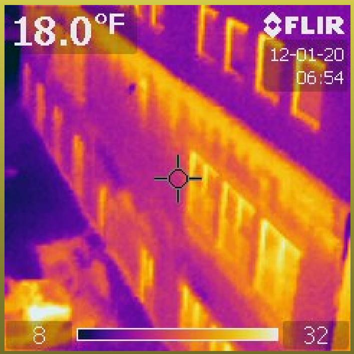

Facility Audit Report

Hollis-Brookline High School

FINAL

May 2012

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A. EXECUTIVE SUMMARY

Program Introduction

The Town of Hollis requested investment grade audits for seven (7) municipal buildings and five (5) school buildings located within the Town. Funding was provided by the United States Department of Energy (DOE) through the New Hampshire Office of Energy and Planning (NHOEP) Energy Efficiency Conservation Block Grant (EECBG) program.

Figure 1: Hollis-Brookline High School

Phase one of the evaluation process involves site assessment planning including evaluating utility bills, benchmarking, reviewing available building and mechanical plans and coordinating site reviews with facility managers. Phase two involves a comprehensive and holistic facility evaluation to gather relevant information and data. Analyzing the collected data and developing recommendations for energy efficiency measures is completed in Phase three. This information is presented to the Town within this report.

The objective of the building evaluation completed at the Hollis-Brookline High School (Figure 1) is to identify measures that reduce the net energy consumption thereby reducing operating costs and the consumption of non-renewable fossil fuel energies. In addition to energy conservation, the evaluations and recommendations presented herein consider occupant comfort and holistic building performance consistent with its intended use and function. The information obtained as part of this evaluation has been used to develop recommended Energy Efficiency Measures (EEMs). These EEMs provide the basis for future building improvements and modifying the manner in which the building systems are operated.

Procedure

Facility audits or evaluations identify all appropriate EEMs and a financial analysis that considers implementation costs, operating costs, and attainable savings. The objective is to identify the predicted energy savings, the amount the measure will cost, and the estimated payback period for each EEM. The evaluation also identifies any changes to operations and maintenance procedures that will reduce energy consumption. A comprehensive field survey of the facility is completed to evaluate the following:

- *Building Characteristics*
- *Building Use and Function*
- *Envelope Systems*
- *Heating and Cooling Systems*
- *Ventilation Systems*
- *Electrical and Lighting Systems*
- *Domestic Hot Water Systems*
- *Plug Loads*

Following completion of the field evaluation, the data and information are reviewed to develop proposed recommendations for the facility. All information, data, and recommendations are then compiled into a comprehensive report. The final report is then distributed to the municipality or school to assist with implementation and budgeting of the proposed EEMs. The information provided in the reports will assist the owner with determining the best value EEMs for their facilities. The reports also identify potential financial resources available to help fund the EEMs.

Between December 20th, 2011 and January 23rd, 2012, AEC personnel completed site surveys at the Hollis-Brookline High School (HBHS) to obtain the information necessary to complete an assessment of overall building performance. All building systems that impact energy consumption were evaluated including the building envelope, heating and cooling, ventilation, electrical, plumbing, and mechanical. Secondary observations are also reported herein and include building code compliance, life safety, structural systems, and roofing systems. This evaluation also considers whole building performance that measures how well the integrated building systems in the HBHS function as a composite system.

AEC completed a desktop review of the data provided by the town including historical energy consumption data. The field review included an evaluation of all building systems and data collection including an infra-red thermal imaging survey, indoor air quality measurements, lighting density measurements, and metering of lighting fixtures and HVAC equipment. The HBHS building was modeled using a building energy modeling computer program (eQUEST®) and calibrated to historical energy data. A series of energy efficiency measures (EEMs) were then simulated in the 3-D building model to measure their effect on energy consumption. Capital investment costs for each EEM were developed, and based upon the predicted cost savings associated with the energy efficiency measure, the payback term is calculated. A savings to investment ratio (SIR) for each EEM is then calculated based on the cost of implementation, the predicted energy cost savings, and the predicted service life of the measure/equipment. Other noted recommendations relate to indoor air quality, occupant comfort, code compliance, accessibility, and life safety.

Summary of Findings

The following significant findings are presented for the Hollis-Brookline High School (HBHS) building:

1. Energy consumption is lower than national and regional averages for K-12 facilities.
2. Mechanical equipment is relatively inefficient compared to modern systems.
3. Indoor air quality measurements indicate that exchange air ventilation and distribution of heating is inconsistent throughout the building.

Notable Observations

The following notable observations were made during the desktop data review and/or the building evaluation. Notable observations may be related to data that is outside the normal or expected range, irregularities in building use or function, or problematic systems.

- Electrical consumption peaks in transitional months (spring and fall) and summer usage is higher than expected for a K-12 facility.
- Indoor air quality (IAQ) measurements (temperature, relative humidity, and CO_2) range dramatically throughout the building. This is indicative of unbalanced heating and ventilation distribution. Some spaces are over-ventilated (gymnasium) while others appear to be under-ventilated.
- Measured temperatures in the building consistently exceed recommended setpoints.
- Measured lighting densities consistently exceed recommended levels.
- Four (4) boilers provide heat and domestic hot water. The three (3) large units are powered down at the end of heating season and the smaller unit remains operational year round to provide domestic hot water.

- Facility staff is energy conscious and utilize the direct digital controls (DDC) system in the school to schedule events, monitor equipment, and control outdoor air. All air handling equipment was functional, well maintained, and clean. Belts were in place and appeared to be within tolerance. A supply of parts is maintained at the facility.
- There are numerous refrigerators (31 compact and 5 full size) and microwaves (18) in the building. Many of these units had limited items in them but where powered on.
- The building has a current ENERGY STAR® rating of 86 indicating the building's heating and ventilation equipment is operated in an efficient manner.
- There are some roof and windows leaks in the building. Notably the roof leaks by the gymnasium and the windows leak along the front of the building (east) when there is a driving rain.
- The quantity of liquefied propane for the science labs is not sufficient.
- Occupants continually expressed that sections of the building were cold however temperatures throughout the building were consistent and exceeded the recommended setpoints.

Summary of Recommendations

Following is a summary table identifying the proposed recommendations, EEM investment costs, predicted annual energy cost savings, simple payback period and savings to investment ratio. Part G provides a more detailed explanation of these recommendations.

The energy cost savings and resulting payback are based upon each independent measure implemented for the building in its current condition and function. There are interdependencies among measures that will affect the net composite energy savings. Interdependent measures are parametrically related therefore the net energy savings from two dependent measures do not equal the resulting savings determined by the addition of the two measures considered independent of each other. Investment costs are provided for budgetary planning only. They are estimated based on current industry pricing. A detailed cost estimate should be developed prior to appropriating capital funds for the more costly measures. Budgetary cost estimates for the Tier III and more costly Tier II measures are presented in Appendix J.

Table 1: Energy Efficiency Measure Summary

EEM No.	EEM Description	Capital Cost	Annual Cost Savings	Payback (yrs.)	SIR
T1-1	Power down all electronics when not in use. Consolidate laser jet printers (13) and copiers (6).	$0	$1,300	0	-
T1-2	Disconnect water fountain condensers in the building (8).	$0	$800	0	-
T1-3	Instruct occupants and afterschool programs to not prop open entry doors during the heating season.	$0	$500	0	-
T1-4	Remove all compact refrigerator units (31) and replace five (5) full-size ENERGY STAR® rated models.	$2,500	$3,080	0.8	14.8
T1-5	Install smart-strip time programmable controllers on photocopiers (6).	$360	$495	0.7	13.8
T1-6	Install low-flow aerators on lavatory faucets and shower heads.	$700	$600	1.2	6.0
T1-7	Install food temperature sensing controllers (eCube®) in walk-in refrigerators/freezers (3).	$1,500	$600	2.5	4.0
T2-1	Insulate hollow metal door frames with open-cell (low expansion) polyurethane foam.	$2,600	$650	4.0	6.3
T2-2	Reduce lighting densities in corridors with lower wattage lamps and controls.	$3,000	$1,100	2.7	5.5
T2-3	Replace 20-gallon DHW tank serving the mini gymnasium with an electric tankless demand unit.	$2,700	$450	6.0	2.5
T2-4	Complete air-sealing on all entry door jambs, partings, headers, thresholds, and moldings (interior and exterior).	$5,000	$1,400	3.6	2.0
T2-5	Install four (6) de-stratification fans in the mini-gym and six (6) in the gymnasium.	$5,400	$960	5.6	1.7
T3-1	Replace larger electrical transformers with high efficiency units (4).	$47,771	$12,240	3.9	6.4
T3-2	Install pressure actuated dampers on all exhaust fans.	$12,264	$2,560	4.8	6.3
T3-3	Replace walk-in freezer condensers with high efficiency units (3).	$5,584	$1,068	5.2	2.7
T3-4	Replace three (3) existing boilers with two (2) 90% efficient modulating oil-fired units. Retain third unit as backup. Install VFD controllers on pumps.	$278,070	$23,710	11.7	2.1
T3-5	Install DDC demand controllers on all AHUs.	$20,056	$1,560	12.9	1.9
T3-6	Replace the split A/C units on rooftop (3) supplying the AHUs with high-efficiency units (SEER>18, EER>15).	$20,309	$2,607	7.8	1.9
T3-7	Install a hybrid heating system consisting of a ground-source heat pump system (geothermal) augmented by the existing oil-fired boilers during peak heating demand (10% of heating frequency).	$512,325	$36,780	13.9	1.8
T3-8	Replace the existing DHW boiler with electric condensing tank unit and connect to PSNH HEATSMART meter.	$26,278	$2,314	11.4	1.6
T3-9	Install vestibule storefront entry in gymnasium/auditorium lobby.	$22,126	$1,110	19.9	1.5
T3-10	Install energy recovery units and VFD motor controllers on existing AHUs (11).	$154,954	$9,812	15.8	1.1
T3-11	Replace exterior light fixtures (wallpacks and OH) with LED units (41) (PSNH SmartSTART Program).	$42,067	$1,852	22.7	0.9

The following table summarizes the renewable energy technologies that were considered for the Hollis Police Department. Scores are determined based upon the feasibility of the technology for the facility. A more focused feasibility study should be completed prior to considering any renewable energy system(s).

Table 2: Renewable Energy Technology Feasibility Scoring Results

Renewable Energy Technology	Grade
Geothermal Heating/Cooling	84%
Roof Photovoltaic	81%
Ground Photovoltaic	79%
Biomass Heating	78%
Wind Turbine Generator	78%
Solar DHW	76%
Solar Thermal	75%
Combined Heat & Power	70%

Insulation resistance values (R-values) were determined based on given information, time of construction and visual observations. The industry standard *International Energy Conservation Code (IECC), 2009* for Commercial Buildings in Climate Zone 5 required values are provided along with the installed values in Table 3. The IECC values are for new construction only, however provide a guide as to how this facilities insulation compares with new construction.

Table 3: Facility Insulation Summary

Insulation Values			
Space	Required (IECC, 2009)	Recommended	Installed
Floor Area 1	NA	10	1.2
Floor Area 2	NA	10	2.0
Floor Area 3 (Gym)	NA	10	1.7
Wall Type 1	13+3.8ci	13+3.8ci	3.3+7.2ci
Wall Type 2	13+3.8ci	13+3.8ci	3.3+7.2ci
Wall Type 3	13+3.8ci	13+3.8ci	2.1+10.8ci
Wall Type 4	13+3.8ci	13+3.8ci	17.8+7.2ci
Wall Type 5	13+3.8ci	13+3.8ci	17.8+10.8ci
Wall Type 6	13+3.8ci	13+3.8ci	17.3+7.2ci
Wall Type 7	13+3.8ci	13+3.8ci	12.7+7.2ci
Wall Type 8	13+3.8ci	13+3.8ci	11.3+5.4ci
Wall Type 9	13+3.8ci	13+3.8ci	10.9+5.4ci
Wall Type 10	13+3.8ci	13+3.8ci	17.8+5.4ci
Wall Type 11	13+3.8ci	13+3.8ci	2.0+10.8ci
Roof 1 (Gym)	38.0	38.0	17.2
Roof 2 (Main)	38.0	38.0	17.1

Master Planning Considerations

The Hollis-Brookline High School is a cooperative school servicing students from the Towns of Hollis and Brookline for grades nine (9) through twelve (12). The facility was constructed in 1997 to accommodate an increasing trend in student population. When the new high school was constructed in 1997, the existing high school was converted into the Hollis-Brookline Middle School and the upper elementary grades (4-6) were moved to the Hollis Upper Elementary School facility with the lower grades (Pre-K-3) remaining in the Hollis Primary School.

Figure 2: HBHS Logo

In 1998 an addition was constructed which included the auditorium and classrooms at the northwest corner of the building. In 2001, the first pre-planned addition was added which included the mini gym off the southwest corner of the building and additional classrooms off the northeast corner of the building. A third renovation project was completed in 2005 but no major additions were added at this time. The lighting in the building was upgraded as part of the Town wide lighting upgrade project in 2011.

In 2008 a facilities space needs study committee, comprised of eight (8) voting members of Hollis, one non-voting member from the Hollis-Brookline Cooperative School Board (HBCSB), and the former chair of the HBCSB representing the Town of Brookline as a non-voting member analyzed the current and predicted special needs of the school. The report incorporated the Hollis Primary School, Hollis Upper Elementary School, Hollis Brookline Middle School and Hollis Brookline High School to consider master planning in terms of special constraints and analyzed options including whether to plan for expansion of one or more schools or dismantling the co-op between Hollis and Brookline. As of 2008, projections indicated that by 2015 all four schools may reach and exceed capacities which would require either an addition or reconfiguration of the school district to accommodate the increased student population. The report predicted a few years of declining population with an eventual growth; however since the time this report was presented, the economic landscape has changed which has changed current and future population growth and the 2008 data may be artifactual. While the report should be considered if this growth is realized again, the current population trends are continuing downward and predicted downward and a contingency plan should be addressed.

The windows on the building provide air leakage and thermal transfer through frames and glazing resulting in nuisance drafts and increased heating and cooling loads. The siding of the building exterior appears to be in satisfactory condition and under infrared imaging revealed little thermal transfer. The roof was also observed to be in satisfactory condition.

Because walls are well insulated, thermal imaging revealed little thermal losses. The heating system contains three large boilers which are controlled by a direct digital controls (DDC) system. The DDC system is optimized to run during school and event hours and has a setback setting when the spaces are unoccupied. Cooling is provided to sections of the building by rooftop air handling units, air conditioning units, and mini-split air conditioning units.

Functional space within the building includes classrooms, administrative rooms, a full-sized and half-sized gymnasium, auditorium, library, cafeteria, various special interest rooms and mechanical/electrical closets. The current capacity and space uses appear to support the demand of the users. Considering the condition of the HBHS building and systems and date of original construction and renovations, a major renovation is not necessary. Replacing aging equipment at the end of its useful life and continued preventative maintenance will ensure the building could continue in to operate at current capacity. Based on observations and budgeted costs, the facilities management program at the HBHS is well organized and efficient. The Facilities Manager is actively engaged in optimizing the function of the HVAC systems to reduce energy consumption and maintaining indoor air quality standards.

As of October 1st 2011, the total enrollment for the HBHS is 904. Total district enrollment for the HBCSD is 1,341. The HBHS student density is 170 square feet per full-time enrolled student (SF/FTE) which is considerably higher in student density than comparable regional high schools where area per student exceeds 300 SF/FTE. If current data analysis indicates that the predicted FTE population is trending upward then the HBCSD should plan an expansion of current facilities.

B. PROCEDURES & METHODOLOGY

Standards and Protocol

The American Society for Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) has developed the most widely accepted process for completing energy audits at commercial facilities. ASHRAE document RP-669, SP-56, *Procedures for Commercial Building Energy Audits* defines several levels of audits. The appropriate level of audit for a particular facility depends on the availability of existing data and information, owner objectives, and owner budget. Levels range from simple benchmarking to a comprehensive review of all building systems. The most comprehensive audit is a Level III. Level III audits are commonly referred to as "Investment Grade Audits".

Basic elements of a Level III Investment Grade Audit include the following:

- A review of existing facility data including energy usage.
- Benchmarking the facilities energy usage relative to similar use facilities.
- An on-site inspection and survey of all facility systems.
- On-site measurements and data collection.
- Informal interviews with owners, facility managers, and occupants.
- Energy use analysis and development of efficiency measures.
- Developing a simple payback cost estimate for each recommended measure.
- Development of a comprehensive report that clearly presents all findings and provides recommended energy conservation measures and the associated costs.

In addition to the ASHRAE standard for commercial audits, there are industry and code-based standards that must be considered when analyzing building systems and evaluating energy conservation measures. All recommendations must be consistent with the intent of these standards. For example, the US Environmental Protection Agency (EPA) has established a recommended carbon dioxide (CO_2) threshold concentration of 1,000 parts per million (ppm) to promote a healthy indoor air environment. ASHRAE defines recommended temperatures, relative humidity levels, minimum ventilation rates, and energy standards. The Illuminating Engineering Society of North America (IESNA) prescribes recommended lighting densities based on the designated space use. The International Code Council (ICC) is the adopted standard for all building and energy codes (2009) in the state of New Hampshire. New Hampshire has also adopted ASHRAE Standards 62.1 and 90.1.

Table 4: Relevant Industry Codes and Standards

Standard	Description
28 CFR Part 36	ADA Standards for Accessible Design
ANSI/ASHRAE Standard 55	Thermal Environmental Conditions for Occupancy
ANSI/ASHRAE Standard 62.1	Ventilation for Acceptable Indoor Air Quality
ANSI/ASHRAE/IESNA Standard 90.1	Energy Standards for Buildings Except Low-Rise Residential Buildings
ICC 2009	International Building Code (IBC)
ICC 2009	International Existing Building Code (IEBC)
ICC 2009	International Energy Conservation Code (IECC)
ICC 2009	International Mechanical Code (IMC)
ICC 2009	International Fuel Gas Code (IFGC)
IESNA Lighting Handbook	Reference and Application
NFPA 70	National Electrical Code (NEC)

While the primary objective of an energy audit is identify energy conservation measures, such measures cannot adversely affect occupant comfort and indoor air quality. For example, if a building ventilation system is inadequate then it would be recommended that additional ventilation capacity be added. The electrical power required to operate the added ventilation equipment would increase energy consumption. Typically, the net energy usage incorporating the sum of the recommended conservation measures would still be less than the current usage even with the added ventilation equipment.

It is noted that although there is a prescriptive approach to commercial building audits, that every building is unique in many ways. Buildings should be evaluated consistent with the characteristics that define its need and appropriate function. This includes the following:

- *Use*: Current building use and occupant needs.
- *Systems*: Building systems characteristics and integration.
- *Control*: The effectiveness in which the existing building systems controls are utilized.

Desktop Data Review

Ideally, the building owner provides all available information to the engineering firm prior to initiating the facility site review. Information such as utility bills, building plans, repair records, planned improvements, and occupant concerns will help the building engineer identify potential issues before initiating the site review. The Building Engineer can then focus the site review toward problematic and energy intensive building systems.

Facility Site Review

Following the desktop data review, the Engineer initiates the facility site review. This review includes all major building systems including the envelope, electrical, mechanical, heating, cooling, and ventilation. The Engineer not only determines the performance and operating characteristics of all building systems, they also evaluate how the users operate the systems and how they perceive building performance. Photographs of representative systems, major equipment, and any identified issues are obtained to help document existing conditions. Field notes are maintained by the Engineer to further document building and user characteristics.

Data Measurements

In addition to collecting equipment information, several data measurements are obtained as part of the facility site review. This data is necessary to identify potential building issues and to collect the information needed to develop an accurate energy analysis. Measurements include:

- Infra-red thermal imaging survey of the building envelope.
- Indoor air quality (IAQ) measurements (temperature, relative humidity, and CO_2).
- Lighting metering to determine energy use and operating schedules.
- Lighting output density.
- Metering of energy intensive electrical equipment (e.g., motors, compressors, heaters) to determine energy use and operating schedules.
- Metering of energy intensive plug-loads to determine energy use and operating schedules.

Data Gap Review

Once the facility site review and data measurements are substantially complete, the Engineer begins reviewing and processing all of the collected data. Any data gaps discovered during this process are addressed prior to completing the audit report.

Energy Modeling and Conservation Measures

To identify the best value EEMs and ensure that the calculated energy and cost savings are relatively accurate, a DOE approved energy modeling software program is utilized. A three-dimensional model of the building is created using the simulation program (Figure 3). This includes all characteristic envelope systems, HVACR systems, domestic hot water systems, and mechanical systems. The geographic position and orientation of the building is input and regional climatic data is imported from the program database.

After the building is accurately modeled, the program simulates building performance and provides the estimated energy use for electric and heating fuel(s). The Engineer then compares the energy data to actual building data. The cause for any significant differences is determined and the building is re-simulated until the model closely matches the actual data. AEC utilizes eQUEST© for all building simulations and energy modeling.

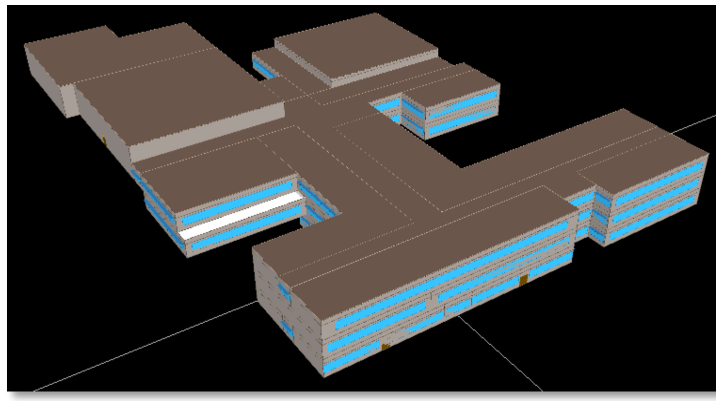


Figure 3: eQUEST® Model of HBHS

With the base model complete, the Engineer then implements various energy reducing measures and simulates the performance of the building with the new measure. The resulting energy consumption is then compared to the baseline model and predicted energy savings are analyzed.

Cost Estimating and Payback

The cost for implementing each evaluated EEM is then estimated by the Engineer. This provides a net estimated energy savings per dollar invested. Simple payback calculations determine the number of years required for the capital investment cost to equal the present day cost savings realized from energy reductions. The savings to investment ratio (SIR) is the accumulated annual cost savings (as determined by the expected service life of the material or equipment associated with the EEM) divided by the cost of investment. A SIR equal to 1.0 indicates that the EEM has a "break-even" or net-zero cost. The higher the SIR, the more favorable the return on investment is.

C. FACILITY INFORMATION / EXISTING CONDITIONS

Setting

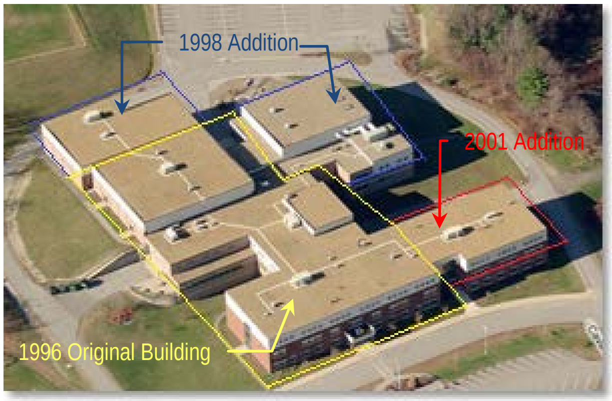


Figure 4: Aerial Photo of HBHS (2011)

The Hollis-Brookline High School (HBHS) is located in Hollis, NH (Figure 4). The building and facilities are located on a conservation land parcel owned by the Town of Hollis. The school is located at 24 Cavalier Court, set slightly west of Main Street / State Route 122.

A large student parking lot, a softball field, and wooded areas are located to the west of the facility. Athletic fields occupy the space to the south of the facility. To the east is parking for staff and visitors as well as a smaller overflow lot. A set of trees defines a boundary beyond the lots and driveways. To the north lies another tree boundary, with a short road leading to a track and field area. Cavalier Court, which is the access road from Main St. to the east, runs east to west, passing the baseball field which is to the north and a second overflow parking lot / baseball parking lot to the south before entering the tree-bound property and looping around the school. The gross area of the HBHS is 153,429 square feet.

History

Hollis and Brookline formed their cooperative school district in 1991. The Hollis Brookline High School was constructed in 1997 due to an upward trending population. When the new high school was constructed, the existing high school was converted into the Hollis-Brookline Middle School and the upper elementary grades (4-6) were moved to the HUES facility with the lower grades (Pre-K-3) remaining in the Hollis Primary School. In 1998 an addition was built which included the auditorium and classrooms at the northwest corner of the building. In 2001, the first pre-planned addition was added which included the mini gym off the southwest corner of the building and additional classrooms off the northeast corner of the building. A third renovation project was conducted in 2005 but no major additions were added at this time.

Use, Function & Occupancy Schedule

The HBHS and the land it occupies are owned by the Town of Hollis. The building site gently slopes from west to east. The main building is located on the east side of the facility and is a three-story structure at grade and functional space here includes mostly classrooms with administrative offices and the library in this space. The three-story structure has a section extending off the middle of the west side. This leads into a two-story structure with the elimination of the first floor (sloping lot) and functional space within here includes classrooms, the kitchen and the cafeteria. This continues westward into the hill leaving the top tier which eliminates the second floor. The west section of the building includes the gymnasium, mini gym, auditorium and some classrooms.

The school follows a typical school year schedule with the 2011-2012 school year outlined in Table 5 below. The typical class schedule starts each day at 0715 and concludes at 1424 providing 7 hours and 9 minutes of daily instruction and 35 hours and 45 minutes of instruction per week. Typical of K-12 facilities the building is normally occupied 40 to 50 hours per week due to teacher schedules.

Table 5: 2011 – 2012 School Calendar

Month	No. School Days	Breaks
August	1	-
September	21	Labor Day (09/05)
October	20	Early Release (10/04)
		Columbus Day (10/10)
November	17	Teacher Workshop Day (11/08)
		Veterans Day (11/11)
		Teacher Workshop Day (11/23)
		Thanksgiving Recess (11/24-11/25)
December	17	Early Release (12/07)
		Holiday Recess (12/26-01/02)
January	19	Holiday Recess (12/26-01/02)
		Teacher Workshop Day (01/10)
		Martin Luther King Day (01/16)
February	18	Early Release (02/09)
		Winter Vacation (02/27-03/02)
March	20	Winter Vacation (02/27-03/02)
		Teacher Workshop Day (03/13)
April	16	Early Release (04/11)
		Spring Vacation (04/23-04/27)
May	22	Early Release (05/24)
		Memorial Day (05/28)
June	9	-

Anecdotal Information

Anecdotal information includes all relevant information collected during the desktop review, as part of occupant interviews, or general observations noted during the site evaluation. Generally, anecdotal information corresponds to issues or concerns that may not be apparent during the building evaluation. It includes complaints about seasonal occupant comfort, maintenance issues, systems or equipment performance issues, recent improvements or changes in use, and previous reports prepared by others. Anecdotal information obtained during the HBHS evaluation includes the following:

- Some occupants indicate that the building is too cold, however, elevated temperatures were consistently recorded throughout the building.
- Lighting densities in many classrooms is excessive. Many occupants utilize the reduced lamp settings.
- Some occupants indicate that ventilation in the building is inadequate when the systems are shut down after the building is normally occupied (school day).
- The science teachers indicated the gas supply is insufficient for the Bunsen burners.

Utility Data

Utility data for the Hollis-Brookline High School (HBHS) was provided by the Town. Table 6 summarizes the total energy consumption for the two-year period including electric and oil usage. Energy consumption and cost for electricity per pay period is shown in Table 7 and Figure 5. The regional electric utility supplier is Public Service Company of New Hampshire (PSNH) and No. 2 fuel oil is provided by a local supplier.

Table 6: Annual Energy Consumption (2010 – 2012)

Energy	Period	Consumption	Units	Cost
Electric	February 2010 – January 2011	926,000	Kilowatt hours	$137,535
No. 2 Fuel Oil	February 2010 – January 2011	27,862	Gallons	$57,905
Total Annual Energy Cost (2010 – 2011):				*$195,440*
Electric	February 2011 – January 2012	849,800	Kilowatt hours	$136,166
No. 2 Fuel Oil	February 2011 – January 2012	26,241	Gallons	$71,549
Total Annual Energy Cost (2011 – 2012):				$207,715

Over the twelve (12) month period (2010 – 2011), February was the peak demand month, consuming 96,800 kWh of electricity. Over the second twelve month period (2011-2012), February was also the peak demand month, consuming 82,600 kWh of electricity. The electrical consumption does not follow a steady trend over the course of the year however the lowest consumption month occurs in August which is expected since school is not in session. The consumption in July, also a summer session month, is higher than that of May and November when school is in session which indicates excess energy is being consumed during the summer when the school is unoccupied. The normal trend line (yellow dashed line in Figure 5) for a K-12 facility is a curved line peaking in February and the lowest point occurring in July or August.

Table 7: Monthly Electric Consumption (2010 – 2012)

Month	Year	Electric Consumption (kWh)	Electric Cost
Feb	2010	96,800	$13,445
Mar	2010	78,600	$11,524
Apr	2010	80,400	$11,569
May	2010	81,800	$11,795
June	2010	74,400	$11,257
July	2010	62,400	$9,705
Aug	2010	65,000	$9,662
Sep	2010	71,000	$10,961
Oct	2010	85,800	$12,524
Nov	2010	74,200	$11,509
Dec	2010	78,600	$11,815
Jan	2011	77,000	$11,769
Totals:	*'10 - '11*	*926,000*	*$137,535*
Feb	2011	82,600	$12,215
Mar	2011	74,800	$11,287
Apr	2011	82,000	$11,952
May	2011	64,000	$9,980
June	2011	70,600	$10,828
July	2011	65,000	$11,427
Aug	2011	54,000	$9,700
Sep	2011	67,800	$11,834
Oct	2011	76,800	$12,306
Nov	2011	64,800	$10,928
Dec	2011	68,800	$11,461
Jan	2012	78,600	$12,250
Totals:	*'11 - '12*	*849,800*	*$136,166*
Totals:	*'10 - '12*	*1,775,800*	*$273,702*

Average annual electric usage for the Hollis-Brookline High School based on the most recent data provided by Town (February 2010 through January 2012) is 887,900 kWh at an average cost of $136,851. Based on the building size and function, this usage is higher than expected.

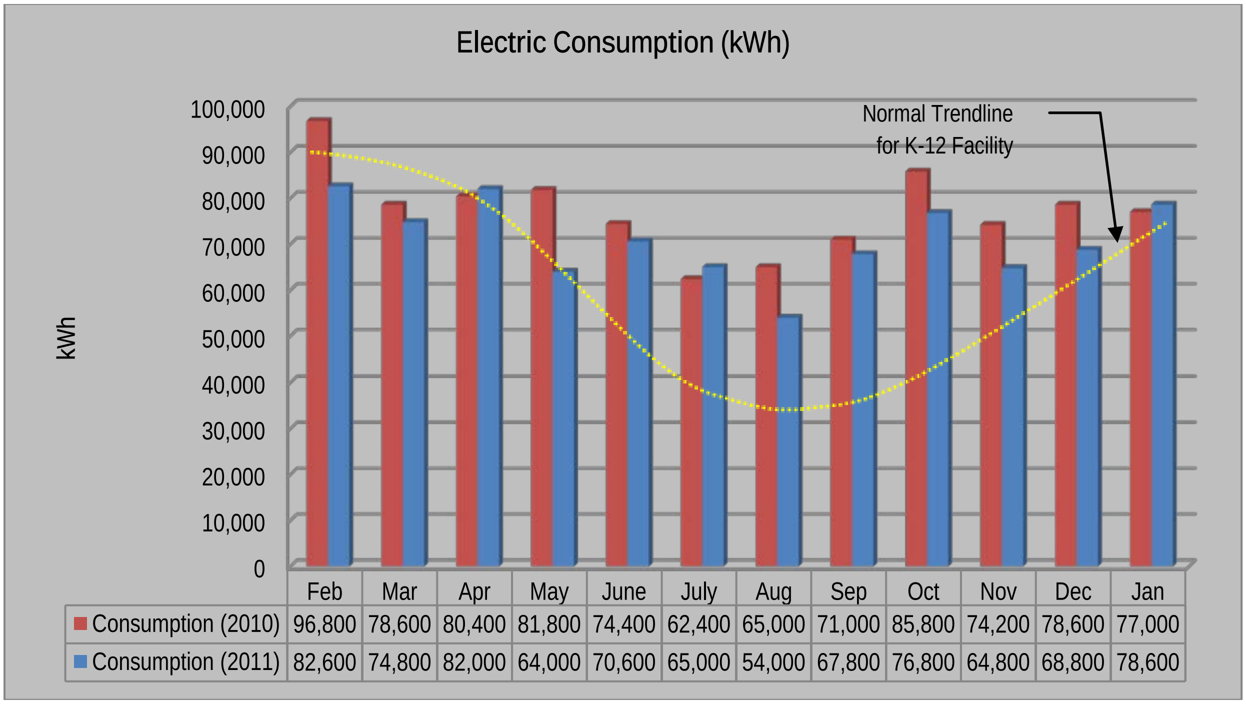


Figure 5: Electric Consumption (2010 – 2012)

To provide the most accurate recommendations for energy conservation, the energy consumption based on end use was determined. Table 8 presents the estimated electrical usage for categories including lighting, plug loads, and mechanical equipment. Mechanical equipment includes all hard-wired, permanently installed equipment including ventilation, exhaust, heating, cooling, pumps, etc. These values were determined using observations from the field audit and typical energy consumption data for appliances observed throughout the building. A more detailed accounting of all electrical equipment by end-use is presented in Part C of this Report.

Table 8: Categorized Electrical Consumption (2011)

Equipment Type	Annual Consumption (kWh/yr)	% of Total Consumption	Annual Cost
Mechanical Equipment	483,956	57%	$77,433
Lighting Fixtures	252,037	30%	$40,326
Plug Loads	112,339	13%	$17,974
Totals:	848,331	100%	$135,733

Electrical consumption is largely consumed by mechanical equipment, at a predicted annual consumption of 483,956 kWh/yr. The mechanical systems are well maintained and run on effective digital controls but measures can still be taken to lower this consumption. Lighting fixtures consume a moderate amount of electricity at an estimated 252,037 kWh/yr. A lighting upgrade project was completed in 2011 which included retrofitting fixtures with more efficient units. Measures can still be taken to further reduce the cost to operate lighting fixtures including controls. Plug loads are predicted to consume the least amount of electricity at an estimated 112,339 kWh/yr.

