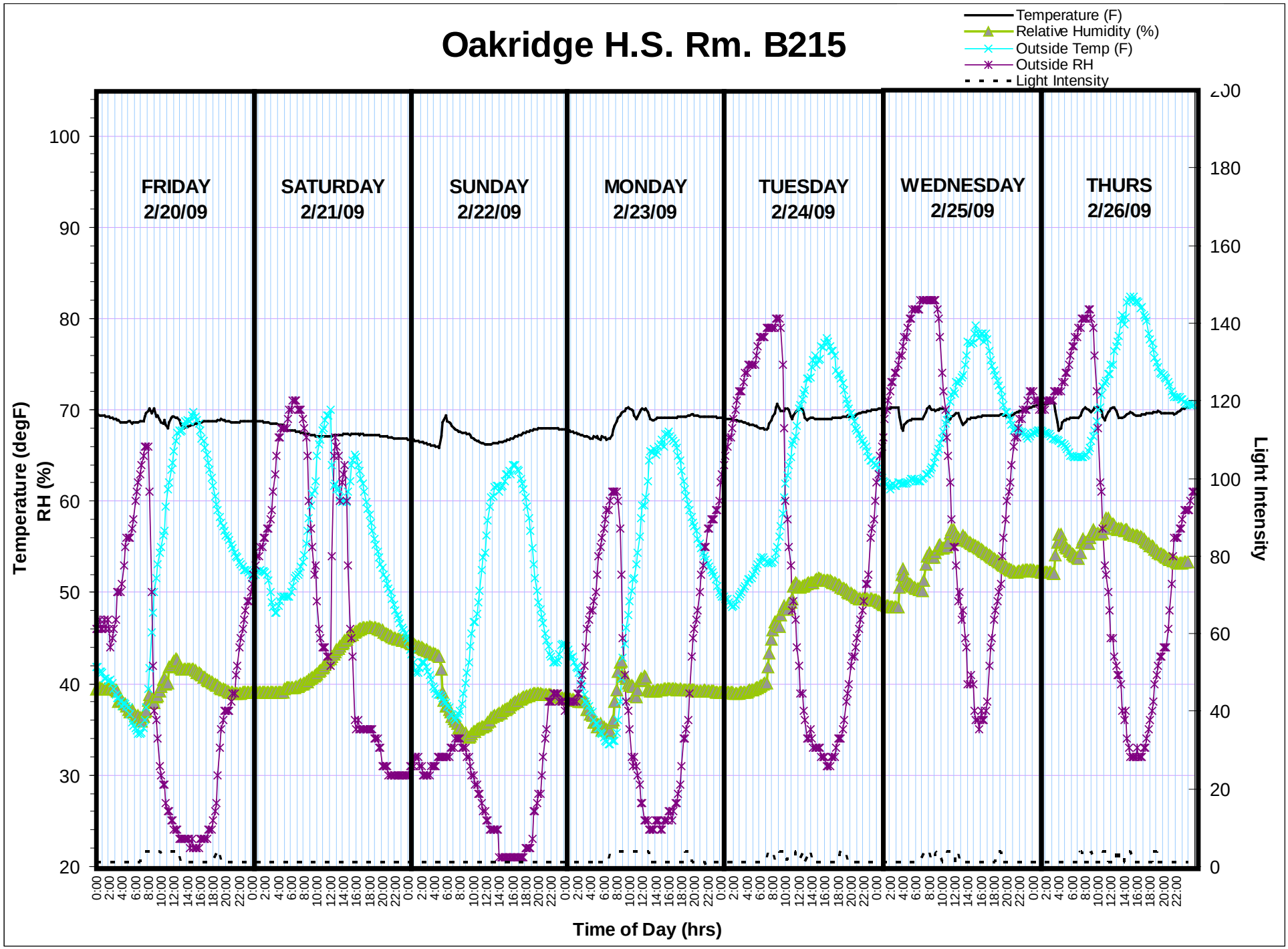
REAVES ELEMENTARY



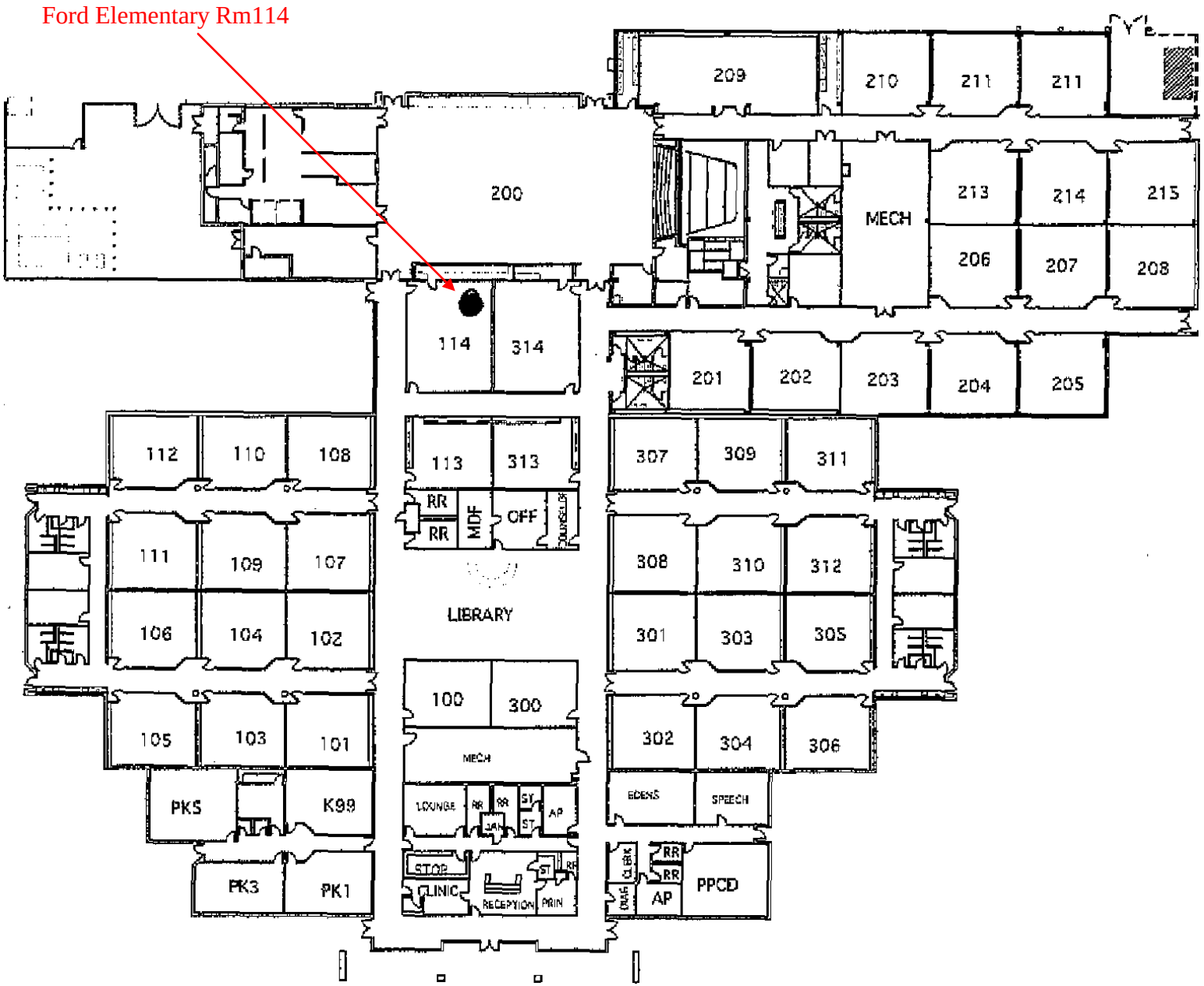

Reaves Elementary Rm. G202
Temperature (F)
Relative Humidity (%)
Outside Temp (F)
Outside RH
Light Intensity
FRIDAY 2/20/09
SATURDAY 2/21/09
SUNDAY 2/22/09
MONDAY 2/23/09
TUESDAY 2/24/09
WEDNESDAY 2/25/09
THURS 2/26/09
Temperature (degF)
RH (%)
Light Intensity
Time of Day (hrs)