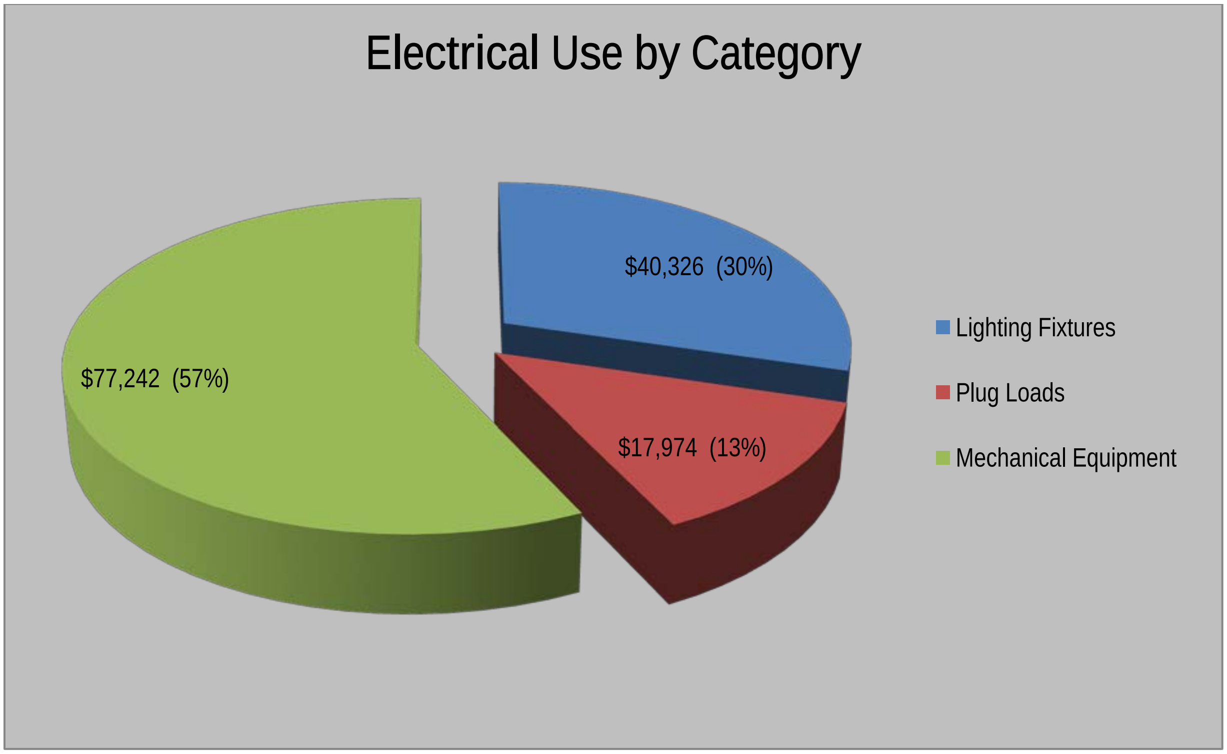


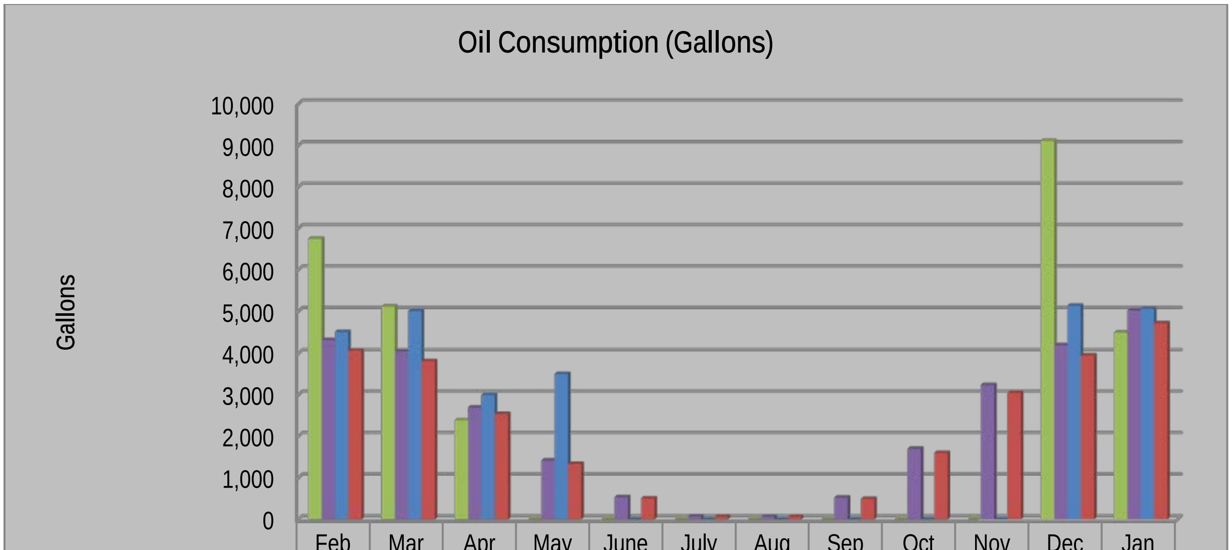
Figure 6: Hollis-Brookline High School Electrical Cost by Category (2011)

At 57%, the proportional consumption for mechanical systems exceeds the expected range of 40%-50%. The annual electric cost for mechanical systems is $77,242. Lighting fixtures consume a moderate amount of electricity but are within a reasonable electrical consumption at 30% and a cost of $40,326. Plug loads are below the expected range accounting for the lowest annual cost of $17,974 (2011).

Table 9: Monthly Heating Fuel Consumption (2010 – 2012)

Month	Year	Oil Purchased (Gallons)	Cost of Purchase	Oil Consumption (Gallons)	Cost of Consumption
Feb	2010	6,747	$11,875	4,324	$8,986
Mar	2010	5,115	$9,002	4,052	$8,420
Apr	2010	2,389	$4,205	2,698	$5,606
May	2010	0	$0	1,420	$2,951
June	2010	0	$0	536	$1,114
July	2010	0	$0	72	$150
Aug	2010	0	$0	70	$145
Sep	2010	0	$0	524	$1,090
Oct	2010	0	$0	1,703	$3,539
Nov	2010	0	$0	3,241	$6,735
Dec	2010	9,111	$21,971	4,199	$8,727
Jan	2011	4,500	$10,852	5,024	$10,441
Totals:	*10 - '11*	*27,862*	*$57,905*	*27,862*	*$57,905*
Feb	2011	4,520	$10,900	4,072	$9,821
Mar	2011	5,010	$12,081	3,816	$9,201
Apr	2011	3,002	$7,240	2,541	$6,127
May	2011	3,505	$8,448	1,337	$3,223
June	2011	0	$0	505	$1,217
July	2011	0	$0	68	$164
Aug	2011	0	$0	66	$158
Sep	2011	0	$0	494	$1,190
Oct	2011	0	$0	1,604	$3,866
Nov	2011	0	$0	3,052	$8,583
Dec	2011	5,137	$16,499	3,955	$12,701
Jan	2012	5,066	$16,380	4,732	$15,298
Totals:	*11 - '12*	*26,241*	*$71,549*	*26,241*	*$71,549*
Totals:	*10 - '12*	*54,104*	*$129,453*	*54,104*	*$129,454*

Heating fuel for space heating and domestic hot water heating at the Hollis-Brookline High School is provided by a local supplier (Table 9, Figure 7). The building consumed a total of 27,862 gallons of heating fuel in the first twelve month period (February 2010 to January 2011) and 26,241 gallons of heating fuel oil in the past year (February 2011 to January 2012) for an annual average of 27,052 gallons. The average annual heating fuel cost was $64,727.



	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan
Oil Purchased (2010)	6,747	5,115	2,389	0	0	0	0	0	0	0	9,111	4,500
Oil Consumed (2010)	4,324	4,052	2,698	1,420	536	72	70	524	1,703	3,241	4,199	5,024
Oil Purchased (2011)	4,520	5,010	3,002	3,505	0	0	0	0	0	0	5,137	5,066
Oil Consumed (2011)	4,072	3,816	2,541	1,337	505	68	66	494	1,604	3,052	3,955	4,732

Figure 7: Fuel Oil Consumption (2010 – 2012)

Considering the building systems including the envelope integrity (insulation and air leakage), mechanical equipment, and use of the facility, the heating fuel usage is within the expected range. Heat is provided to the building three (3) Weil-McLain® 83.5% efficient boilers and domestic hot water is supplied by one (1) Weil-McLain® 84.2% efficient boiler. Combustion efficiencies of these units have decreased with age and predicted efficiencies are less than 82%. The units have fuel-catalyzation units which may provide some benefits by improving the quality of degraded refined fuels. It is unknown how much added benefit there is from these units however it is not assumed to be significant.

Explanations for the high usage include heating setpoints that are higher than recommended in occupied portions of the building. For example, thirty-seven (37) temperature readings were taken at representative locations throughout the school and all measurements exceeded the 70°F maximum recommended setpoint with an average recorded temperature of 73.3°F. The recommended heating setpoints for a K-12 facility range between 66°F and 70°F depending on the space use and occupant activity (i.e., gymnasium versus a classroom).

D. FACILITY SYSTEMS

Building Envelope

The following sections present the building envelope systems and insulation values for each assembly. Assembly values are compared to the *International Energy Conservation Code (IECC), 2009* for commercial buildings located in Climate Zone 5. The IECC code is used as a standard of comparison only and existing buildings are not required to comply with the code unless it undergoes a substantial renovation. New construction and major renovations are required to comply with current energy codes. A partial set of building design plans was made available for the original building constructed in 1996 and the renovation in 2001. A full set of building design plans was made available for the 1998 renovation.

Floor Systems

The building is built into a hillside which slopes downward from east to west with three separate tiers. The concrete floor in each tier of the building is four (4) inches in thickness on grade. Structural fill is specified below the concrete slabs with a reinforced vapor barrier between the fill and the slab. There are three (3) different floor systems at grade: one with a vinyl tile finish, one with a carpet finish and the gymnasium and mini gym with a wood finish, with insulation values outlined in Table 10. The floor system has an installed assembly insulation resistance (R) value of 1.2, 2.0 and 1.7 respectively. Although the IECC does not specify an insulation requirement for unheated slab on grade floors in Climate Zone 5, a minimum value of R-10 is generally recommended. The perimeter of the foundation is insulated with two (2) inch polystyrene board insulated to depth of four (4) feet.

Table 10: Floor Insulation Values

Floor Area 1 (Vinyl Covering)				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Concrete slab	4.0	0.3	1.0	0.3
Vinyl Tile	¼	0.2	1.0	0.2
Interior air film	NA	0.7	NA	0.7
			Installed Assembly	1.2
			2009 IECC Requirement:	NR
			Best Practice Recommendation:	10.0
Floor Area 2 (Carpet Covering)				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Concrete slab	4.0	0.3	1.0	0.3
Carpet	NA	1.0	1.0	1.0
Interior air film	NA	0.7	NA	0.7
			Installed Assembly	2.0
			2009 IECC Requirement:	NR
			Best Practice Recommendation:	10.0
Floor Area 3 (Gymnasium Floor)				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Concrete slab	4.0	0.3	1.0	0.3
Hardwood	¾	0.7	1.0	0.7
Interior air film	NA	0.7	NA	0.7
			Installed Assembly	1.7
			2009 IECC Requirement:	NR
			Best Practice Recommendation:	10.0

Wall Systems

The building is a three-tiered structure sited on a gently sloping parcel (west to east). The original building includes single-story and three-story structures framed out of 12-inch concrete masonry unit (CMU) blocks clad in brick or cement veneer (stucco) with finished metal studs walls on the interior. The 1998 addition (including the auditorium wing with classrooms) is framed with 8-inch CMU blocks with brick or cement cladding. Drawing plans with building sections were not available for the 2001 addition. There are a total of eleven (11) wall types at the HBHS which are outlined in Table 11 below. The foundation of the building below grade includes a layer of rigid perimeter insulation.

Figure 8: Exterior Wall Systems

A reinforced acrylic coat (RAC) system wraps around most upper sections of the facility. This is an exterior finishing system applied by priming the surface, filling cracks, applying a waterproof elastic coating with reinforcing fleece, and finishing with another coat of waterproof elastic coating. This system is applied to the rigid insulation adhered to the CMU wall.

Building plans made available for the original 1996 building only includes wall sections from the gymnasium. The main wall type for the gymnasium is outlined as Wall Type 1 in Table 11 below. There are four separate R.A.C systems around the gymnasium which are outlined as Wall Types 3 through 6. Since wall sections were not made available for the remainder of the original building, it is assumed that Wall Type 1 was constructed throughout with varying R.A.C systems installed throughout as described by Wall Types 3 through 6.

Building plans were made available for the 1998 building which includes the auditorium and classrooms. These wall types include Wall Type 2, which is finished in brick facing, and five types of R.A.C wall types, described as Wall Types 7 through 11. Wall Type 2 differs from Wall Type 1 in that it was constructed out of 8" CMU block instead of 12" CMU block. R.A.C systems have varying levels of differences.

Building plans made available for the 2001 classroom addition along the three-story structure at the east side of the facility do not include wall sections. Based on the limited plans which are available and based on construction best practice, it is assumed that the wall types follow those of the original building from 1996. Therefore Wall Type 1 and R.A.C Wall Types 3 through 6 are assumed to be how the building is constructed.

Table 11: Wall Assembly Insulation Values

Wall Type 1				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
Facing Brick	4	0.4	0.9	0.4
Air Space	2	1.0	NA	1.0
Cavity Wall Insulation	2	8	0.9	7.2
CMU Block	12	1.3	0.8	1.0
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	3.3+7.2ci
			2009 IECC Requirement:	11.4ci
			Code Compliant?	NO
Wall Type 2				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
Facing Brick	4	0.4	0.9	0.4
Air Space	2	1.0	NA	1.0
Cavity Wall Insulation	2	8	0.9	7.2
CMU Block	8	1.1	0.8	0.9
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	3.2+7.2ci
			2009 IECC Requirement:	11.4ci
			Code Compliant?	NO
Wall Type 3 R.A.C.				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
Cement Finish	NA	0.2	NA	0.2
Insulation Board	3	12.0	0.9	10.8
CMU Block	12	1.3	0.8	1.0
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	2.1+10.8ci
			2009 IECC Requirement:	11.4ci
			Code Compliant?	NO
Wall Type 4 R.A.C.				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
Cement Finish	NA	0.2	NA	0.2
Insulation Board	2	8.0	0.9	7.2
Exterior sheathing	½	0.6	0.9	0.5
Fiberglass Batt Insulation	6	19.0	0.8	15.2
Exterior Sheathing	½	0.6	0.9	0.5
Vapor Barrier	NA	NA	NA	-
Gypsum Board	5/8	0.6	0.9	0.5
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	17.8+7.2ci
			2009 IECC Requirement:	11.4ci
			Code Compliant?	NO
Wall Type 5 R.A.C				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
Cement Finish	NA	0.2	NA	0.2
Insulation Board	3	12.0	0.9	10.8
Exterior Sheathing	½	0.6	0.9	0.5
Fiberglass Batt Insulation	6	19.0	0.8	15.2
Exterior Sheathing	½	0.6	0.9	0.5
Vapor Barrier	NA	NA	NA	-

Gypsum Board	5/8	0.6	0.9	0.5
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	17.8+10.8ci
			2009 IECC Requirement:	11.4ci
			Code Compliant?	NO
Wall Type 6 R.A.C				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
Cement Finish	NA	0.2	NA	0.2
Insulation Board	2	8.0	0.9	7.2
Exterior sheathing	½	0.6	0.9	0.5
Fiberglass Batt Insulation	6	19.0	0.8	15.2
Vapor Barrier	NA	NA	NA	-
Gypsum Board	5/8	0.6	0.9	0.5
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	17.3+7.2ci
			2009 IECC Requirement:	11.4ci
			Code Compliant?	NO
Wall Type 7 R.A.C				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
Cement Finish	NA	0.2	NA	0.2
Insulation Board	2	8.0	0.9	7.2
Exterior sheathing	½	0.6	0.9	0.5
Fiberglass Batt Insulation	3-5/8	13.0	0.8	10.4
Vapor Barrier	NA	NA	NA	-
Gypsum Board	5/8	0.6	0.9	0.5
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	12.7+7.2ci
			2009 IECC Requirement:	11.4ci
			Code Compliant?	NO
Wall Type 8 R.A.C				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
Cement Finish	NA	0.2	NA	0.2
Insulation Board	1½	6.0	0.9	5.4
Exterior sheathing	½	0.6	0.9	0.5
Fiberglass Batt Insulation	3-5/8	11.0	0.8	8.8
Vapor Barrier	NA	NA	NA	-
CMU Block	8	1.1	0.8	0.9
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	11.3+5.4ci
			2009 IECC Requirement:	11.4ci
			Code Compliant?	NO
Wall Type 9 R.A.C				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
Cement Finish	NA	0.2	NA	0.2
Insulation Board	1½	6.0	0.9	5.4
Exterior sheathing	½	0.6	0.9	0.5
Fiberglass Batt Insulation	3-5/8	11.0	0.8	8.8
Vapor Barrier	NA	NA	NA	-
Gypsum Board	5/8	0.6	0.9	0.5
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	10.9+5.4ci
			2009 IECC Requirement:	11.4ci

			Code Compliant?	NO
Wall Type 10 R.A.C				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
Cement Finish	NA	0.2	NA	0.2
Insulation Board	1½	6.0	0.9	5.4
Exterior sheathing	½	0.6	0.9	0.5
Fiberglass Batt Insulation	6	19	0.8	15.2
Vapor Barrier	NA	NA	NA	-
Gypsum Board	5/8	0.6	0.9	0.5
Acoustical Wall	5/8	0.6	0.9	0.5
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	17.8+5.4ci
			2009 IECC Requirement:	11.4ci
			Code Compliant?	NO
Wall Type 11 R.A.C				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
Cement Finish	NA	0.2	NA	0.2
Insulation Board	3	12.0	0.9	10.8
CMU	8	1.1	0.8	0.9
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	2.0+10.8ci
			2009 IECC Requirement:	11.4ci
			Code Compliant?	NO

Ceiling Systems

Ceilings throughout most of the building are suspended acoustical tile (SAT) systems. The above ceiling space is used for routing of ducting, piping, conduit and electrical cable. The ceiling of the gymnasium and auditorium are made of aluminum and are attached below the roof system. Acoustical insulation is located above the choral room ceiling space (1998 addition).

Roofing Systems

Figure 9: Multi-Level Ballasted Roof

The entire building has multiple levels of flat roof sections. Building plans made available include roof sections above the gymnasium, auditorium and classroom space as part of the auditorium addition. Plans for the 1996 original building include the gymnasium roof system which is outlined in Table 12 as Roof Insulation 1 and indicate an acoustic roof deck. Plans for the 1998 auditorium addition specify acoustical roof only above the auditorium and is the same system as the one above the gymnasium. The roofing above classroom spaces in the 1998 addition is a simpler system and is outlined as Roof Insulation 2 in Table 12. Since building sections were not made available for the remainder of the building it is assumed that Roof Insulation 2 is the system used throughout. Insulation values are the same for each roof type as the metal deck does not provide any insulation resistance value. These roof types do not meet current code.

Table 12: Roof Insulation Values

Roof Insulation 1 (Gymnasium/Mini Gym, Auditorium)				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
Membrane Roof-Ballasted	NA	0.3	NA	0.3
Rigid Roof Insulation	4	16.0	1.0	16.0
Acoustic Roof Deck	NA	-	NA	-
Reinforced Vapor Barrier	NA	-	NA	-
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	17.2
			2009 IECC Requirement:	20.0ci
			Code Compliant?	NO
Roof Insulation 2 (Main Building)				
Material	Thickness (in.)	R-value	Integrity Factor	Installed R-value
Exterior Air Film	NA	0.2	NA	0.2
Membrane Roof-Ballasted	NA	0.3	NA	0.3
Rigid Roof Insulation	4	1.06	1.0	16.0
Roof Deck	NA	-	NA	-
Interior Air Film	NA	0.7	NA	0.7
			Installed Assembly:	17.2
			2009 IECC Requirement:	20.0ci
			Code Compliant?	NO

Fenestration Systems

Fenestration systems on the HBHS building include operable windows, fixed window units, and fully-glazed entry doors. Consistent with IECC requirements, fenestration performance is measured by the U-factor, the solar heat gain coefficient (SHGC), and air leakage as determined by the unit manufacturer. Glass manufacturer information was found on the north side set of the storefront assembly extending three stories. The tempered glass manufacturer is AGCD® and it complies with CPSC 16, CFR 1201 and ANSIZ97.1 architectural standards (Figure 10). No manufacturer information was available for the remaining windows or doors therefore compliance with IECC standards for commercial buildings located in Climate Zone 5 cannot be established.

Figure 10: North Windows and Manufacturer Information

Figure 11: IR of North Exterior Door

Thermal transfer and air leakage commonly occurs at the seals of operable windows and the interface between the window and the wall opening which was observed using infrared imaging. Recommendations include exterior and interior inspection and re-caulking of window jambs, headers, and sills as needed. If the operable window units have adjustable jambs, they should be inspected and adjusted as necessary to maintain a complete air seal.

Doors

The door units in HBHS building include metal framed doors with full window glazing for all main and side entrances and solid steel doors for secondary entrances and emergency exits. Based on visual observations and thermal imaging, the thermal integrity of the uninsulated door units is low. Additionally, seals on door jambs, partings, and thresholds are incomplete allowing air leakage. Recommendations include exterior and interior inspection, weather stripping and re-caulking around windows as needed. The hollow frames can insulated with open-cell (low expansion) polyurethane foam.

Air Sealing

Based on the thermal imaging survey and visual observations, air leakage occurs through windows and entry doors. Although this is typical even for a modern building, simple measures can significantly reduce air leakage. Recommended measures for windows include: 1) adjusting jamb seals on operating windows; 2) adding weather-stripping; 3) caulking interior frames and moldings; and, 4) locking/clasping windows to maintain a complete seal.

Air sealing of all door units can be improved with commercial weather-stripping. All door and window units should be regularly inspected (every 2 to 3 years) to ensure proper operation, identify faulty seals, and to identify any deteriorated caulking requiring replacement. Other air sealing recommendations include inspecting all exhaust and ventilation ducts to determine if they have a positive pressure actuated damper. Dampers are recommended on all exterior ducting to prevent passive air leakage.

Thermal Imaging Survey

The thermal imaging survey was conducted on December 20th and 28th 2011, and on the morning of January 20th 2012. Outdoor ambient temperature was approximately 28°F during the first two surveys and 17°F during the third survey. The survey was conducted using a FLIR© B-CAM infra-red (IR) camera. The building exterior and interior envelope and major mechanical and electrical equipment were surveyed with the IR camera. IR camera surveys not only identify heat transfer through building envelopes, they also identify trapped moisture, electrical system overloading, heat loss through ducting and piping, high energy lighting fixtures, and energy intensive plug load equipment. Appendix B presents the survey report.

The IR surveys revealed the following notable observations:

Figure 12: IR of Exterior Wall

- Significant thermal transfer occurs at the exposed foundation walls and at the top of the brick faced sections before they meet the RAC wall system (Figure 12). This upper wall section is within the suspended ceiling where elevated temperatures occur due to heat loss from hydronic piping.
- The RAC wall system (third floor) performs relatively well (Figure 12).
- Windows and glazed doors reveal substantial thermal transfer through the hollow metal frames.
- Poorly sealed windows and doors allow thermal transfer and air leakage.
- Energy intensive electrical equipment such as copiers and vending machines reveal high thermal energy produced.
- Lights in the gymnasium create a high thermal energy.
- Air handle units on the roof produce a high thermal energy which is lost to the exterior. Some units exhaust high temperature air to the exterior as well.
- The air handle unit in the gymnasium produces thermal energy which is lost through the unit while other thermal energy is lost through the uninsulated ductwork. A roof pipe penetration has a poor seal which results in thermal loss as well.

- Circulation pumps run often and their motors create thermal energy (wasted as heat) which is lost to the mechanical room in which they are installed.

Electrical Systems

Supply & Distribution

Grid electricity is supplied to HBHS to the main electrical room by an underground service provided by a large pad mounted transformer. Several sub-distribution electrical rooms with panels and transformers are located throughout the building. Three-phase grid power is supplied to the building by PSNH via overhead transmission lines.

Figure 13: High-Efficiency Transformer (Powersmiths®)

Most electrical rooms were easily accessible and clear of stored items. Some electrical rooms were used as storage which limits access to these panels and is creates a code compliance issue. Old and outdated transformers are inefficient and lose a significant amount of energy in the form of heat. This excess heat is typically removed from the building with exhaust fans or tempered with air conditioning units further increasing electric consumption. Replacing old transformers with new, energy efficient units (Figure 13) can significantly reduce energy losses and costs.

Figure 14: Exterior Metal Halide Lighting

Lighting Systems

As presented in Table 13, there are a variety of lighting fixtures and lamp types at the HBHS facility. Lighting fixtures in the building consist mainly of recessed mounted high performance T8 fluorescent fixtures. T5 fixtures are the main source of lighting in the gymnasium, mini gym and Room 369 near the auditorium. These fixtures account for the second highest total wattage. The auditorium is lit with 400 watt high pressure sodium (HPS) fixtures accounting for the third highest in total wattage. Exterior lights are metal halide (MH) units. The remaining fixtures include stage lighting, halogens, compact fluorescents (CFL), LED's in exit signs and two incandescent bulbs.

Table 13: Lighting Fixture Schedule

Fixture Lamp Type	Location(s)	Control	No. Lamps	Watts	Qty.	Total Watts
T8	Throughout	Motion, Switch	1-4	32	1,524	114,848
T5	Gym, Mini Gym, Rm. 369	Switch	4	54	64	13,824
HPS	Auditorium	Switch	1	400	21	8,400
MH	Exterior	Photocell	1	70, 150	66	7,260
Stage	Auditorium	Switch	1	100	32	3,200
Halogen	Auditorium, Rm. 329	Switch	1	54	51	2,754
CFL	Throughout	Motion, Switch	1, 2, 4	17, 54	42	1,122
LED	Exit Signs	Always On	1	5	82	410
Inc	Rm. 156	Switch	1	60	2	120
				Totals:	1,884	151,938

Table 14 presents the predicted energy consumption by lighting fixture type. Lighting fixtures account for an estimated 252,037 kWh of electricity per year. The high performance T8 fluorescent fixtures are the main source of lighting and account for 75% of all lighting energy consumption annually at an estimated 190,222 kWh/yr. The T5 fixtures are frequently used and are estimated to have the second highest lighting consumption by fixture type at 11%. Exterior metal halide fixtures consume an estimated 23,217 kWh/yr. Continuously lit LED exit signs account for just over 1% of lighting electricity. The remaining fixtures individually account for less than 1% of total lighting consumption based on their low usage frequency –they account for the remaining 4% of lighting electrical consumption.

Table 14: Lighting Fixture Energy Consumption

Fixture Lamp Type	Location(s)	Est. Usage (KWH/yr)	% of Total
T8	Throughout	190,222	75%
T5	Gym, Mini Gym, Rm. 369	28,581	11%
MH	Exterior	23,217	9%
LED	Exit Signs	3,582	1%
HPS	Auditorium	2,352	<1%
Halogen	Auditorium, Rm. 329	1,579	<1%
CFL	Throughout	1,410	<1%
Stage	Auditorium	896	<1%
Inc	Rm. 156	197	<1%
	Totals:	252,037	100%

Lighting density measurements in HBHS building were obtained to establish if building illumination is consistent with the *Illuminating Engineer Society of North America* (IESNA) standards for the prescribed use. These measurements were obtained during normal operating conditions on December 20th, 2011 between the hours of 1115 and 1403. Table 15 presents the lighting density measurements obtained in units of foot-candles (FCs).

Large yard lights are rented from PSNH. It may be beneficial to replace these units with LED fixtures and connect them to the building meter.

IESNA Standards

Lighting densities were recorded at twenty-nine (29) representative locations. Seventeen (17) of the measurements exceed IESNA recommended standards. Most of the common areas such as hallways, vestibules and the cafeteria significantly exceed recommended standards. Other spaces which exceeded recommended standards include the main office, guidance office, and a few classrooms. Classroom fixtures have multi-lamp (3) settings and most had partial lighting (1 or 2 of the 3 lamps on). Full lighting densities (3 lamps) in classrooms significantly exceed recommended lighting densities. Motion controllers are installed in many of the first floor classrooms. As part of the lighting upgrade project of 2011 the lamps were designed to output higher densities than recommended with the intention of losing densities over time to their recommended levels. While this will ensure proper densities are always met it is not the most efficient way of providing lighting. Methods to reduce frequency of lighting and how many lamps are illuminated have been implemented in some areas which is recommended for all areas.

Figure 15: T8 Light Fixtures in Vestibule

Areas where illumination densities are significantly below IESNA standards include the gymnasium and the auditorium. Measured density in the gymnasium is 26 FCs and the recommended level for a high school basketball court is 70 FCs. The auditorium lighting is very low (3 FCs) and presents a life safety concern for emergency egress. Increasing illumination in both areas is recommended.

Methods to reduce lighting densities include reducing the quantity of fixtures, replacing them with lower-wattage fixtures, and installing lower wattage bulbs in the existing fixtures. Other methods to reduce lighting density include replacing overhead lighting with task lighting, adding multiple control zones, adding daylight controls and adding dimming controls. Newer technology fixtures provide higher lighting density per watt than the existing older fixtures and provide improved lighting quality. The lighting density data is included in Appendix C.

Table 15: Illumination Densities

Location	Lighting Density (FC)	Recommended Density (FC) (1)	Notes
163 Art	45	50	
First fl EW corridor	48	10	
First fl NS corridor	51	10	
Main office	63	50	
128 guidance	42	50	
Classroom 175	48	30	
North stairwell 1-2	25	10	
Library 205	56	30	
Classroom 225	16	30	Partial lighting
Cafeteria	66	10	
2nd fl EW corridor	25	10	
Classroom 203	19	30	Partial lighting
Classroom 202	46	30	
Classroom 216	22	30	Partial lighting
Classroom 310	50	30	
3rd fl NS corridor	32	10	
Classroom 304	34	30	Partial lighting
Classroom 301	20	30	Partial lighting
Classroom 370	22	30	Partial lighting
Classroom 223	24	30	Partial lighting
Classroom 249	40	30	
Classroom 249B	24	30	Partial lighting
Gymnasium	26	70	
Auditorium	3	15	
Classroom 335	32	30	Partial lighting
Classroom 368	26	30	Partial lighting
3rd fl lobby	68	10	
Classroom 321	35	30	Partial lighting
Classroom 372	28	30	Partial lighting
Classroom 373	20	30	Partial lighting

(1) Based upon IESNA standards and AEC recommendations.

Plug Loads

Plug loads for the HBHS facility were determined based on equipment nameplate information. The operating time for each item is based on observations, occupant loading, schedule, and typical operating time for the equipment. Plug loads are categorized as either appliances or electronics and office equipment. Appendix F presents an inventory of all plug load equipment.

Figure 16: ENERGY STAR® Rated Vending Machine

Based on this analysis, the total annual plug load is 112,339 kWh/yr. This accounts for just 13% of annual consumption for the facility. Appliances account for approximately the same amount of consumption as office equipment, computers and electronics, with appliances predicted to account for slightly more at 51%. High appliance loads include thirty-one (31) compact refrigerators which consume an estimated 22,320 kWh/yr. The numerous refrigerators account for 39% of the total appliance loads and 20% of total plug load consumption. Other appliances which consume a considerable amount of energy include six (6) vending machines and eight (8) water fountains with cooling condensers. One of the vending machines is ENERGY STAR® rated (Figure 16). The office equipment, computer and miscellaneous electronic loads are within the expected range however consumption can be reduced. Computers and office equipment remain powered on when the building is unoccupied and consume a considerable amount of electricity even if they are in a low powered / sleep mode. Placing equipment such as copiers and computers on smart power strips with time scheduling capability would automatically cut power when the building is unoccupied.

Table 16: Plug Load Energy Consumption

Category	Location(s)	Est. Usage (kWh/year)	% of Total
Appliances	Throughout	56,978	51%
Office Equipment, Computers, Electronics	Throughout	55,360	49%
	Subtotals	112,339	100%

Motors

Electrical motors are used for the elevator, air handling unit (AHU) fans, walk-in freezers condensers, unit ventilators, air condition condensing units, exhaust fans and the well pump. Replacement of failed motors with premium efficiency NEMA rated motors is recommended. Variable Frequency Drives (VFDs) are also recommended for replacement AHU motors.

Emergency Power Systems

There is a diesel powered generator which is run every Friday morning for 15 minutes powered generator supplies the building with electricity during grid outages. The unit is expected to provide enough capacity to supply critical systems in the event of an outage.

Plumbing Systems

Figure 17: Well Pump Controllers in Boiler Room

Domestic Water Supply

Domestic water supply for the HBHS is provided by a four (4) on-site wells, Three (3) of which automatically supply the school and the fourth is offline. Water demand includes lavatory, locker rooms (showers, toilets, sinks), kitchen and washing machine uses. According to facility personnel the shower facilities are infrequently used. Water demand is expected to be moderate.

Domestic Water Pump Systems

The water system is integrated with a controls system on a 480-volt 3-phase system in the boiler room (Figure 17). The controls system monitors flow and level of each well and automatically shuts down a well pump if there is no water. Each well is equipped with a ¾ horsepower pump discharging into a storage tank. Two booster pumps supply water from the tank to the point of supply.

Domestic Water Treatment Systems

A water softening system in the boiler room is used to reduce water hardness (mineral content).

Domestic Hot Water Systems

Domestic hot water (DHW) is heated by a Weil-McLain® series 78 boiler which had an efficiency of 84% when new. Heated water is stored in a 500-gallon insulated cylindrical tank located in the boiler room. An HB Smith® hot water tank heater (20-gallons) is located in the mini gym at the opposite end of the building as the boiler room to supply hot water to a single lavatory. DHW capacity exceeds expected demand requirements for the building.

Hydronic Systems

Space conditioning is provided by hot water coils and fin-tube baseboard connected to a hydronic loop. Water is circulated by two (2) 7½-horsepower (HP) circulation pumps located in the boiler room. Pumps and distribution piping were observed to be in fair condition however piping insulation can be improved.

Mechanical Systems

Figure 18: Heating Boilers

Heating Systems

Heat is provided by three (3) Weil-McLain® 1188 oil-fired boilers (Figure 18). The rated efficiency of these units when new is 83.5% and the de-rated efficiency is estimated at less than 81%. Low boiler combustion efficiencies result in a substantial amount of heat loss, reduced system inefficiency, and CO_2 emissions. The boiler supplies the hydronic system including zoned fin-tube baseboards and fifty-eight (58) fan heating coils in the mechanical equipment. The three boiler units have individual rated outputs of 3,264 MBH which appears to supply a sufficient amount of heat to the building.

Table 17: Heating Supply Systems

Heating Unit	Unit Description	Area(s) Served	Output (MBH)	Age (yrs.)	AFUE (new)	Control Type
Boiler No. 1-3	Weil-McLain®	Throughout	3,264	16	83.5%	DDC

Cooling Systems

Cooling is provided to sections of the building by rooftop units and condensers. There are two (2) Trane® rooftop units which are for air conditioning only. There are three (3) AHUs on the roof which are connected to air conditioning condensing units (ACCU) 1-3 (Figure 19). ACCU-1 is a 4-ton Trane® unit and ACCU-2 and ACCU-3 are 6-ton Trane® units. In addition there are two (2) Mitsubishi® ACCU units on the rooftop. Condensers are charged with R-22 refrigerant. It is noted that the use of refrigerant R-22 is no longer permitted (per USEPA) based on its high ozone depletion potential. The Seasonal Energy Efficiency Ratio (SEER) of these units is not available however based on age and condition the estimated de-rated SEER is at 10.

Figure 19: Air Condition Condensing Unit 1 on Roof

Operating efficiency tends to decrease with system age. As cooling condensing units fail, they should be replaced with the highest rated equipment available. All exterior condensers piping insulation should be rated for outdoor exposure. As prescribed by the 2009 IECC, the current minimum SEER for smaller cooling systems is 13 and larger units are rated at a minimum EER of 11.2. Modern cooling systems can achieve SEERs up to 24. As example, replacing a unit with a SEER rating of 8 with a new unit rated at 16 would reduce energy consumption by 50% and provide an equivalent cooling capacity.

Pumps

Two (2) water circulation pumps are located in the boiler room to circulate heated water through the hydronic loop. One pump is located within the well and two (2) pumps are located in the mini gym. The circulation pumps in the boiler room are each 7½ horsepower (HP). The well pump is estimated to be 2-HP. The pumps in the mini gym are 1 HP each. It is recommended that when the motors on these pumps need to be replaced that premium rated NEMA motors with VFD controllers be installed.

Controls Systems

The heating and cooling systems are tied into a direct digital controls (DDC) system. Thermostats are located within classrooms to give occupants some control of their heating and cooling zone. Temperatures were measured in thirty-seven (37) representative locations and exceeded recommended temperatures in all 37 locations. It is recommended heating setpoints be between 67°F and 70°F and recommended cooling setpoint temperatures between 73°F and 76°F

Refrigeration

Three (3) walk-in commercial refrigeration units are located in the kitchen with roof-mounted condensers (Figure 20). These units consume a significant amount of energy annually. Recommendations include replacing failed condensers with high efficiency units (SEER/EER). Other recommendations include installing eCube® food temperature sensing thermostat controls. By measuring constant food temperature instead of more variable air temperatures, eCube® controllers significantly reduce the frequency of condenser operation (www.getecube.com).

Figure 20: Walk-in Freezer Condensers on Roof

Mechanical Equipment Energy Consumption

The electrical energy consumption for mechanical equipment was determined according to nameplate information and building function and occupancy schedules. Table 18 presents a summary of the mechanical equipment and annual energy usage. Appendix E presents the detailed inventory and the associated energy consumption for each piece of mechanical equipment. Total mechanical consumption per year is estimated to be 483,956 kWh per year compared to 252,037 kWh for light fixture loads and 112,339 kWh for lighting.

Table 18: Mechanical Equipment Energy Consumption

Equipment Type	Qty.	Item Manufacturer(s)	Consumption (kWh/yr)	% of Total
Rooftop Unit Ventilators	11	Trane®	322,674	66%
A/C Condensing Units	5	Trane®	70,730	15%
Exhaust Fan	19	Greenheck, Kanalflakt®	29,388	6%
Circulation Pumps	4	Bell & Gossett®	28,608	6%
Walk-in Refrigerators and Freezer	3	NA	16,690	3%
Unit Ventilator	4	Trane®	6,446	1%
Heat Recovery Ventilator	1	Des Champs®	5,960	1%
Boiler Blowers	3	Carlin®	2,179	<1%
Well pump	1	NA	1,743	<1%
Unit Heater	25	Trane®	1,205	<1%
Shop Exhaust	2	Airomax®	75	<1%
		Totals:	485,699	100%

The eleven (11) rooftop ventilator units are estimated to consume the most amount of energy of all the mechanical loads. These are used throughout the year to condition and provide fresh air to the building. Two of these units are for air conditioning only. The total consumption for these units is estimated to be 322,674 kWh/yr which is 66% of total electric consumption of mechanical equipment. The five (5) air condition condensing units also consume a moderately high amount of energy at an estimated 70,730 kWh/yr.

Ventilation Systems

Exhaust Ventilation Systems

Exhaust fan units provide several functions including humidity control, odor control, venting of VOC containing materials (e.g., cleaning solvents), chemical gas venting in laboratories, and venting of cooking fumes. Operation frequency and schedules for the fans units should be consistent with the use type and intensity of the vented space. For example, lavatories may be demand ventilated (interlocked with light switch) or they may operate continuously at a low rate during occupied periods. Spaces equipped with exhaust fans are commonly over-ventilated resulting in increased energy consumption. All exhaust controls and rates should be consistent with ASHRAE Standard 62.1. Fan ducting should have pressure actuated dampers to restrict air flow and heat loss when the units are not operating.

Exhaust ventilation systems in the HBHS include lavatory, kitchen, auditorium, and gymnasium exhaust fans. These units are estimated to consume 29,388 kWh/yr of electricity. The fan units connected to the DDC system. Control of the units should be consistent with the type of space being vented to optimize operation.

Exchange Air Ventilation Systems

Exchange air ventilation systems exhaust interior air with high CO_2 concentrations and humidity and replace it with fresh outdoor air. Ventilation rates and system capacity should be designed consistent with the minimum prescribed code standards (ASHRAE 62.1). Systems should be demand (CO_2) controlled with energy recovery capacity (ASHRAE 90.1).

Figure 21: Rooftop AHU

Exchange air ventilation in the HBHS building is provided by eleven (11) rooftop AHUs and an AHU (RTU-2) with an energy recovery unit (ERU) (Figure 21). CO_2 concentrations in the HBHS building revealed that the building was adequately ventilated in most areas. The AHUs are equipped with economizers which control the minimum percentage of outside air introduced to the conditioned space. Control of the units is provided by the schedule-based DDC system. Installing demand controllers would significantly reduce operation frequency and energy consumption –this is a current mechanical code requirement (IMC and ASHRAE 90.1).

Replacement AHUs should be commercial rated units with economizers, VFD motor controllers, ERUs, and demand controllers to optimize system efficiency.

Energy Recovery Ventilation Systems

Only the Munters Des Champs® rooftop unit contains an ERU (Figure 21). Replacement of the other AHUs should consider packaged ERUs.

Indoor Air Quality

Indoor air quality (IAQ) is established based upon temperature (°F), relative humidity (%), and carbon dioxide (CO_2); measured in parts per million (ppm). This data provides the best representation of building ventilation performance and occupant comfort. They are also indicative of conditions that are detrimental to building systems including moisture intrusion and the potential for fungi growth (mold and mildew) and related damage of building materials.

Recommended temperatures vary based on the season, occupant activity, and relative humidity levels. Generally, recommended setpoint heating temperatures in northern New England range between 67°F and 70°F and recommended cooling setpoint temperatures range between 73°F and 76°F. Relative humidity (RH) levels fluctuate consistent with seasonal atmospheric conditions. A range between 30% and 65% is recommended (ASHRAE). While there are no known adverse health effects related to elevated CO_2 concentrations, it can cause acute illness including headaches, drowsiness, lethargy, and nausea. For this reason, the U.S. Environmental Protection Agency (EPA) has established a recommended threshold concentration of 1,000 ppm.

The IAQ in the HBHS was measured on December 20th, 2011 between the hours of 1115 and 1403. The building was normally occupied when the measurements were obtained. Thirty-seven (37) IAQ measurements were obtained at representative locations throughout the building. Appendix C presents all of the measurements. Results of the IAQ measurements are summarized as follows:

- Temperatures in the building ranged from 70.1°F in the unoccupied auditorium to 78.2°F in the school resource officer's office. The average recorded temperature was 73.3°F.

- Relative humidity measurements ranged from 8.5% in the occupied gymnasium to 22.0% in occupied guidance office. The average relative humidity was 16.3%.
- CO_2 concentrations ranged from 550 ppm in the gymnasium to 1,295 ppm in classroom 321 with an average of 875 ppm.

Table 19: Summary of IAQ Data

IAQ Metric	Low	High	Avg.	Range of Variance	Recommended
Temperature (°F)	70.1	78.2	73.3	8.1	67 – 70
Relative Humidity (%)	8.5	22.0	16.3	13.5	30 – 65
Carbon Dioxide (ppm)	550	1,295	875	745	<1,000

Temperatures range significantly with a variance of 8.1°F. The highest recorded temperature (78.2°F) was measured in the SRO office which is a small interior office without ventilation located directly above the boiler room with the pipes going through the office. All temperatures exceed the recommended range of setpoints and the average temperature is 73.3°F. Relative humidity also varied widely throughout the building with a 13.5% range of variance between the lowest and highest recordings. All relative humidity levels were measured lower than the recommended range however this is typical for winter conditions in New England. Controlling humidity would require installation of humidification systems in the AHUs and would increase energy consumption. CO_2 concentrations varied widely with twenty-five (25) of the thirty-seven (37) recordings below the EPA recommended threshold suggesting that portions of the building are over-ventilated. Figure 22 below graphically depicts the relationships between temperature, relative humidity and CO_2 concentrations.

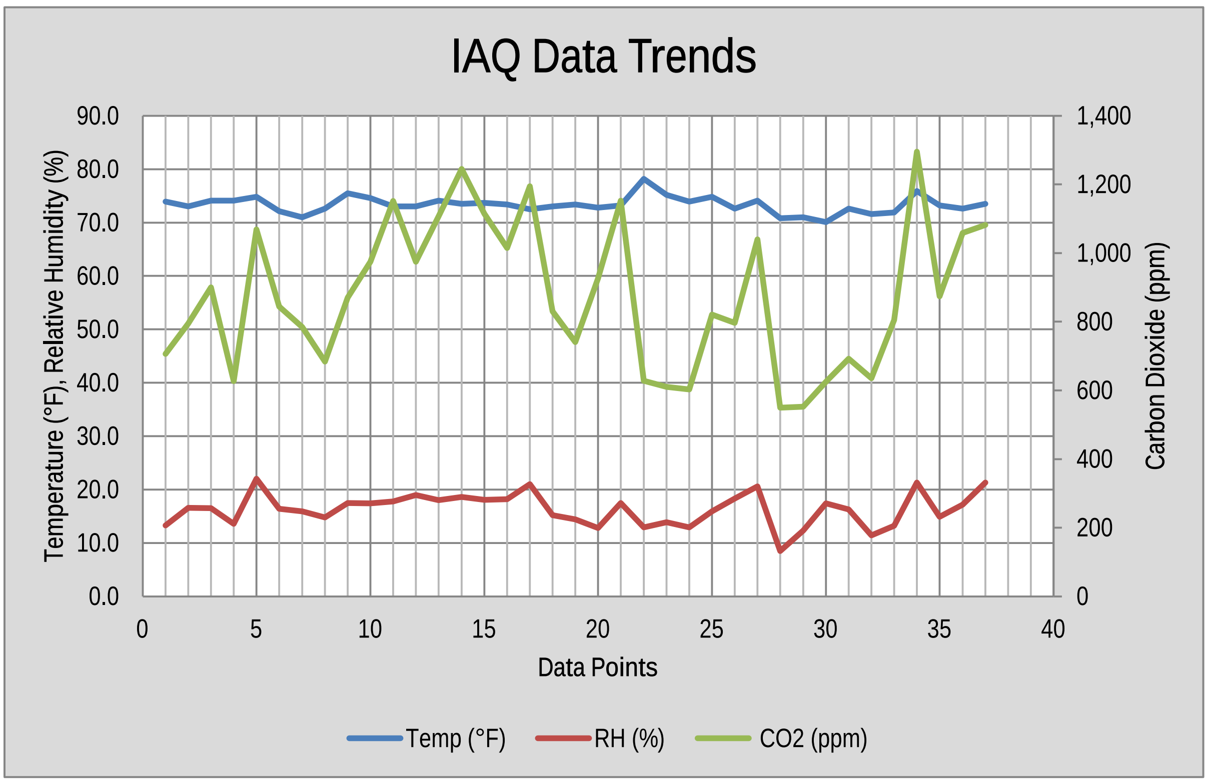


Figure 22: Indoor Air Quality Data Trends

Secondary Observations

Observations noted herein are not directly related to the objective of the energy audit. Investigation of these items is beyond the defined scope of services and these observations are not intended to be inclusive of all building issues and code infractions. They are provided as anecdotal information for the Town's consideration and may warrant further investigation.

Structural Systems

There were no structural system issues noted within the HBHS facility.

Roofing Systems

There were no roofing system issues observed at the HBHS.

Building Code

Minor building code issues include restricted access (storage items) to some electrical panels located in closets throughout the school.

Figure 23: Dual Flush Toilet

Water Supply Systems

Water supply capacity from the three on-site wells is insufficient. Measures to increase capacity include over-boring of existing wells and installing additional wells which are costly measures. Recommendations include reducing domestic water demand by installing low-flow aerators on lavatory sinks and showerheads and installing new water conserving urinals and toilets including waterless urinals and dual-flush toilets (Figure 23). Urinals and toilets account for approximately 85% of domestic water usage in a typical K-12 facility. Alternative supply systems include rainwater harvesting and storage for gray-water plumbing (toilets and urinals).

Life Safety Code

Lighting densities in the auditorium are below the recommended levels for emergency egress of an assembly use area. Increasing illumination in the auditorium is recommended.

ADA Accessibility

The HBHS facility substantially complies with current ADA standards.

Hazardous Building Materials

Based on the year of original construction (1996) and renovations (1998 and 2001) it is presumed that there are no hazardous building materials.

E. BUILDING ENERGY MODELING

Source Data

Required source data input for the eQUEST© model includes geographical location, building use type(s), occupancy schedules, building dimensions, envelope systems, fenestration systems, lighting systems, and all mechanical systems (heating, cooling, ventilation domestic hot water). The building characteristics and systems data was obtained during the building site review. Energy usage was provided by the Town for grid electricity and heating oil.

Model Calibration

The quality of the output data is a function of the accuracy of the input data. While eQUEST© is a sophisticated computer simulation program, like any program there are limitations resulting from unusual building characteristics and operating variables that cannot be discretely defined in the program. To ensure that the model simulates the building operation with high accuracy, an iterative model calibration process is completed where actual building energy usage data is checked against the model output values. This process is repeated until the deviation between the energy usage derived from the baseline building simulation and the actual energy consumption is within an acceptable range.

Summary of Model Results

The HBHS facility was modeled using eQUEST© computer simulation program. Developing an accurate baseline model of the building presented certain challenges including accounting for the high electrical usage and the high heating fuel usage. Once the baseline calibration was completed, several major Energy Efficiency Measures (EEMs) were simulated within the model including:

- Replacing the three heating boilers with higher efficiency units.
- Replacing the three heating boilers with heat pumps.
- Replace the exterior lighting with LED lights.
- Replacing the DHW boiler with a higher efficiency unit.

The resulting energy savings and costs for these measures are presented in Section G (Recommendations) and the model output is provided in Appendix I. Tables 20 and 21 present a summary of the model predicted annual energy usage by category for electrical and heating fuel. The actual electrical consumption of 849,800 kWh/yr is slightly higher than the model prediction of 845,210 kWh/yr.

Table 20: Model Predicted Baseline Electrical Usage

Electric Category	Annual Usage (kWh x 1,000)
Space Cooling	40.74
Refrigeration	16.69
Vent. Fans	390.68
Pumps & Aux.	35.03
Exterior Lighting	23.15
Plug Loads	112.31
Area Lights	226.61
Total Predicted:	**845.2**
Total Actual:	**849.8**

Actual heating fuel consumption (3,265 MBtu) is slightly lower than the model predicted value (3,639 MBtu) based on available data through January 2012. This variation is within the expected range of deviation.

Table 21: Model Predicted Heating Fuel Usage

Electric Category	Annual Usage (MBtu)
Space Heating	3,456.0
Hot Water	135.2
Total Predicted:	3,591
Total Actual:	3,639

The energy modeling results are depicted graphically by a monthly bar graph (Figure 24) which breaks down the energy consumption for electricity and gas consumption separately by category. For example, "Misc. Equipment" is relatively consistent throughout the year while "Space Cooling" and "Area Lighting" consumes a variable amount of electricity depending on the time of year.

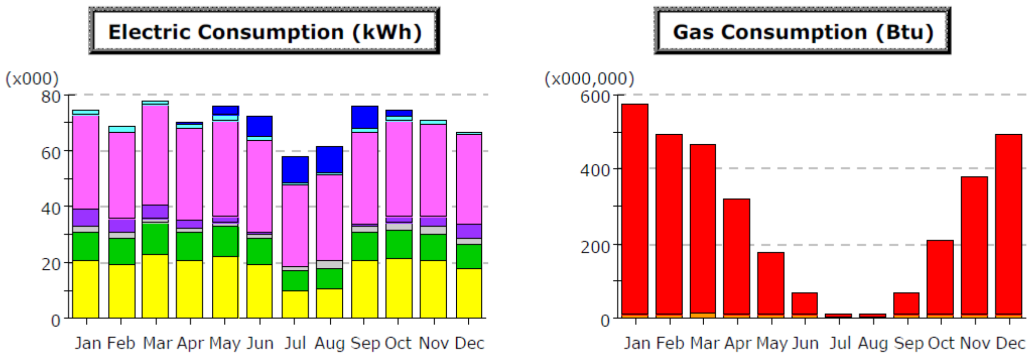


Figure 24: Predicted Monthly Energy Use by Category (Baseline)

Annual energy consumption by category is also graphed using eQUEST® (Figure 25). This information is depicted in a pie graph and helps determine the largest overall use categories. For HBHS the "Ventilation Fans" category (46%) is determined to use the most electrical energy while "Space Heating" consumes the most all of the oil (96%). A final comparison between the baseline and modeled energy efficiency measures is also provided in the appendices in bar graph format to illustrate changes in energy use with each measure. This provides an indication of where the EEM savings occur and any possible increased energy use from the new measure. That information is then used to formulate whether the EEM is economically sound for the particular application.

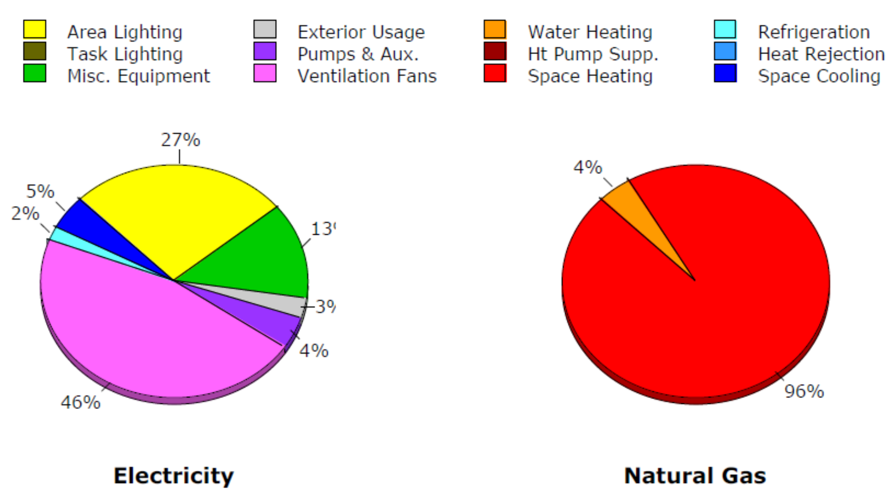


Figure 25: Predicted Annual Energy Use by Category (Baseline)

F. FACILITY BENCHMARKING

ENERGY STAR for Commercial Buildings

The HBHS was benchmarked using the EPA's ENERGY STAR® Portfolio Manager for Commercial Buildings. This benchmarking program accounts for building characteristics, regional climatic data, and user function. It then ranks a building within its defined category amongst all other buildings entered in the program to date. The defining metric is the building Energy Use Intensity (EUI). If a building scores at or above the 75th percentile within its category then it becomes eligible for ENERGY STAR® certification pending an on-site validation review by a licensed Professional Engineer. Currently the program does not have categories for every commercial building type but they can still be entered into the program and checked against similar buildings to determine where the building ranks compared to the current national average. The average energy intensity for every building type category is constantly changing and theoretically is it reducing as more efficient buildings are constructed and existing buildings implement energy efficiency measures. Therefore, buildings that currently meet the eligibility requirements may not be eligible next year when they apply for annual re-certification.

The Hollis-Brookline High School is defined as a "K-12 School" use building and cannot be certified in the Commercial Building ENERGY STAR® program do to its use category. Utility data for electric and heating fuel for the preceding twelve (12) months was input into the benchmarking program. Table 22 presents the annual energy use (through January 2012) and Table 23 presents a summary of the Statement of Energy Performance (SEP) benchmarking results. The SEP is presented in Appendix G.

Table 22: Annual Energy Consumption

Energy	Site Usage (kBtu)
Electric – Grid	2,899,518
Oil	3,639,433
Total Energy:	6,538,951

Table 23: SEP Benchmarking Summary

Facility	Site EUI (kBtu/ft²/yr)	Source EUI (kBtu/ft²/yr)
Hollis-Brookline High School	43	87
National Median (K-12 School)	63	129
	% Difference:	-32%
	Portfolio Manager Score:	85

Compared to the office buildings that have entered data into Portfolio Manager to date, the HBHS facility energy use is considerably lower than the national average. The source EUI for the HBHS building is 87 kBtu/ft²/yr while the national average is 129 kBtu/ft²/yr, meaning it uses 32% less energy than the average K-12 facility.

Regional Benchmarking

Regional benchmarking provides a valuable comparison of local facilities that are similar in use, function, and size. Two data groups were used to complete independent benchmark comparisons for:

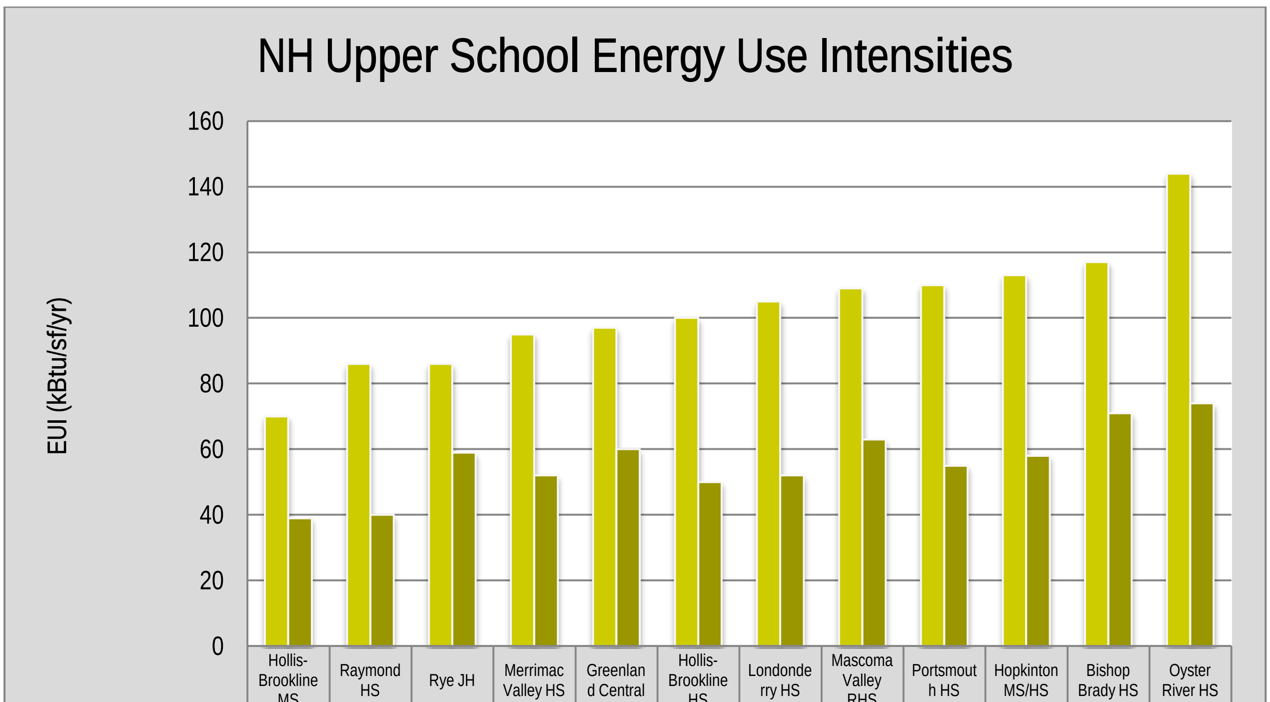
1. Regional School Full Time Enrollment Densities.
2. ENERGY STAR® Energy Use Intensities (source and site).

As an initial comparison, the densities of school area per student (SF/FTE) of eleven (11) schools were compared to the HBHS. The selected schools provide a fair representation of regional junior and senior high school facilities located in the southern New Hampshire region. The selected schools and characteristics are presented in Table 24.

Table 24: Regional School FTE Densities

School	Location	Area (SF)	FTE	Density (SF/FTE)
Bishop Brady High School	Concord, NH	76,332	369	207
Greenland Central School	Greenland, NH	91,226	354	258
Hollis-Brookline High School	Hollis, NH	153,429	904	170
Hollis-Brookline Middle School	Hollis, NH	96,025	437	220
Hopkinton Middle/High School	Hopkinton, NH	74,589	329	227
Londonderry High School	Londonderry, NH	235,520	1,796	131
Mascoma Valley High School	Canaan, NH	57,740	439	132
Merrimack Valley High School	Penacook, NH	141,000	887	159
Oyster River High School	Durham, NH	198,000	675	293
Portsmouth High School	Portsmouth, NH	353,659	1,091	324
Raymond High School	Raymond, NH	106,000	444	239
Rye Junior High School	Rye, NH	67,891	216	314
			Average:	223

Figure 26 presents the source and site Energy Use Intensities (EUIs) for the twelve schools. EUIs are measured in units of energy per area or kBtu per square foot (kBtu/SF). Source EUIs consider all of the energy required to develop the energy and distribute the energy to the site location including inefficiency losses such as electrical distribution grids. Site energy is the energy consumed at the point of service or meter. At 100 kBtu/SF/yr, the HBHS source EUI is just below the average of 103 kBtu/SF/yr for the twelve schools. The site EUI is also just below the average of 56 kBtu/SF/yr of the schools compared and is measured at 50 kBtu/SF/yr.



	Hollis-Brookline MS	Raymond HS	Rye JH	Merrimac Valley HS	Greenlan d Central	Hollis-Brookline HS	Londonde rry HS	Mascoma Valley RHS	Portsmout h HS	Hopkinton MS/HS	Bishop Brady HS	Oyster River HS
Source EUI (kBtu/sf/yr)	70	86	86	95	97	100	105	109	110	113	117	144
Site EUI (kBtu/sf/yr)	39	40	59	52	60	50	52	63	55	58	71	74

Figure 26: NH Upper School Energy Use Intensities

G. RECOMMENDATIONS

Energy Conservation Measures

Based on the observations and measurements of the HBHS, several energy conservation measures (EEMs) are proposed for consideration (Tables 25 to 27). These recommendations are grouped into three tiers based on the cost and effort required to implement the EEM. EEMs are ranked within each tier based on the capital cost for implementation versus the net estimated energy cost savings.

Tier I EEMs are measures that can be quickly implemented with little effort for no or little cost. They include routine maintenance items that can often be completed by facility maintenance personnel and changes in occupant behavior or building operation. Tier II items generally require contracted tradesmen to complete but can generally be implemented at low cost and within operating building maintenance budgets. EEMs that require large capital expenditure and budgetary planning (one year or greater) are categorized as Tier III measures.

Simple payback is calculated for the proposed EEMs. The cost to implement the measure is estimated based on current industry labor and equipment costs and the annual cost savings represents the reduced costs for energy savings. The net energy and cost savings for smaller EEMs is based on the estimated reduction of the associated energy consumption as defined in the model and equipment inventory. Using these costs, the payback period is then calculated as the number of years at which the capital cost of implementation equals the accumulated energy cost savings. Other qualitative considerations that do not influence the Simple Payback Method calculation but should be considered by the owner during the decision-making process include:

- Occupant comfort.
- Relative operation and maintenance requirements.
- Remaining useful life of equipment and systems to be replaced.

Energy cost savings are based current cost of electricity at $0.14 per kWh (PSNH) and the current price of oil of $4.05 per gallon. (NHOEP March 12, 2012)

Tier I Energy Efficiency Measures

Tier I EEMs are measures that can be quickly implemented with little effort for zero or little cost (Table 25). They include routine maintenance items that can often be completed by facility maintenance personnel, and changes to occupant behavior or building operation. Seven (7) Tier I EEMs are recommended.

Table 25: Tier I Energy Efficiency Measures

EEM No.	EEM Description	Capital Cost	Annual Cost Savings	Payback (yrs.)	SIR
T1-1	Power down all electronics when not in use. Consolidate laser jet printers (13) and copiers (6).	$0	$1,300	0	-
T1-2	Disconnect water fountain condensers in the building (8).	$0	$800	0	-
T1-3	Instruct occupants and afterschool programs to not prop open entry doors during the heating season.	$0	$500	0	-
T1-4	Remove all compact refrigerator units (31) and replace five (5) full-size ENERGY STAR® rated models.	$2,500	$3,080	0.8	14.8
T1-5	Install smart-strip time programmable controllers on photocopiers (6).	$360	$495	0.7	13.8
T1-6	Install low-flow aerators on lavatory faucets and shower heads.	$700	$600	1.2	6.0
T1-7	Install food temperature sensing controllers (eCube®) in walk-in refrigerators/freezers (3).	$1,500	$600	2.5	4.0

Recommended Tier I EEMs include reducing the plug load by powering down electronics while not in use, consolidating the energy intensive laser jet printers and copiers, disconnecting water fountain condensers, and removing all 31 compact refrigerators and replacing them with five full sized ENERGY STAR® rated models. Compact refrigerators can cost over $100 a year to run each. Doors were noticed to be propped open by occupants and afterschool programs during the heating season which allows heat to escape. It is recommended that occupants are instructed not to leave unattended doors propped open.

Tier II Energy Efficiency Measures

Tier II items generally require contracted tradesmen to complete but can be implemented at low cost and within operating building maintenance budgets. Five (5) recommended Tier II EEMs are presented in Table 26.

Table 26: Tier II Energy Efficiency Measures

EEM No.	EEM Description	Capital Cost	Annual Cost Savings	Payback (yrs.)	SIR
T2-1	Insulate hollow metal door frames with open-cell (low expansion) polyurethane foam.	$2,600	$650	4.0	6.3
T2-2	Reduce lighting densities in corridors with lower wattage lamps and controls.	$3,000	$1,100	2.7	5.5
T2-3	Replace 20-gallon DHW tank serving the mini gymnasium with an electric tankless demand unit.	$2,700	$450	6.0	2.5
T2-4	Complete air-sealing on all entry door jambs, partings, headers, thresholds, and moldings (interior and exterior).	$5,000	$1,400	3.6	2.0
T2-5	Install four (6) de-stratification fans in the mini-gym and six (6) in the gymnasium.	$5,400	$960	5.6	1.7

The hollow metal entry doors provide substantial thermal transfer and heat loss. Injecting low-expansion foam insulation into the frames will reduce thermal losses. Lighting densities in the corridors were found to be consistently very high. Corridors are lit for the longest period of any space and are occupied only between class periods. It is recommended densities be reduced throughout the corridors. This can be accomplished by replacing bulbs with lower wattage bulbs and removing bulbs or fixtures. Controls can be used to reduce lighting frequency including time-scheduled controllers and occupancy sensors.

Replacing the electric DHW tank unit with an electric tankless demand unit will reduce energy consumption and provide adequate capacity. Typical of K-12 facilities, a considerable amount of energy is lost through gaps in door and window seals. It is recommended a complete air-sealing be conducted on all entry door jambs, partings, headers, thresholds and moldings.

Tier III Energy Efficiency Measures

EEMs that require large capital expenditure and budgetary planning (one year or greater) are categorized as Tier III measures. Nine (9) Tier III EEMs are provided in Table 27 for the HBHS facility.

The oil-fired hot water boilers are relatively old and inefficient compared to modern units with higher combustion and thermal efficiencies and modulating capability. Replacement options include installing two (2) high-efficiency oil-fired units and maintaining the third boiler as a backup unit. A renewable energy option includes installing a ground-source heat pump system consisting of geothermal wells and closed loop. This GSHP system would be integrated with the existing oil-fired boilers and would provide 90% of the heat load with the boilers providing approximately 10% heating during peak demand periods.

Table 27: Tier III Energy Efficiency Measures

EEM No.	EEM Description	Capital Cost	Annual Cost Savings	Payback (yrs.)	SIR
T3-1	Replace larger electrical transformers with high efficiency units (4).	$47,771	$12,240	3.9	6.4
T3-2	Install pressure actuated dampers on all exhaust fans.	$12,264	$2,560	4.8	6.3
T3-3	Replace walk-in freezer condensers with high efficiency units (3).	$5,584	$1,068	5.2	2.7
T3-4	Replace three (3) existing boilers with two (2) 90% efficient modulating oil-fired units. Retain third unit as backup. Install VFD controllers on pumps.	$278,070	$23,710	11.7	2.1
T3-5	Install DDC demand controllers on all AHUs.	$20,056	$1,560	12.9	1.9
T3-6	Replace the split A/C units on rooftop (3) supplying the AHUs with high-efficiency units (SEER>18, EER>15).	$20,309	$2,607	7.8	1.9
T3-7	Install a hybrid heating system consisting of a ground-source heat pump system (geothermal) augmented by the existing oil-fired boilers during peak heating demand (10% of heating frequency).	$512,325	$36,780	13.9	1.8
T3-8	Replace the existing DHW boiler with electric condensing tank unit and connect to PSNH HEATSMART meter.	$26,278	$2,314	11.4	1.6
T3-9	Install vestibule storefront entry in gymnasium/auditorium lobby.	$22,126	$1,110	19.9	1.5
T3-10	Install energy recovery units and VFD motor controllers on existing AHUs (11).	$154,954	$9,812	15.8	1.1
T3-11	Replace exterior light fixtures (wallpacks and OH) with LED units (41) (PSNH SmartSTART Program).	$42,067	$1,852	22.7	0.9

(1) Tier III EEM investment costs include fees for design & engineering, construction management, and a 15% cost contingency.

Replacing the DHW boiler and tank system with an electric heat pump (condensing) and connecting it to a PSNH HEATSMART meter would provide substantial savings. The DDC system currently installed provides the best way to efficiently run the entire heating, venting and cooling system. It is recommended all AHUs be placed on the DDC system to optimize system operation while maintaining indoor air quality standards.

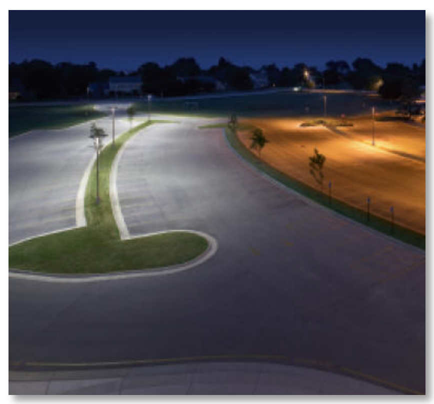


Figure 27: LED vs. MH Lighting
(www.facilitymanagement.com)

Older inefficient transformers can lose up to 15% of the grid energy to heat loss. Replacing them with modern high efficiency units is expected to yield considerable savings. The walk-in freezer units are energy intensive and must be kept running at certain temperatures for food quality control. Replacing the condensers with high efficiency units would maximize the efficiency of the units. The lobby shared by the gymnasium and auditorium does not have a secondary entrance with a vestibule providing an internal air-break. Installing a new storefront assembly would limit energy lost through the frequently used entry doors. Dampers on exhaust fans are necessary to limit the amount of air transfer. A broken damper allows conditioned air to be exhausted 100% of the time which is a loss of energy.

The rooftop AHUs provide air exchange for the building. They operate on intensive schedules and account for a substantial amount of electricity and exhaust conditioned air from the building and replace it with outdoor air. Retrofitting the units with ERUs and VFD motor controllers will provide substantial energy and cost savings. Whole replacement of the units should also be considered based on the age and condition of the existing units. There are forty-one (41) exterior lights which operate a significant number of hours annually. Replacing these with LED units would reduce energy consumption and provide improved lighting quality (Figure 27).

The energy cost savings and resulting payback are based upon each independent measure implemented for the building in its current condition, function, and use. There are interdependencies among measures that will affect the net realized energy savings. For example, replacing lighting fixtures with lower energy units reduces heat load to the building thereby requiring more heating fuel to compensate for the loss in heat generated from the inefficient light fixtures. Also, many of the larger capital Tier III EEM projects may include some of the smaller dependent Tier I and II EEMs.

Capital costs are provided for budgetary planning only. They are estimated based on current industry pricing for materials and labor. A detailed cost estimate should be developed prior to appropriating capital funds for the more costly measures.

EEMs Considered but not Recommended

The following measures were identified as part of the building evaluation but are not recommended as best-value EEMs. Considerations include the cost feasibility and payback term and occupant comfort concerns.

1. A lighting retrofit project was recently completed (2011) and replacing the modern fixtures with higher efficiency units is not cost practical at this time. Other lighting measures as recommended herein should be considered prior to replacing fixtures.
2. Several insulation gaps were noted during the IR survey of walls. Spot injection insulation would improve the thermal integrity of the walls however the cost payback is substantial.
3. Adding rigid insulation to the roof would substantially reduce thermal transfer through the envelope however removing a functioning roof system to install insulation is not cost practical. Increased insulation (min. R-28) should be installed as part of any roof replacement project.

O&M Considerations

O&M and considerations are provided for existing systems and for proposed EEMs. They are intended to provide best-value practices for the building manager and to identify any O&M requirements for the proposed EEMs.

1. New warranted heating boilers will reduce maintenance and repair costs and replacement parts are more readily available.
2. Reducing the operating frequency of all mechanical equipment (notably ventilation equipment) will extend the service life and reduce maintenance and repair costs.
3. A new warranted domestic hot water heating unit will reduce maintenance and repair costs and replacement parts are more readily available.
4. Fixing or replacing the damaged insulation on the Auditorium AHU ducting will extend the service life and reduce maintenance and repair costs.

Indoor Air Quality Measures

Based upon the measured indoor air quality in the Hollis-Brookline High School, 25 of 37 areas were below the EPA CO_2 recommended threshold of 1,000 ppm. CO_2 concentrations ranged between 550 and 1295, with a building average of 875 ppm. With mostly low measurements the building may be over-ventilated. Measures to reduce ventilation frequency are provided herein.

Renewable Energy Considerations

While renewable energy systems generally require a higher capital investment, they provide a significant reduction in the consumption of non-renewable fossil fuel energies. Other obvious benefits include a reduction in ozone depleting gas emissions (as measured by CO_2 equivalency), otherwise referred to as the "carbon footprint". Renewable energy systems also reduce the reliance upon fossil fuels derived from foreign nations and mitigate pricing fluctuations in a volatile and unpredictable market.

Evaluating the practicality of a renewable energy system for a specific facility should consider several facility specific variables including:

- Geographical location.
- Building orientation.
- Adjacent and abutting land features.
- Site footprint and open space.
- Building systems configuration and condition.
- Local zoning or permitting restrictions.
- Currently available financial resources (grants, utility provider rebates, tax incentives).

Table 28 provides a summary description of the more common and proven renewable energy technologies. The Table also provides a preliminary feasibility assessment for implementing each technology at the HBHS facility. Additionally, each renewable energy technology is scored and graded based on technology and facility specific characteristics. Appendix H presents the criteria used to develop the score and grade for each renewable energy technology. A more rigorous engineering evaluation should be completed if the Town is considering implementing any renewable energy system.