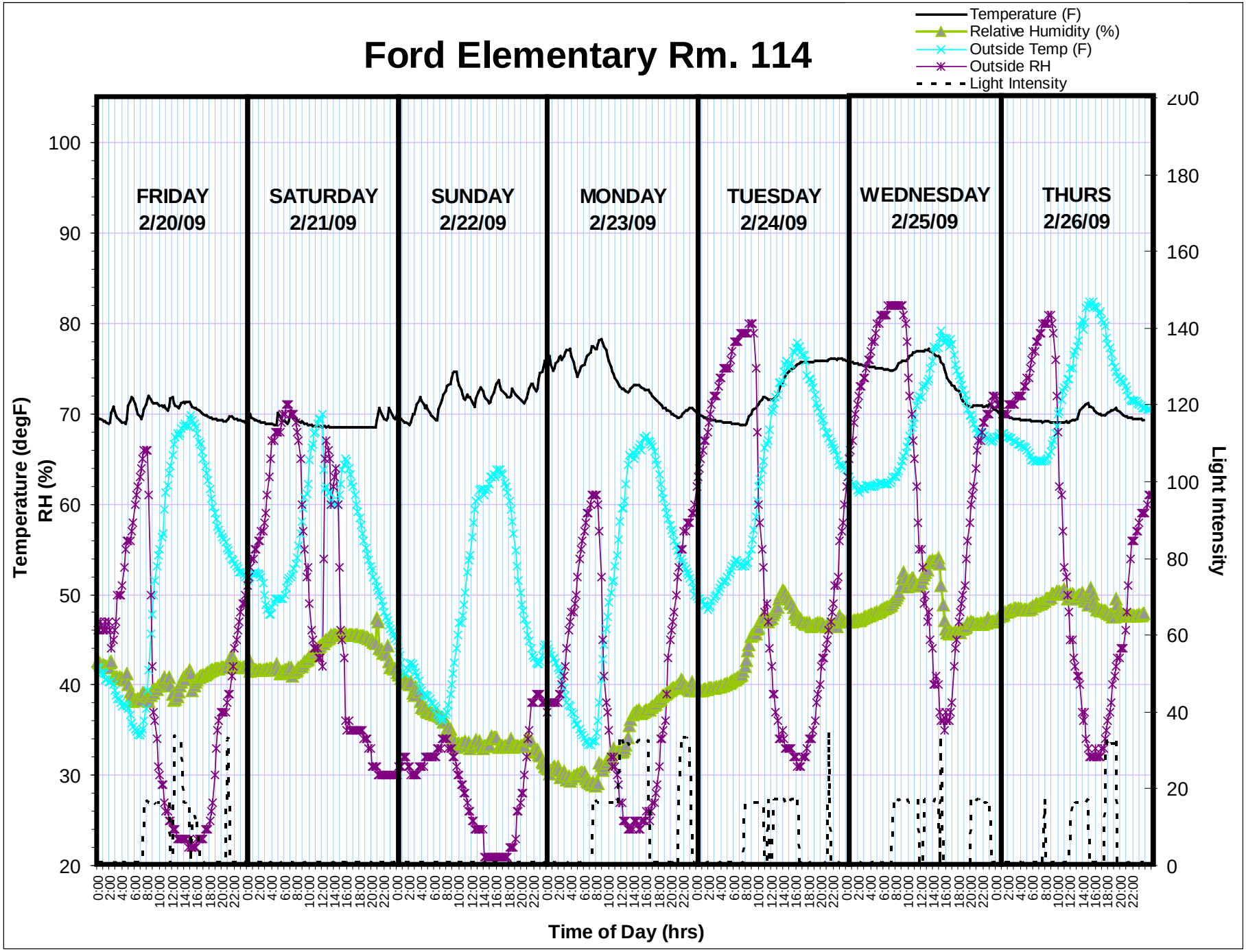
OAKRIDGE HIGH SCHOOL

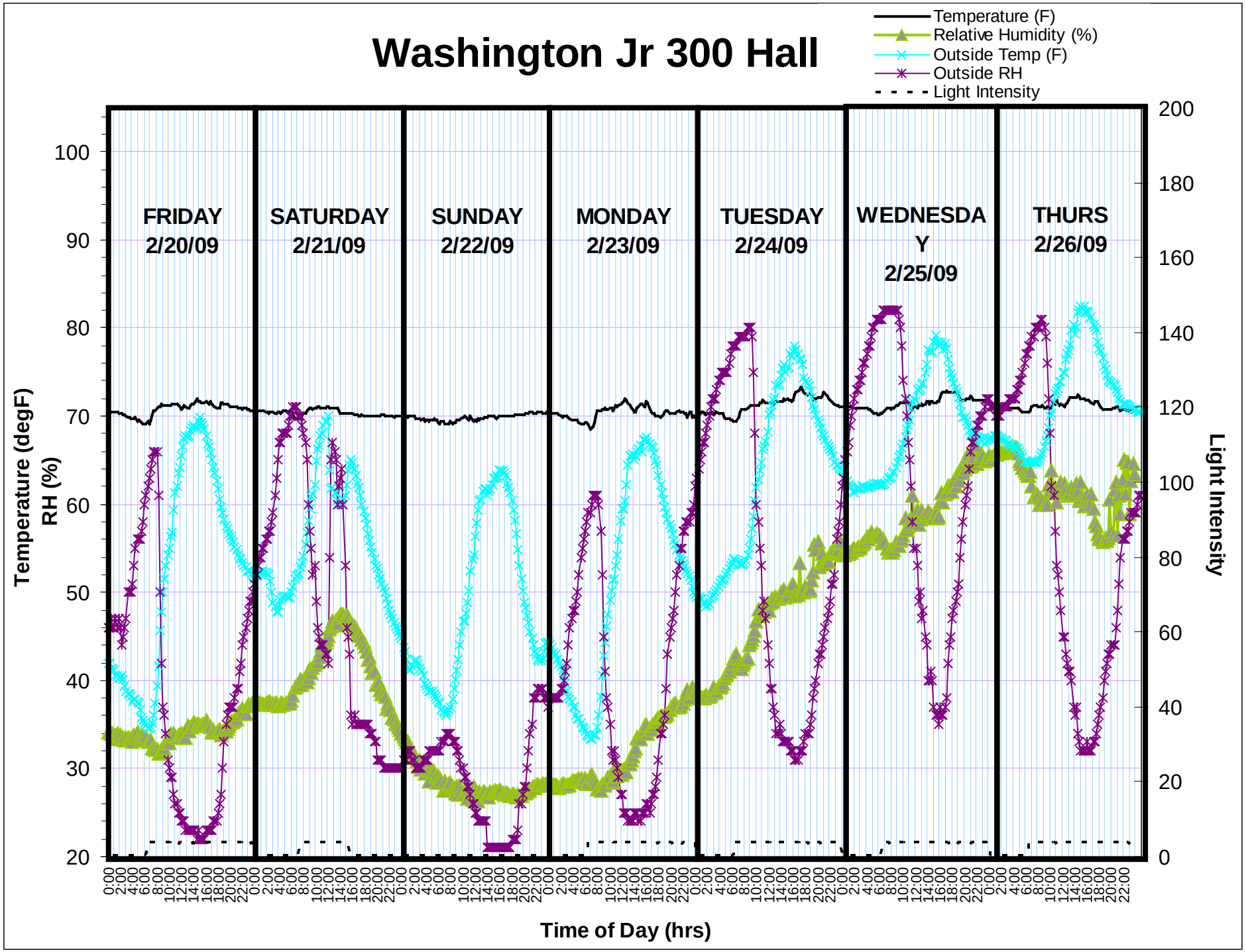



Oakridge H.S. Rm. B215
Temperature (F)
Relative Humidity (%)
Outside Temp (F)
Outside RH
Light Intensity
FRIDAY 2/20/09
SATURDAY 2/21/09
SUNDAY 2/22/09
MONDAY 2/23/09
TUESDAY 2/24/09
WEDNESDAY 2/25/09
THURS 2/26/09
Temperature (degF) RH (%)
Light Intensity
Time of Day (hrs)

FORD ELEMENTARY




Ford Elementary Rm. 114
Temperature (F)
Relative Humidity (%)
Outside Temp (F)
Outside RH
Light Intensity
FRIDAY 2/20/09
SATURDAY 2/21/09
SUNDAY 2/22/09
MONDAY 2/23/09
TUESDAY 2/24/09
WEDNESDAY 2/25/09
THURS 2/26/09
Temperature (degF)
RH (%)
Light Intensity
Time of Day (hrs)


Washington Jr 300 Hall
Temperature (F)
Relative Humidity (%)
Outside Temp (F)
Outside RH
Light Intensity
FRIDAY 2/20/09
SATURDAY 2/21/09
SUNDAY 2/22/09
MONDAY 2/23/09
TUESDAY 2/24/09
WEDNESDAY 2/25/09
THURS 2/26/09
Temperature (degF) RH (%)
Light Intensity
Time of Day (hrs)

APPENDIX F

WATT WATCHERS PROGRAM

Watt Watchers of Texas

Saving Energy in Texas Schools

1-888-US WATTS

or

1-888-WATTEAM

Watt Watchers of Texas is a free, state sponsored program to help schools save energy and money by getting students involved. Students patrol their school looking for empty classrooms with the lights on. They turn out the lights and leave a ticket for the teacher. It may sound trivial but...when the teacher forgets to turn out the lights an extra 2 hours per day, at lunch and after school, for example - it costs the district $50 every year.

Get your students involved.
Save energy, save money,
and prevent pollution.

Sign Up for a free kit today.

Watt Watchers of Texas
University of Texas at El Paso – Energy Center
PO Box 68660
El Paso, Texas 79968
http://wattwatchers.org

Watt Watchers of Texas is sponsored by the Texas State Energy Conservation Office/Comptroller of Public Accounts and the U.S. Department of Energy

APPENDIX G

LOANSTAR INFORMATION

Texas LoanSTAR Program

FACTS ABOUT LoanSTAR

The State of Texas LoanSTAR (Saving Taxes and Resources) Program finances energy efficient facility up-grades for state agencies, public schools, institutions of higher education, local governments, municipalities, and hospitals. The program's revolving loan mechanism allows participants to borrow money and repay all project costs through the stream of **cost savings** produced.

ELIGIBLE PROJECTS

Up-grades financed through the program include, but are not limited to, (1) energy efficient lighting systems; (2) high efficiency heating, ventilation and air conditioning systems; (3) energy management systems; (4) boiler efficiency improvements; (5) energy recovery systems; (6) building shell improvements; and (7) load management projects. The prospective borrower hires a Professional Engineer to analyze the potential energy efficient projects that will be submitted for funding through the Loan STAR Program. All engineering costs are covered under the program.

PROGRAM REQUIREMENTS

Once the projects are analyzed and the prospective borrower agrees with the recommended projects, the engineer prepares an Energy Assessment Report (EAR) with the project descriptions and calculations. The EAR must be prepared according to the LoanSTAR Technical Guidelines. The EAR is reviewed and approved by the State Energy Conservation Office (SECO) technical staff before project financing is authorized. Projects financed by LoanSTAR must have an average simple payback of ten years or less. Borrowers do, however, have the option of buying down paybacks to meet the composite ten-year limit.

To ensure up-grade projects are designed and constructed according to the EAR, SECO performs a review of the design documents at the 50% and 100% completion phases. On-site construction monitoring is also performed at the 50% and 100% completion phases.

SAVINGS VERIFICATION

To ensure that the Borrower is achieving the estimated energy savings, monitoring and verification is required for all LoanSTAR funded projects. The level of monitoring and verifications may range from utility bill analysis to individual system or whole building metering depending on the size and type of retrofit projects. If whole building metering is required, metering and monitoring cost can be rolled into the loan.

For additional information regarding the
LoanSTAR program, please contact:

Theresa Sifuentes
SECO, LoanSTAR Program Manager
(512) 463-1896

APPENDIX H

DESCRIPTION OF SECO PROGRAMS

Texas State Energy Conservation Office (SECO)

The Texas State Energy Conservation Office (SECO) helps Texas make the most of domestic energy, reduce state and local government energy costs and promote cost-effective, clean-energy technologies. SECO's mission is to maximize energy efficiency while protecting the environment.

LoanSTAR Revolving Loan Program: has saved taxpayers more than $224.6 million through energy-efficiency projects for state agencies, institutions of higher education, school districts, county hospitals and local governments. Borrowers repay loans through cost savings generated by the projects. LoanSTAR-funded projects have also prevented the release of 7,781 tons of nitrogen oxides (NOx), 2.3 million tons of carbon dioxide (CO2) and 5,339 tons of sulfur dioxide (SO2).