Table 28: Renewable Energy Considerations

Renewable Energy System	System Description & Site Feasibility
Geothermal Heating & Cooling	System Description: Geothermal heating systems utilize solar energy residing in the upper crust of the earth. Cooling is provided by transferring heat from the building to the ground. There are a variety of heating/cooling transfer systems but the most common consists of a deep well and piping loop network. All systems include a compressor and pumps which require electrical energy. Geothermal systems are a proven and accepted technology in the New England region. Site constraints and building HVAC characteristics determine the practicality.
Score: 84%	***Site Feasibility:*** *Considering the existing hydronic heating equipment is compatible with a ground-source water heat pump system, it is a practical technology for the building. There appears to be ample land available for the system to be installed and because it is entirely below grade the land can be used for other functions (e.g., athletic fields). The heating demand for the building is relatively high which and unit costs for geothermal systems decreases as the system size increases.*
Roof-Mounted Solar Photovoltaic Systems	System Description: Photovoltaic (PV) systems are composed of solar energy collector panels that are electrically connected to DC/AC inverter(s). The inverter(s) then distributes the AC current to the building electrical distribution system. Surplus energy is sent into the utility grid via net metering and reimbursed by the utility at a discounted rate. The capital investment cost for PV systems is high but the technology is becoming increasingly more efficient thereby lowering initial costs.
Score: 81%	***Site Feasibility:*** *There is an ample amount of roof space which could accommodate a large-sized (30kW-75kW) system. This would require a design and permitting process with the local utility for a grid-tie connection. Current utility incentives and renewable energy grants would help offset the capital cost for the system. A structural evaluation of the roof framing system would be required to ensure that it could accommodate the increased loading. The existing electrical systems may require upgrade especially if the PV system is interconnected to the grid.*
Ground-Mounted Solar Photovoltaic Systems	System Description: A ground-mounted PV system is composed of the same solar collector panels used for a roof-mount system. The collectors are mounted on a frame support system on the ground verses a roof structure. This is advantageous when roof framing cannot accommodate the increased load of the collector panel and the ease of installation and access for maintenance and repair.
Score: 79%	***Site Feasibility:*** *There is an ample amount of grounds open at the HBHS where a medium- (10kW-30kW) to large- (30kW-75kW) sized system could be installed. However, future use of the open space based on increased need (e.g., athletic fields) would be restricted. This would require a design and permitting process with the local utility for a grid-tie connection. Current utility incentives and renewable energy grants would help offset the capital cost for the system.*
Biomass Heating Systems	System Description: Biomass heating systems include wood chip fueled furnaces and wood pellet fueled furnaces. For several reasons, wood chip systems are generally practical only in large scale applications. Wood pellet systems can be practical in any size. Wood chip systems are maintenance intensive based on the market availability and procurement of woodchip feedstock and variability of woodchip characteristics (specie, size, moisture content, bark content, Btu value) which affect the operating efficiency of the furnace and heating output. They require a constant feed via a hopper and conveyor system and feed rates must vary according to feedstock Btu value and heating demand. For these reasons they typically require full-time maintenance and are practical only in large scale applications. Wood pellet systems are much less maintenance intensive and feedstock availability and consistency is less of an issue. Both systems reduce the dependency on fossil-fuels and feedstock can be harvested locally.
Score: 78%	***Site Feasibility:*** *A conventional pellet boiler unit may not be a practical heating system for the building however a large sized system may. This requires procurement of pellets, storing pellets, periodic filling the pellet hopper during the heating season, and emptying the ash. However, there are new systems with automated feed and ash removal systems that would be a practical application at the HBHS. A wood-chip fired district system may be practical for heating the HBHS and HBMS. A feasibility study is recommended if this is a consideration.*

Wind Turbine Generator	System Description: Wind turbine generators (WTGs) simply convert wind energy into electrical energy via a turbine unit. WTGs may be pole mounted or rooftop mounted however system efficiency improves with increased elevation. Due to cost and site related constraints, WTG technology in New England is only practical for select sites. Constraints include local geographical and manmade features that alter wind direction, turbulence, or velocity. Other technology constraints include local variability of wind patterns and velocity. Additionally, WTGs require permitting (local, state, FAA) and local zoning that may restrict systems due to height limitations, and/or, visual detraction of the local landscape. Presently, WTG technology is not widely used in New England based on the relatively high capital cost compared to the energy savings.
Score: 78%	*Site Feasibility:* *There is adequate site space to install a small (<5kW) to medium-sized (10kW) pole-mounted wind turbine. However, considering the relatively low mean wind speeds in the region, a WTG unit may not be a cost practical consideration.*
Solar Domestic Hot Water	System Description: Solar domestic hot water (DHW) systems include a solar energy collector system which transfers the thermal energy to domestic water thereby heating the water. These are typically used in conjunction with an existing conventional DHW system as a supplemental water heating source. Because of the high capital cost, solar DHW systems are only feasible for facilities that have a relatively high demand for DHW.
Score: 76%	*Site Feasibility:* *Based on the moderate demand for domestic hot water, a solar hot-water system may be a practical consideration for the building. The capital cost could be offset with substantial utility rebates and incentives. The system could provide primary DHW during summer months when demand is low. In colder months, it would provide secondary heating.*
Solar Thermal Systems	System Description: Similar to a roof-mounted solar PV system, solar thermal systems are most commonly installed on rooftops. These systems utilize solar energy for heating of outdoor air. The most common application is for pre-heating of outdoor air used for air exchanges systems in buildings. This reduces the heating fuel required to maintain setpoint temperatures in interior spaces.
Score: 75%	*Site Feasibility:* *The building currently has an ample amount of space for a PV system to be installed and the solar-thermal could utilize the existing air handling units. A more focused evaluation is required to determine if this would be a cost practical solution.*
Combined Heat & Power (CHP)	System Description: Combined heat and power (CHP) systems are reliant on non-renewable energies. Systems are composed of a fossil-fuel powered combustion engine and electrical generator. Electrical current is distributed to the building distribution system to reduce reliance on grid supplied electricity. Byproduct thermal energy derived from the combustion engine is recovered and used to heat the building (this is generally considered to be renewable energy). Another benefit of CHP systems is that they provide electrical energy during power outages in buildings that do not have emergency power backup. Larger CHP units require a substantially large fuel supply and if natural gas is not available then a LPG tank must be sited.
Score: 70%	*Site Feasibility:* *Considering the moderate electric and heating demand for the HBHS, a larger (75kW) CHP may be practical. However there is no natural gas within the Town and costs associated with the infrastructure development for a large propane tank would be high. CHP systems also require intensive maintenance and have a low expected service life.*

H. ENERGY EFFICIENCY INCENTIVE AND FUNDING OPPORTUNITIES

The State of New Hampshire along with the utility companies offer multiple programs designed to improve the energy efficiency of municipal and school buildings through financial incentives and technical support. Some of the currently available programs are presented herein however building managers are encouraged to explore all funding and incentive opportunities as some programs end and new programs are developed. For a current listing of advertised programs and initiatives, visit www.dsireusa.org.

Northeast Energy Efficiency Partnerships

Northeast Collaborative for High Performance Schools (NE-CHPS)

NE-CHPS is a set of building and design standards for all schools from pre-K through community colleges tailored specifically for NH state code requirements, the New England climate, and the environmental priorities of the region. NH Department of Education offers up to a 3% reimbursement for New Construction School projects. To learn more about NE-CHPS and incentive programs please visit: http://neep.org/public-policy/hpse/hpse-nechps .

New Hampshire Public Utilities Commission

New Hampshire Pay for Performance

This program addresses the energy efficiency improvement needs of the commercial and industrial sector. The Program is implemented through a network of qualified Program Partners. Incentives will be paid out on the following three payment schedule: Incentive # 1: Is based on the area of conditioned space in square feet. Incentive #2: Per kWh saved and Per MMBTU saved based on projected savings and paid at construction completion. Incentive #3: Per kWh saved and Per MMBTU saved based on actual energy savings performance one year post construction. Total performance incentives (#2 and #3) will be capped at $300,000 or 50% of project cost on a per project basis. For more information visit http://nhp4p.com.

New Hampshire Public Utilities Commission's Renewable Energy Rebates

The Sustainable Energy Division provides an incentive program for solar electric (photovoltaic or PV) arrays and solar thermal systems for domestic hot water, space and process heat, with a capacity of 100 kW or equivalent thermal output or less. The rebate for PV systems as follows: $1.00 per Watt, capped at 25% of the costs of the system or $50,000, whichever is less. For solar hot water (SHW) systems, the base rebate is $0.07 per rated or modeled kBtu/year, capped at 25% of the cost of the facility or $50,000, whichever is less, as a one-time incentive payment. http://www.puc.state.nh.us/Sustainable%20Energy/RenewableEnergyRebates-CI.html.

New Hampshire Community Development Finance Authority

New Hampshire Community Development Finance Authority Revolving Loan Fund

The Enterprise Energy Fund is a low-interest loan and grant program available to businesses and nonprofit organizations to help finance energy improvements and renewable energy projects in their buildings. The loans will range from $10,000 to $500,000. Larger amounts will be considered on a case by case basis. The program is available to finance improvements to the overall energy efficiency performance of buildings owned by businesses and nonprofits, thereby lowering their overall energy costs and the associated carbon emissions. More information about the program can be found on their website www.nhcdfa.org. These activities may include:

- Improvements to the building's envelope, including air sealing and insulation in the walls, attics and foundations;
- Improvements to HVAC equipment and air exchange;
- Installation of renewable energy systems;
- Improvements to lighting, equipment, and other electrical systems; and
- Conduction of comprehensive, fuel-blind energy audits.

Public Service of New Hampshire (PSNH)

Commercial (Electric) Energy Efficiency Incentive Programs

This program targets any commercial/industrial member building a new facility, undergoing a major renovation, or replacing failed (end-of-life) equipment. The program offers prescriptive and custom rebates for lighting and lighting controls, motors, VFDs, HV AC systems, chillers and custom projects. http://www.psnh.com/SaveEnergyMoney/For-Business/Energy-Saving-Programsand-Incentives.aspx

SmartSTART

The SmartSTART (Savings Through Affordable Retrofit Technologies) advantage is simple – pay nothing out of pocket to have energy efficiency products and services installed in your building. The SmartSTART program is limited to PSNH's municipal customers only and includes schools. The program is available on a first-come, first served basis to projects which have been pre-qualified by PSNH. The cost of the improvements is fronted by PSNH which is then repaid over time by the municipality or school using the savings generated by the products themselves. This program is for lighting and lighting controls, air sealing, insulation and other verifiable energy savings measures which have sufficient kilowatt-hour savings. For more information on this program visit: http://www.psnh.com/SaveEnergyMoney/For-BusinesslMunicipal-Smart-Start-Program.aspx

Schools Program

For major renovation or equipment replacement projects, this program offers prescriptive and custom rebates for energy efficient lighting, motors, HVAC, chillers, and variable frequency drives to towns or cities that install energy efficient equipment at their schools. Financial incentives are available for qualifying energy efficient equipment. Technical assistance is also offered through the Schools Program. http://w.Ytw.psnh.com/SaveEnergy MoneyILarge-Power/Schools-Program.aspx

Clean Air - Cool Planet

Community Energy Efficiency

CA-CP works with communities throughout the Northeast to find solutions to climate change and build constituencies for effective climate policies and actions. Much of their work focuses on successful models for energy efficiency and renewable energy planning. They advise and partner with citizens, educators, faith groups, small businesses, municipal governments, and other local leaders. They explore cost-effective opportunities that exist for communities to reduce their emissions as well as their vulnerability to climate impacts. One such example is CA-CP's partnership with the University of New Hampshire, NH Sustainable Energy Association and UNH Cooperative Extension to create www.myenergypian.net . A groundbreaking suite of web and outreach tools for individual action used by households, schools and community groups around the northeast. http://www.cleanair-coolplanet.orglfor_communities/index.php .

Environmental Protection Agency (EPA)

ENERGY STAR Challenge for Schools

EPA is challenging school administrators and building managers to improve energy efficiency throughout their facilities. More than 500 school districts across the country are helping to fight climate change by committing to reducing their energy use with help from ENERGY STAR. Schools that take the ENERGY STAR Challenge can use energy tracking tools, technical guidance, case studies and other ENERGY STAR tools and resources to help them improve their energy efficiency. More information can be found at:
http://www.energystar.gov/index.cfm?c=challenge.bus_challenge

Cool School Challenge

The Cool School Challenge is a program of the Puget Sound Clean Air Agency, developed in collaboration with Redmond High School environmental science teacher Mike Town, and Puget Sound Energy's Powerful Choices for the Environment program.

Conceptually modeled after the U.S. Mayor's Climate Protection Agreement, the Cool School Challenge aims to motivate students, teachers, and school districts to reduce carbon dioxide and other greenhouse gas emissions schoolwide. At the heart of the Cool School Challenge is the philosophy that big changes start with small steps, and that taken together, simple individual actions create a world of difference.

The goals of the Cool School Challenge are to:

- Educate young people, and by proxy their families, about climate change and everyday actions they can take to reduce their impact locally and globally;
- Reduce carbon dioxide emissions and other greenhouse gas emissions in and around schools;
- Encourage student leadership and empowerment;
- Foster a community of teachers/students working together to reduce their greenhouse gas emissions; and
- Foster a new generation of environmental/air quality advocates.
- Learn more about the Cool School Challenge at: http://www.coolschoolchallenge.org/.

APPENDIX A

Photographs

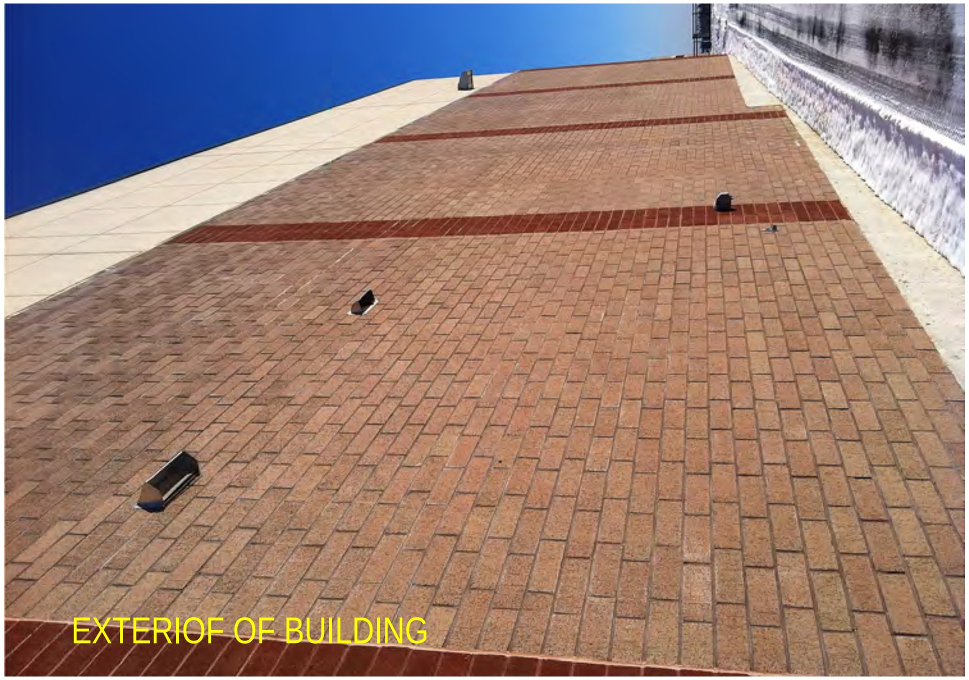

EXTERIOR OF BUILDING


EXTERIOR OF BUILDING


YARD LIGHT


EXTERIOR OF BUILDING


EXTERIOR OF BUILDING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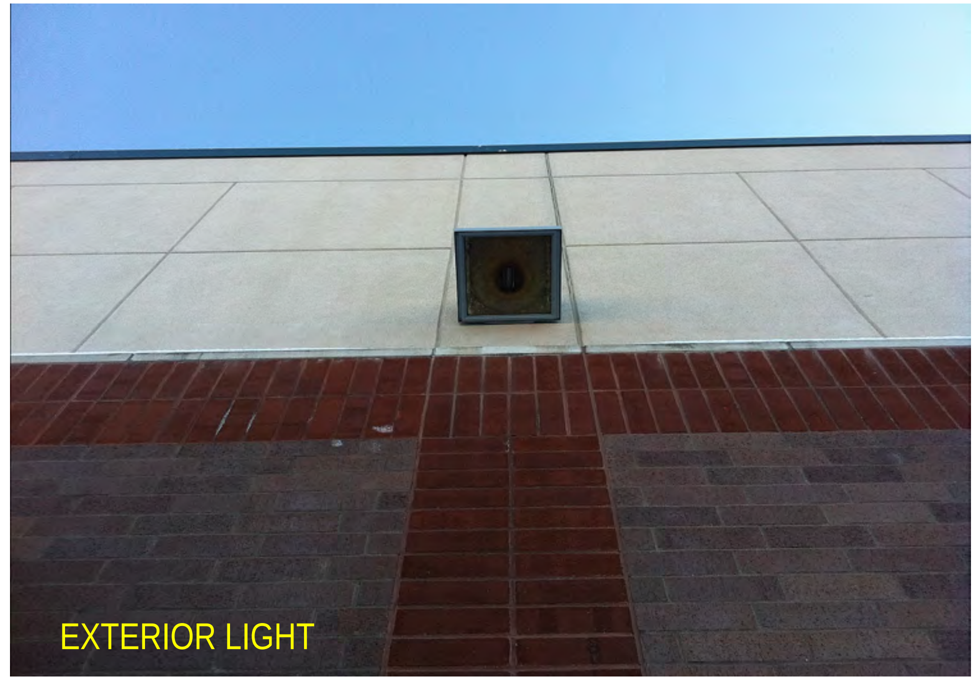
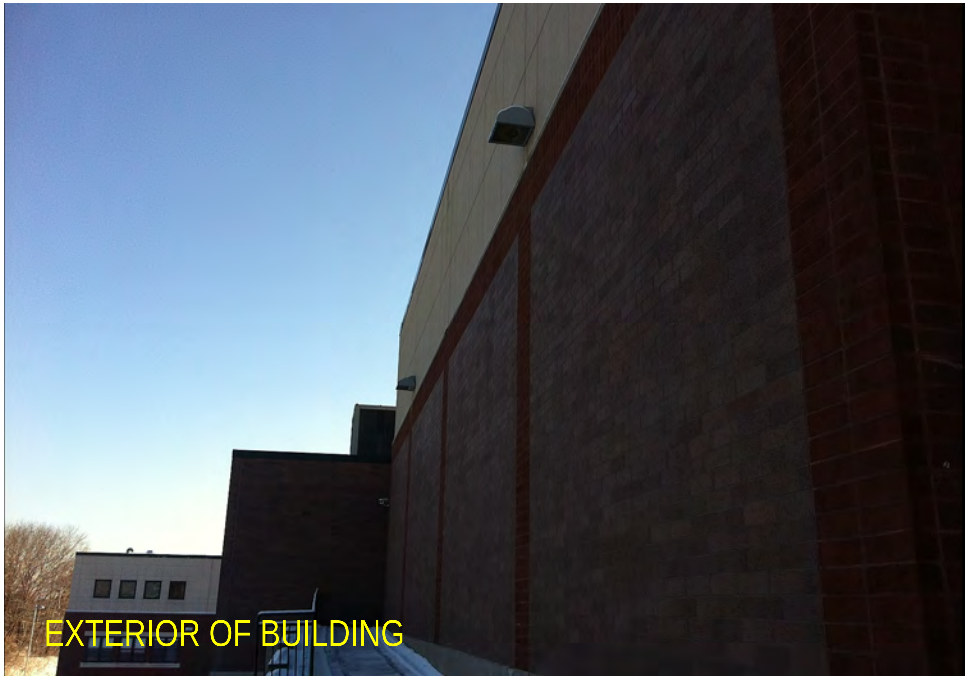


EXTERIOR LIGHT

EXTERIOR OF BUILDING

EXTERIOR OF BULIDING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DETERIORATING CONCRETE ON BULIDING EXTERIOR


EXTERIOR OVERHANG LIGHT


EXTERIOR OF BUILDING


EXTERIOR OF BUILDING


EXTERIOR OF BUILDING

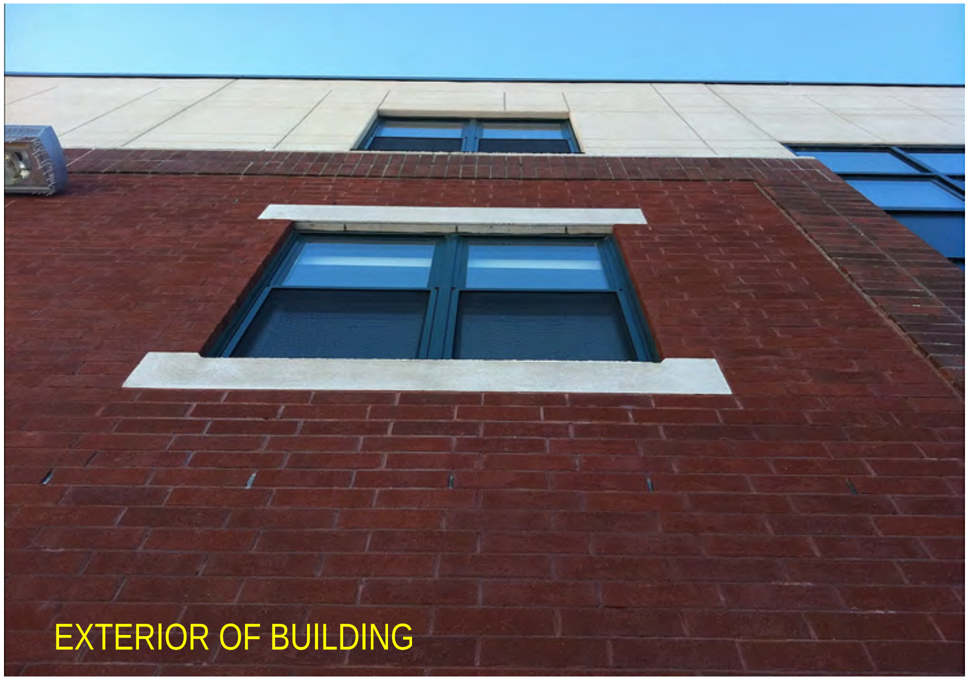

DETERIORATING CONCRETE ON BUILDING EXTERIOR


BUILDING EXTERIOR


EXTERIOR WINDOW


EXTERIOR OF BUILDING


EXTERIOR OF BULIDING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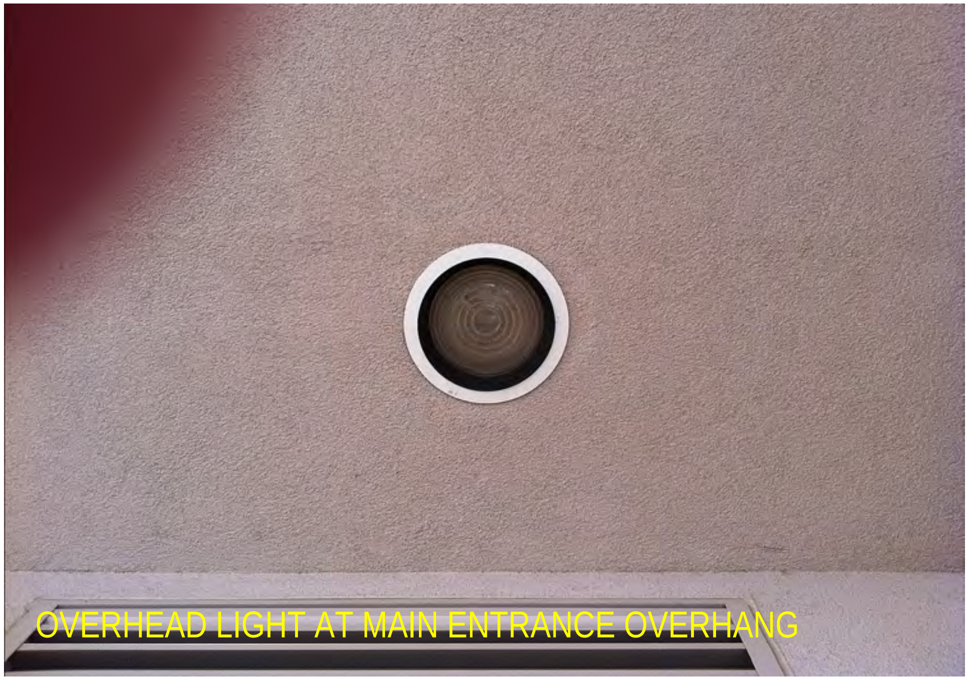


OVERHEAD LIGHT AT MAIN ENTRANCE OVERHANG

LIGHT FIXTURES

WINDOW TAG

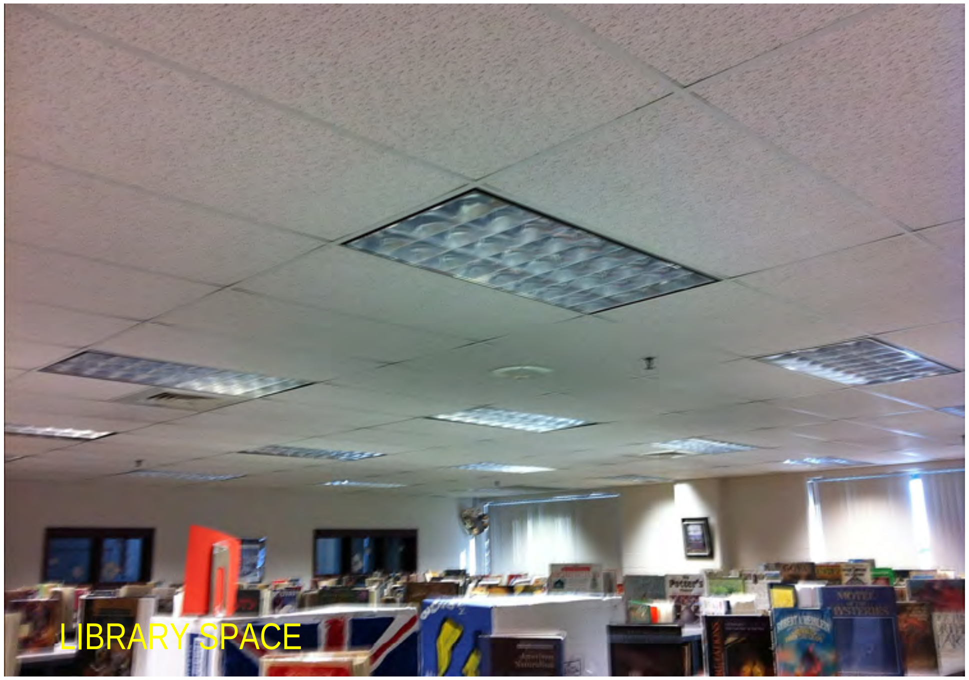
EXTERIOR ENTRANCE OVERHANG


FIRST FLOOR HALLWAY

FIRST FLOOR HALLWAY


OPEN WINDOW


LIGHT DENSITY MEASUREMENT IN FIRST FLOOR HALLWAY


LIBRARY SPACE


CAFETERIA SPACE

LIGHT DENITY MEASUREMENT IN FIRST FLOOR HALLWAY

LIGHT DENSITY MEASUREMENT

GYMNASIUM SPACE

AUDITORIUM SPACE

LIGHT DENSITY MEASUREMENT IN CAFETERIA

LIGHT DENSITY MEASUREMENT IN GYMNASIUM

GYMNASIUM / AUDITORIUM FOYER

LIGHT DENSITY MEASUREMENT IN THIRD FLOOR HALLWAY

LIGHT DENSITY MEASUREMENT IN AUDITORIUM


THIRD FLOOR HALLWAY SPACE

VENDING MACHINE ENERGY STAR TAG

VENDING MACHINE ENERGY STAR MODE LABEL

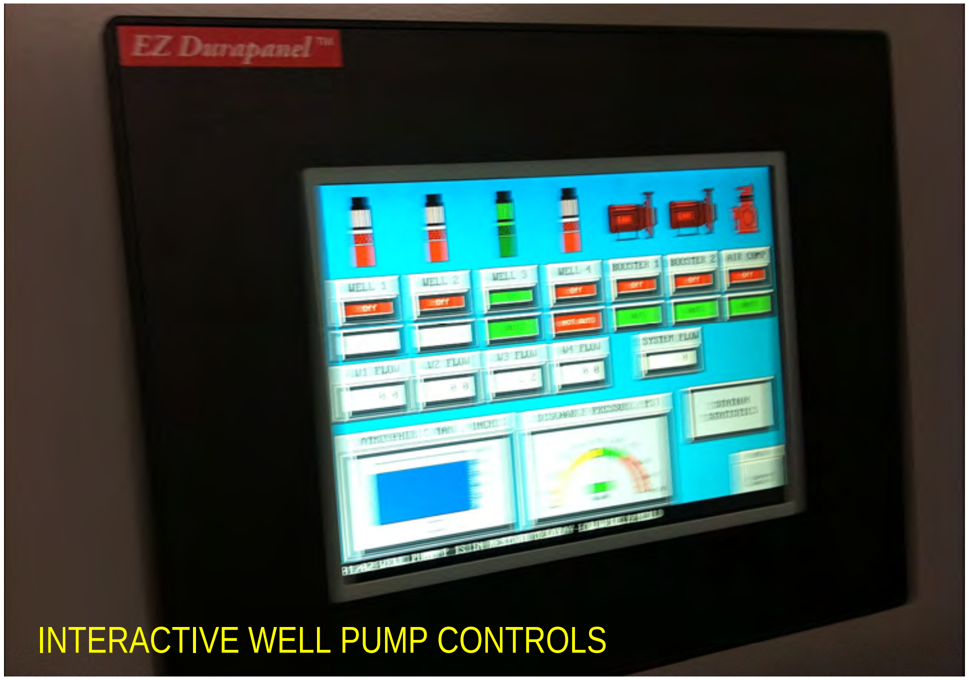

GYMNASIUM / AUDITORIUM FOYER VENDING MACHINE

VENDING MACHINE ENERGY STAR MODE LABEL


MECHANICAL EQUIPMENT DATA COLLECTION


MAGNETIC FLOW METERS IN BOILER ROOM

WELL PUMP COVER

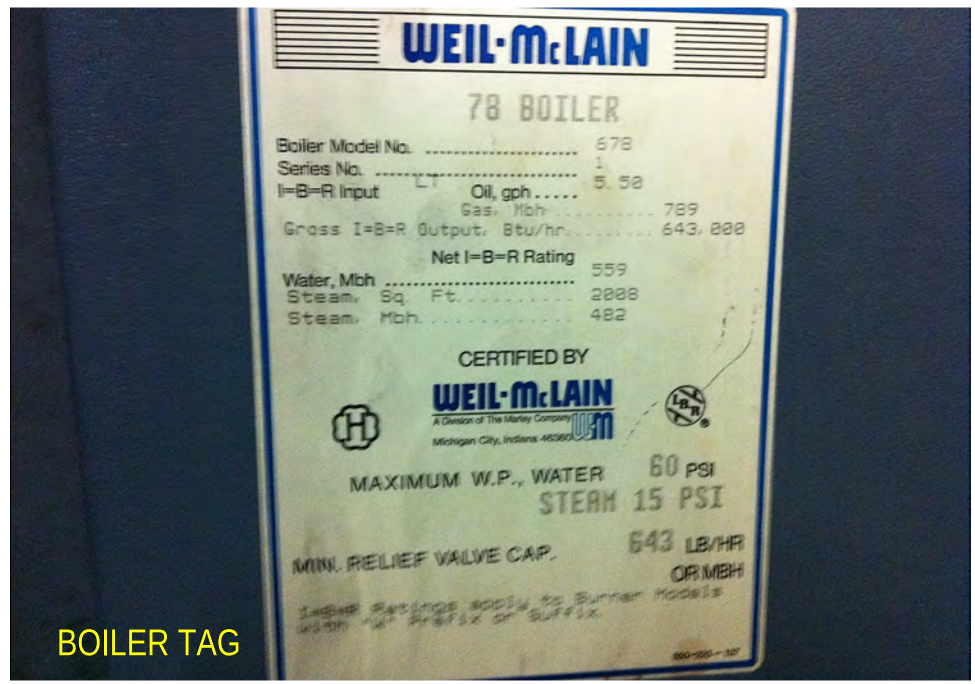


INTERACTIVE WELL PUMP CONTROLS

UNINSULATED PIPES LEADING TO STORAGE TANK

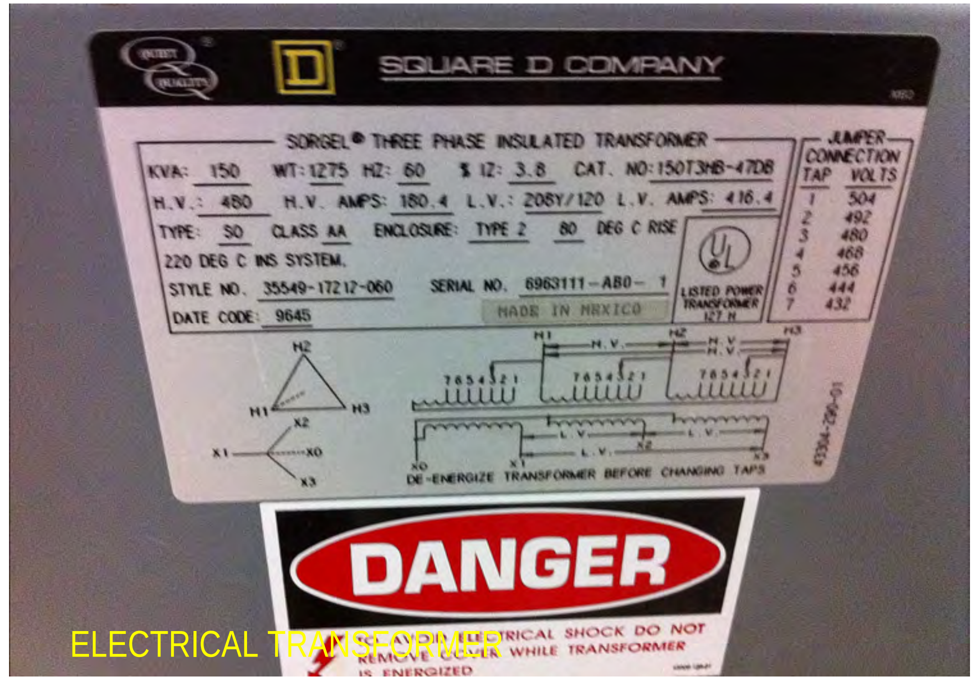
INSULATED STORAGE TANK

WEIL-MCLAIN BOILER IN BOILER ROOM

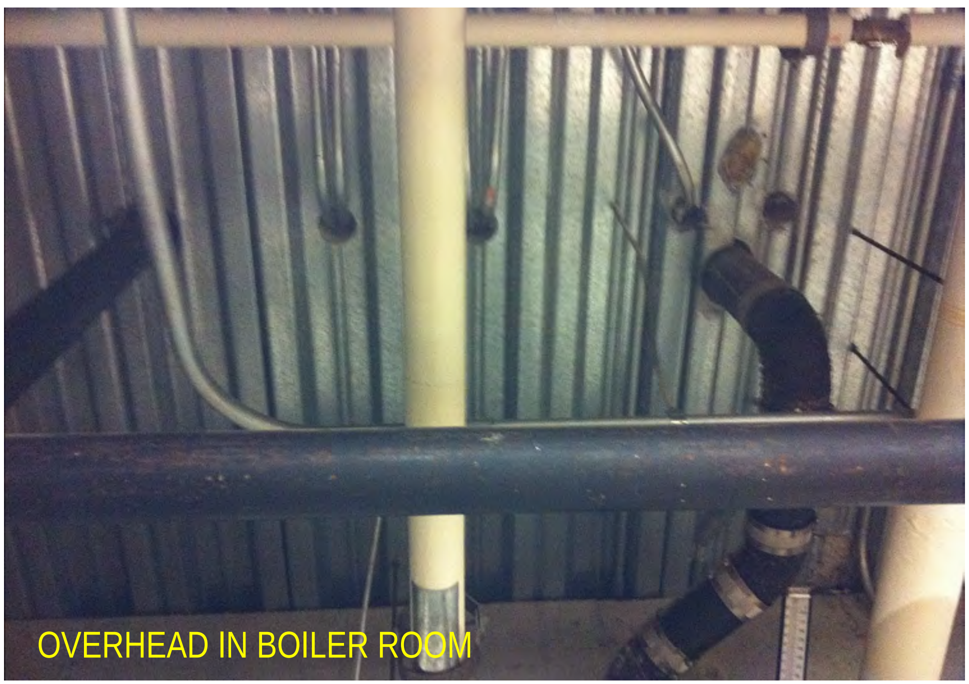


BOILER TAG

INSPECTION RECORDS AND IMPORTANT INFORMATION



ELECTRICAL TRANSFORMER


OVERHEAD IN BOILER ROOM

WELL PUMP PANEL


DAYLIGHT VISIBLE UNDERNEATH EXTERIOR DOOR


PHOTOCOPIER AND PRINTER


PHOTOCOPIER


REFRIGERATOR AND VENDING MACHINE


GYMNASIUM SPACE


BUILDING ROOFTOP AND MECHANICAL EQUIPMENT


COMPACT REFRIGERATOR AND MICROWAVE


INSIDE OF ROOFTOP MECHANICAL EQUIPMENT

BUILDING ROOFTOP AND MECHANICAL EQUIPMENT

BUILDING ROOFTOP AND EXHAUST

BUILDING ROOFTOP AND MECHANICAL EQUIPMENT

BUILDING ROOFTOP AND MECHANICAL EQUIPMENT

BUILDING ROOFTOP AND MECHANICAL EQUIPMENT

BUILDING ROOFTOP AND MECHANICAL EQUIPMENT

BUILDING EXTERIOR, ROOFTOP AND MECHANICAL EQUIPMENT

BUILDING ROOFTOP AND MECHANICAL EQUIPMENT

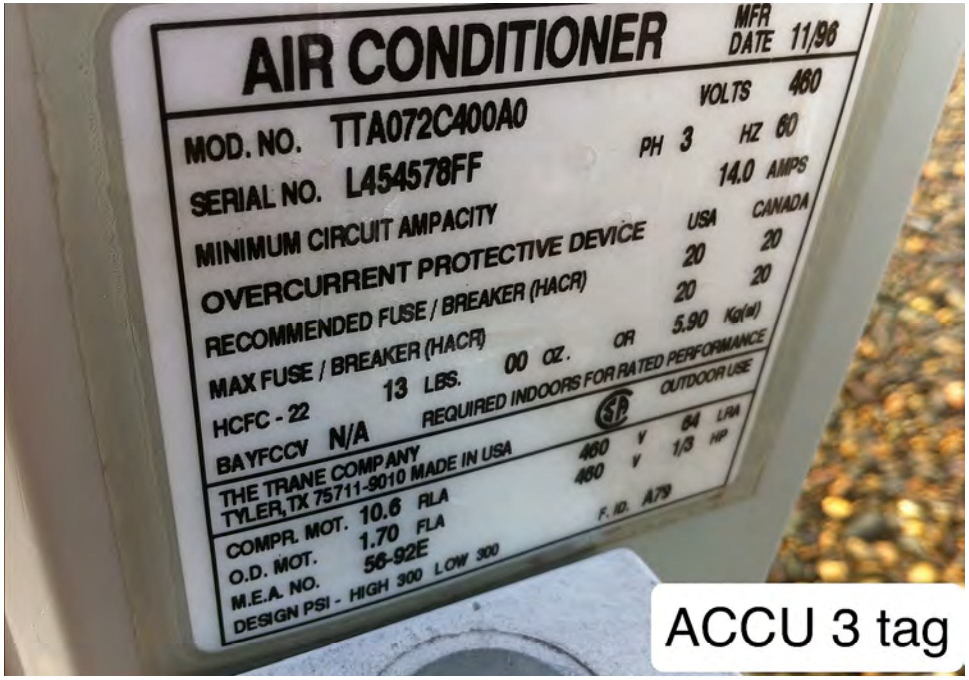

RUSTED AND CRACKED EXHAUST ON ROOFTOP


OLD MECHANICAL BELTS IN MECHANICAL EQUIPMENT


BUILDING ROOFTOP AND EXHAUST


RUSTED AND CRACKED EXHAUST ON ROOFTOP


RTU 1


AIR CONDITIONER
MFR DATE 11/96
MOD. NO. TTA072C400A0
SERIAL NO. L454578FF
VOLTS 460
PH 3 HZ 60
14.0 AMPS
MINIMUM CIRCUIT AMPACITY
USA CANADA
OVERCURRENT PROTECTIVE DEVICE 20 20
RECOMMENDED FUSE / BREAKER (HACR) 20 20
MAX FUSE / BREAKER (HACR)
HCFC - 22 13 LBS. 00 OZ. OR 5.90 Kg(a)
BAYFCCV N/A REQUIRED INDOORS FOR RATED PERFORMANCE
OUTDOOR USE
THE TRANE COMPANY
TYLER,TX 75711-9010 MADE IN USA
COMPR. MOT. 10.6 RLA
O.D. MOT. 1.70 FLA
M.E.A. NO. 56-92E
DESIGN PSI - HIGH 300 LOW 300
ACCU 3 tag