Schools/Local Government Energy Program: has helped more than 3,500 schools and other units of local government set up and maintain effective energy-efficiency programs. SECO provides facility preliminary energy assessments, energy management training workshops, technical support in designing new facilities and on-site training for student energy awareness projects. Clean energy technologies are demonstrated at public facilities and school districts to increase awareness and address air quality at the community level. Texas schools also employ the computer power management software that puts monitors to "sleep" when not in use. Over 136,000 school computers now use this software, saving 42 million kWh and reducing energy costs by $3 million annually.

Energy Education Program: promotes energy conservation and efficiency through education. The program strives to lay the foundation for environmental stewardship in teachers and students through critical-thinking and problem-solving investigations in Texas Education Agency approved workshops. Over 2,500 teachers have attended these workshops and utilized the materials in their classrooms reaching over 375,000 students. The program also supports fuel cell technical training curriculum development at the college level.

State Agencies/Higher Education Program: ensures that new facilities are designed and built with energy efficiency and water conservation in mind. Projects include administration and maintenance of the Energy and Water Conservation Design Standard for new state buildings and major renovation projects. Other initiatives include development of statewide employee energy awareness through workshops on how energy efficiency and employee behavior can reduce energy use. The program provides educational materials on how to use energy more efficiently through product procurement, innovative technologies and sustainable design practices. This program also provides education and outreach on residential and commercial energy codes statewide. The goal is to demonstrate the clear benefits of energy codes and standards in improving the quality of life, the environment and the safety and health of communities.

Alternative Fuels Program: demonstrates the positive environmental impact, technical feasibility and energy efficiency of domestically-produced alternative fuels. The Alternative Fuels Program is designed to assist state agencies, school districts, local government and private fleets to operate more of their fleets on alternative fuels. Initiatives include support for the Clean Cities Program, Clean School Bus USA Program, Mechanics Education Outreach and Air Quality Demonstration Projects.

Energy Management Services: a comprehensive energy management program designed to significantly reduce energy and utility expenditures in state-owned facilities. The State of Texas spent over $216 million in energy and utility expenditures in 2006. Program components include construction of a state-of-the-art energy and utility information management system, a comprehensive analysis of historic and future utility bills, energy procurement at the lowest possible rates and best available terms, and owner's representative services on ongoing and future energy-conservation projects. Institutions of higher education, state university systems and local governments are eligible to participate in the program.

Innovative Energy Program: promotes the use of renewable energy and sustainable building practices through technology demonstration, hands-on instruction and renewable energy education. Renewable energy has significant economic, security and reliability benefits and opportunities for Texas communities and individuals as they develop and use these resources. SECO increases public awareness of Texas' vast renewable energy resources and provides the public better access to vendors, financing options, and renewable energy incentives through its educational web site, The Infinite Power of Texas, at www.infinitepower.org.

Housing Partnership Program: promotes the efficient use of energy in low-to-moderate-income housing through partnerships among nonprofit organizations, community action agencies, local governments, utility companies, public housing authorities and social service organizations. The program encourages community and residential involvement in energy-efficiency projects such as housing retrofits, model demonstration projects, technical training assistance and energy education workshops and seminars.

Pollution Mitigation Program: assists political subdivisions in the 41 non-attainment counties to reduce electric consumption in their facilities by implementing cost-effective energy efficiency projects. SECO provides technical support and guidance through the Texas Energy Partnership, a joint initiative involving SECO, the U. S. Department of Energy and ENERGY STAR®. Information, planning tools and electronic reporting are offered at www.texasenergypartnership.org.

Pantex Program: The Pantex Nuclear Weapons plant, located in Carson County, is responsible for assembling and disassembling nuclear weapons. The U.S. Department of Energy funds the Texas Agreement in Principle, which SECO has administered since 1990. SECO contracts with a variety of state and local governments to ensure that human health and safety, and the environment, are protected around the plant. The Pantex Program also administers a DOE grant to train local emergency responders along routes that have shipments of radioactive waste going to the Waste Isolation Pilot Plant near Carlsbad, New Mexico, and eventually shipments of spent fuel tentatively scheduled to go to Yucca Mountain in Nevada.

State Energy Conservation Office
111 East 17th Street
Austin, TX 78774-1440
Phone: (512) 463-1931
Fax: (512) 475-2569
www.seco.cpa.state.tx.us

APPENDIX I

TYPICAL EQUIPMENT MAINTENANCE CHECKLISTS

Boilers Checklist

Description	Comments	Maintenance Frequency			
		Daily	Weekly	Monthly	Annually
Boiler use/sequencing	Turn off/sequence unnecessary boilers	X			
Overall visual inspection	Complete overall visual inspection to be sure all equipment is operating and safety systems are in place	X			
Follow manufacturer's recommended procedures in lubricating all components	Compare temperatures with tests performed after annual cleaning	X			
Check steam pressure	Is variation in steam pressure as expected under different loads? Wet steam may be produced if the pressure drops too fast	X			
Check unstable water level	Unstable levels can be a sign of contaminates in feedwater, overloading of boiler, equipment malfunction	X			
Check burner	Check for proper control and cleanliness	X			
Check motor condition temperatures	Check for proper function	X			
Check air temperatures in boiler room	Temperatures should not exceed or drop below design limits	X			
Boiler blowdown	Verify the bottom, surface and water column blow downs are occurring and are effective	X			
Boiler logs	Keep daily logs on: • Type and amount of fuel used • Flue gas temperature • Makeup water volume • Steam pressure, temperature, and amount generated Look for variations as a method of fault detection	X			
Check oil filter assemblies	Check and clean/replace oil filters and strainers	X			
Inspect oil heaters	Check to ensure that oil is at proper temperature prior to burning	X			
Check boiler water treatment	Confirm water treatment system is functioning properly	X			
Check flue gas temperatures and composition	Measure flue gas composition and temperatures at selected firing positions - recommended O2% and CO2% Fuel / O2 % / CO2% Natural gas / 1.5 / 10 No. 2 fuel oil / 2.0 / 11.5 No. 6 fuel oil / 2.5 / 12.5 Note: percentages may vary due to fuel composition variations		X		

Boilers Checklist (contd)

Description	Comments	Maintenance Frequency			
		Daily	Weekly	Monthly	Annually
Check all relief valves	Check for leaks		X		
Check water level control	Stop feedwater pump and allow control to stop fuel flow to burner. Do not allow water level to drop below recommended level.		X		
Check pilot and burner assemblies	Clean pilot and burner following manufacturer's guidelines. Examine for mineral or corrosion buildup.		X		
Check boiler operating characteristics	Stop fuel flow and observe flame failure. Start boiler and observe characteristics of flame.		X		
Inspect system for water/ steam leaks and leakage opportunities	Look for: leaks, defective valves and traps, corroded piping, condition of insulation		X		
Inspect all linkages on combustion air dampers and fuel valves	Check for proper setting and tightness		X		
Inspect boiler for air leaks	Check damper seals		X		
Check blowdown and water treatment procedures	Determine if blowdown is adequate to prevent solids buildup			X	
Flue gases	Measure and compare last month's readings flue gas composition over entire firing range			X	
Combustion air supply	Check combustion air inlet to boiler room and boiler to make sure openings are adequate and clean			X	
Check fuel system	Check pressure gauge, pumps, filters and transfer lines. Clean filters as required.			X	
Check belts and packing glands	Check belts for proper tension. Check packing glands for compression leakage.			X	
Check for air leaks	Check for air leaks around access openings and flame scanner assembly.			X	
Check all blower belts	Check for tightness and minimum slippage.			X	
Check all gaskets	Check gaskets for tight sealing, replace if do not provide tight seal			X	
Inspect boiler insulation	Inspect all boiler insulation and casings for hot spots			X	
Steam control valves	Calibrate steam control valves as specified by manufacturer			X	
Pressure reducing/regulating valves	Check for proper operation			X	

Boilers Checklist (contd)

Description	Comments	Maintenance Frequency			
		Daily	Weekly	Monthly	Annually
Perform water quality test	Check water quality for proper chemical balance			X	
Clean waterside surfaces	Follow manufacturer's recommendation on cleaning and preparing waterside surfaces				X
Clean fireside	Follow manufacturer's recommendation on cleaning and preparing fireside surfaces				X
Inspect and repair refrac-tories on fireside	Use recommended material and procedures				X
Relief valve	Remove and recondition or replace				X
Feedwater system	Clean and recondition feedwater pumps. Clean condensate receivers and deaeration system				X
Fuel system	Clean and recondition system pumps, filters, pilot, oil preheaters, oil storage tanks, etc.				X
Electrical systems	Clean all electrical terminals. Check electronic controls and replace any defective parts.				X
Hydraulic and pneumatic valves	Check operation and repair as necessary				X
Flue gases	Make adjustments to give optimal flue gas composition. Record composition, firing position, and temperature.				X
Eddy current test	As required, conduct eddy current test to assess tube wall thickness				X

Chillers Checklist

Description	Comments	Maintenance Frequency			
		Daily	Weekly	Semi-Annually	Annually
Chiller use/sequencing	Turn off/sequence unnecessary chillers	X			
Overall visual inspection	Complete overall visual inspection to be sure all equipment is operating and safety systems are in place	X			
Check setpoints	Check all setpoints for proper setting and function	X			
Evaporator and condenser coil fouling	Assess evaporator and condenser coil fouling as required		X		
Compressor motor temperature	Check temperature per manufacturer's specifications		X		
Perform water quality test	Check water quality for proper chemical balance		X		
Leak testing	Conduct leak testing on all compressor fittings, oil pump joints and fittings, and relief valves		X		
Check all insulation	Check insulation for condition and appropriateness		X		
Control operation	Verify proper control function including: • Hot gas bypass • Liquid injection		X		
Check vane control settings	Check settings per manufacturer's specification			X	
Verify motor load limit control	Check settings per manufacturer's specification			X	
Verify load balance operation	Check settings per manufacturer's specification			X	
Check chilled water reset settings and function	Check settings per manufacturer's specification			X	
Check chiller lockout setpoint	Check settings per manufacturer's specification				X
Clean condenser tubes	Clean tubes at least annually as part of shutdown procedure				X

Building Controls Checklist

Description	Comments	Maintenance Frequency			
		Daily	Weekly	Semi-Annually	Annually
Overall visual inspection	Complete overall visual inspection to be sure all equipment is operating and safety systems are in place	X			
Verify control schedules	Verify in control software that schedules are accurate for season, occupancy, etc.	X			
Verify setpoints	Verify in control software that setpoints are accurate for season, occupancy, etc.	X			
Time clocks	Reset after every power outage	X			
Check all gauges	Check all gauges to make sure readings are as expected		X		
Control tubing (pneumatic system)	Check all control tubing for leaks		X		
Check outside air volumes	Calculated the amount of outside air introduced and compare to requirements		X		
Check setpoints	Check setpoints and review rational for setting		X		
Check schedules	Check schedules and review rational for setting		X		
Check deadbands	Assure that all deadbands are accurate and the only simultaneous heating and cooling is by design		X		
Check sensors	Conduct thorough check of all sensors - temperature, pressure, humidity, flow, etc. - for expected values			X	
Time clocks	Check for accuracy and clean			X	
Calibrate sensors	Calibrate all sensors: temperature, pressure, humidity, flow, etc.				X

Pumps Checklist

Description	Comments	Maintenance Frequency			
		Daily	Weekly	Monthly	Annually
Pump use/sequencing	Turn off/sequence unnecessary pumps	X			
Overall visual inspection	Complete overall visual inspection to be sure all equipment is operating and safety systems are in place	X			
Check lubrication	Assure that all bearings are lubricated per the manufacture's recommendation			X	
Check packing	Check packing for wear and repack as necessary. Consider replacing packing with mechanical seals.			X	
Motor/pump alignment	Aligning the pump/motor coupling allows for efficient torque transfer to the pump			X	
Check mountings	Check and secure all pump mountings			X	
Check bearings	Inspect bearings and drive belts for wear. Adjust, repair, or replace as necessary.				X
Motor condition	Checking the condition of the motor through temperature or vibration analysis assures long life				X

Fans Checklist

Description	Comments	Maintenance Frequency			
		Daily	Weekly	Monthly	Annually
System use/sequencing	Turn off/sequence unnecessary equipment	X			
Overall visual inspection	Complete overall visual inspection to be sure all equipment is operating and safety systems are in place	X			
Observe belts	Verify proper belt tension and alignment			X	
Inspect pulley wheels	Clean and lubricate where required			X	
Inspect dampers	Confirm proper and complete closure control; outside air dampers should be airtight when closed			X	
Observe actuator/linkage control	Verify operation, clean, lubricate, adjust as needed			X	
Check fan blades	Validate proper rotation and clean when necessary			X	
Filters	Check for gaps, replace when dirty - monthly			X	
Check for air quality anomalies	Inspect for moisture/growth on walls, ceilings, carpets, and in/outside of duct-work. Check for musty smells and listen to complaints.			X	
Check wiring	Verify all electrical connections are tight				X
Inspect ductwork	Check and refasten loose connections, repair all leaks				X
Coils	Confirm that filters have kept clean, clean as necessary				X
Insulation	Inspect, repair, replace all compromised duct insulation				X

Electric Motors Checklist

Description	Comments	Maintenance Frequency			
		Daily	Weekly	Monthly	Annually
Motor use/sequencing	Turn off/sequence unnecessary motors	X			
Overall visual inspection	Complete overall visual inspection to be sure all equipment is operating and safety systems are in place	X			
Motor condition	Check the condition of the motor through temperature or vibration analysis and compare to baseline values		X		
Check lubrication	Assure that all bearings are lubricated per the manufacture's recommendation			X	
Check packing	Check packing for wear and repack as necessary. Consider replacing packing with mechanical seals.			X	
Motor alignment	Aligning the motor coupling allows for efficient torque transfer to the pump			X	
Check mountings	Check and secure all motor mountings			X	
Check terminal tightness	Tighten connection terminals as necessary			X	
Cleaning	Remove dust and dirt from motor to facilitate cooling			X	
Check bearings	Inspect bearings and drive belts for wear. Adjust, repair, or replace as necessary.				X
Motor condition	Checking the condition of the motor through temperature or vibration analysis assures long life				X
Check for balanced three-phase power	Unbalanced power can shorten the motor life through excessive heat build up				X
Check for over-voltage or under-voltage conditions	Over- or under-voltage situations can shorten the motor life through excessive heat build up				X

APPENDIX J

BUILDING COMMISSIONING INFORMATION

EnergyIdeas
Clearinghouse

Energy Efficiency FACTSHEET

Building commissioning provides benefits such as a smoother construction process, reduced operation and maintenance costs, lower energy costs, and satisfied building occupants and tenants.

Building Commissioning for New Buildings

Building commissioning for new buildings is a quality assurance process to verify and document that building systems function as designed and meet the operational needs of the building owner and building users. The initial costs of commissioning are recovered many times over through operating savings, improved staff performance, and avoidance of costly construction problems.

Photo courtesy of DOE/NREL

What is building commissioning?

The key elements in building commissioning include:

- Thoroughly documenting system design intent, operating sequences and test procedures.
- Verifying system performance based on extensive functional testing and measurement.
- Ensuring that building operations staff members receive the training and resources they need on system operation and maintenance procedures.

It is important to realize that building commissioning is not standard practice, although it is becoming more common for large or complicated buildings. Building commissioning goes beyond standard testing, adjusting, and balancing and beyond traditional inspections. The Building Commissioning Association describes building commissioning as *"a quality based process with documented confirmation that building systems are planned, designed, installed, tested, operated and maintained in compliance with the owner's project requirements."*

Why perform building commissioning?

Commissioned buildings are more likely to perform as intended and avoid operational problems. Poorly performing buildings inherently have high costs. Benefits from commissioning include a smoother construction process (from improved communication, fewer change orders, and avoided litigation), reduced operation and maintenance costs, lower energy costs (through improved energy efficiency) and satisfied building occupants and tenants (through improved indoor air quality and thermal comfort).

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Extension Energy Program

With support from:
Northwest Energy Efficiency Alliance
www.nwalliance.org

Experience has shown that a building that is not commissioned will cost 8 to 20 percent more to operate than a commissioned building. A 2004 report[1] showed that, on average, the cost of performing commissioning was paid back in 4.8 years from energy savings alone. When other benefits were accounted for (from improved equipment lifetimes, reduced change-orders due to early detection of problems, prevention of premature equipment breakdown by timely correction of problems, reduced operation and maintenance costs, and improved indoor environment), they essentially offset the entire cost of new-building commissioning.

As buildings and systems have become more complex and occupant requirements have increased, the need for commissioning is even greater. Informed building owners recognize that a high performance building is a key element for business success. It gives them a competitive advantage.

In addition, the Washington State and Seattle Energy Codes for non-residential buildings require systems commissioning for mechanical and lighting systems (see sections 1416 and 1513.7). For lighting and simple HVAC systems, the requirements are limited to controls[2]. The code states that drawing notes specify commissioning, that specifications and plans identify the equipment to be tested and the procedures to be used, that systems be tested to ensure they operate in accord with the approved plans, and that a commissioning report be submitted to the owner. For complex mechanical systems, a preliminary commissioning report is to be completed prior to the building official issuing a final certificate of occupancy.

[1] *The Cost-Effectiveness of Commercial-Buildings Commissioning: A Meta-Analysis of Energy and Non-Energy Impacts in Existing Buildings and New Construction in the United States*, Report Number 56637, Lawrence Berkeley National Laboratory, Portland Energy Conservation Inc., Texas A&M University Energy Systems Laboratory, December 2004.
http://eetd.lbl.gov/emills/PUBS/Cx-Costs-Benefits.html

[2] ASHRAE Standard 90.1-2004, the model for the energy codes in many states, includes a minimum level of systems commissioning as part of the completion requirements (6.7.2) for mechanical systems that is less detailed than the Washington and Seattle Energy Codes. California and Massachusetts have commissioning-like provisions in their codes and Oregon has considered a commissioning requirement for their energy code.

Photo courtesy of DOE/NREL
Photo by Kenneth Shipp, DOE

It is important to recognize that these minimum requirements fall short of the level of commissioning recommended by many commissioning providers and that the local jurisdictions often do not have the resources to fully enforce all the requirements in the energy code. A building owner needs to be sure they are receiving an adequate level of commissioning from a qualified commissioning provider in order to obtain the benefits that commissioning offers.

When should building commissioning start?

Ideally, building commissioning should begin early in the design phase of the project. This allows the commissioning provider to work with the design team and become familiar with the project goals and design intent as decisions are made. Plans can be made to effectively incorporate commissioning into the development process. This helps to ensure success and avoid problems and additional work later in the project. Commissioning can occur in the construction process or after construction is complete, but this makes it more difficult to document the design intent, identify design problems, develop testing plans and conduct tests. This can compromise the potential for success.

Who should perform building commissioning?

Who actually performs commissioning depends on the owner and the project. Typically, the building owner hires an independent third party to perform commissioning. This individual is often referred to as the commissioning provider (or authority).

Those involved in the building commissioning field generally believe the commissioning provider should work for the owner and should represent the owner's interest. However, there are numerous options. As commissioning becomes

more popular, a greater number of firms are offering building commissioning as part of their services. These include construction managers, test and balance contractors, design engineers, and mechanical contractors. The nature of the project will determine which option is best.

Trained and certified commissioning providers can be located through the Building Commissioning Association (see list of resources at the end of this factsheet).

What are the steps in a commissioning process?

The extent of the commissioning process can vary as well as the roles of those involved in the project. A comprehensive process beginning in pre-design and running through post-occupancy is justified for large, complex projects. The commissioning process for smaller buildings should be simpler, focusing on system balancing, simple functional tests of key systems, and documentation. The commissioning process, with an emphasis on the roles of the commissioning provider (CP), is described below for the phases of the design and construction process.

Predesign

The CP, working with the owner, establishes the parameters and expectations for the commissioning process. The CP may have a limited input and review role in this phase.

Design Phase

The CP outlines the scope of design requirements and design intent, describes the systems to be installed, outlines the documentation requirements for each party involved in the commissioning process, defines subsequent commissioning procedures, and documents the process. This includes design review to identify design issues and the development of a commissioning specification that describes the roles and responsibilities of the contractor in the commissioning process.

Photo courtesy of DOE/NREL, Photographer David Parsons

Construction Phase

The CP completes the commissioning plan at the beginning of the construction phase. The CP obtains project schedules and develops a commissioning project schedule. The CP gathers and reviews the contractor submittals and operation and maintenance manuals. The CP writes detailed functional performance test plans for each system and piece of equipment involved in the commissioning process.