RTU2

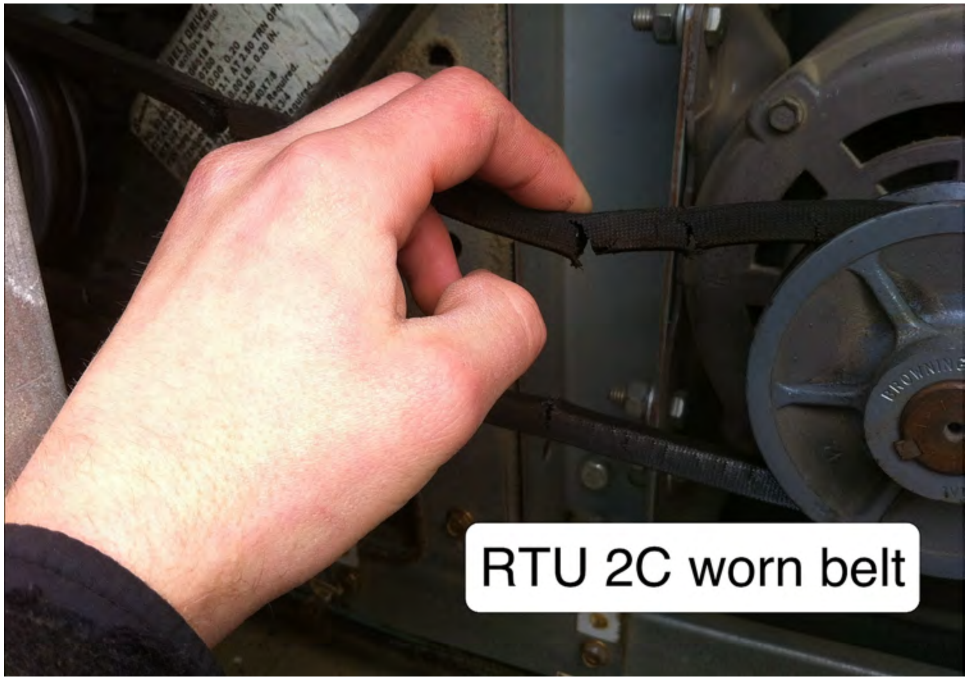

ACCU 3


ACCU-2
AIR CONDITIONER
MFR DATE 09/96
MOD. NO. TTA072C400A0
VOLTS 460
SERIAL NO. L39120DFF
PH 3 HZ 60
MINIMUM CIRCUIT AMPACITY 14.0 AMPS
OVERCURRENT PROTECTIVE DEVICE USA CANADA
RECOMMENDED FUSE / BREAKER (HACR) 20 20
MAX FUSE / BREAKER (HACR) 20 20
HCFC - 22 13 LBS. 00 OZ. OR 5.90 Kg(al)
BAYFCCV N/A REQUIRED INDOORS FOR RATED PERFORMANCE
THE TRANE COMPANY
OUTDOOR USE
ACCU 2

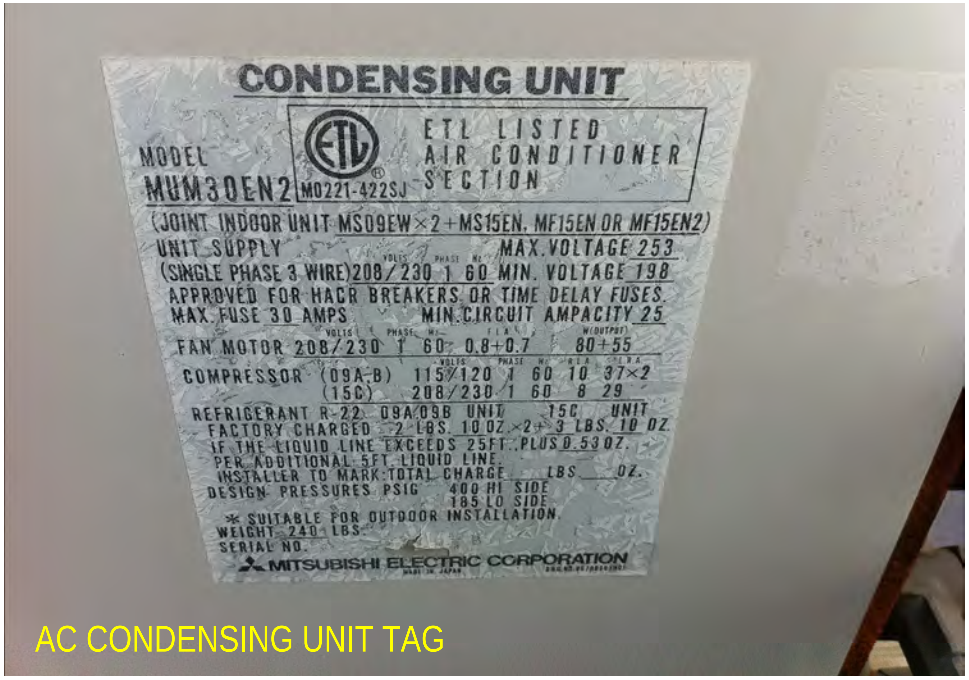

RTU-2C
RTU-2C


EF 7


RTU-1C
RTU-1C



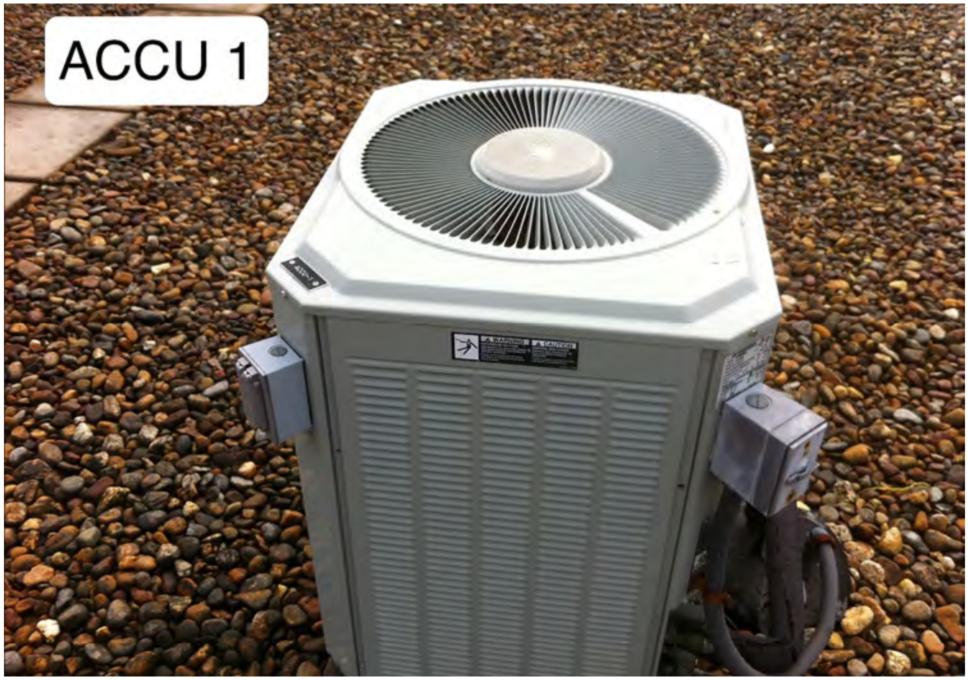
RTU 2C worn belt



AC CONDENSING UNIT TAG

EF-10

AC CONDENSING UNIT AND EXHAUST


ACCU 1

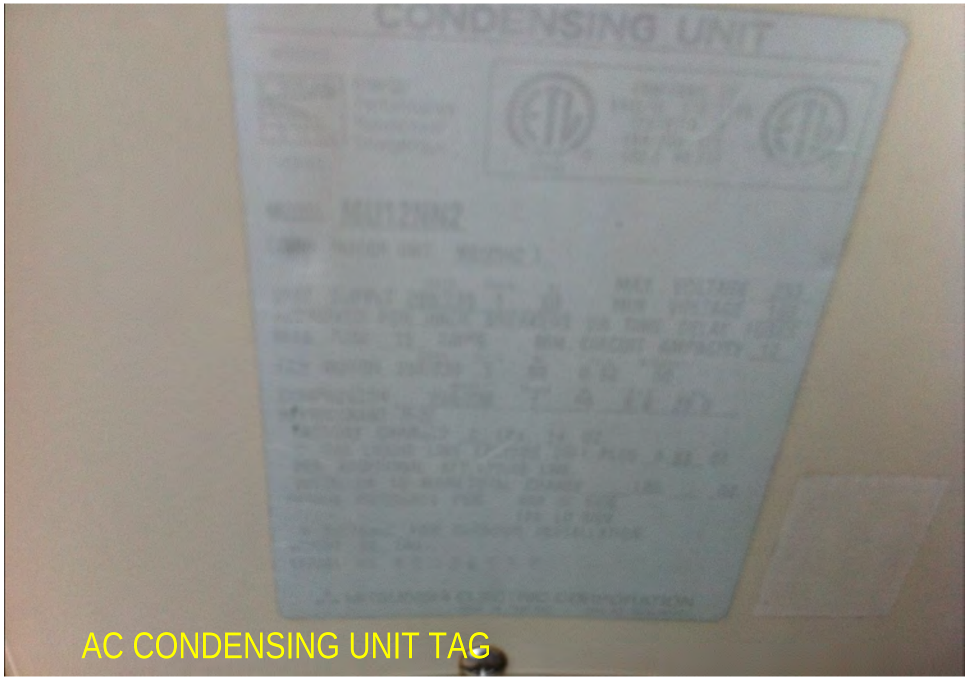

ROOFTOP AIR CONDITIONER CONDENSING UNIT ACCU1


EF-8


ACCU 1 tag
AIR CONDITIONER
MFR DATE 11/96
MOD. NO. TTA048C400A0
VOLTS 460
SERIAL NO. L4714U9BF
PH 3 HZ 60
MINIMUM CIRCUIT AMPACITY 10.0 AMPS
OVERCURRENT PROTECTIVE DEVICE USA CANADA
RECOMMENDED FUSE / BREAKER (HACR) 15 15
MAX FUSE / BREAKER (HACR) 15 15
HCFC - 22 7 LBS. 02 OZ. OR 3.23 Kg(al)
BAYFCCV 083A REQUIRED INDOORS FOR RATED PERFORMANCE
THE TRANE COMPANY
TYLER, TX 75711-9010 MADE IN USA
OUTDOOR USE
COMPR. MOT. 7.0 RLA 460 V 51 LRA
O.D. MOT. .80 FLA 460 V 1/4 HP
M.E.A. NO. 56-92E
DESIGN PSI - HIGH 300 LOW 300
F. ID. A75

ROOFTOP EXHAUST

CRACK IN ROOF DUCT INSULATION

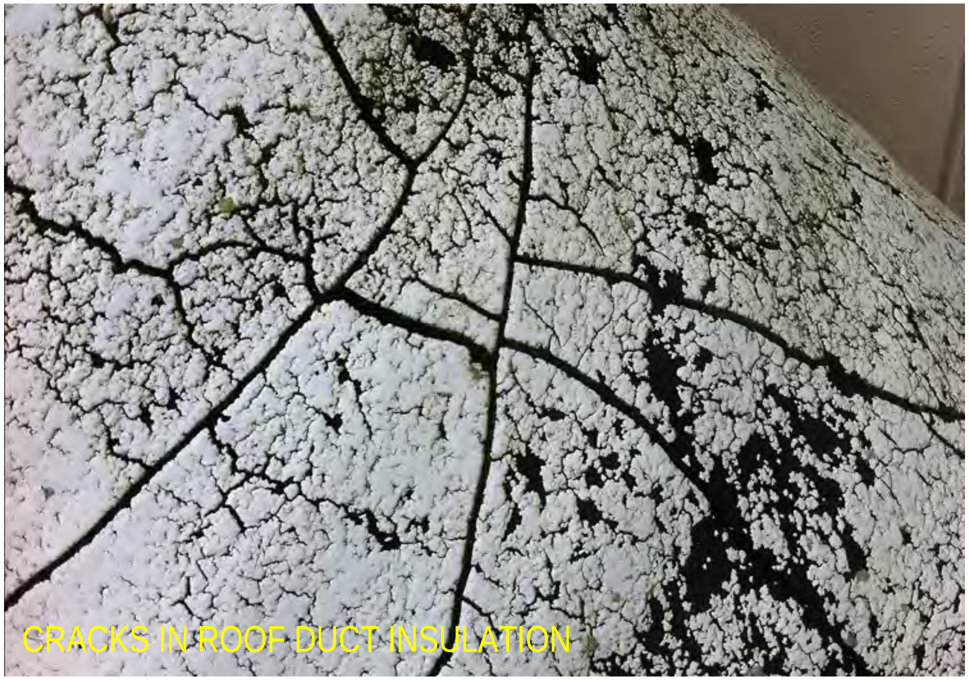


AC CONDENSING UNIT TAG

CRACK IN ROOF DUCT INSULATION


CRACKS IN ROOF DUCT INSULATION

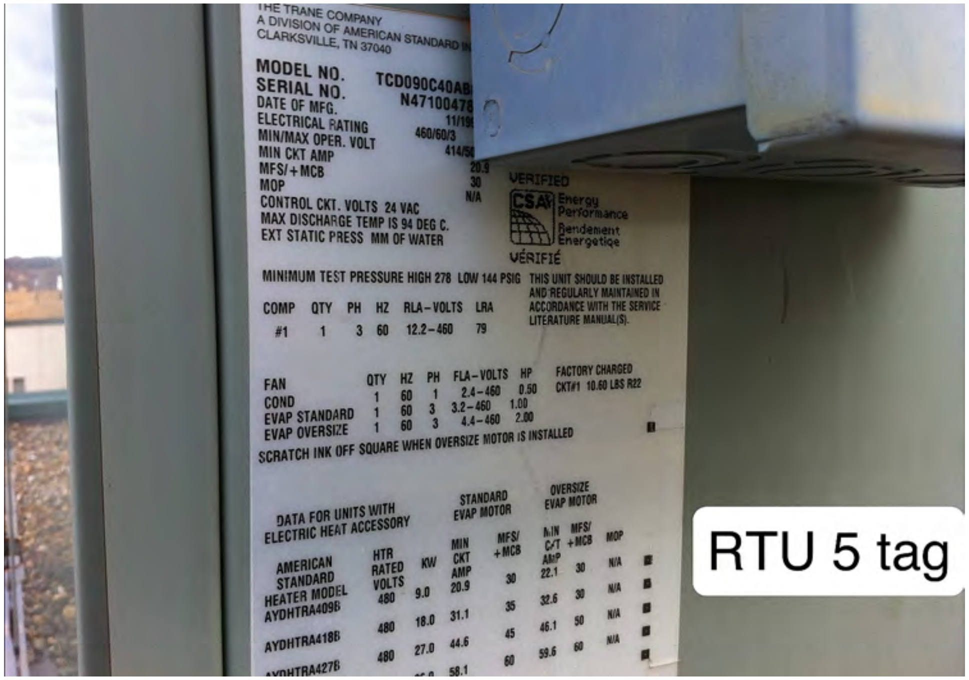
RTU-5

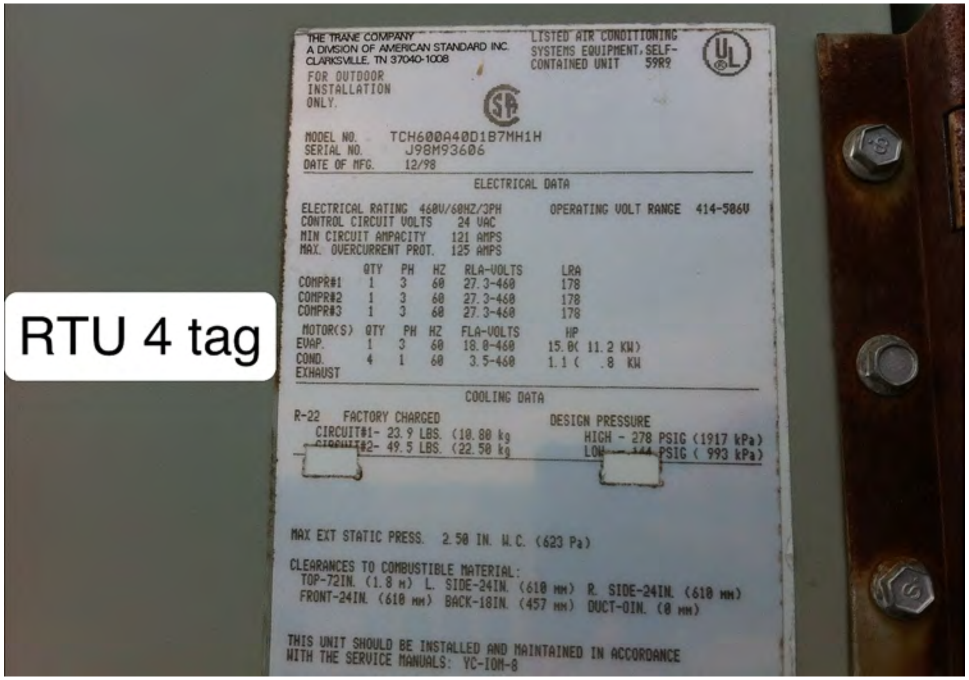

CRACKS IN ROOF DUCT INSULATION

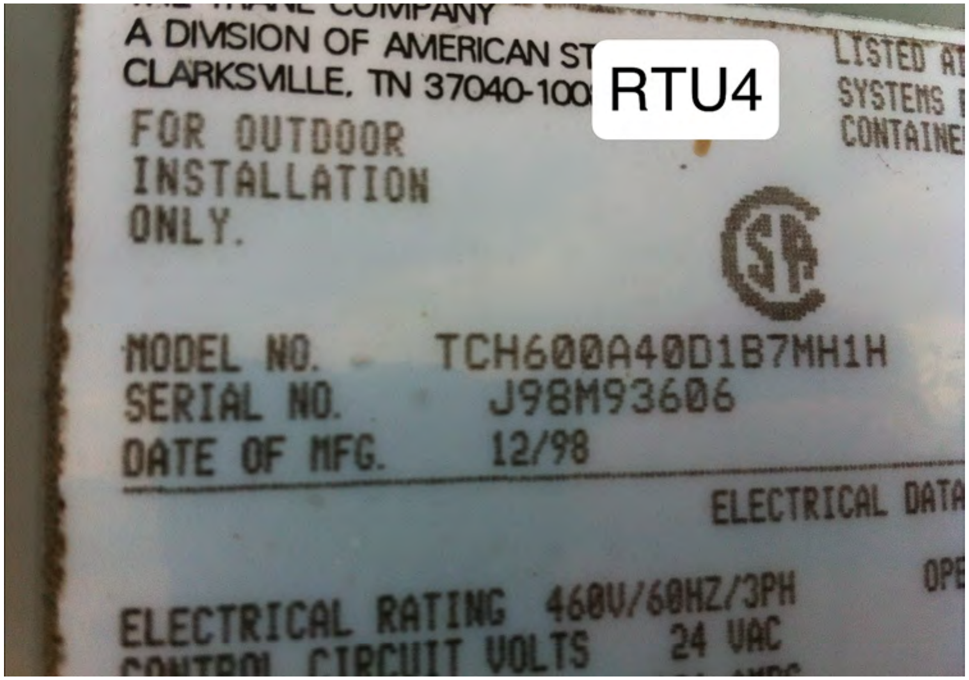

ROOFTOP EXHAUST AND DUCTWORK


RTU 4 filters
16x20x2
16x20x2
NON-FLAMMABLE GAS


ROOFTOP DUCTWORK


RTU 5 tag
A DIVISION OF AMERICAN STANDARD
CLARKSVILLE, TN 37040
MODEL NO.
SERIAL NO.
DATE OF MFG.
ELECTRICAL RATING
MIN/MAX OPER. VOLT
MIN CKT AMP
MFS/+MCB
MOP
CONTROL CKT. VOLTS 24 VAC
MAX DISCHARGE TEMP IS 94 DEG C.
EXT STATIC PRESS MM OF WATER
VERIFIED
Energy Performance
Rendement Energetique
VÉRIFIÉ
MINIMUM TEST PRESSURE HIGH 278 LOW 144 PSIG
THIS UNIT SHOULD BE INSTALLED AND REGULARLY MAINTAINED IN ACCORDANCE WITH THE SERVICE LITERATURE MANUAL(S).
COMP QTY PH HZ RLA-VOLTS LRA
#1 1 3 60 12.2-460 79
FAN QTY HZ PH FLA-VOLTS HP
COND 1 60 1 2.4-460 0.50
EVAP STANDARD 1 60 3 3.2-460 1.00
EVAP OVERSIZE 1 60 3 4.4-460 2.00
FACTORY CHARGED CKT#1 10.60 LBS R22
SCRATCH INK OFF SQUARE WHEN OVERSIZE MOTOR IS INSTALLED
DATA FOR UNITS WITH ELECTRIC HEAT ACCESSORY
AMERICAN STANDARD HEATER MODEL
AYDHTRA409B
AYDHTRA418B


RTU 4 tag
THE TRANE COMPANY
A DIVISION OF AMERICAN STANDARD INC.
CLARKSVILLE, TN 37040-1008
LISTED AIR CONDITIONING SYSTEMS EQUIPMENT, SELF-CONTAINED UNIT
FOR OUTDOOR INSTALLATION ONLY.
MODEL NO. TCH600A40D1B7MH1H
SERIAL NO. J98M93606
DATE OF MFG. 12/98
ELECTRICAL DATA
ELECTRICAL RATING 460V/60HZ/3PH
CONTROL CIRCUIT VOLTS 24 VAC
MIN CIRCUIT AMPACITY 121 AMPS
MAX. OVERCURRENT PROT. 125 AMPS
OPERATING VOLT RANGE 414-506V
QTY PH HZ RLA-VOLTS LRA
COMPR#1 1 3 60 27.3-460 178
COMPR#2 1 3 60 27.3-460 178
COMPR#3 1 3 60 27.3-460 178
MOTOR(S) QTY PH HZ FLA-VOLTS HP
EVAP. 1 3 60 18.0-460 15.0(11.2 KW)
COND. 4 1 60 3.5-460 1.1 (.8 KW
EXHAUST
COOLING DATA
R-22 FACTORY CHARGED
CIRCUIT#1- 23.9 LBS. (10.80 kg
CIRCUIT#2- 49.5 LBS. (22.50 kg
DESIGN PRESSURE
HIGH - 278 PSIG (1917 kPa)
LOW - 144 PSIG (993 kPa)
MAX EXT STATIC PRESS. 2.50 IN. W.C. (623 Pa)
CLEARANCES TO COMBUSTIBLE MATERIAL:
TOP-72IN. (1.8 M) L. SIDE-24IN. (610 MM) R. SIDE-24IN. (610 MM)
FRONT-24IN. (610 MM) BACK-18IN. (457 MM) DUCT-0IN. (0 MM)
THIS UNIT SHOULD BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH THE SERVICE MANUALS: YC-IOM-8