The CP makes site visits to observe construction, notes details that might affect equipment and system performance or operation, and coordinates with the various contractors to perform the pre-functional performance tests. The CP oversees all start-up tests and ensures that the pre-functional performance tests and checklists are completed and all deficiencies resolved.

Acceptance Phase

Using the functional performance test plans, the CP observes and verifies the proper operation of equipment, systems, and controls per contract documents; verifies that corrective measures are taken; and ensures the presence of completed operation and maintenance manuals. The actual performance testing is usually carried out by the various contractors. The CP oversees this process and may be actively involved. Shortly after the functional performance test is complete, the CP finishes the draft commissioning report, including all documentation, and submits it to the owner.

Training for the building operation staff generally occurs near the end of the acceptance phase or shortly after building occupancy. It can be performed prior to, or as part of, the functional performance testing. This provides an opportunity for hands-on experience that can reinforce the training. The training should be done by the installation contractors, designers and manufacturers' representatives, and may include the CP. The CP should be involved in establishing

the training needs of the building operation and maintenance staff and ensuring those needs are met.

Post-Acceptance Phase

Building operation and maintenance staff ensure that the facility's systems function properly, adapt the systems to changing occupancy and use, maintain a facility history, and document all changes. The CP can be involved in establishing the documentation methods for this phase and can review performance and recommend improvements. The CP may also be involved in conducting any seasonal performance testing that could not be performed when the building was completed. Results from the post-acceptance phase are added to the commissioning report. The tools and resources developed during the commissioning process provide the basis for ongoing performance monitoring by building and operation staff to ensure that the benefits of commissioning are maintained.

How much does building commissioning cost?

The price of building commissioning varies depending on the size of the project, complexity of building systems, the systems to be commissioned, when commissioning begins, and the level of detail required in the commissioning process. A good rule of thumb is between two to four percent of the construction cost of the systems being commissioned. In the 2004 study referenced in footnote 1, the median cost for new-building commissioning was $1.00/square foot (0.6 percent of total construction costs).

Owners often say they cannot afford to pay for building commissioning. It is important to recognize the potential costs of *not* commissioning. These costs can include schedule overruns, change orders, litigation costs, high vacancy levels, uncomfortable occupants, excessively long shakedown periods, costly post-occupancy corrections, inability to perform adequate operation and maintenance, and high operation costs. These costs can far exceed the price paid for commissioning. Commissioning reduces the risk of incurring these costs.

Where can I get more information about building commissioning?

The following resources provide more information on building commissioning for new commercial buildings.

Programs and Organizations

BetterBricks.com – Articles, success stories, and other resources on commissioning from BetterBricks, an initiative of the Northwest Energy Efficiency Alliance.
www.betterbricks.com/commissioning

Building Commissioning Association – BCA promotes building commissioning practices that maintain high professional standards and fulfill building owners' expectations. Site includes *White Paper on Commissioning*, February 2005.
www.bcxa.org

Portland Energy Conservation, Inc. (PECI) Resource Library – Access to commissioning documents and links to other information resources. *www.peci.org/library.htm*

The National Conference on Building Commissioning – An annual forum of owners, contractors, designers, and commissioning professionals to further the practices of building commissioning. *www.peci.org/ncbc/index.htm*

National Clearinghouse for Educational Facilities (NCEF) – Created in 1997 by the U.S. Department of Education, NCEF is a free public service that provides information about K-12 school planning, design, financing, construction, operations and maintenance.
www.edfacilities.org/rl/commissioning.cfm

U.S. General Services Administration Commissioning Program – Provides resources including a guide for building commissioning.
www.gsa.gov/Portal/gsa/ep/channelView.do?pageTypeId=8195&channelPage=%2Fep%2Fchannel%2FgsaOverview.jsp&channelId=-15374

Documents

Commissioning for Better Buildings in Oregon (pdf file) – A comprehensive 44-page introduction to building commissioning. *www.energy.state.or.us/bus/comm/commintr.pdf*

The Cost-Effectiveness of Commercial-Buildings Commissioning: A Meta-Analysis of Energy and Non-Energy Impacts in Existing Buildings and New Construction in the United States, Report Number 56637, Lawrence Berkeley National Laboratory, Portland Energy Conservation, Inc., Texas A&M University Energy Systems Laboratory, December 2004. *http://eetd.lbl.gov/emills/PUBS/Cx-Costs-Benefits.html*

Energy User News Fundamentals Series – "Understanding the Commissioning Process." *www.energyusernews.com/CDA/Article_Information/Fundamentals_Item/0,2637,27467,00.html*

State and Local Resources

Idaho Department of Water Resources Energy Division – For information on building commissioning in Idaho. *www.idwr.state.id.us/energy/builders/index.htm*

Montana Department of Environmental Quality – For information on building commissioning and related activities in Montana. *www.deq.state.mt.us/Energy/buildings/index.asp*

Oregon Department of Energy – Activities in Oregon to promote building commissioning including handbooks for new and existing building commissioning, a commissioning toolkit, and case studies. *www.energy.state.or.us/bus/comm/bldgcx.htm*

Washington State Department of General Administration Building Commissioning – Information on the department's building commissioning program, success stories, and resources. *www.ga.wa.gov/Eas/bcx/index.html*

The California Commissioning Collaborative – Government, utility and building services organizations and professionals have come together to create a viable market for building commissioning in California. The website includes a comprehensive library and hundreds of resources for building owners and service providers. *www.cacx.org/index.html*

Commissioning for Nonresidential Mechanical and Lighting Systems (pdf file), Seattle Department of Planning and Development. *www.ci.seattle.wa.us/dclu/Publications/cam/cam419.pdf*

Seattle City Light Building Commissioning Assistance – Assistance and support for building commissioning projects. This includes a link to Seattle City Light's Building Commissioning Handbook, which has case studies and standard commissioning procedures. *www.cityofseattle.net/light/conserve/business/bdgcoma/cv5_bca.htm*

Technical Assistance

If you are a commercial or industrial customer of a Northwest utility, you can call the EnergyIdeas Clearinghouse with your specific questions about building commissioning or other energy efficiency issues.

The EnergyIdeas Clearinghouse provides information on a broad range of energy technologies for commercial and industrial customers of Pacific Northwest utilities. The EnergyIdeas Clearinghouse provides a searchable website and has a team of energy specialists ready to respond to technical information requests by phone or email. Sponsored by the Northwest Energy Efficiency Alliance.

Web: *www.EnergyIdeas.org*
Regional Hotline: 1-800-872-3568
Email: *info@energyideas.org*

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RECOMMISSIONING

Overview

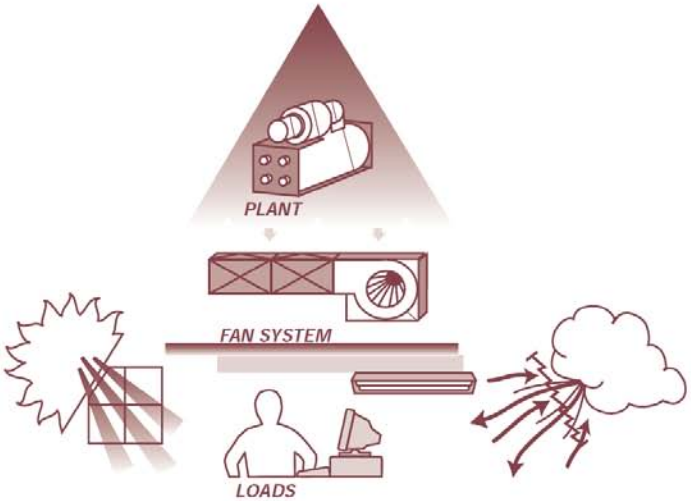
Recommissioning is essentially the same process as commissioning, but applied to existing building's HVAC, controls, and electrical systems. When standardized maintenance and energy management procedures fail to fix chronic building problems, recommissioning provides a systematic approach for discovering and solving them. Recommsioning entails the examination of actual building equipment systems operation and maintenance procedures for comparison to intended or design operation and maintenance procedures.

The heat flow diagram (Figure 1) illustrates the interaction of all buildings systems and activities. Recommissioning capitalize on heating, cooling, and electrical load reductions by continually monitoring energy consumption to optimize energy performance and savings. Recommisioning can be a cost-effective retrofit in itself, sometimes generating more savings than the cost of the retrofit measure. This can result in additional savings other than direct energy cost reductions. For example, a recommissioning may help avoid the need to install new or additional equipment, resulting in capital savings. In the recommissioning phase, you will continue to implement numerous cost-effective strategies to reduce your heating, cooling, and electrical loads, and your overall energy consumption, while improving occupant comfort.

Previously referred to as Building Tune-Up, the recommissioning chapter will help you understand if the building is operating as intended and if current operational needs are being met. It will help you identify improper equipment performance, opportunities for saving energy and money, and strategies for improving performance of the various building systems. "Best Ways to Save" and "Take Action" are checklists of typical opportunities to tune-up equipment and how to approach funding recommissioning.

CHANGE FOR THE BETTER WITH ENERGY STAR

Figure 1: Heat Flow In Buildings



Heat Flow In Buildings: Building Systems Interactions

Figure 2 shows the interaction of heating, cooling, and electrical loads with the HVAC equipment. Arrows indicate heat flow pathways. Reducing heating, cooling, and electrical loads reduces the demand on HVAC equipment, thus saving energy.

The Best Ways To Save

- Calibrate building controls such as thermostats and occupancy sensors.
- Adjust operating schedules to ensure equipment is on only when necessary.
- Check for leaking or improperly functioning steam traps.
- Clean heat exchanger tubes in the condenser, evaporator, and boiler to maintain optimal efficiency.

Take Action!

- Recognize building tune-up as an opportunity to reduce energy costs and regain or improve comfort.
- Allocate time and funding to a building tune-up separately from your ongoing maintenance budget.
- Explore available financing options if in-house funds are not available.

Understanding Recommisioning Process

Making low-cost or no-cost adjustments to your building systems will not only minimize your current operating costs but will also lower future maintenance costs. Furthermore, performing a recommissioning will help you understand your building's current operational needs, how it is intended to operate, and how you can improve the current level of performance in the other stages.

Commissioning

Commissioning is a quality assurance process that ensures design intent and operational needs are met for new buildings or major rehabilitation. Ideally, commissioning takes place during the construction process and continues through occupancy.

Maintenance

Maintenance is an ongoing process to ensure that equipment operates at peak performance. It should take place following the initial system tune-up and should be routinely scheduled for the life of the equipment.

Unlike the other four stages of an integrated upgrade approach recommissioning does not necessarily require purchasing and installing new equipment or technology. However, both time and budget should be set aside expressly for a building recommissiong. Savings, though often surprising, can be harder to estimate in advance; yet, because recommissioning plays an integral role in the process of identifying potential upgrade opportunities to be implemented in the other stages, it should be viewed, planned, and funded as a process separate from standard maintenance.

Financing can be a limiting factor, especially if a recommissioning is mistakenly lumped into the maintenance budget. Financing options are often available. See Financing Your Energy-Efficient Upgrade chapter.

Performing a Successful Recommisioning Project

The key to a successful recommissioning process is the commitment of the commissioning team. The commitment may be express through a written contract defining the responsibilities and contractual relationship of team members, and the specific tasks to be performed by each team member according to area of expertise. One major task in the process is for the owner's design professionals and contractors to set realistic contract agreements and assign appropriate responsibilities. Communication among the recommissioning team and facility staff is paramount for uncovering building systems problems and opportunities.

A successful recommissioning effort also depends not only on a deep understanding of building systems but also a firm grasp on how people interact to operate the building systems from day to day. This helps the recommissioning team to collect accurate data and propose cost-effective and energy savings solutions.

Recommissioning may be performed by in-house staff or by outside contractors. A decision to obtain outside expertise should not be viewed as "pointing the finger" at maintenance staff for previous oversights but instead as an opportunity to get a non-bias assessment of building systems operation and maintenance procedures.

Facility staff that are trying to fix these problems work under a variety of constraints, including limited labor force, limited budgets, and limited access to monitoring equipment. Sometimes, facility maangement lack technical expertise or staff to perform diagnostic tests and repair problems.

However, recommissioning will affect the building's future maintenance and operations program, facility staff should be updated on revised maintenance and operations procedures. In addition, facility staff should undergo regular training to learn how to effectively operate and maintain building's systems.

Recommissioning Strategy and Savings Potential

The strategy for recommissioning is a series of building recommissioning that build upon one another in a staged approach. By following the order suggested below, you can capitalize on the benefits of a comprehensive systems upgrade approach.

When recommissioning your building, you should keep in mind the primary goal, does the building operate as intended and are operational needs being met. For example, occupant comfort is paramount in the operational needs assessment. Occupants *will* modify their personal space to achieve comfort. This often results in tampering with thermostats and sensor calibrations, using inefficient portable lighting or space heaters, or even blocking vents, all of which will further increase energy use.

Potential Savings

Building Recommissioning Offer Surprising Paybacks

A detailed assessment of the costs and benefits of tuning up buildings was conducted based on a survey of results from more than 40 tune-up projects. Results from the study confirmed that recommissioning can typically translate into energy savings of 5 to 15 percent. Although it is difficult to pinpoint exactly which tune-up procedures generate the greatest savings, a study performed by the Energy Systems Laboratory of Texas A&M University showed that about 80 percent of all savings from recommissioning come from optimizing building control systems. Improving operations and maintenance accounts for nearly all remaining savings.

Financing the tune-up of a building may require spending funds up front, although parts are generally inexpensive and expenses are minimal. However, you should plan on incurring additional labor costs. If your building's maintenance staff does not have the skills to perform tune-up procedures, or, if your staff is simply too busy, look into outside consultants such as energy service companies or utility companies. Energy service companies have offered tune-up services for years as part of shared-savings contracts. Some utilities continue to conduct re-commissioning on a fee-for-service basis.

Source: "Commissioning Existing Buildings," E SOURCE Tech Update (TU-97-3, March 1997).

Recommissioning will assist you with systematically assessing building performance and effects of occupants and equipment loads on performance. The recommissioning process consist of a series of strategically ordered building recommissioning should be implemented in the following order:

Building Tune-Up Strategy

- Lighting + Supplemental Loads
- Building Envelope
- Controls
- Testing, Adjusting, and Balancing
- Heat Exchange Equipment
- Heating and Cooling System

Lighting

The lighting systems within a building are an integral part of a comfortable working environment. Over the course of its life, all lighting systems become gradually less efficient. Certain efficiency losses are unavoidable, such as reduction in light output are due to the aging of lighting equipment. However, other efficiency losses, such as improperly functioning controls, or dirt accumulation on fixture lenses and housings and lamp lumen depreciation can be avoided by regularly scheduled lighting maintenance.

Insufficient lighting can have a negative impact on energy performance of the building. Without adequate lighting, occupants will bring in less efficient fixtures, thus increasing the lighting and cooling loads in the building.

Lighting Tune-Up

A lighting system tune-up should be performed in the following order:

1. Follow a strategic lighting maintenance plan of scheduled group relamping and fixture cleaning.
2. Measure and ensure proper light levels.
3. Calibrate lighting controls.

(see Lighting chapter for lighting system specifications and details)

Periodically cleaning the existing fixtures and replacing burned-out lamps and ballasts can considerably increase fixture light output. This simple and cost-effective tune-up item can restore light levels in a building close to their initial design specifications.

After the fixtures have been cleaned and group relamping has taken place, the next step is to measure existing light levels to ensure that proper illuminance levels are provided for the tasks being performed in the space. As space use and furnishings may change over time, it is important to match the lighting level to the current occupant requirements. The Illuminating Engineering Society of North America issues recommended illuminance levels depending on the job or activity performed. Overlighted or underlighted areas should be corrected. Lighting uniformity should also be assessed, as relocation of furniture and even walls may have altered lighting distribution.

Once the proper light levels and uniformity have been achieved in the space, examine the automatic lighting controls. Many buildings use a variety of automatic controls for time-based, occupancy-based, and lighting level-based strategies. These controls may have never been properly calibrated during installation or may have been subsequently tampered with by occupants. Adjusting these controls and associated sensors now will reduce occupant complaints, maintain safety, and ensure maximum energy savings.

Many buildings utilize energy management systems, time clocks, and electronic wallbox timers to control lighting automatically based on a predictable time schedule. These systems need to be programmed correctly to ensure that lights are only operating when the building is occupied, and that overrides are operational where required. Exterior lighting schedules must also be changed throughout the year according to the season.

The performance of occupancy or motion sensors depends on customizing the sensitivity and time-delay settings to the requirements of each individual space. The sensor's installed position should also be checked to ensure adequate coverage of the occupied area. Also, keep all furnishings from obstructing the sensor's line of sight. A sample commissioning protocol is available to guide your staff or contractor to commission occupancy sensors properly (call the ENERGY STAR hotline at 1-888-STAR YES for more information).

Any indoor and outdoor photocells should also be checked at this time to ensure the desired daylight dimming or daylight switching response. Set-points should be adjusted so that the desired light levels are maintained. Photocells and dimming ballasts are also used to save energy in non-daylight areas through lumen maintenance control, a strategy to adjust system output to compensate for aging lamps and dirt accumulation on luminaries. To maintain continued energy savings in lumen maintenance control strategies, you will need to tune the set-point manually to reduce the light level by 25 to 30 percent (the expected light level depreciation over the maintenance cycle) each time fixtures are periodically cleaned and re-lamped. This will allow the ballast to increase the system output over time to maintain the illuminance set-point.

Savings

Although the savings associated with performing a lighting tune-up will vary depending on the quality and performance of the current lighting system, they can be significant. For example, cleaning alone may boost fixture light output from 10 percent in enclosed fixtures in clean environments to more than 60 percent in open fixtures located in dirty areas. Simple calibration of occupancy sensors and photocells can restore correct operation, reducing the energy used by the lighting system in those areas by 50 percent or more.

Considerations

- Is a scheduled lighting maintenance policy in place?
- Are spaces provided with the proper light levels?
- Have all automatic controls been calibrated?

Supplemental Loads

The area of supplemental loads is also an opportunity for recommissioning. In the business world, office equipment constitutes the fastest growing portion of electrical loads. However, much of this energy is wasted because equipment is left on when not in use throughout the workday, at night, and on weekends. Electrical loads from office equipment can be reduced by the use of ENERGY STAR labeled office equipment and/or enabling power management features.

Supplemental Loads Tune-up

For existing office equipment models, check to see if they have power management or other energy-saving features and that these features are enabled. Whether or not they may not meet the ENERGY STAR specifications, these features will provide some energy savings if activated.

Educate employees so that they understand what power management is and why it is important. Here are some examples of issues that you should focus on:

- Sleeping equipment still draws some electricity; so turn it off when not in use for long periods of time.
- Heat is a leading cause of equipment failure. When the power-management feature is used, the computer generates less heat, so it may last longer and have improved reliability.
- If screen savers are used in the office, be sure to choose those that will display images for a predetermined period of time and then enter the sleep mode. Graphical screen savers are primarily for entertainment and are not energy-efficient features.

Savings

Energy-efficient equipment with the ENERGY STAR label cost the same as comparable non- labeled equipment. However, the savings are greater for labeled equipment. Products that meet ENERGY STAR specifications use about half as much electricity as conventional equipment. ENERGY STAR labeled and non-labeled equipment produce less heat when powered down or not in use, which results in reduced cooling loads, and energy costs.

Considerations

- Is your organization purchasing office equipment with the ENERGY STAR label?
- Are energy saving features enabled on office equipment?

Building Envelope

The next step of a building tune-up is to reduce air infiltration through the building envelope to enhance occupant comfort. Outside air can penetrate a building through a variety of places, most commonly through the windows, doors, walls, and roof. Drafts created by improperly sealed windows and doors can cause cold hands and feet in the winter and discomfort in the summer.

In general, a building envelope should meet recommended infiltration standards. For commercial buildings, the National Association of Architectural Metal Manufacturers recommends infiltration rates per unit of exterior wall not to exceed 0.06 cubic feet per minute per square foot (cfm/sf) at a pressure difference of 0.3 in. of water (ASHRAE *Fundamentals Handbook*, 2001, 26.24).

A frequent result of infiltration problems, other than general occupant complaints, is an increase in building heating, cooling, and/or electrical loads (when, for example, occupants bring in space heaters or fans). In addition, the escape of conditioned air forces the air handling system to work longer and harder to provide the required

space temperature. Thus, tuning up the envelope of a building can reduce HVAC costs while greatly improving occupant comfort.