KITCHEN SUPPLY FAN KSF-1

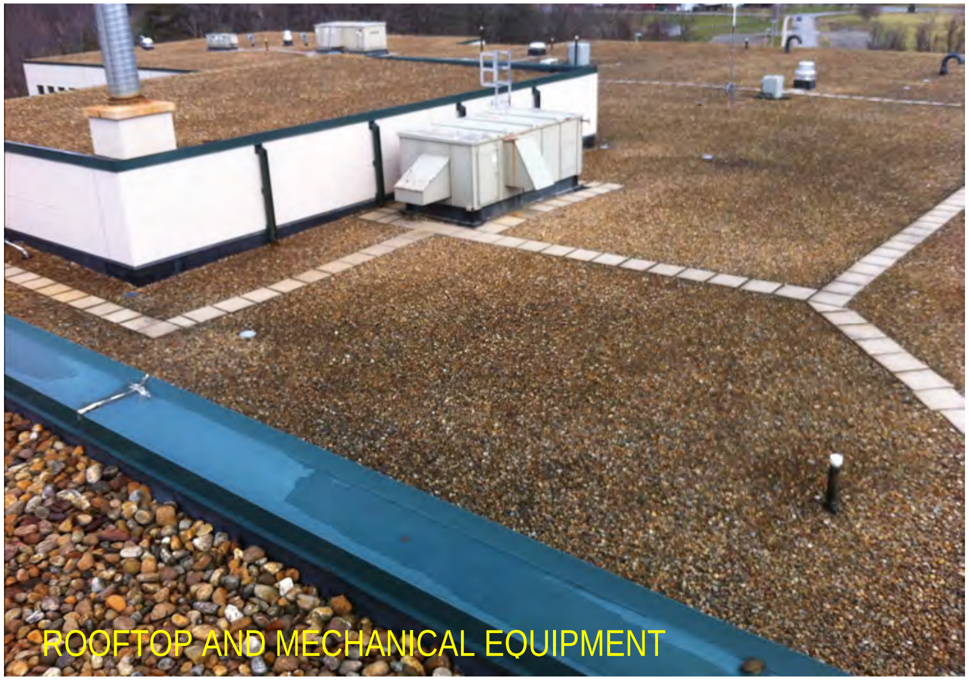

LARGE CRACK IN DUCTWORK INSULATILON

KITCHEN EXHAUST FAN KEF-2


HRU 1
DES CHAMPS
EXHAUST
BLOWER
ACCESS
Z PACK


RTU 3


Walk ins


ROOFTOP AND MECHANICAL EQUIPMENT


PIPING IN UV1


EMPTY COMPACT REFRIGERATOR


UV1


Empty but on mini fridge


NEAR EMPTY COMPACT REFRIGERATOR


ELECTRICAL BOX WITH "NO STORAGE" NOTE


COMPACT REFRIGERATOR

COMPACT REFRIGERATOR

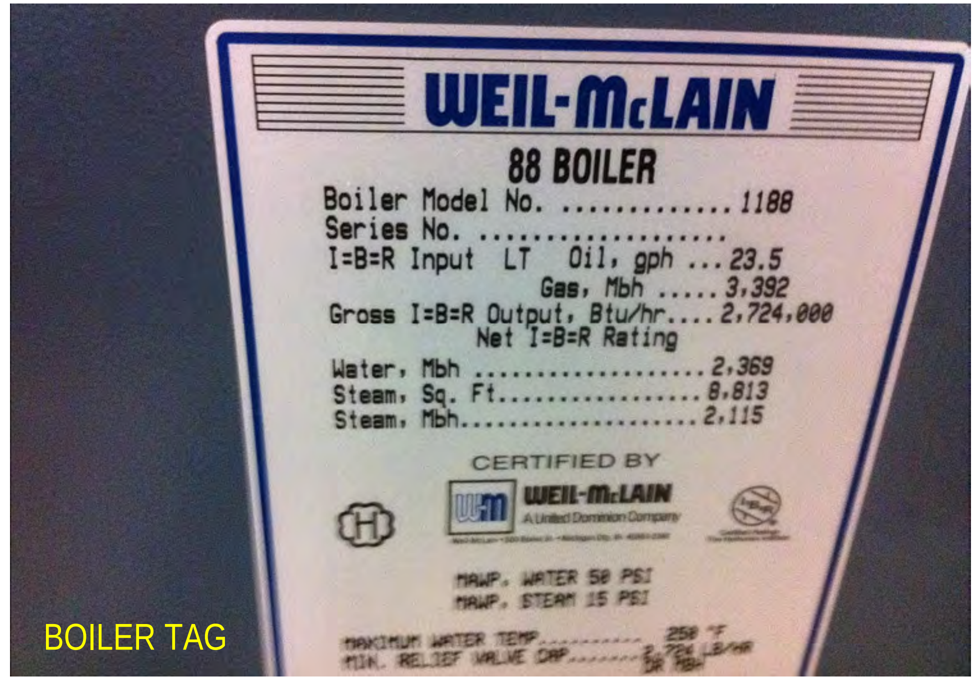
WATER PUMP CONTROLS


WATER SOFTENERS FOR WATER TREATMENT


ELECTRICAL TRANSFORMER


SPRINKLER PUMP AND PIPING

WEIL-MCLAIN BOILWER



BOILER TAG

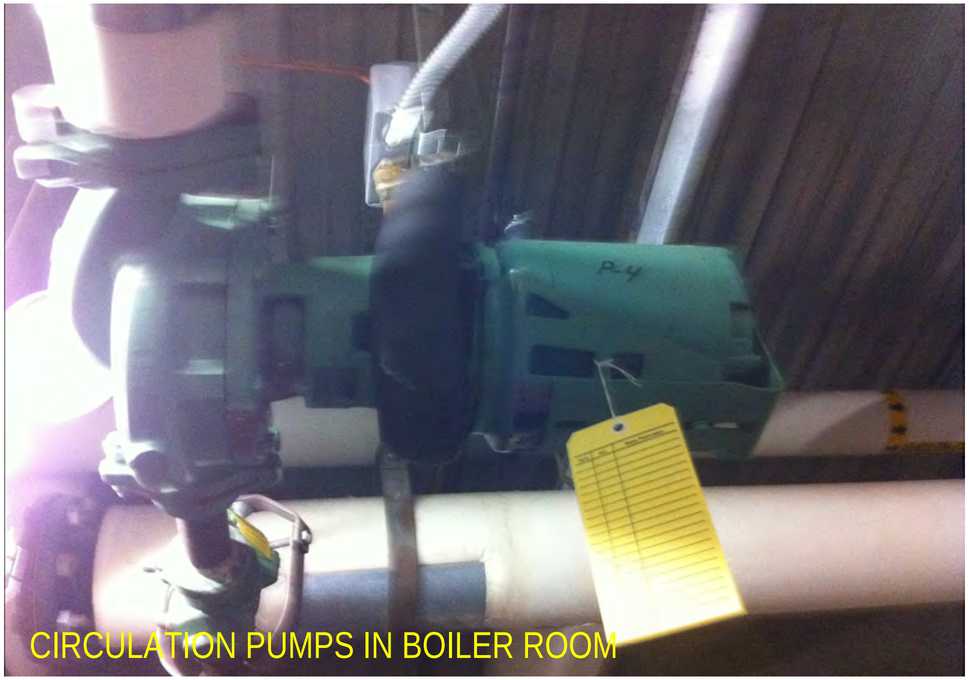
BOILER ROOM

THREE WEIL MCLAIN BOILERS


BREAKER BOXES

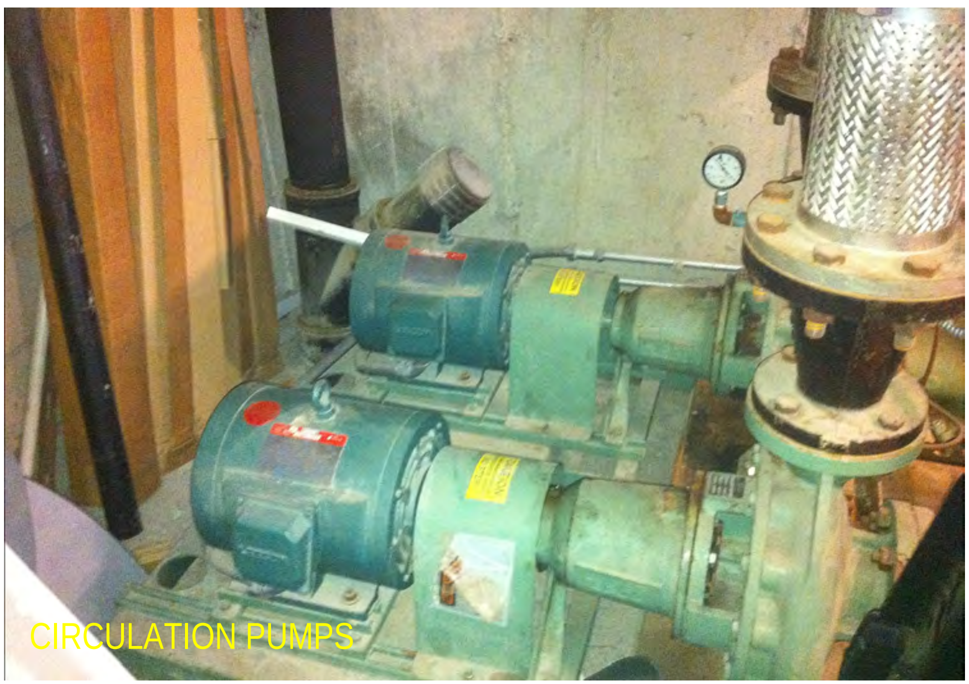

CIRCULATION PUMPS IN BOILER ROOM AND PRESSURE GUAGE


CIRCULATION PUMPS IN BOILER ROOM

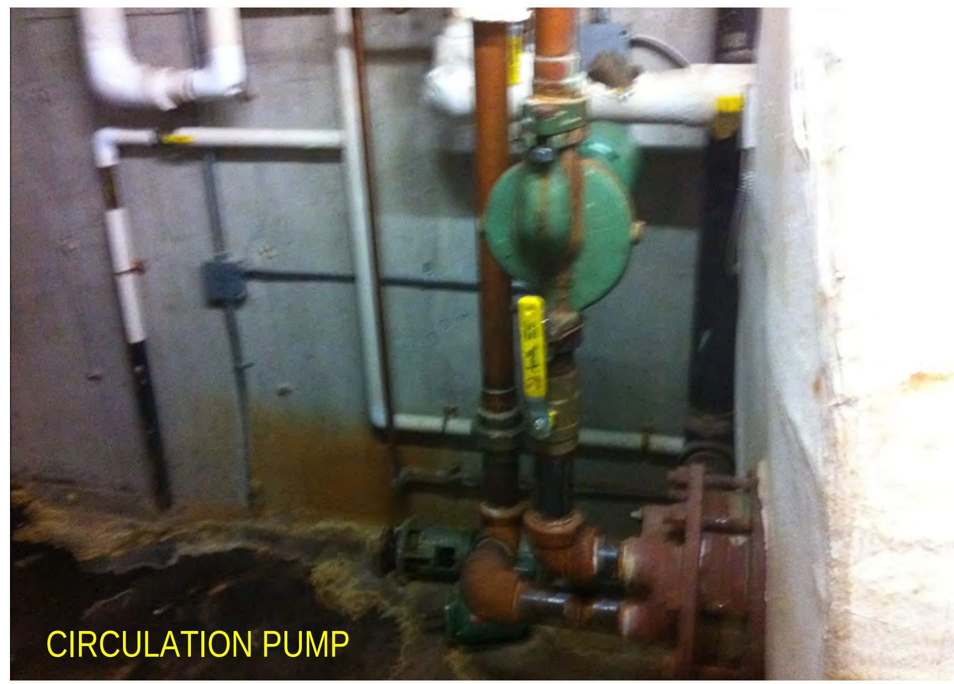

P-4
CIRCULATION PUMPS IN BOILER ROOM

BOILER

PRESSURE GUAGES



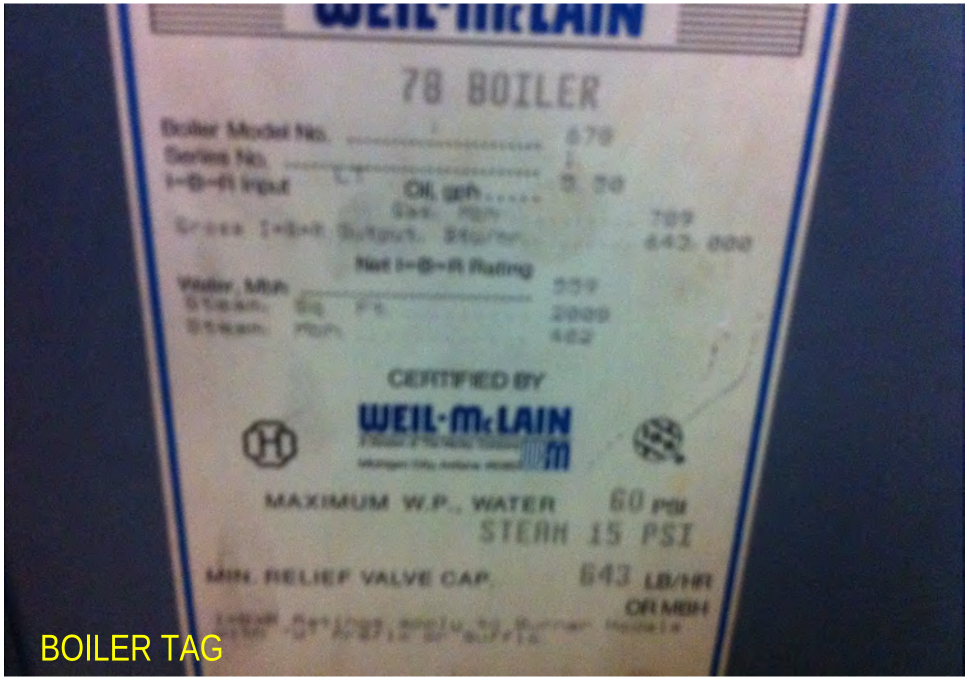
CIRCULATION PUMPS



CIRCULATION PUMP

LIBRARY COMPUTERS

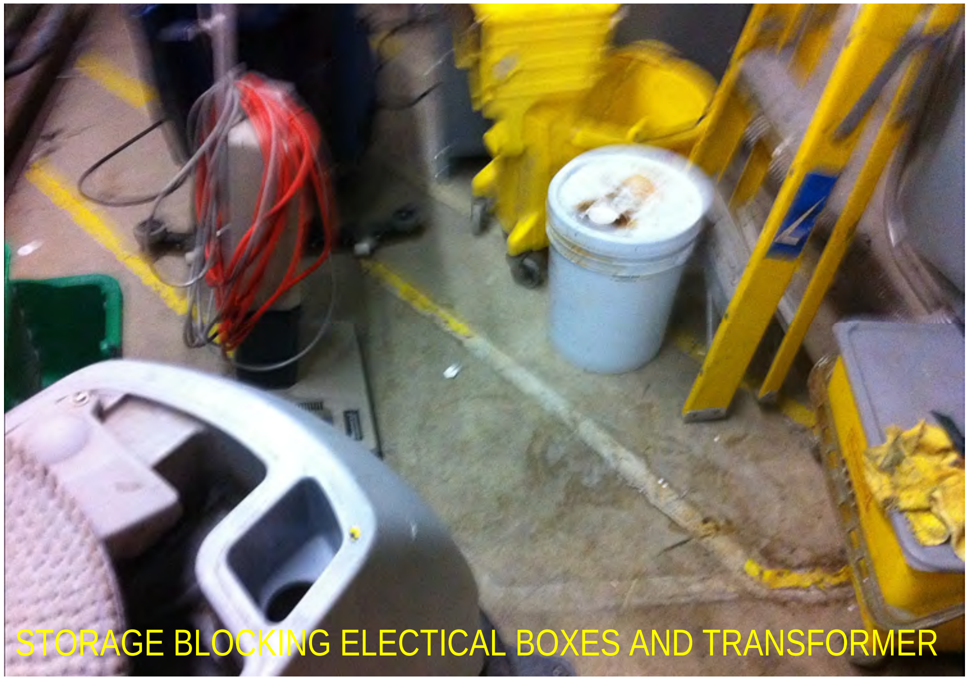
LIBRARY AHU



BOILER TAG

Library AHU

STORAGE BLOCKING ELECTICAL BOXES AND TRANSFORMER



STORAGE BLOCKING ELECTICAL BOXES AND TRANSFORMER

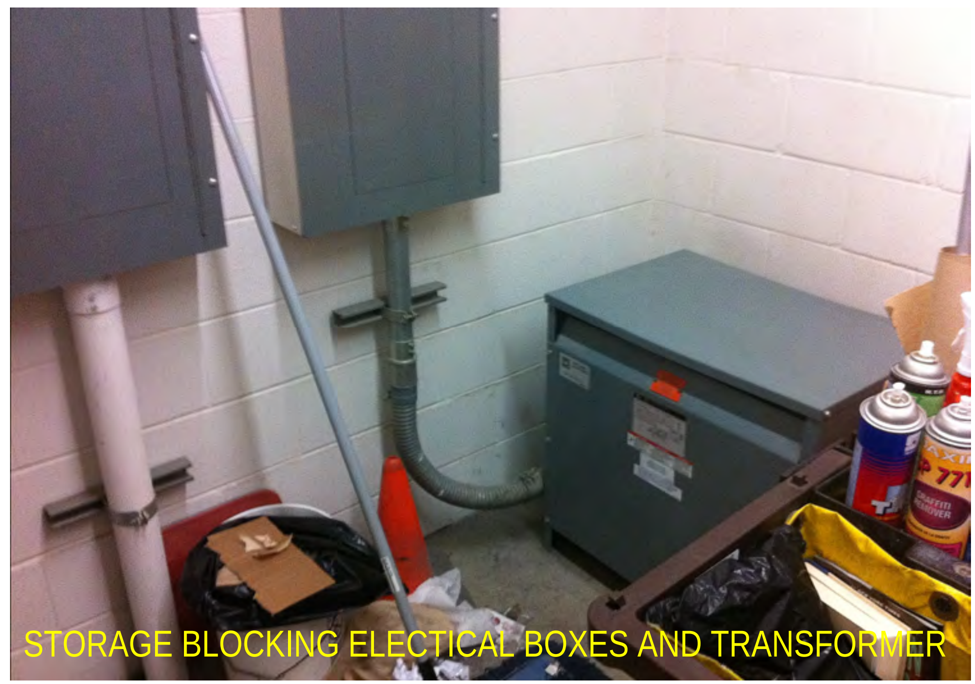
ELECTRICAL TRANSFORMER

STORAGE BLOCKING ELECTICAL BOXES AND TRANSFORMER

EMPTY COMPACT REFRIGERATOR


PARTIALLY FULL REFRIGERATOR


STORAGE BLOCKING ELECTICAL BOXES AND TRANSFORMER


STORAGE BLOCKING ELECTICAL BOXES AND TRANSFORMER

HEATING VENT HV-1 CONTROLS

FIRE EXTINGUISHER INACCESSIBLE

HV 2

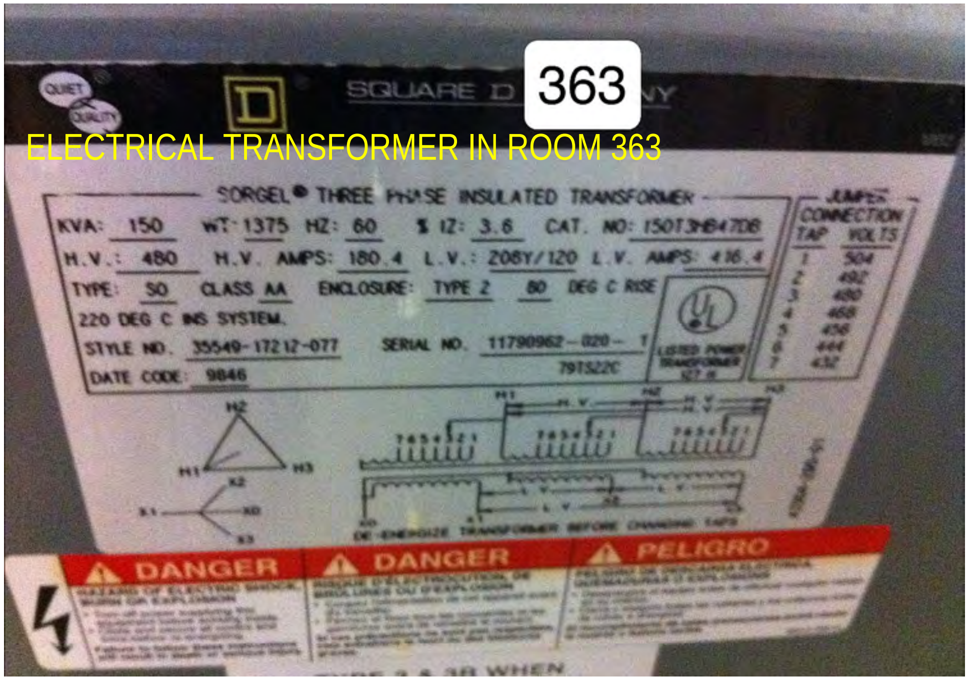
HV-2


HOT WATER TANK

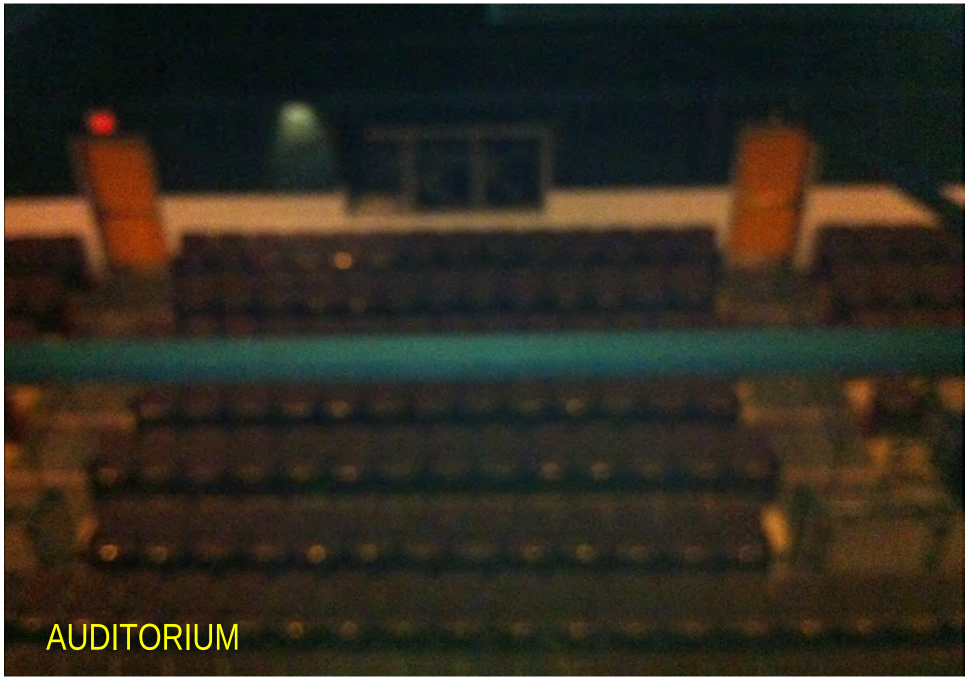
STORAGE BLOCKING ELECTRICAL BREAKER BOX

RTU-2 CONTROLS


SPACE HEATER IN STORAGE ROOM



ELECTRICAL TRANSFORMER IN ROOM 363


AUDITORIUM


MECHANICAL EQUIPMENT IN GYMNASIUM CEILING


AUDITORIUM LIGHT FIXTURE

RTU-2 AND EXHAUST MELTING SNOW

AUDITORIUM LIGHT FIXTURE

APPENDIX B

Thermal Imaging Survey Reports

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

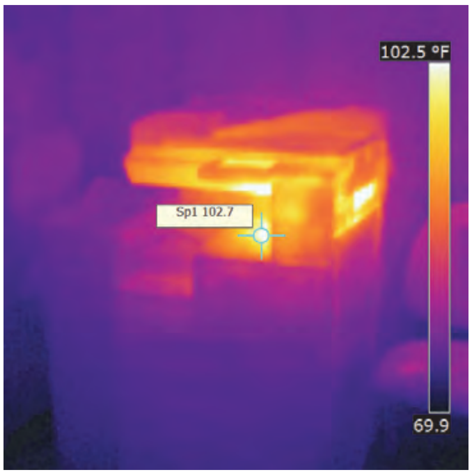


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	12/20/2011 12:19:14 PM
Image Name	IR_1881.jpg
Emissivity	0.96
Reflected apparent temperature	104.0 °F
Object Distance	8.0 ft

Text Comments

Description

Running photocopier. Recommend putting all photocopiers on a timeclock to power down when unoccupied. (EEM T1-1)

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

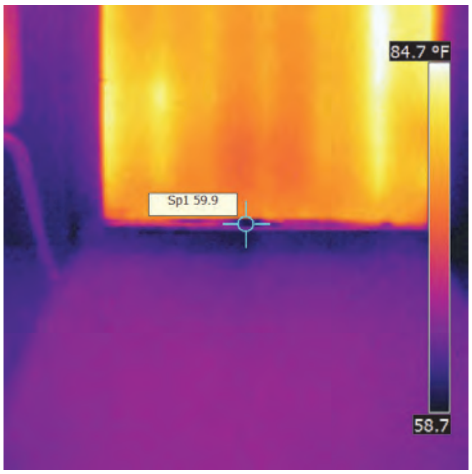


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	12/20/2011 12:29:34 PM
Image Name	IR_1882.jpg
Emissivity	0.96
Reflected apparent temperature	60.0 °F
Object Distance	5.0 ft

Text Comments

Description

Exterior door has air gap underneath allowing conditioned air to escape. Recommend weather sealing all exterior doors and windows wih air gaps (EEM T2-4).

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

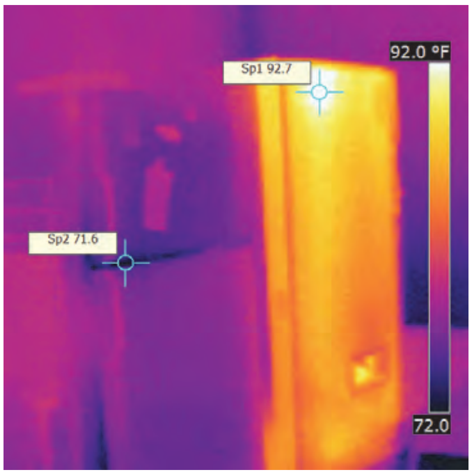


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	12/20/2011 2:11:28 PM
Image Name	IR_1883.jpg
Emissivity	0.96
Reflected apparent temperature	93.0 °F
Object Distance	10.0 ft

Text Comments

Description

Dasani vending machine (right) produces thermal energy while refrigerator (left) has poor seals. Recommend unplugging vending machine and replacing refrigerator with ENERGY STAR model ((T1-4).

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

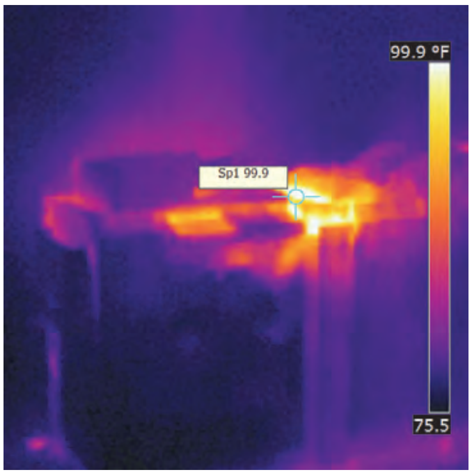


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	12/20/2011 2:12:19 PM
Image Name	IR_1884.jpg
Emissivity	0.96
Reflected apparent temperature	101.0 °F
Object Distance	10.0 ft

Description

Large photocopier produces thermal energy. Recommend putting all copiers on a timeclock to shut down when unoccupied.(EEM T1-5)

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

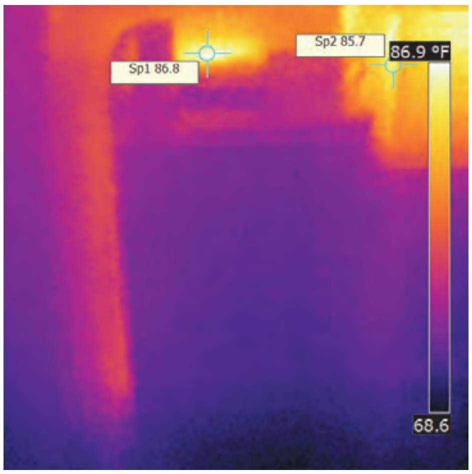


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	12/20/2011 2:18:56 PM
Image Name	IR_1885.jpg
Emissivity	0.96
Reflected apparent temperature	87.0 °F
Object Distance	8.0 ft

Text Comments

Description

Old compact refrigerator shows no signs of a poor seal around door, however does emit thermal energy through the back of the unit where the motor is. Old microwave (right) also emits thermal energy.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

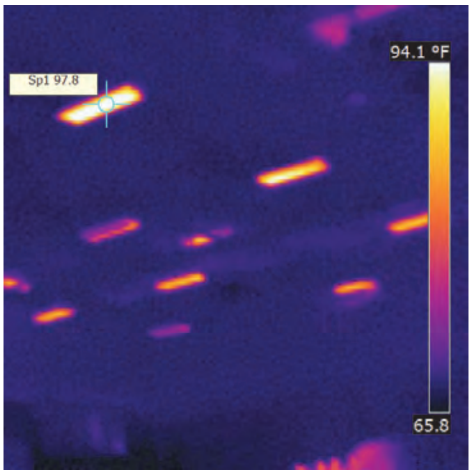


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	12/20/2011 2:26:53 PM
Image Name	IR_1886.jpg
Emissivity	0.96
Reflected apparent temperature	99.0 °F
Object Distance	30.0 ft

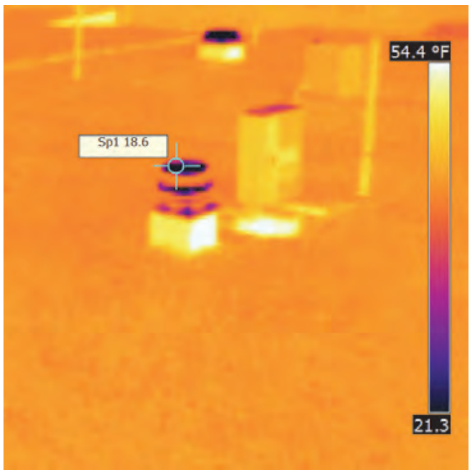
Text Comments

Description

T5 lighting fixtures producing thermal energy in the gymnasium.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



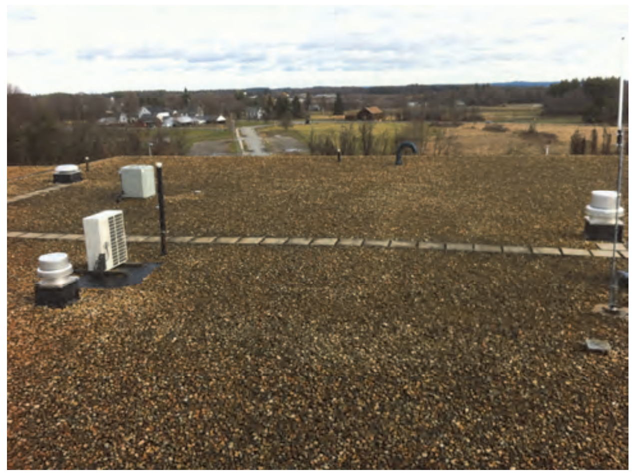


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	12/28/2011 11:45:17 AM
Image Name	IR_1949.jpg
Emissivity	0.96
Reflected apparent temperature	16.0 °F
Object Distance	15.0 ft

Text Comments

Description

Rooftop exhaust fan and split system. Unit exhaust conditioned air from building.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

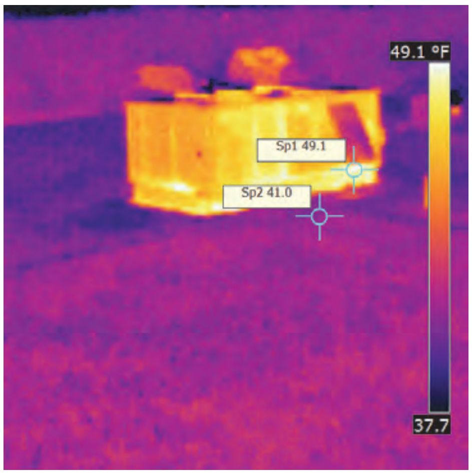


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	12/28/2011 11:45:24 AM
Image Name	IR_1951.jpg
Emissivity	0.96
Reflected apparent temperature	48.0 °F
Object Distance	30.0 ft

Text Comments

Description

Rooftop unit exhaust conditioned higher than ambient outdoor temperature.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

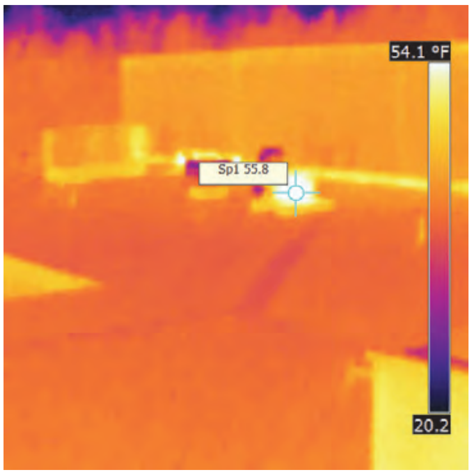


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	12/28/2011 11:45:51 AM
Image Name	IR_1952.jpg
Emissivity	0.96
Reflected apparent temperature	55.0 °F
Object Distance	40.0 ft

Description

IR of rooftop equipment and evidence of how much thermal breaching can occur from an open conditioned space to the oudoors.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

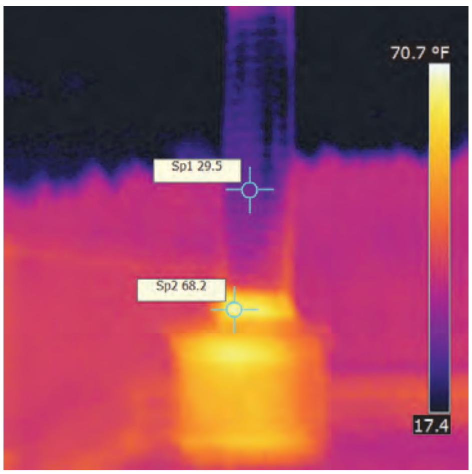


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	12/28/2011 11:46:04 AM
Image Name	IR_1953.jpg
Emissivity	0.96
Reflected apparent temperature	68.0 °F
Object Distance	15.0 ft

Text Comments

Description

IR of exhaust pipe shows higher thermal energy in base (concrete) than in pipe (metal).

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

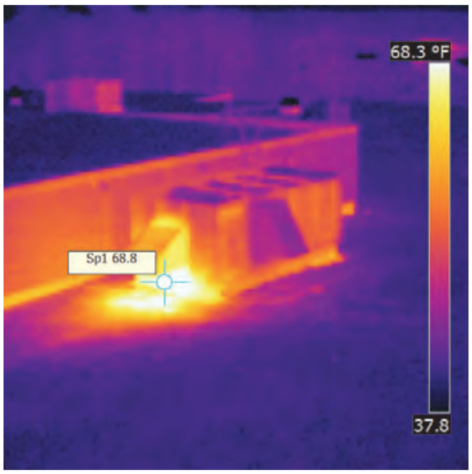


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	12/28/2011 12:09:12 PM
Image Name	IR_1954.jpg
Emissivity	0.96
Reflected apparent temperature	68.0 °F
Object Distance	50.0 ft

Description

Rooftop unit exhausting conditioned air.

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

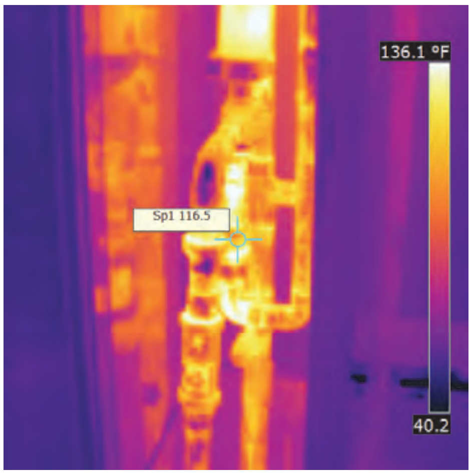


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	12/28/2011 12:11:10 PM
Image Name	IR_1956.jpg
Emissivity	0.96
Reflected apparent temperature	118.0 °F
Object Distance	3.0 ft

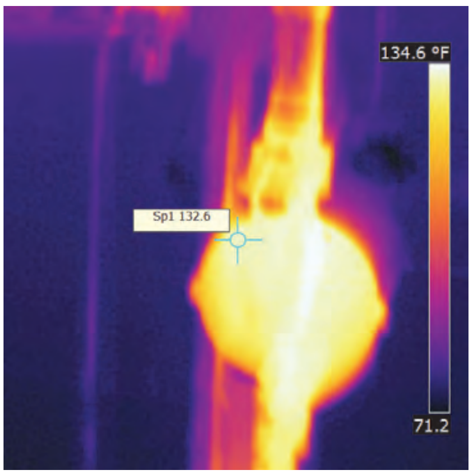
Description

Hot water pipes in rooftop unit UV1. Recommend insulating all hot water pipes throughout building.

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



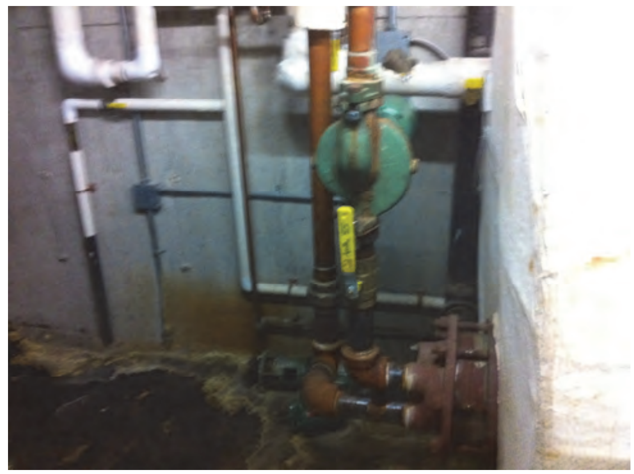


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	12/28/2011 1:39:17 PM
Image Name	IR_1958.jpg
Emissivity	0.96
Reflected apparent temperature	135.0 °F
Object Distance	3.0 ft

Description

Pump in boiler room shows high thermal energy produced and emitted through pump and uninsulated pipes.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

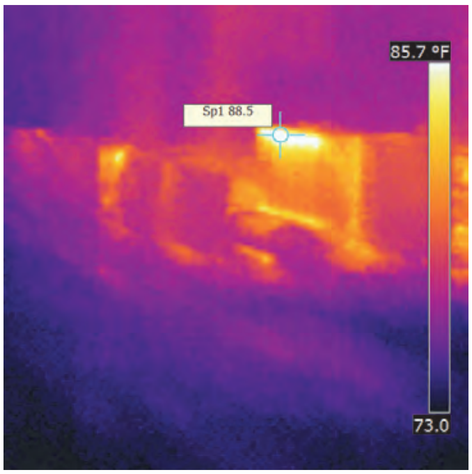


Image and Object Parameters

Text Comments

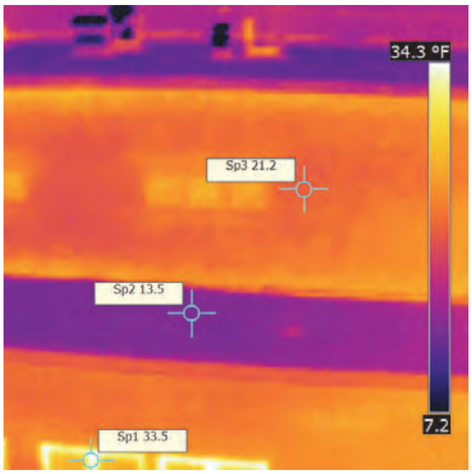
Camera Model	B-CAM Western S
Image Date	12/28/2011 1:43:49 PM
Image Name	IR_1962.jpg
Emissivity	0.96
Reflected apparent temperature	85.0 °F
Object Distance	10.0 ft

Description

Powered computers in the Library produce thermal energy. Recommend shutting down all computer equipment when not in use. (T1-1)

Inspection Report

Report Date	5/30/2012		
Company	AEC	**Customer**	Hollis Brookline High School
Address	90 Main Street	**Site Address**	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	**Contact Person**	



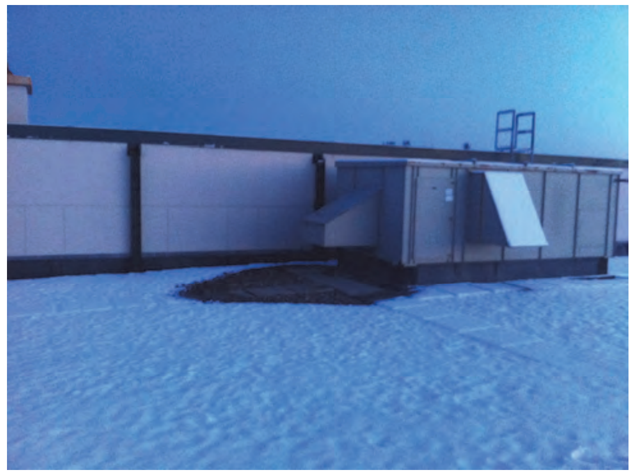


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/20/2012 6:54:05 AM
Image Name	IR_2325.jpg
Emissivity	0.96
Reflected apparent temperature	18.0 °F
Object Distance	50.0 ft

Description

Exterior IR of the building of different levels reveals difference in thermal transfer. Highest breaching through second story window frames (bottom).

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

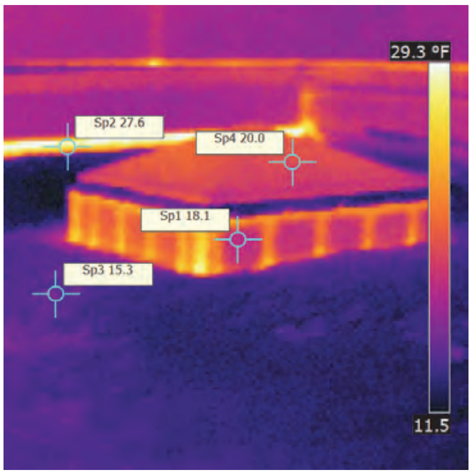


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 6:51:43 AM
Image Name	IR_2320.jpg
Emissivity	0.96
Reflected apparent temperature	15.0 °F
Object Distance	10.0 ft

Text Comments

Description

IR of roof shows little thermal transfer through skylight glass and fixture and more thermal transfer through concrete in wall (background).

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

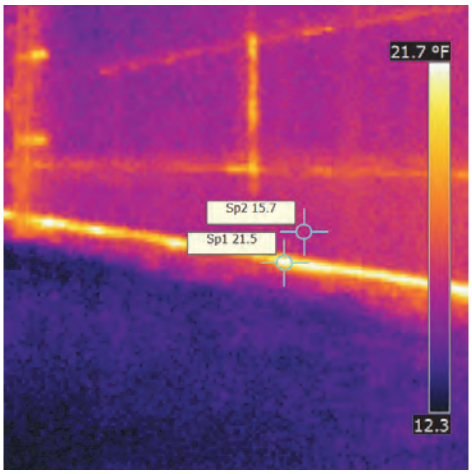


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/20/2012 6:52:04 AM
Image Name	IR_2321.jpg
Emissivity	0.96
Reflected apparent temperature	18.0 °F
Object Distance	15.0 ft

Description

IR of rooftop wall shows some thermal transfer through concrete base of wall.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

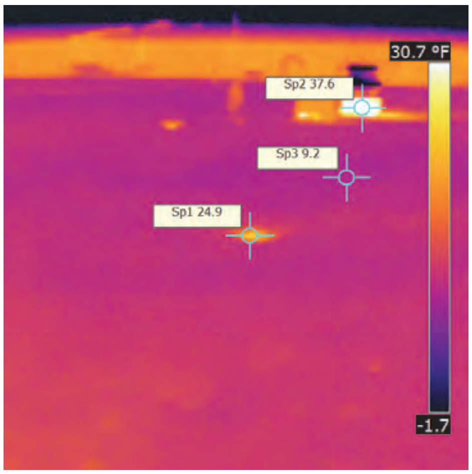


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/20/2012 6:52:37 AM
Image Name	IR_2322.jpg
Emissivity	0.96
Reflected apparent temperature	35.0 °F
Object Distance	25.0 ft

Description

Rooftop IR reveals higher thermal transfer at the base of the exhast fan (background) and around the drain (foreground) than the temperature of the roof with snow on it (middle).

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

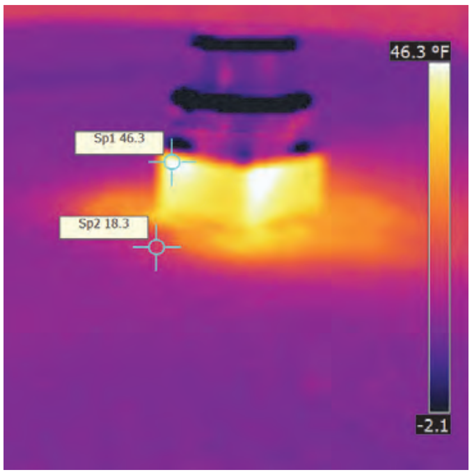


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/20/2012 6:53:16 AM
Image Name	IR_2323.jpg
Emissivity	0.96
Reflected apparent temperature	45.0 °F
Object Distance	8.0 ft

Description

IR of rooftop exhaust fan reveals thermal breaching through stand that the fan sits on and melted snow around the exhaust.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

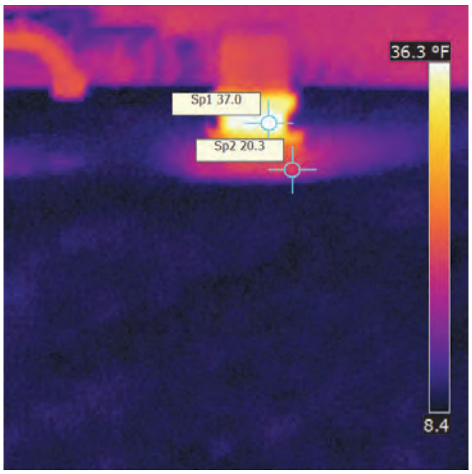


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/20/2012 6:53:33 AM
Image Name	IR_2324.jpg
Emissivity	0.96
Reflected apparent temperature	35.0 °F
Object Distance	10.0 ft

Description

Rooftop exhaust shows thermal breaching through stand the fan sits on, however no snow has yet melted around the exhaust.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

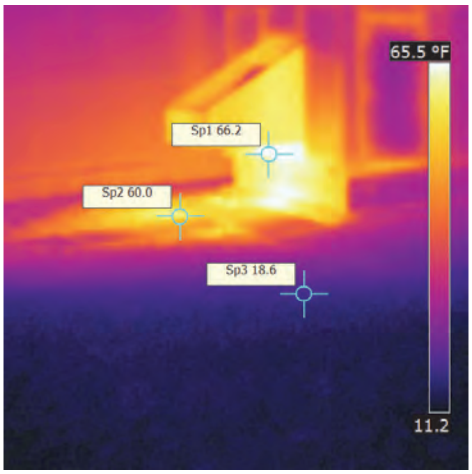


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 6:50:57 AM
Image Name	IR_2319.jpg
Emissivity	0.96
Reflected apparent temperature	66.0 °F
Object Distance	20.0 ft

Text Comments

Description

Conditioned air being exhausted from rooftop unit has melted the snow around exhaust.

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

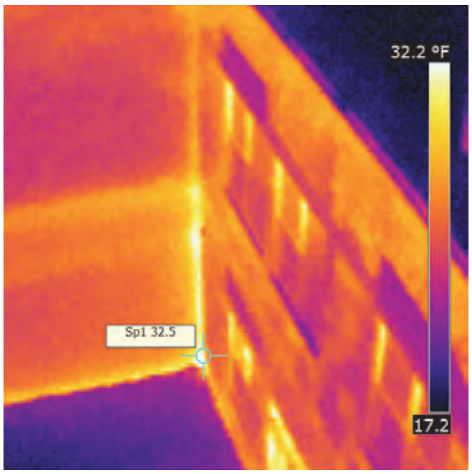


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 6:54:19 AM
Image Name	IR_2326.jpg
Emissivity	0.96
Reflected apparent temperature	30.0 °F
Object Distance	50.0 ft

Text Comments

Description

IR of exterior of the building reveals different thermal breachings in different areas of the exterior. Seam between intersecting walls shows the highest breaching.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

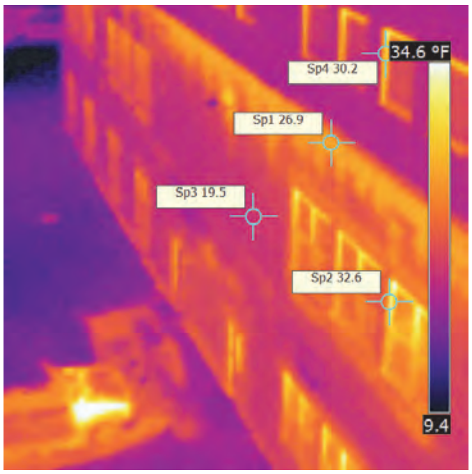


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 6:54:48 AM
Image Name	IR_2327.jpg
Emissivity	0.96
Reflected apparent temperature	25.0 °F
Object Distance	50.0 ft

Text Comments

Description

IR of exterior of the building reveals thermal breaching around third story windows, second story window frames and through brick fascade above the second story windows.

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

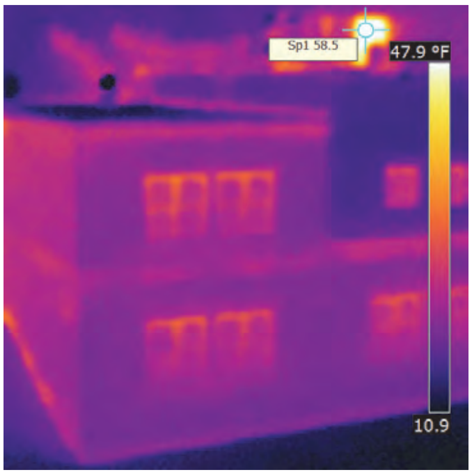


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/20/2012 6:55:19 AM
Image Name	IR_2329.jpg
Emissivity	0.96
Reflected apparent temperature	19.0 °F
Object Distance	100.0 ft

Description

IR of building rooftop and exterior reveals thermal transfer around rooftop unit servicing the auditorium.

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

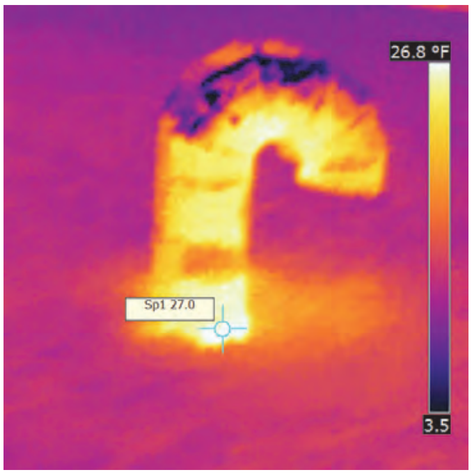


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 6:55:34 AM
Image Name	IR_2330.jpg
Emissivity	0.96
Reflected apparent temperature	24.0 °F
Object Distance	5.0 ft

Text Comments

Description

Rooftop exhaust pipe shows signs of thermal bridging through the exhaust pipe and not out the end. (EEM T2-4)

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

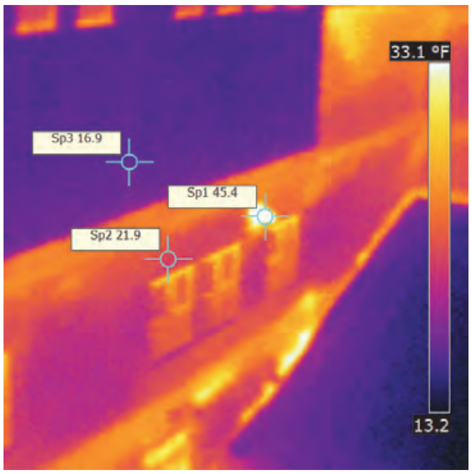


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/20/2012 6:55:47 AM
Image Name	IR_2331.jpg
Emissivity	0.96
Reflected apparent temperature	43.0 °F
Object Distance	50.0 ft

Description

IR of building exterior shows disparity in thermal transfer between top and bottom fascades. Exterior illuminated light (right) also produces thermal energy.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

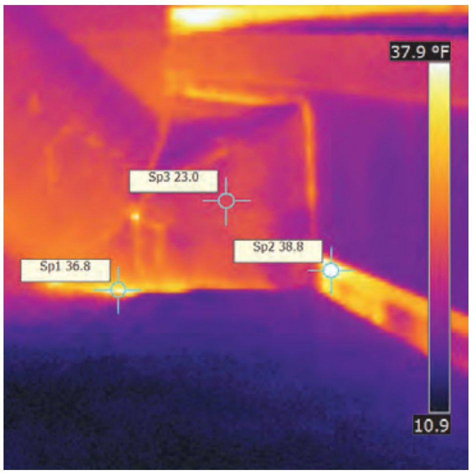


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 6:57:27 AM
Image Name	IR_2334.jpg
Emissivity	0.96
Reflected apparent temperature	35.0 °F
Object Distance	10.0 ft

Text Comments

Description

IR of rootop exhaust for large rooftop unit shows some thermal bridging at bottom of exhaust duct as well as thermal briding around base of rooftop wall.

AEC

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

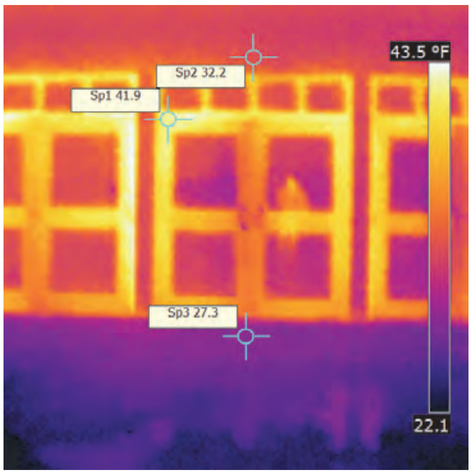


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:00:55 AM
Image Name	IR_2335.jpg
Emissivity	0.96
Reflected apparent temperature	30.0 °F
Object Distance	15.0 ft

Description

IR of auditorium and gymnasium entrance shows some thermal transfer through the door and window frames. (EEM T2-1)

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

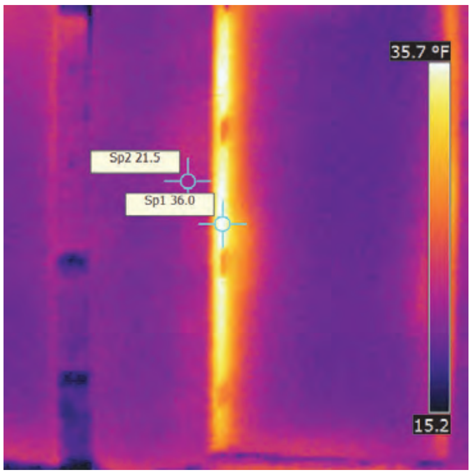


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:01:16 AM
Image Name	IR_2336.jpg
Emissivity	0.96
Reflected apparent temperature	35.0 °F
Object Distance	8.0 ft

Description

IR of side exterior door shows poor sealing along hinged side of door as well as on jamb side. Recommend weather stripping all exterior doors and windows. (EEM T2-4)

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

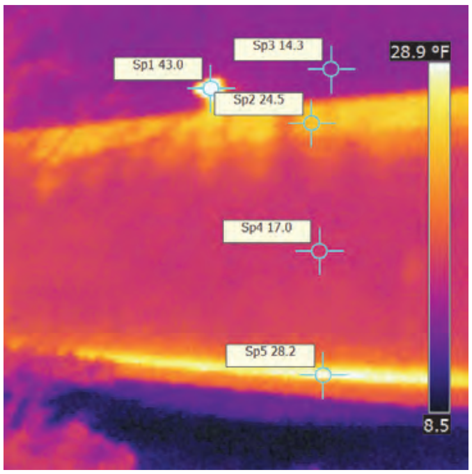


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:01:44 AM
Image Name	IR_2337.jpg
Emissivity	0.96
Reflected apparent temperature	25.0 °F
Object Distance	15.0 ft

Text Comments

Description

IR of exterior shows different areas of thermal energy. Illuminated light shows highest thermal energy, while thermal bridging occurs through concrete slab at bottom and brick fascade at top.

AEC

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

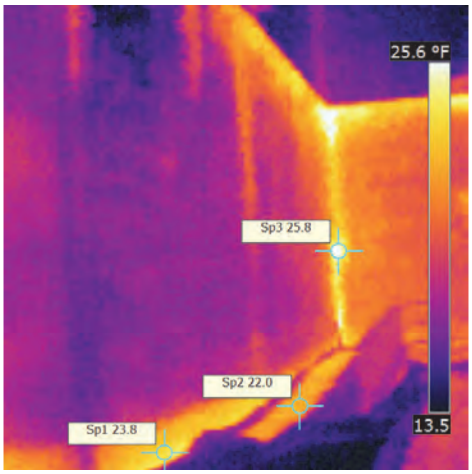


Image and Object Parameters	
Camera Model	B-CAM Western S
Image Date	1/20/2012 7:01:56 AM
Image Name	IR_2338.jpg
Emissivity	0.96
Reflected apparent temperature	20.0 °F
Object Distance	20.0 ft

Text Comments

Description

IR of exterior rear of building reveals thermal transfer through concrete in building foundation and walkway. Thermal briding also occuring at corner of building.

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

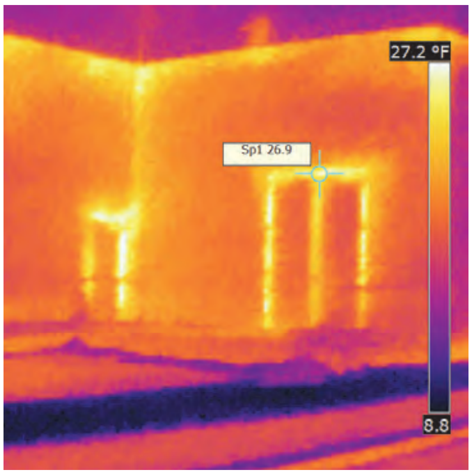


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:02:14 AM
Image Name	IR_2339.jpg
Emissivity	0.96
Reflected apparent temperature	25.0 °F
Object Distance	20.0 ft

Description

Thermal transfer occurs through door frame to exterior. Recommend weather stripping all exterior doors and windows. (EEM T2-4)

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

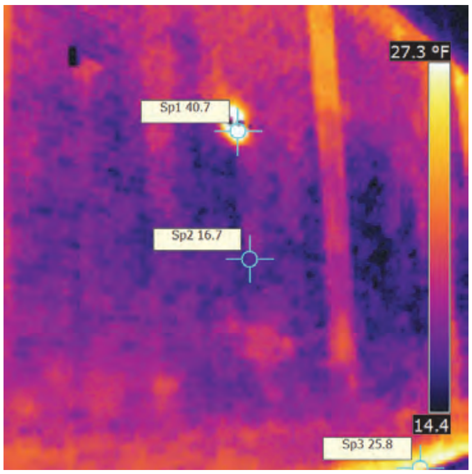


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:02:52 AM
Image Name	IR_2340.jpg
Emissivity	0.96
Reflected apparent temperature	15.0 °F
Object Distance	10.0 ft

Text Comments

Description

IR of building exterior reveals thermal transfer through small exhaust as well as concrete foundation.

Inspection Report

Report Date	5/30/2012		
Company	AEC	**Customer**	Hollis Brookline High School
Address	90 Main Street	**Site Address**	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	**Contact Person**	

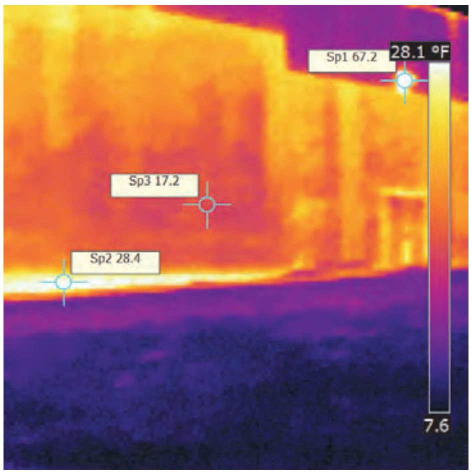


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:03:11 AM
Image Name	IR_2341.jpg
Emissivity	0.96
Reflected apparent temperature	25.0 °F
Object Distance	25.0 ft

Text Comments

Description

IR of building exterior reveals thermal transfer through concrete in building foundation as well as thermal energy produced from exterior illuminated light.

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

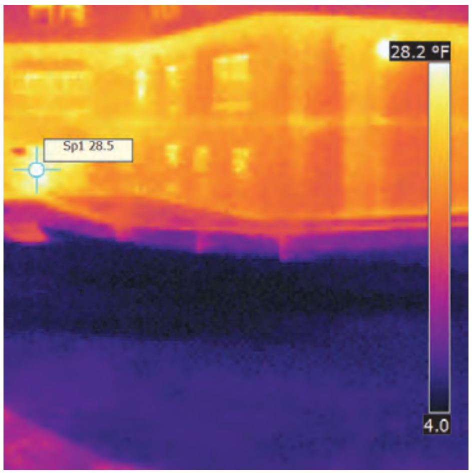


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:04:14 AM
Image Name	IR_2343.jpg
Emissivity	0.96
Reflected apparent temperature	26.0 °F
Object Distance	6.6 ft

Text Comments

Description

IR of the side of the building reveals thermal transfer where a door may be open.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

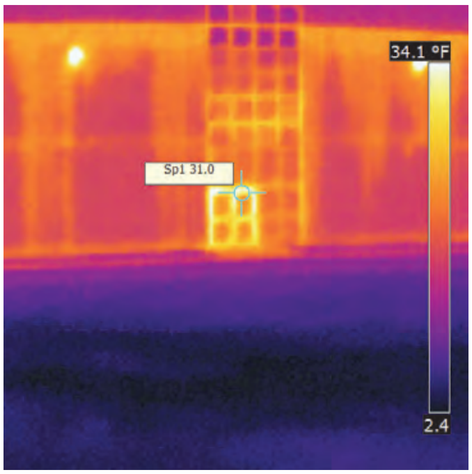


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:04:35 AM
Image Name	IR_2344.jpg
Emissivity	0.96
Reflected apparent temperature	30.0 °F
Object Distance	40.0 ft

Text Comments

Description

IR at the side of the building reveals thermal transfer through the exterior door as well as thermal energy produced from the illuminated lights.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

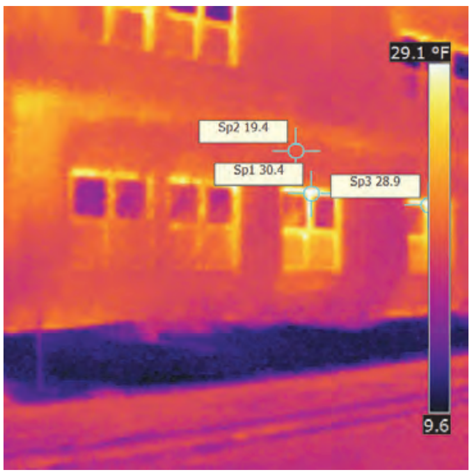


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:05:19 AM
Image Name	IR_2345.jpg
Emissivity	0.96
Reflected apparent temperature	28.0 °F
Object Distance	15.0 ft

Description

Thermal bridging occuring through exterior window frame. (EEM T2-1)

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

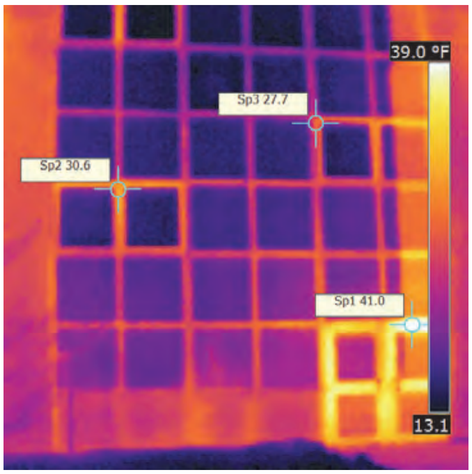


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:06:16 AM
Image Name	IR_2348.jpg
Emissivity	0.96
Reflected apparent temperature	29.0 °F
Object Distance	25.0 ft

Text Comments

Description

IR of large window on the buildings exterior reveals some thermal transfer around the window frames as well as around the door frame.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/20/2012 7:07:34 AM
Image Name	IR_2351.jpg
Emissivity	0.96
Reflected apparent temperature	34.0 °F
Object Distance	40.0 ft

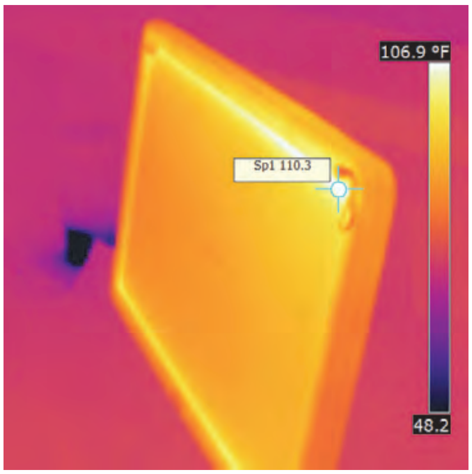
Description

Exterior IR of the building shows thermal transfer occuring around the exterior door.

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	



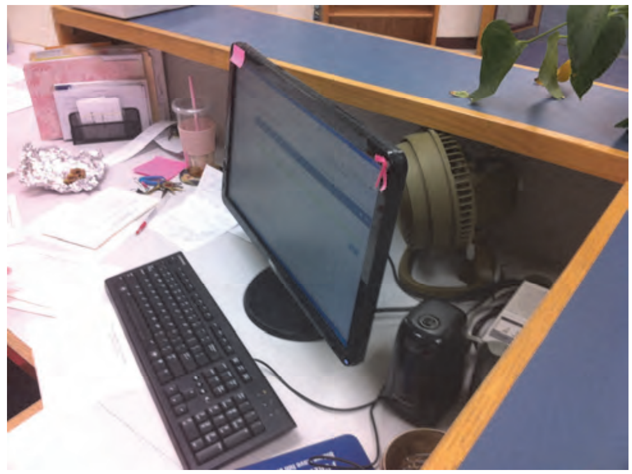


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 8:49:22 AM
Image Name	IR_2401.jpg
Emissivity	0.96
Reflected apparent temperature	112.0 °F
Object Distance	3.0 ft

Text Comments

Description

IR of LCD monitor reveals thermal energy monitor produces. (EEM T1-1)

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

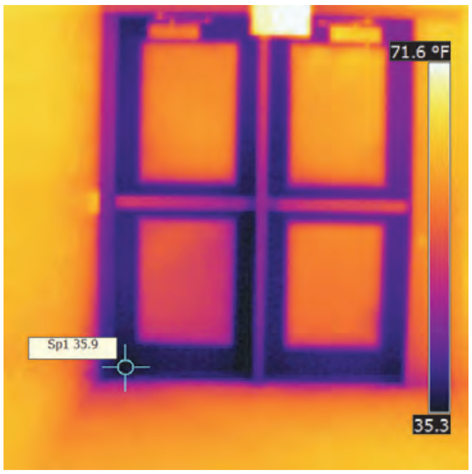


Image and Object Parameters	
Camera Model	B-CAM Western S
Image Date	1/20/2012 8:52:20 AM
Image Name	IR_2402.jpg
Emissivity	0.96
Reflected apparent temperature	35.0 °F
Object Distance	10.0 ft

Text Comments

Description

IR of inside of exterior door reveals poor thermal transfer through door. Recommend insulated all hollow door frames (EEM T2-1)

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

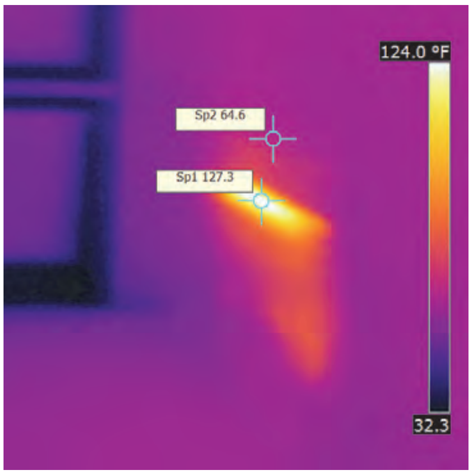


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 8:52:25 AM
Image Name	IR_2403.jpg
Emissivity	0.96
Reflected apparent temperature	130.0 °F
Object Distance	10.0 ft

Text Comments

Description

IR of cabinet heater in hallway reveals high heat being emitted.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

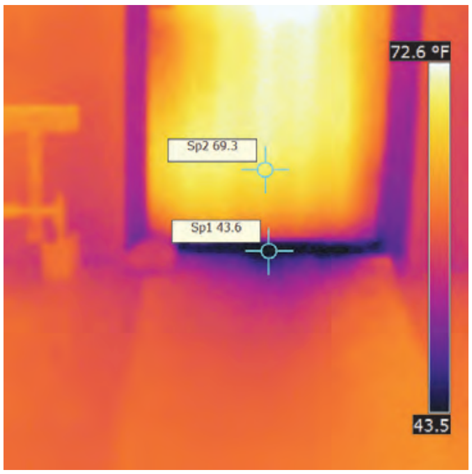


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/20/2012 9:04:00 AM
Image Name	IR_2404.jpg
Emissivity	0.96
Reflected apparent temperature	69.0 °F
Object Distance	10.0 ft

Description

IR of inside of exterior (cafeteria) door reveals thermal bridging underneath door. From photo (right), daylight can be seen. (EEM T2-4)

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

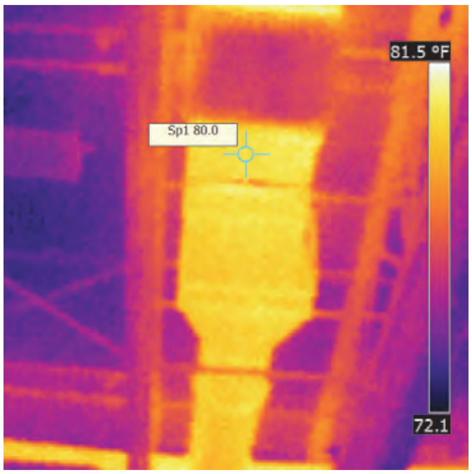


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 9:06:05 AM
Image Name	IR_2405.jpg
Emissivity	0.96
Reflected apparent temperature	80.0 °F
Object Distance	25.0 ft

Text Comments

Description

Ductwork in the gymnasium ceiling reveals thermal transfer.

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

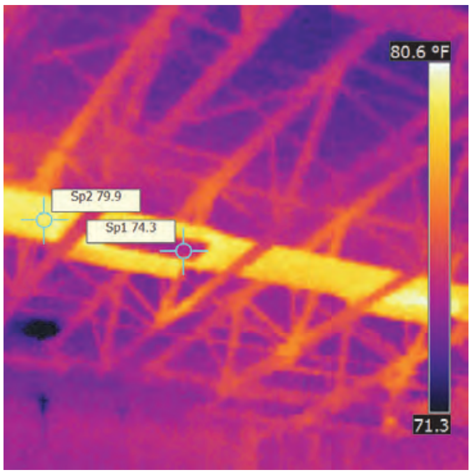


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 9:06:09 AM
Image Name	IR_2406.jpg
Emissivity	0.96
Reflected apparent temperature	76.0 °F
Object Distance	30.0 ft

Text Comments

Description

IR of ductwork in gymnasium reveals thermal transfer. More thermal enregy being transfered through ductwork than by overhead light (Sp1).

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

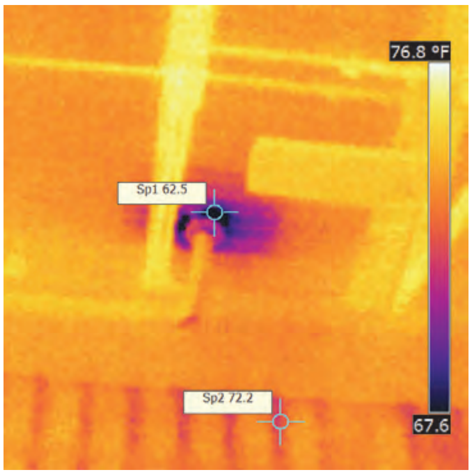


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/20/2012 9:06:50 AM
Image Name	IR_2407.jpg
Emissivity	0.96
Reflected apparent temperature	62.0 °F
Object Distance	25.0 ft

Description

IR of pipe through the ceiling reveals poor seal around the pipe and thermal transfer occuring. Metal studs in the wall are also vising below the pipe. (EEM T2-4)

Inspection Report

Report Date	5/30/2012		
Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

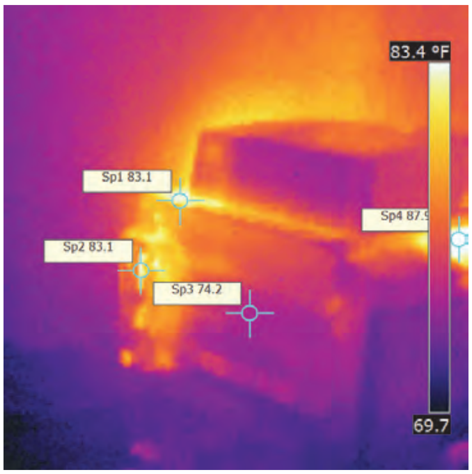


Image and Object Parameters

Text Comments

Camera Model	B-CAM Western S
Image Date	1/20/2012 9:19:23 AM
Image Name	IR_2409.jpg
Emissivity	0.96
Reflected apparent temperature	84.0 °F
Object Distance	8.0 ft

Description

IR of photocopier reveals thermal energy produced and emitted.

Inspection Report

Report Date	5/30/2012

Company	AEC	Customer	Hollis Brookline High School
Address	90 Main Street	Site Address	24 Cavalier Court, Hollis, NH 03049
Thermographer	Hans Kuebler	Contact Person	

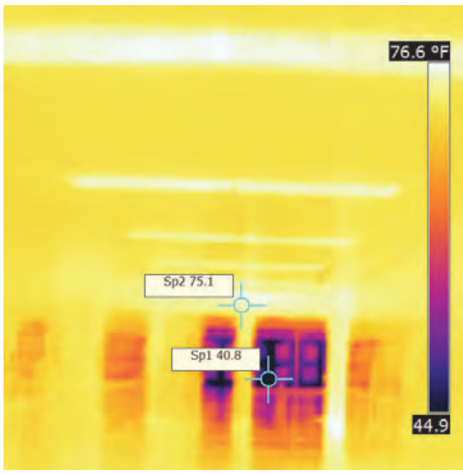


Image and Object Parameters

Camera Model	B-CAM Western S
Image Date	1/20/2012 9:19:48 AM
Image Name	IR_2410.jpg
Emissivity	0.96
Reflected apparent temperature	40.0 °F
Object Distance	50.0 ft

Text Comments

Description

IR of corridor reveals thermal transfer through exterior doors at the end of the corridor. (EEM T2-1)

APPENDIX C

Indoor Metering Data

INDOOR METERING DATA

Facility:	Location:	Date:	Ambient Outdoor:
HBHS	Hollis, NH	12/20/2011	Temp= 40 RH= 35 CO2= 310

Location /Use Description	Time	Occupied	Air Quality			Lighting Density		Notes
			Temp (°F)	RH (%)	CO2 (ppm)	Horiz (FC)	Vert (FC)	
163 Art	1115	Y	73.9	13.3	706		44.5	
First fl EW hall	1115	N	73.0	16.6	795		44.8	
First fl ns hall	1118	N	74.1	16.5	900		45	
Main office	1119	Y	74.1	13.6	627		63	
128 guidance	1120	Y	74.8	22.0	1,069		42	
175	1123	Y	72.1	16.4	844	21	48	
North stair 1-2	1124	Y	71.0	15.9	785		25	
205 lib	1125	Y	72.6	14.8	684		55.7	
218	1127	Y	75.5	17.5	870			Warm, not consistent, don't use overhead lights
225	1129	Y	74.6	17.4	975		15.9	
Cafeteria	1130	Y	73.0	17.8	1,152		52	
2nd fl EW hall	1132	Y	73.0	19.0	975		25	
203	1133	Y	74.1	18.0	1,107		18.5	Third of bulbs on
202	1135	Y	73.5	18.6	1,245	30	46	
216	1136	Y	73.7	18.1	1,115		22	Third on
273	1138	N	73.4	18.2	1,015			Windows leak into room when raining
310	1148	Y	72.5	21.0	1,195		50	Door open, AC running next to door
3rd fl ns hall	1149	N	73.0	15.2	830		31.5	
304	1150	N	73.4	14.4	741	31	34	Heat inconsistent, not enough gas for bunsen burner
301	1210	Y	72.8	12.8	926		20	
370	1211	Y	73.2	17.5	1,153		22	
230	1311	N	78.2	12.9	628			SRO
229 2nd fl staff	1313	Y	75.2	13.9	610			
226	1315	Y	73.9	12.9	603			Writing lab
223	1318	Y	74.8	15.9	821	20	24	
249	1320	N	72.6	18.3	797		40	
249B	1322	Y	74.1	20.6	1,040		24	Gets cold, below ground level
Gym	1329	Y	70.8	8.5	550		26	
335	1331	Y	71.0	12.3	552		32	Gets cold
Auditorium	1336	N	70.1	17.4	625			
368	1340	Y	72.6	16.3	692		26	
360/361	1342	N	71.6	11.4	635			
3rd fl lobby	1346	N	71.9	13.2	805		68	
321	1347	Y	75.9	21.3	1,295	30	35	
372	1350	Y	73.2	14.9	874		28	Too hot in summer
373	1358	Y	72.6	17.2	1,059		20	Cold, partial lights on
171	1403	Y	73.5	21.3	1,082			
Averages			**73.3**	**16.3**	**875**			

APPENDIX D

Lighting Fixture Inventory

LIGHTING FIXTURE INVENTORY

Facility:	Location:	Date:
HBHS	Hollis, NH	12/20/2011

Location /Use Description	Fixture	Watts/fixture	Qty	Controls	Total watts	Est. Hr/Wk	Est. KWH Consumption/Yr
128	CFL	17	5	Motion	85	35	119
129	CFL	17	1	Motion	17	35	24
166	CFL	17	6	Switch	102	41	167
Main office	CFL	17	6	Switch	102	55	224
108	CFL	34	1	Switch	34	41	56
109	CFL	34	1	Switch	34	41	56
112	CFL	34	1	Switch	34	41	56
131	CFL	34	1	Switch	34	41	56
132	CFL	34	1	Switch	34	41	56
136	CFL	34	1	Switch	34	41	56
138	CFL	34	1	Switch	34	41	56
147	CFL	34	1	Switch	34	41	56
148	CFL	34	1	Switch	34	41	56
206	CFL	34	1	Switch	34	41	56
212	CFL	34	1	Switch	34	41	56
333	CFL	34	1	Switch	34	41	56
334	CFL	34	1	Switch	34	41	56
137 restroom	CFL	34	1	Switch	34	41	56
Auditorium	CFL	34	10	Switch	340	7	95
329	Hal	54	11	Switch	594	41	974
Auditorium	Hal	54	40	Switch	2,160	7	605
Auditorium	HPS	400	21	Switch	8,400	7	2,352
156	Inc	60	2	Switch	120	41	197
Exit	Led	5	82	Switch	410	168	3,582
Exterior	MH	70	8	Switch	560	62	1,791
Exterior	MH	70	25	Switch	1,750	62	5,597
Exterioir	MH	150	33	Switch	4,950	62	15,830
Auditorium	Stage	100	32	Switch	3,200	7	896
369	T5	216	8	Switch	1,728	41	2,834
Gymnasium	T5	216	36	Switch	7,776	55	17,107
Mini gym	T5	216	20	Switch	4,320	50	8,640
105	T8	32	2	Switch	64	41	105
108	T8	32	1	Switch	32	41	52
109	T8	32	1	Switch	32	41	52
112	T8	32	4	Switch	128	41	210
132	T8	32	1	Switch	32	41	52
136	T8	32	1	Switch	32	41	52
143	T8	32	2	Switch	64	41	105
231	T8	32	1	Switch	32	41	52
232	T8	32	1	Switch	32	41	52

249	T8	32	2	Switch	64	41	105
280	T8	32	1	Switch	32	41	52
281	T8	32	1	Switch	32	41	52
316	T8	32	1	Switch	32	41	52
329	T8	32	2	Switch	64	41	105
346	T8	32	2	Switch	64	41	105
363	T8	32	4	Switch	128	41	210
364	T8	32	4	Switch	128	41	210
367	T8	32	1	Switch	32	41	52
131 men	T8	32	1	Switch	32	41	52
137 restroom	T8	32	1	Switch	32	41	52
170a	T8	32	2	Switch	64	41	105
Auditorium	T8	32	2	Switch	64	7	18
Mini gym	T8	32	6	Switch	192	50	384
107	T8	64	2	Switch	128	41	210
113	T8	64	2	Switch	128	41	210
119	T8	64	2	Motion	128	35	179
123	T8	64	2	Motion	128	35	179
124	T8	64	2	Motion	128	35	179
125	T8	64	2	Motion	128	35	179
146	T8	64	1	Switch	64	41	105
147	T8	64	4	Switch	256	41	420
148	T8	64	2	Switch	128	41	210
158	T8	64	26	Switch	1,664	41	2,729
163	T8	64	1	Switch	64	41	105
171	T8	64	12	Switch	768	41	1,260
172	T8	64	4	Switch	256	41	420
173	T8	64	3	Switch	192	41	315
174	T8	64	11	Switch	704	41	1,155
175	T8	64	12	Switch	768	41	1,260
176	T8	64	12	Switch	768	41	1,260
177	T8	64	12	Switch	768	41	1,260
208	T8	64	3	Switch	192	41	315
211	T8	64	1	Switch	64	41	105
219	T8	64	4	Switch	256	41	420
226	T8	64	2	Switch	128	41	210
227	T8	64	1	Switch	64	41	105
229	T8	64	4	Switch	256	41	420
230	T8	64	1	Switch	64	41	105
235	T8	64	1	Switch	64	41	105
236	T8	64	4	Switch	256	41	420
237	T8	64	3	Switch	192	41	315
245	T8	64	1	Switch	64	41	105
246	T8	64	1	Switch	64	41	105
247	T8	64	3	Switch	192	41	315

248	T8	64	10	Switch	640	41	1,050
249	T8	64	24	Switch	1,536	41	2,519
270	T8	64	14	Switch	896	41	1,469
271	T8	64	16	Switch	1,024	41	1,679
272	T8	64	3	Switch	192	41	315
273	T8	64	16	Switch	1,024	41	1,679
274	T8	64	16	Switch	1,024	41	1,679
275	T8	64	16	Switch	1,024	41	1,679
276	T8	64	16	Switch	1,024	41	1,679
277	T8	64	1	Switch	64	41	105
278	T8	64	3	Switch	192	41	315
279	T8	64	3	Switch	192	41	315
300	T8	64	12	Switch	768	41	1,260
301	T8	64	20	Switch	1,280	41	2,099
303	T8	64	2	Switch	128	41	210
304	T8	64	20	Switch	1,280	41	2,099
306	T8	64	2	Switch	128	41	210
307	T8	64	20	Switch	1,280	41	2,099
307	T8	64	12	Switch	768	41	1,260
309	T8	64	20	Switch	1,280	41	2,099
310	T8	64	12	Switch	768	41	1,260
314	T8	64	3	Switch	192	41	315
315	T8	64	3	Switch	192	41	315
316	T8	64	1	Switch	64	41	105
318	T8	64	12	Switch	768	41	1,260
321	T8	64	12	Switch	768	41	1,260
322	T8	64	3	Switch	192	41	315
323	T8	64	14	Switch	896	41	1,469
327	T8	64	12	Switch	768	41	1,260
329	T8	64	6	Switch	384	41	630
329	T8	64	17	Switch	1,088	41	1,784
332	T8	64	12	Switch	768	41	1,260
333	T8	64	3	Switch	192	41	315
334	T8	64	3	Switch	192	41	315
335	T8	64	1	Switch	64	41	105
356	T8	64	5	Switch	320	41	525
360	T8	64	15	Switch	960	41	1,574
361	T8	64	15	Switch	960	41	1,574
362	T8	64	13	Switch	832	41	1,364
365	T8	64	2	Switch	128	41	210
366	T8	64	2	Switch	128	41	210
369	T8	64	10	Switch	640	41	1,050
370	T8	64	12	Switch	768	41	1,260
371	T8	64	20	Switch	1,280	41	2,099
372	T8	64	24	Switch	1,536	41	2,519