Tune-Up

The first step in reducing air infiltration is to tighten the existing building by locating all air leaks in the windows, doors, walls, and roofs. Once you have detected the air leaks, seal them with appropriate materials and techniques such as weather-stripping on doors, sealing and caulking on windows, and proper insulation distribution in walls, ceilings, and roofing.

If your building is equipped with revolving doors, you should encourage their use. Revolving doors significantly reduce drafts and conditioned air loss. Automatic doors should be calibrated to minimize air loss from the building envelope.

Savings

Reducing infiltration will result in a reduction in heating and cooling loads. Savings will depend on many factors, including the existing condition of the building; the building surface area-to-volume ratio; construction type; geographical location; and the internal heating, cooling, and electrical loads. Typical savings for a large office building range up to 5 percent of heating and cooling costs.

Considerations

- Are any areas particularly drafty?
- Are any areas routinely serviced?
- Do the windows and doors close and seal properly?
- Are the windows and door frames adequately caulked?
- Is weather stripping installed on windows and doorways?
- Is there any wet or deteriorating insulation that needs to be replaced?

Controls

The energy management system and controls within a building play a crucial role in providing a comfortable building environment. Over time, temperature sensors or thermostats often become out of tune. Wall thermostats are frequently adjusted by occupants, throwing off controls and causing unintended energy consumption within a building.

Poorly calibrated sensors cause increased heating and cooling loads and occupant discomfort. As with envelope infiltration problems, occupants are likely to take matters into their own hands if they are consistently experiencing heating or cooling problems. By integrating mechanical and control recommissioning within each system, you are more likely to improve occupant comfort.

Tune-Up

The first step in tuning up controls is to calibrate the indoor and outdoor building sensors. Calibration of room thermostats, duct thermostats, humidistats, and pressure and temperature sensors should be in accordance with the original design specifications. Calibrating these controls may require specialized skills or equipment, such as computer software. Thus, you should seriously consider the use of outside expertise for this tune-up item.

In addition to calibrating the sensors, damper and valve controls should be inspected to make sure they are functioning properly. Check pneumatically controlled dampers for leaks in the compressed air hose lines. Also examine dampers to ensure they open and close properly. Stiff dampers can cause improper modulation of the amount of outside air being used in the supply air stream. In some cases, dampers may have actually be wired in a single position or disconnected entirely, violating minimum outside air requirements (for a more detailed explanation, see Supplemental Load Reductions).

As part of tuning up controls, be sure to review building operating schedules. Often, while control schedules remain constant, occupancy schedules change frequently over the life of a building. This results in discomfort at the beginning and end of each day. HVAC controls must be adjusted to heat and cool the building properly during occupied hours. For example, operating schedules should be adjusted to reflect Daylight Savings Time.

When the building is unoccupied, set the temperature back to save some heating or cooling energy. Keep in mind that some minimum heating and cooling may be required when the building is unoccupied. In cold climates, for example, heating may be needed to keep water pipes from freezing.

In addition to the building's operation schedule, review the utility rate schedule. Utilities typically charge on-peak and off-peak times within a rate, which can dramatically affect the amount of your electric bills. If possible, equipment should run during the less expensive off-peak hours. For certain buildings, precooling and/or preheating strategies may be called for. (See also Supplemental Load Reductions, Night Precooling, p. 14.)

Savings

The main savings associated with tuning controls result from reductions in charges for heating and cooling energy (and possibly demand). Because savings are heavily dependent on the existing condition of the controls, it is difficult to estimate the actual savings that will result from a tune-up. Savings will depend on many factors related to the building including heating and cooling system types; construction; geographical location; and internal heating, cooling, and electrical loads. Typical savings can range up to 30 percent of annual heating and cooling costs.

Considerations

- Are building sensors, such as thermostats and humidistats, calibrated and operating properly?
- Are damper and valve controls functioning properly?
- Are there any leaks present in the pneumatic control systems?
- Do equipment schedules reflect occupancy schedules and seasonal changes?
- Can certain equipment be scheduled to operate during utility off-peak hours?
- Can temperatures be set-back during unoccupied times?

Testing, Adjusting, And Balancing

Proper air and water distribution in an HVAC system is critical to create comfortable conditions within a given space. Excessive room air temperature fluctuations, excessive draft, and improper air distributions will lead to occupants' discomfort and can increase energy consumption.

Testing, adjusting, and balancing (TAB) involves investigating the current state of a system and making adjustments to bring the HVAC system back into balance and close to its original design specifications. As we mentioned before, over time, occupancy levels and space utilization may change dramatically. The TAB process will help identify and make necessary adjustments to fit these changes, thereby improving occupant comfort and saving energy costs.

A qualified TAB contractor should:

- Verify the current state of the system.
- Identify and correct any problems with the system.
- Ensure the system provides proper indoor air quality.

Testing, Adjusting, And Balancing

Testing, Adjusting, and Balancing (TAB) is the process of adjusting HVAC system components to supply air and water flows to match load requirements.

TAB generally includes:

Testing. The process of evaluating the performance of the equipment in its current state and making recommendations for improvements.

Adjusting. The process of regulating flow rates of air or water for the purpose of balancing the system.

Balancing. The process of proportioning the air or water flows throughout a building to match the loads.

Perform TAB analysis on a building whenever you think that the air or water distribution system is not functioning as designed. Indicators that TAB is needed include frequent complaints from occupants about hot or cold spots in a building, the

renovation of spaces for different uses and occupancy, and the frequent adjustment of HVAC components to maintain comfort.

Tune-Up

A TAB analysis usually includes a complete review of a building's design documentation. Typical HVAC system components and parameters to investigate may include:

- Air system flow rates, including supply, return, exhaust, and outside airflow. Flows include main ducts, branches, and supply diffusers that lead to specific spaces in a building.
- Water system flow rates for chillers, condensers, boilers, and primary and/or secondary heating and cooling coils.
- Temperatures of heating and cooling delivery systems (air side and water side).
- Positions and functioning of flow control devices for air and water delivery systems.
- Control settings and operation.
- Fan and pump speeds and pressures.

The TAB contractor will provide a test and balance report with a complete record of the design specifications, preliminary measurements, and final test data. All discrepancies between the design and test data should be outlined along with an analysis. The report should also include recommended and completed adjustments.

Savings

The savings associated with TAB come from the reductions in the energy used by the heating and cooling system. Because savings are heavily dependent on the building's condition, it is difficult to estimate the actual savings that will result from TAB. Savings will differ depending on many factors related to the building including heating and cooling system types, construction, geographical location, and internal heating, cooling, and electrical loads. Savings can range up to 10 percent of heating and cooling costs.

Considerations

- Are occupants frequently complaining about the temperature, humidity, etc., in the building?
- Have HVAC system components been replaced or modified?
- Has any building space been renovated?
- Can the HVAC system satisfy comfort requirements during very hot or very cold days?

Heat Exchange Equipment

The next steps in building tune-up focus on the heat exchange equipment that cools and heats the air that ultimately reaches building spaces. This equipment usually consists of heating and cooling coils installed in air handlers, fan coil terminal units, or baseboard radiators. These units are typically supplied with chilled water and hot water from a central plant. The heating and cooling coils can also be part of a packaged unit such as a rooftop air conditioning unit or central station air handling unit.

As with other tune-up items, tuning up your heat exchange equipment has the potential not only to save energy costs but also to increase your building occupants' comfort.

Although many of the tune-up recommendations presented below should be performed as normally scheduled maintenance, they are included in Supplemental Load Reductions because of the potential for resultant energy cost savings.

The controls and flow issues for heat exchange equipment were addressed in the previous controls and TAB sections. The remaining action is to ensure that all surfaces and filters are clean. Dirty surfaces reduce heat transfer, increase pressure loss, and increase energy use.

Tune-Up

Clean the air side of heating and cooling coils, whether in an air handler or in a rooftop unit, to reduce deposit buildup. Methods for cleaning may include compressed air, dust rags/brushes, and power washes. Check baseboard heating systems for dust build up and clean if necessary.

The water side of heating and cooling systems is generally inaccessible for mechanical cleaning. Chemical treatments are often the best solution to clean these surfaces. Ongoing water treatment and filtering of the water side is recommended to reduce dirt, biological, and mineral scale buildup. Filters for both air side and water side systems should be cleaned and replaced as necessary.

Avoid covering or blocking terminal fan coil units and baseboards with books, boxes, or file cabinets. Besides creating a fire hazard (in the case of radiators), blocking the units prevents proper air circulation and renders heating and cooling inefficient.

Savings

The savings you will see from a tune-up of your heat exchange equipment are highly dependent upon the existing conditions of the equipment. In general, the more you can improve the heat transfer of surfaces, the more you will save. Additionally, cleaning coils and filters may reduce the pressure drop across the coil and reduce fan or pump energy consumption.

Savings will differ depending on many factors related to the building, including heating and cooling system types; construction; geographical location; and internal heating, cooling, and electrical loads. Typical heating and cooling system cost savings can range up to 10 percent.

Considerations

- Are the heating and cooling surfaces clean?
- Are air and water filters changed regularly?
- Are heating or cooling terminal units and baseboards blocked by furniture or debris?

Heating and Cooling System

Following the framework of the integrated approach, the final step is to tune up the heating and cooling system. The heating and cooling system, generally a central plant, supplies all of the heating and cooling to make building spaces comfortable. Some buildings may have distributed heating and cooling units or a combination of both instead of a designated central plant.

The information gathered during the previous sections may become useful in determining any potential operational changes to the central plant. Additionally, recommissioning conducted on the HVAC and lighting systems should reduce the amount of energy the central plant consumes.

Some of the following tune-up items should be performed as part of normal scheduled maintenance. They are included here because of their potential for resultant energy cost savings. Specially trained and qualified personnel should perform all of these tune-up procedures.

Chiller Tune-Up

Chillers are similar to air conditioners found in any home, except that chillers supply cool water and home air conditioners supply cool air. The cool water from a chiller is eventually pumped through a heat exchanger (i.e., cooling coil), which cools the building's air. (For more information on specific types of chiller equipment, see Heating And Cooling System Upgrades.)

Chilled Water And Condenser Water Temperature Reset – A chiller's operating efficiency can be increased by raising the chilled water temperature and/or by decreasing the temperature of the condenser water. Chilled water reset is the practice of modifying the chilled water temperature and/or condenser water temperature in order to reduce chiller energy consumption.

If you decide to undertake chilled water reset, be careful that all of the considerations are taken into account. Although raising the chilled water will reduce

chiller energy consumption, it may increase supply fan energy consumption. Reducing the condenser water temperature may increase the cooling tower fan energy consumption as well. Be sure to consult experts who can analyze all the effects of chilled water reset. If in doubt, using the intended design temperatures is your safest bet (E Source, *Space Cooling Atlas*,).

Chiller Tube Cleaning And Water Treatment – Optimum heat transfer relies on clean surfaces on both the refrigerant and water side of the chiller tubes. Typically, the water side of the condenser needs the most attention because evaporative cooling towers have an open loop and new water is introduced continuously. Thus, water treatment is needed to keep surfaces clean and reduce biological films and mineral scale. Similar treatments may be needed for the chilled water loop.

As part of the tune-up, clean the condenser and evaporator tubes to remove any scale or buildup of biological film. To do this, the surfaces usually have to be physically scrubbed and sometimes treated with chemicals.

Reciprocating Compressor Unloading – Reciprocating compressors are typically used for smaller chillers. Many of these compressors utilize multiple stages (that is, more than one piston for the compressor) of cooling to allow for more efficient part-load performance and reduced cycling of the compressor motor.

At part-load performance, one or more of the stages are unloaded. If the controls of the system fail to unload the cooling stage, then the system may cycle unnecessarily during low cooling loads. Because starting and stopping is inherently inefficient, cycling decreases the efficiency of the cooling system. Additionally, increased cycling can lead to compressor and/or electrical failures (E Source, *Space Cooling Atlas*).

Consult manufacturer's maintenance information to check for proper cooling stage unloading. Unloading may be controlled by a pressure sensor that is set for a specific evaporator pressure. This sensor, and the controls dependent upon it, can fall out of calibration or fail.

Boiler Tune-Up

In many buildings, the boiler is the heart of the heating system. Steam or hot-water boilers are present in approximately 42 percent of heated commercial floor space (CBECS, 1995).

When considering a tune-up for a boiler, always make sure that you and the maintenance staff or contractor know and fully understand all safety precautions. Also, always follow manufacturer's information on maintenance and local safety or environmental codes. Energy Star recommends you consider obtaining specialized expertise for boiler tune-up items.

Boiler System Steam Traps – Steam heating systems use mechanical devices called steam traps to remove condensate and air from the system. Steam traps frequently become stuck in the open or closed position. When a trap is stuck open, steam can escape through the condensate return lines to the atmosphere, and the resulting energy loss can be significant. Check steam traps for leaks frequently and make repairs as needed. Because special tools and experience are required, you should consider the use of outside expertise.

Combustion Air – More air is typically supplied for combustion than is needed. Excess air helps prevent incomplete combustion, which contributes to associated hazards such as smoke and carbon monoxide buildup. If too much air is introduced, some of the fuel is wasted heating this excess air. A tune-up of combustion air consists of adjusting combustion air intake until measured oxygen levels in the flue gas reach a safe minimum. (This tune-up measure does not apply to electric boilers.)

Boiler Tube Cleaning And Water Treatment – Optimum heat transfer relies on clean surfaces on both the boiler's combustion and water or steam side. Surfaces that are dirtied with fouling (see sidebar) will ultimately increase the energy consumption of the heating system. A tune-up consists of removing fouling buildup from both the fire side and water side of the boiler tubes by physically scrubbing the surfaces and sometimes by applying a chemical treatment.

Additionally, treating the heating water may be a good option to reduce the further deterioration of your boiler tubes.

Fouling

Fouling is the buildup of a film that reduces heat transfer. Soot, ash, or other particles can build up on the fire side surfaces of a boiler. Mineral deposits or other materials can build up on the water or steam side surfaces.

Heating and Cooling Equipment Savings

The savings associated with central plant recommissioning are derived from reducing the energy consumption of the heating and cooling system. Savings are highly dependent on the existing condition of the equipment. Other related factors include the heating and cooling system types; construction type; geographical location; and internal heating, cooling, and electrical loads.

Savings for most of the central plant recommissioning are listed below. When all recommissioning are taken together, heating and cooling cost savings can reach upwards of 15 percent.

Chilled Water and Condenser Water Temperature Reset – The savings associated with a water temperature reset will vary, depending on equipment type and system interactions. Because temperature reset does not require the purchase of new

equipment, it can often be inexpensive. The complexity of reset, however, could result in incorrect implementation, instead increasing your energy use. Therefore, a professional consultant should be contacted who will be able to estimate the savings potential.

Chiller Tube Cleaning and Water Treatment – The savings achieved by cleaning tube surfaces are highly dependent on the current state of the tubes. Savings can be estimated by looking at what the temperature change through the evaporator or condenser should be and comparing it to the actual temperature change. Contact an HVAC consultant or a chiller specialist for a savings estimate.

Boiler System Steam Traps – The savings achieved by fixing steam trap leaks is highly dependent on the size of the leak and the pressure of the system. Table 1 compares orifice size with the estimated steam leaked per month and the resulting costs.

Table 1: Steam Trap Leaks

Size of Orifice (in.)	*Steam Leak per month (lb.)*	*Total Cost per month ($)*
1/2	835,000	2,480
7/16	637,000	1,892
3/8	470,000	1,396

Based on: 100 psi, boiler efficiency of 80 percent, energy cost of $2 per million Btu.

Source: Wayne C. Turner. *Energy Management Handbook*, 2nd ed., 1993, Fairmont Press, Table 14.17, page 341.

Boiler Combustion Air – The savings for the reduction of combustion air depend on the type of fuel used and the exiting flue gas temperature. Stage Five—Heating and Cooling System Upgrades includes a detailed plot of boiler fuel savings as excess air is adjusted. For example, for every 10 percent reduction in excess air, the boiler efficiency will increase 0.7 percent (based on burning No. 2 fuel oil with a flue gas temperature of 500° F).

Boiler Tube Cleaning and Water Treatment – The savings achieved by cleaning the tube surfaces is highly dependent on the current state of the tubes. Tables 2 and 3 illustrate the increased fuel consumption that results from surface fouling on the combustion and water side of a boiler.

Table 2: Boiler Combustion Fouling

Soot layer on heating surface (in.)	Increase in fuel consumption (%)
1/32	2.5
1/16	4.4
1/8	8.5

Source: W.H. Axtman, *Boiler Fuel Management and Energy Conservation*, American Boiler Manufacturers Association.

Table 3: Boiler Water Side Fouling

Thickness of scale (soft carbonate scale) (in.)	Increase in fuel consumption (%)
1/32	7.0
1/16	12.5
1/11	15.0

Source: W.H. Axtman, *Boiler Fuel Management and Energy Conservation*, American Boiler Manufacturers Association.

Considerations

Chillers

- Have you consulted an expert to determine the implications of chilled water temperature reset on supply fan energy consumption?
- How dirty are your evaporator and condenser tubes?
- Are reciprocating compressor cylinders unloading at part load?

Boilers

- Have the steam traps been inspected for leaks?
- Has combustion air been checked in the last year?
- Have the combustion and water or steam side heat transfer surfaces been cleaned recently?

Summary

To recap, your strategy for recommissioning should follow the framework an integrated staged approach. Keep in mind that the overriding concern in performing recommissioning is to ensure that the building operates as intended and meets current operational needs.

Building tune-up strategies should be implemented in the following order:

- Lighting + Supplemental Loads
- Building Envelope
- Controls
- Testing, Adjusting, And Balancing
- Heat Exchange Equipment
- Heating And Cooling System

Next Steps

- Make certain that facility staff receive training so that they are familiar with tuning and maintaining building systems.
- Use the information learned in recommissioning to identify and implement other energy performance strategies and savings opportunities in throughout the entire building and its systems.

APPENDIX K

REQUEST FOR ENERGY ASSISTANCE

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REQUEST FOR ENERGY ASSISTANCE

Energy efficiency is increasingly important for our local communities and the state of Texas. It reduces costs, increases available capital, spurs economic growth, improves working, learning and living environments and preserves precious resources. The State Energy Conservation Office (SECO) offers a number of **free and cost shared** programs and services to help public agencies establish and achieve their energy efficiency goals.

SECO through its engineering consultants offers public agencies the following free or cost shared energy management services:

• On-Site Energy Assessments Of Facilities	Free
• Senate Bill 12 and House Bill 3693 Assistance	Free
• On-Site Training For Maintenance And Operations Personnel	Free
• Workshops For Energy Managers, Maintenance Personnel And Administrators	Free
• Energy Efficiency Programs For Students and Teachers	Free
• Energy Master Planning	50% Cost Shared
• Energy Management Policy Development And Implementation	Free
• Assistance In Identifying Energy Retrofit Funding Sources	Free

Specific responsibilities of the partner and SECO in this agreement:

- Partner will select a contact person to work with SECO and its engineering consultant to establish an energy policy and set realistic energy efficiency goals.
- SECO's contractor will contact partners to assess their energy management needs.
- SECO will provide a report, which identifies no cost/low cost recommendations, capital retrofit projects, potential sources of funding and other needs and opportunities.
- Partner will schedule a time for SECO's contractor to present its findings and recommendations to key decision makers.
- Partner pledges that it is ready and willing to consider implementing the energy saving recommendations.

Acceptance Of Agreement And Request For Energy Management Assistance

Signature: Don Stockton

Date: June 25, 2008

Name (Mr./Ms./Dr.) Dr. Don Stockton

Title: Superintendent

Organization: Conroe ISD

Phone: 936-709-7701

Address: 3205 W. Davis
Conroe, Texas 77304-2098

Fax: 936-760-7704

E-mail: dstockton@conroeisd.net

Assigned Program Person:

Name : Dan Cox

Title: Chief Financial Officer

Phone: 936-709-7777

County: Montgomery

Fax: 936-760-7715

E-Mail: dcox@conroeisd.net

Please complete and mail or fax to the following SECO Consultant : Texas Energy Engineering Services, Inc. (TEESI), ATTENTION: Saleem Khan, P.E., 1301 Capital Of Texas Highway #B-325, Austin, TX. 78746, Phone 512-328-2533, **Fax 512-328-2544.** If you need to contact the State Energy Conservation Office, please call **Glenda Baldwin At 512-463-1731** or you may write to her at: Comptroller Of Public Accounts, State Energy Conservation Office, 111 E. 17th Street, Austin, Texas 78774.