373	T8	64	12	Switch	768	41	1,260
374	T8	64	30	Switch	1,920	41	3,149
147a	T8	64	1	Switch	64	41	105
1st fl hall ew	T8	64	7	Switch	448	55	986
1st fl hall ns	T8	64	39	Switch	2,496	55	5,491
2-3 fl hall west	T8	64	3	Switch	192	55	422
2nd fl hall	T8	64	61	Switch	3,904	55	8,589
3rd floor	T8	64	20	Switch	1,280	55	2,816
3rd floor	T8	64	16	Switch	1,024	55	2,253
3rd floor	T8	64	33	Switch	2,112	55	4,646
3rd floor lobby	T8	64	25	Switch	1,600	60	3,840
Boys locker	T8	64	20	Switch	1,280	50	2,560
East stair	T8	64	2	Switch	128	50	256
Girls locker	T8	64	20	Switch	1,280	50	2,560
Gymnasium	T8	64	4	Switch	256	55	563
Kitchen	T8	64	17	Switch	1,088	40	1,741
Mech room	T8	64	6	Switch	384	10	154
North stair	T8	64	7	Switch	448	55	986
South stair	T8	64	8	Switch	512	55	1,126
101	T8	96	8	Switch	768	41	1,260
102	T8	96	4	Switch	384	41	630
103	T8	96	4	Switch	384	41	630
104	T8	96	6	Switch	576	41	945
112	T8	96	4	Switch	384	41	630
121	T8	96	3	Switch	288	41	472
122	T8	96	2	Motion	192	35	269
126	T8	96	2	Motion	192	35	269
127	T8	96	6	Motion	576	35	806
128	T8	96	5	Motion	480	35	672
129	T8	96	4	Motion	384	35	538
137	T8	96	2	Switch	192	41	315
137	T8	96	8	Switch	768	41	1,260
138	T8	96	3	Switch	288	41	472
141	T8	96	20	Switch	1,920	41	3,149
149	T8	96	6	Switch	576	41	945
150	T8	96	1	Switch	96	41	157
151	T8	96	6	Switch	576	41	945
153	T8	96	2	Switch	192	41	315
156	T8	96	12	Switch	1,152	41	1,889
163	T8	96	23	Switch	2,208	41	3,621
164	T8	96	2	Switch	192	41	315
170	T8	96	19	Switch	1,824	41	2,991
201	T8	96	12	Switch	1,152	41	1,889
202	T8	96	12	Switch	1,152	41	1,889
203	T8	96	12	Switch	1,152	41	1,889

206	T8	96	6	Switch	576	41	945
207	T8	96	3	Switch	288	41	472
212	T8	96	4	Switch	384	41	630
216	T8	96	12	Switch	1,152	41	1,889
217	T8	96	12	Switch	1,152	41	1,889
218	T8	96	4	Switch	384	41	630
221	T8	96	14	Switch	1,344	41	2,204
222	T8	96	15	Switch	1,440	41	2,362
222	T8	96	4	Switch	384	41	630
223	T8	96	15	Switch	1,440	41	2,362
224	T8	96	12	Switch	1,152	41	1,889
225	T8	96	16	Switch	1,536	41	2,519
229	T8	96	8	Switch	768	41	1,260
302	T8	96	2	Switch	192	41	315
305	T8	96	3	Switch	288	41	472
317	T8	96	12	Switch	1,152	41	1,889
323	T8	96	14	Switch	1,344	41	2,204
144 men	T8	96	3	Switch	288	41	472
145	T8	96	3	Switch	288	41	472
204	T8	96	12	Switch	1,152	41	1,889
205 media/lib	T8	96	60	Switch	5,760	41	9,446
Cafeteria	T8	96	36	Switch	3,456	40	5,530
Main office	T8	96	8	Switch	768	55	1,690
South stairwell	T8	96	7	Switch	672	55	1,478
329	T8	128	16	Switch	2,048	41	3,359
Auditorium	T8	128	40	Switch	5,120	7	1,434
128	T8 short	64	1	Motion	64	35	90
Totals:			**1,884**		**151,938**		**252,037**

APPENDIX E

Mechanical Equipment Inventory

MECHANICAL EQUIPMENT INVENTORY

Facility:	Location:	Date:
HBHS	Hollis, NH	12/20/2011

Location /Use Description	Qty	Affiliated System	MBH	CFM	Fan RPM	HP	V	phase	Star	Model	Est. kWh/yr
Roof / Refrigeration for Walk-in	3	Walk-in Freezer								M0H025L63CF	16,690
model shop / AC-1C	1			1050	1075	0.25	120	1	speed switch	Airomax series 1101	37
model shop / AC-2C	1			1050	1075	0.25	120	1	speed switch	Airomax series 1101	37

AIR HANDLING UNIT INVENTORY

Facility:		Location:		Date:
HBHS		Hollis, NH		12/20/2011

Name / Location	Year	Serves	Affiliated System	CFM (EXH)	CFM (SUP)	Min OA	HP (EXH)	HP (SUP)	V	Phase	Manufacturer	Model	Est. kWh/yr
RTU-1	2000	Library	Venting	12,200	12,200	17%	10	15	480	3	Trane	T-Series 25	77,480
RTU-1	1996		Venting	12,280	12,280	17%	10	10.0	480	3	Trane	PCC-23	61,984
RTU-1C	2000		Venting	13,605	13,605	17%	7.5	10.0	480	3	Trane	TSCA025TBB0AAA	54,236
RTU-2	1996		Venting	12,490	12,490	17%	10	10.0	480	3	Trane	PCC-23	61,984
RTU-2C	2000		Venting	-	1,600	40%	0	1.0	480	3	Trane	T-series 3	3,099
RTU-3	1996		Venting	-	12,000		0	10.0	480	3	Trane	PCC-23	30,992
RTU-4 / Roof	1998		AC Only	-	16,000		0	15.0	480	3	Trane	TCH600A40A0B	13,410
RTU-5 / Roof	1998		AC Only	-	3,000	17%	0%	1.0	480	3	Trane	TCD09004	894
HRU-1	1996		Heating	3,080	2,380		3	2.0	480	3	Des Champs	MZ-4070	5,960
UV-1	1996		Venting	-	1,500	38%	0	0.5	120	1	Trane	HUVA1501CAOH1	1,550
UV-2	1996		Venting	-	720	22%	0	0.33	120	1	Trane	HUVA1501CAOH1	1,023
UV-3	1996		Venting	-	2,000	38%	0	0.75	120	1	Trane	HUVA1501CAOH1	2,324
UV-1	2000		Venting	-	1,400	40%	0	0.5	120	1	Trane	HUVA1501CFOH5	1,550
HVAC-1	1996		ACCU-1	-	2,510	15%	0	1.5	408	3	Trane	MCC-6A	4,649
HVAC-2	1996		ACCU-2	-	2,260	15%	0	1.5	408	3	Trane	MCC-6A	4,649
HVAC-3	1996		ACCU-3	-	5,010	15%	0	3	408	3	Trane	MCC-10A	9,298
FAI-1	1996	Admin	HVAC-1	-	2,500	-	-	-	-	-	Greenheck	GRS-24	-
FAI-2	1996	Guidance	HVAC-2	-	2,500	-	-	-	-	-	Greenheck	GRS-24	-
Total:					**105,955**								**335,081**

AIR CONDITION CONDENSING UNIT INVENTORY

Facility:			Location:					Date:	
HBHS			Hollis, NH					12/20/2011	
Name	**Serves**	**Affiliated System**	**Location**	**Phase**	**Cooling (ton)**	**Manufacturer**	**EER**	**Model**	**Est. kWh/yr**
ACCU-1		AC	Roof	3	4.0	Trane		TTA048C400A0	16,882
ACCU-2		AC	Roof	3	6.0	Trane		TTA072C400A0	25,322
ACCU-3		AC	Roof	3	6.0	Trane		TTA072C400A0	25,322
ACCU-?		AC	Roof	1		Mitsubishi	9.9 (10.0 SEER)	MUM30EN2	1,602
ACCU-?		AC	Roof			Mitsubishi		MU12NNU	1,602
Total:					**16**				**70,730**

BLOWER COIL UNIT INVENTORY

Facility:					Location:		Date:	
HBHS					Hollis, NH		12/20/2011	
Location /Use Description	**Year Installed**	**CFM**	**MBH**	**GPM**	**Manufacturer**	**Model**	**Est. kWh/yr**	
BC-1	1996	1540	49.9	3.3	Trane	Type TT 20"L X 18"W		
BC-2	1996	970	31.4	2.1	Trane	Type TT 18"L X 12"W		
BC-3	1996	890	25.0	1.9	Trane	Type TT 18"L X 12"W		
BC-4	1996	1370	44.4	3.0	Trane	Type TT 24"L X 12"W		
BC-5	1996	730	23.7	1.6	Trane	Type TT 18"L X 12"W		
BC-6	1996	1700	55.1	3.7	Trane	Type T 20"L X 18"W		
BC-7	1996	890	25.0	1.9	Trane	Type TT 18"L X 12"W		
BC-8	1996	360	11.7	0.8	Trane	Type TT 12"L X 9"W		
BC-9	1996	750	24.4	1.6	Trane	Type TT 14"L X 12"W		
BC-10	1996	750	24.4	1.6	Trane	Type TT 14"L X 12"W		
BC-11	1996	750	24.4	1.6	Trane	Type TT 14"L X 12"W		
BC-12	1996	800	26.0	1.7	Trane	Type TT 14"L X 12"W		
BC-13	1996	800	26.0	1.7	Trane	Type TT 14"L X 12"W		
BC-14	1996	750	24.4	1.6	Trane	Type TT 14"L X 12"W		
BC-15	1996	760	24.7	1.6	Trane	Type TT 14"L X 12"W		
BC-16	1996	760	24.7	1.6	Trane	Type TT 14"L X 12"W		
BC-17	1996	760	24.7	1.6	Trane	Type TT 14"L X 12"W		
BC-18	1996	1100	35.6	2.4	Trane	Type TT 18"L X 12"W		
BC-19	1996	700	22.8	1.5	Trane	Type TT 14"L X 12"W		
BC-20	1996	700	22.8	1.5	Trane	Type TT 14"L X 12"W		
BC-21	1996	860	28.0	1.9	Trane	Type TT 16"L X 12"W		
BC-22	1996	860	28.0	1.9	Trane	Type TT 16"L X 12"W		
BC-23	1996	1430	46.6	3.1	Trane	Type T 20"L X 15"W		
BC-24	1996	1430	46.6	3.1	Trane	Type T 20"L X 15"W		
BC-25	1996	1300	42.3	2.8	Trane	Type T 18"L X 15"W		
BC-26	1996	1300	42.3	2.8	Trane	Type T 18"L X 15"W		
BC-27	1996	770	25.1	1.7	Trane	Type TT 14"L X 12"W		
BC-28	1996	850	27.7	1.8	Trane	Type TT 16"L X 12"W		
BC-29	1996	700	22.8	1.5	Trane	Type TT 14"L X 12"W		
BC-30	1996	700	22.8	1.5	Trane	Type TT 14"L X 12"W		

BC-31	1996	700	22.8	1.5	Trane	Type TT 14"L X 12"W
BC-32	1996	2135	69.5	4.7	Trane	Type TT 26"L X 18"W
BC-33	1996	2480	104.9	7.0	Trane	Type TT 30"L X 18"W
BC-34	1998	600	19.5	1.4	Trane	Type T 14"L X 12"W
BC-35	1998	530	17.2	1.2	Trane	Type T 12"L X 12"W
BC-36	1998	600	19.5	1.4	Trane	Type T 14"L X 12"W
BC-37	1998	750	24.3	2.0	Trane	Type T 20"L X 9"W
BC-38	1998	16000	881.0	44.2	Trane	Type W 60"L X 48"W
BC-39	1998	3000	84.2	7.1	Trane	Type W 18"L X 36"W
BC-1	2000	760	27.5	1.8	Trane	Type T 15"L X 12"W
BC-2	2000	1600	52.1	3.5	Trane	Type TT 24"L X 15"W
BC-3	2000	1200	41.7	2.8	Trane	Type T 24"L X 12"W
BC-4	2000	1600	81.2	5.4	Trane	Type TT 20"L X 18"W
BC-5	2000	1200	41.7	2.8	Trane	Type T 24"L X 12"W
BC-6	2000	290	28.8	1.9	Trane	Type TT 22"L X 9"W
BC-7	2000	720	27.1	1.8	Trane	Type TT 18"L X 9"W
BC-8	2000	720	27.1	1.8	Trane	Type TT 18"L X 9"W
BC-9	2000	720	27.1	1.8	Trane	Type TT 18"L X 9"W
BC-10	2000	720	27.1	1.8	Trane	Type TT 18"L X 9"W
BC-11	2000	720	27.1	1.8	Trane	Type TT 18"L X 9"W
BC-12	2000	720	27.1	1.8	Trane	Type TT 18"L X 9"W
BC-13	2000	175	7.2	0.5	Trane	Type ST 12"L X 9"W
BC-14	2000	720	27.1	1.8	Trane	Type TT 18"L X 9"W
BC-15	2000	720	27.1	1.8	Trane	Type TT 18"L X 9"W
BC-16	2000	720	27.1	1.8	Trane	Type TT 18"L X 9"W
BC-17	2000	720	27.1	1.8	Trane	Type TT 18"L X 9"W
BC-18	2000	300	11.1	0.8	Trane	Type T 12"L X 9"W
BC-19	2000	300	11.1	0.8	Trane	Type T 12"L X 9"W

PUMPS DATA SHEET

Facility:				Location:						Date:
HBHS				Hollis, NH						12/20/2011

Name	Serves	Location	Manufacturer	Model Number	RPM	Amps	HP	Volt	Phase	Est. kWh/yr
P-1	Building Heating		Bell & Gossett	Series 1510 2 1/2 BB	1,750		7 1/2	408	3	13,410
P-2	Building Heating		Bell & Gossett	Series 1510 2 1/2 BB	1,750		7 1/2	408	3	13,410
P-3	Mini gym		Bell & Gossett	60 1 1/2"A	1,750		1	480	3	894
P-4	Mini gym		Bell & Gossett	60 1 1/2"A	1,750		1	480	3	894
	Well pump						3/4			1,743
Total:					**7,000**		**18**			**30,351**

FIRE-TUBE HOT WATER BOILER DATA SHEET

Facility:		Location:				Date:
HBHS		Hollis, NH				12/20/2011
Location /Use Description	**Manufacturer**	**Model Number**	**Qty**	**Year**	**Capacity (mbh)**	**Efficiency**
Boiler Room / Boiler #1-#3 Space Heating	Weil-McLain	1188	3	1996	3,264	83.5%
Boiler Room / Boiler #4 DHW	Weil-McLain	678	1	1996	764	84.2%
Boiler Burner	Carlin		3		1/4 hp	

FAN DATA SHEET

Facility:			Location:						Date:
HBHS			Hollis, NH						12/20/2011
Unit Name/Location	**Serves**	**Manufacturer**	**Model Number**	**Qty**	**CFM**	**HP**	**Volt**	**Phase**	**Est. kWh/yr**
EF-1	Room 158	Kanalflakt	K6	1	150	0.05	120	1	116
EF-1C	General Exhaust	Greenheck	GB-140	1	1,125	0.33	120	1	775
EF-2	Room 158	Kanalflakt	K6	1	150	0.05	120	1	116
EF-3	East Side Of Build.	Greenheck	GB-140-5	1	2,160	0.75	208	3	1,743
EF-4	West Side Of Build.	Greenheck	GB-180-10	1	3,080	1.00	480	3	2,324
EF-5	Gymnasium	Greenheck	GB-300-10	1	6,000	1.00	480	3	2,324
EF-6	Gymnasium	Greenheck	GB-300-10	1	8,000	1.00	480	3	2,324
EF-7	Flam. Stor. Cab.	Greenheck	GB-70	1	150	0.25	120	1	581
EF-8	Dark Room #139	Greenheck	G-120-A	1	580	0.25	120	1	581
EF-9	Rooms 243,244,246	Greenheck	CSP-226	1	200	0.71	120	1	1,650
EF-11 / Roof	Electrical Room #312	Greenheck	G-130-A	1	1,100	0.50	120	1	1,162
EF-12 / Roof	General #314	Greenheck	GB-130-5	1	1,250	0.50	120	1	1,162
EF-13 / Roof	Auditorium #304	Greenheck	GB-360-7	1	8,000	0.75	480	1	1,743
EF-14 / Roof	Auditorium #304	Greenheck	GB-360-7	1	8,000	0.75	480	1	1,743
KEF-1	Kitchen	Greenheck	Q-300HP-30-G	1	6,880	3.00	480	3	6,973
KEF-2	Dishwasher	Greenheck	GB-90-4	1	3,440	0.25	120	1	581
KSF-1	Kitchen	Greenheck	RSSP-120	1	600	1.50	480	3	3,487
EF-1	Toilet Room #1103	Greenheck	SP-218	1	150	0.10	120	1	232
EF-2	Toilet Room #1104	Greenheck	SP-218	1	150	0.10	120	1	232
Total:				**19**	**51,165**	**12 5/6**			**29,388**

UNIT HEATER INVENTORY

Facility:			Location:						Date:
HBHS			Hollis, NH						12/20/2011

		Air		Water						
Name	**Year Installed**	**CFM**	**MBH**	**GPM**	**HP**	**V**	**Phase**	**Manufacturer**	**Model**	**Est. kWh/yr**
				CABINET UNIT HEATER						
CH-1	1996	685	50.4	2.0	3/23	120	1	Trane	FFHB080	58
CH-2	1996	685	50.4	2.0	3/23	120	1	Trane	FFHB080	58
CH-3	1996	600	50.4	2.0	3/23	120	1	Trane	FFCB060	58
CH-4	1996	250	21.2	1.5	2/25	120	1	Trane	FFCB030	36
CH-5	1996	500	31.7	1.0	3/23	120	1	Trane	FFCB040	58
CH-6	1996	230	20.0	1.0	4/57	120	1	Trane	FFCB020	31
CH-7	1996	330	26.3	1.0	3/50	120	1	Trane	FFHB040	27
CH-8	1996	174	16.8	1.0	2/67	120	1	Trane	FFD8020	13
CH-9	1996	330	31.2	2.0	3/50	120	1	Trane	FFDB040	27
CH-10	1996	330	31.2	2.0	3/50	120	1	Trane	FFDB040	27
CH-1	1998	330	31.2	2.0	3/50	120	1	Trane	FFDB040	27
CH-2	1998	330	31.2	2.0	3/50	120	1	Trane	FFDB040	27
CH-3	1998	330	31.2	2.0	3/50	120	1	Trane	FFDB040	27
CH-4	1998	330	31.2	2.0	3/50	120	1	Trane	FFDB040	27
CH-1	2000	976	84.3	4.5	1/20	120	1	Trane	FFJB012	22
CH-2	2000	174	16.8	1.0	2/67	120	1	Trane	FFJB020	13
CH-3	2000	400	21.2	1.5	2/67	120	1	Trane	FFCB040	13
Total:		**6,984**	**576.7**	**30.5**	**1 3/13**					**210**
				UNIT HEATER						
UH-1	1998	315	8	0.8	1/25	120	1	Trane	20-W2	18
UH-2	1998	315	8	0.8	1/25	120	1	Trane	20-W2	18
UH-3	1998	514	22.1	2.2	1/20	120	1	Trane	38-W2	22
UH-1	2000	1,208	39.1	2.7	1/8	120	1	Trane	102-P	56
UH-2	2000	514	22.1	2.3	1/20	120	1	Trane	38-W2	22
UH-1C	2000	514	22.1	2.3	1/20	120	1	Trane	38-W2	22
Total:		**2236**	**83.3**	**7.3**	**9/40**					**101**
				HEATING AND VENTING						
HV-1	1996	3,080	287.7	19.2	1	480	3	Trane	MCC-6A	447
HV-1	1998	2,480	-	-	1	480	3	Trane	MCC-6A	447
Total:		**5,560**	**288**	**19.2**	**2**					**894**

TRANSFORMER DATA SHEET

Facility:	Location:	Date:
HBHS	Hollis, NH	12/20/2011

Unit Name/Area Served	Location	kVA	WT	Volt	Amps	Manufacturer	Cat. No.
Transformer/Throughout	Rm. 363	150	1375	480	180.4	Square D Company	150T3H647D6
Transformer/Throughout		150	1275	480	180.4	Square D Company	150T3HB-47DB
Transformer/Throughout	Library					Square D Company	

APPENDIX F

Plug Load Inventory

PLUG LOAD INVENTORY

Facility:		Location:			Date:		
HBHS		Hollis, NH			12/20/2011		
Location /Use Description	**Unit**	**Watts/fixture**	**Qty**	**Total watts**	**Est. Hr/Wk**	**Est. kWh/Yr**	**Notes**
374	Band saw	375	3	1,125	1.5	68	
374	Bench grinder	1,200	1	1,200	1.5	72	
374	Cnc machine	735	1	735	1.5	44	
105	Coffee maker	1,200	1	1,200	2	96	
371	Coffee maker	1,200	1	1,200	2	96	
218	Coffee maker	1,200	1	1,200	2	96	
104	Computer	95	1	95	45	171	
105	Computer	95	1	95	45	171	
121	Computer	95	1	95	45	171	
122	Computer	95	1	95	45	171	
123	Computer	95	1	95	45	171	
124	Computer	95	1	95	45	171	
125	Computer	95	1	95	45	171	
126	Computer	95	1	95	45	171	
129	Computer	95	1	95	45	171	
138	Computer	95	2	190	45	342	
141	Computer	95	24	2,280	45	4,104	
147	Computer	95	13	1,235	45	2,223	
172	Computer	95	2	190	45	342	
204	Computer	95	2	190	45	342	
206	Computer	95	2	190	45	342	
207	Computer	95	1	95	45	171	
217	Computer	95	23	2,185	45	3,933	
219	Computer	95	5	475	45	855	
226	Computer	95	3	285	45	513	
229	Computer	95	1	95	45	171	
230	Computer	95	1	95	45	171	
245	Computer	95	1	95	45	171	
300	Computer	95	2	190	45	342	
302	Computer	95	3	285	45	513	
317	Computer	95	1	95	45	171	
318	Computer	95	1	95	45	171	
321	Computer	95	1	95	45	171	
323	Computer	95	1	95	45	171	
327	Computer	95	1	95	45	171	
329	Computer	95	2	190	45	342	
332	Computer	95	1	95	45	171	
356	Computer	95	1	95	45	171	
372	Computer	95	22	2,090	45	3,762	
249c	Computer	95	1	95	45	171	
Library	Computer	95	21	1,995	45	3,591	
128	Computer	95	1	95	45	171	
173	Computer	95	1	95	45	171	

374	Band saw	375	3	1,125	1.5	68
374	Bench grinder	1,200	1	1,200	1.5	72
374	Cnc machine	735	1	735	1.5	44
105	Coffee maker	1,200	1	1,200	2	96
Main office	Computer	95	2	190	45	342
102	Copier	1,440	1	1,440	30	1,728
128	Copier	1,440	1	1,440	20	1,152
207	Copier	1,440	1	1,440	20	1,152
229	Copier	1,440	1	1,440	20	1,152
322	Copier	1,440	1	1,440	20	1,152
Library	Copier	1,440	1	1,440	20	1,152
202	Cow	600	3	1,800	80	5,760
248	Desk jet	35	1	35	2	3
274	Desk jet	35	1	35	2	3
158	Dishwasher	1,000	1	1,000	5	200
229	Dishwasher	1,000	1	1,000	5	200
270	Dishwasher	1,000	1	1,000	5	200
374	Drill press	780	1	780	1.5	47
158	Dryer	3,360	1	3,360	5	672
354	Dryer	3,360	1	3,360	5	672
156	Fan	20	4	80	3	10
159	Fan	20	1	20	3	2
177	Fan	20	1	20	3	2
222	Fan	20	1	20	3	2
270	Fan	20	1	20	3	2
274	Fan	20	1	20	3	2
301	Fan	20	3	60	3	7
303	Fan	20	3	60	3	7
309	Fan	20	1	20	3	2
318	Fan	20	1	20	3	2
323	Fan	20	1	20	3	2
327	Fan	20	1	20	3	2
332	Fan	20	1	20	3	2
362	Fan	20	1	20	3	2
368	Fan	20	1	20	3	2
371	Fan	20	1	20	3	2
Main office	Fan	20	1	20	3	2
203	Fan	20	1	20	3	2
226	Fan	20	1	20	3	2
317	Fan	20	1	20	3	2
158	Full fridge	500	3	1,500	40	2,400
229	Full fridge	500	1	500	40	800
270	Full fridge	500	1	500	40	800
Kitchen	Full fridge	900	4	3,600	40	5,760
124	Hepa	1,100	1	1,100	1.5	66
354	Icemaker	800	1	800	3	96
170	Kiln	4,320	1	4,320	0.25	43
121	Lamp	60	1	60	40	96

374	Band saw	375	3	1,125	1.5	68
374	Bench grinder	1,200	1	1,200	1.5	72
374	Cnc machine	735	1	735	1.5	44
105	Coffee maker	1,200	1	1,200	2	96
123	Lamp	60	1	60	40	96
125	Lamp	60	1	60	40	96
163	Lamp	60	1	60	40	96
216	Lamp	60	2	120	40	192
217	Lamp	60	2	120	40	192
218	Lamp	60	1	60	40	96
221	Lamp	60	1	60	40	96
229	Lamp	60	1	60	40	96
250	Lamp	60	3	180	40	288
274	Lamp	60	1	60	40	96
156	Lamps	60	4	240	40	384
103	laptop	30	1	30	30	36
104	Laptop	30	1	30	30	36
107	Laptop	30	1	30	30	36
112	Laptop	30	1	30	30	36
129	Laptop	30	1	30	30	36
147	Laptop	30	6	180	30	216
151	Laptop	30	5	150	30	180
153	Laptop	30	1	30	30	36
159	Laptop	30	6	180	30	216
163	Laptop	30	1	30	30	36
163	Laptop	30	1	30	30	36
170	Laptop	30	6	180	30	216
175	Laptop	30	1	30	30	36
176	Laptop	30	1	30	30	36
177	Laptop	30	1	30	30	36
201	Laptop	30	1	30	30	36
202	Laptop	30	1	30	30	36
203	Laptop	30	1	30	30	36
216	Laptop	30	2	60	30	72
218	Laptop	30	1	30	30	36
222	Laptop	30	1	30	30	36
223	Laptop	30	1	30	30	36
248	Laptop	30	1	30	30	36
249	laptop	30	6	180	30	216
271	laptop	30	2	60	30	72
273	Laptop	30	1	30	30	36
274	Laptop	30	1	30	30	36
275	Laptop	30	3	90	30	108
309	Laptop	30	1	30	30	36
327	Laptop	30	1	30	30	36
346	Laptop	30	1	30	30	36
361	Laptop	30	2	60	30	72
362	Laptop	30	1	30	30	36

374	Band saw	375	3	1,125	1.5	68
374	Bench grinder	1,200	1	1,200	1.5	72
374	Cnc machine	735	1	735	1.5	44
105	Coffee maker	1,200	1	1,200	2	96
368	Laptop	30	3	90	30	108
371	Laptop	30	1	30	30	36
147a	Laptop	30	1	30	30	36
Kitchen	Laptop	30	1	30	30	36
Library	Laptop	30	2	60	30	72
156	Laptop	30	12	360	30	432
207	Laptop	30	2	60	30	72
270	Laptop	30	6	180	30	216
307	Laptop	30	1	30	30	36
103	laser jet	500	1	500	2	40
112	Laser jet	500	1	500	2	40
122	Laser jet	500	1	500	2	40
125	Laser jet	500	1	500	2	40
126	Laser jet	500	1	500	2	40
153	Laser jet	500	1	500	2	40
206	Laser jet	500	1	500	2	40
272	Laser jet	500	1	500	2	40
356	Laser jet	500	1	500	2	40
147a	Laser jet	500	1	500	2	40
249c	Laser jet	500	1	500	2	40
107	Laser jet	500	1	500	2	40
Main office	Laserjet	500	1	500	2	40
204	Lcd	30	2	60	45	108
104	LCD	30	1	30	45	54
105	LCD	30	1	30	45	54
121	LCD	30	1	30	45	54
122	LCD	30	1	30	45	54
123	LCD	30	1	30	45	54
124	LCD	30	1	30	45	54
125	LCD	30	1	30	45	54
126	LCD	30	1	30	45	54
128	LCD	30	1	30	45	54
129	LCD	30	1	30	45	54
138	LCD	30	2	60	45	108
141	LCD	30	24	720	45	1,296
147	LCD	30	3	90	45	162
163	LCD	30	1	30	45	54
172	Lcd	30	2	60	45	108
173	LCD	30	1	30	45	54
206	LCD	30	2	60	45	108
207	LCD	30	1	30	45	54
217	LCD	30	23	690	45	1,242
219	LCD	30	3	90	45	162
226	LCD	30	3	90	45	162

374	Band saw	375	3	1,125	1.5	68
374	Bench grinder	1,200	1	1,200	1.5	72
374	Cnc machine	735	1	735	1.5	44
105	Coffee maker	1,200	1	1,200	2	96
229	LCD	30	1	30	45	54
230	LCD	30	1	30	45	54
300	LCD	30	2	60	45	108
302	LCD	30	1	30	45	54
317	LCD	30	1	30	45	54
318	LCD	30	1	30	45	54
321	LCD	30	1	30	45	54
322	LCD	30	2	60	45	108
323	LCD	30	1	30	45	54
327	LCD	30	2	60	45	108
329	LCD	30	1	30	45	54
332	LCD	30	1	30	45	54
356	LCD	30	1	30	45	54
361	LCD	30	2	60	45	108
368	LCD	30	1	30	45	54
372	LCD	30	22	660	45	1,188
249c	LCD	30	1	30	45	54
Library	LCD	30	21	630	45	1,134
Main office	LCD	30	3	90	45	162
362	Light	60	6	360	40	576
102	Microwave	1,000	1	1,000	1	40
138	Microwave	1,000	1	1,000	1	40
153	Microwave	1,000	1	1,000	1	40
158	Microwave	1,000	4	4,000	1	160
170	Microwave	1,000	1	1,000	1	40
172	Microwave	1,000	1	1,000	1	40
173	Microwave	1,000	1	1,000	1	40
177	Microwave	1,000	1	1,000	1	40
216	Microwave	1,000	1	1,000	1	40
229	Microwave	1,000	3	3,000	1	120
270	Microwave	1,000	1	1,000	1	40
273	Microwave	1,000	1	1,000	1	40
304	Microwave	1,000	1	1,000	1	40
322	Microwave	1,000	1	1,000	1	40
372	Microwave	1,000	1	1,000	1	40
147a	Microwave	1,000	1	1,000	1	40
119	Microwave	1,000	1	1,000	1	40
362	Microwave	1,000	1	1,000	1	40
Kitchen	Milk chest	800	1	800	60	1,920
102	Mini fridge	300	1	300	60	720
104	Mini fridge	300	1	300	60	720
105	Mini fridge	300	1	300	60	720
119	Mini fridge	300	1	300	60	720
124	Mini fridge	300	1	300	60	720

374	Band saw	375	3	1,125	1.5	68
374	Bench grinder	1,200	1	1,200	1.5	72
374	Cnc machine	735	1	735	1.5	44
105	Coffee maker	1,200	1	1,200	2	96
138	Mini fridge	300	1	300	60	720
151	Mini fridge	300	1	300	60	720
153	Mini fridge	300	1	300	60	720
156	Mini fridge	300	1	300	60	720
170	Mini fridge	300	1	300	60	720
171	mini fridge	300	1	300	60	720
172	Mini fridge	300	1	300	60	720
174	Mini fridge	300	1	300	60	720
207	Mini fridge	300	1	300	60	720
216	Mini fridge	300	1	300	60	720
218	Mini fridge	300	1	300	60	720
222	Mini fridge	300	1	300	60	720
230	Mini fridge	300	1	300	60	720
249	Mini fridge	300	1	300	60	720
271	Mini fridge	300	1	300	60	720
273	Mini fridge	300	1	300	60	720
304	Mini fridge	300	2	600	60	1,440
322	Mini fridge	300	1	300	60	720
346	Mini fridge	300	1	300	60	720
362	Mini fridge	300	1	300	60	720
368	Mini fridge	300	1	300	60	720
371	Mini fridge	300	1	300	60	720
372	Mini fridge	300	1	300	60	720
177	Mini fridge	300	1	300	60	720
147a	Mini fridge	300	1	300	60	720
202	Netbook	25	12	300	40	480
158	Oven	3,000	4	12,000	3	1,440
170	Pottery wheels	375	1	375	0.5	8
217	Printer	500	1	500	2	40
158	Projector	240	1	240	4	38
163	Projector	240	1	240	4	38
170	Projector	240	1	240	4	38
171	Projector	240	1	240	4	38
174	Projector	240	1	240	4	38
175	Projector	240	1	240	4	38
176	Projector	240	1	240	4	38
177	Projector	240	1	240	4	38
201	Projector	240	1	240	4	38
202	Projector	240	1	240	4	38
204	Projector	240	1	240	4	38
216	Projector	240	1	240	4	38
221	Projector	240	1	240	4	38
222	Projector	240	1	240	4	38
223	Projector	240	2	480	4	77

374	Band saw	375	3	1,125	1.5	68
374	Bench grinder	1,200	1	1,200	1.5	72
374	Cnc machine	735	1	735	1.5	44
105	Coffee maker	1,200	1	1,200	2	96
224	Projector	240	1	240	4	38
248	Projector	240	1	240	4	38
271	Projector	240	1	240	4	38
273	Projector	240	1	240	4	38
274	Projector	240	1	240	4	38
275	Projector	240	1	240	4	38
276	Projector	240	1	240	4	38
300	Projector	240	1	240	4	38
301	Projector	240	1	240	4	38
307	Projector	240	1	240	4	38
309	Projector	240	1	240	4	38
318	Projector	240	1	240	4	38
321	Projector	240	1	240	4	38
323	Projector	240	1	240	4	38
327	Projector	240	1	240	4	38
332	Projector	240	1	240	4	38
371	Projector	240	1	240	4	38
203	Projector	240	1	240	4	38
317	Projector	240	1	240	4	38
370	Projector	240	1	240	4	38
371	Projector	240	1	240	4	38
124	Radio	15	1	15	1	1
177	Radio	15	1	15	1	1
Library	Scan machine	35	1	35	1	1
104	Shredder	200	1	200	1	8
127	Shredder	200	1	200	1	8
270	Stove	4,400	1	4,400	1.5	264
229	Toaster	1,000	1	1,000	1	40
158	Tv	160	1	160	1.5	10
354	Tv	160	1	160	1.5	10
361	Tv	160	1	160	1.5	10
362	Tv	160	1	160	1.5	10
Cafeteria	Tv	160	1	160	1.5	10
202	Tv	160	1	160	1.5	10
163	VCR	25	1	25	0.5	1
175	VCR	25	1	25	0.5	1
176	VCR	25	1	25	0.5	1
201	VCR	25	1	25	0.5	1
202	VCR	25	1	25	0.5	1
271	VCR	25	1	25	0.5	1
273	VCR	25	1	25	0.5	1
274	VCR	25	1	25	0.5	1
275	VCR	25	1	25	0.5	1
371	VCR	25	1	25	0.5	1

374	Band saw	375	3	1,125	1.5	68
374	Bench grinder	1,200	1	1,200	1.5	72
374	Cnc machine	735	1	735	1.5	44
105	Coffee maker	1,200	1	1,200	2	96
102	Vending machine	500	1	500	40	800
Cafeteria	Vending machine	500	3	1,500	40	2,400
Kitchen	Vending machine	500	1	500	40	800
229	Vending machine	500	1	500	40	800
Kitchen	Warming try	3,000	4	12,000	10	4,800
158	Washer	1,200	1	1,200	5	240
354	Washer	1,200	1	1,200	5	240
All	Water fountain	350	8	2,800	70	7,840
Totals:			**640**	**152,325**		**112,339**

APPENDIX G

ENERGY STAR® Statement of Energy Performance

OMB No. 2060-0347

STATEMENT OF ENERGY PERFORMANCE
Hollis Brookline High School

Building ID: 1746663
For 12-month Period Ending: January 31, 2012[1]
Date SEP becomes ineligible: N/A

Date SEP Generated: February 16, 2012

Facility
Hollis Brookline High School
24 Cavalier Court
Hollis, NH 03049

Facility Owner
Town of Hollis
7 Monument Square
Hollis, NH 03049

Primary Contact for this Facility
Troy Brown
7 Monument Square
Hollis, NH 03049

Year Built: 1995
Gross Floor Area (ft^2): 153,429

Energy Performance Rating[2] (1-100) 85

Site Energy Use Summary[3]	
Electricity - Grid Purchase(kBtu)	2,899,518
Fuel Oil (No. 2) (kBtu)	3,639,433
Natural Gas - (kBtu)[4]	0
Total Energy (kBtu)	6,538,951

Energy Intensity[4]	
Site (kBtu/ft^2/yr)	43
Source (kBtu/ft^2/yr)	87

Emissions (based on site energy use)
Greenhouse Gas Emissions ($MtCO_2e$/year) 589

Electric Distribution Utility
Public Service Co of New Hampshire [Northeast Utilities]

National Median Comparison	
National Median Site EUI	63
National Median Source EUI	129
% Difference from National Median Source EUI	-32%
Building Type	K-12 School

Stamp of Certifying Professional

Based on the conditions observed at the time of my visit to this building, I certify that the information contained within this statement is accurate.

Meets Industry Standards[5] for Indoor Environmental Conditions:

Ventilation for Acceptable Indoor Air Quality	**N/A**
Acceptable Thermal Environmental Conditions	**N/A**
Adequate Illumination	**N/A**

Certifying Professional
Timothy Nichols
20 Madbury Road STE 3
Durham, NH 03824

Notes:
1. Application for the ENERGY STAR must be submitted to EPA within 4 months of the Period Ending date. Award of the ENERGY STAR is not final until approval is received from EPA.
2. The EPA Energy Performance Rating is based on total source energy. A rating of 75 is the minimum to be eligible for the ENERGY STAR.
3. Values represent energy consumption, annualized to a 12-month period.
4. Values represent energy intensity, annualized to a 12-month period.
5. Based on Meeting ASHRAE Standard 62 for ventilation for acceptable indoor air quality, ASHRAE Standard 55 for thermal comfort, and IESNA Lighting Handbook for lighting quality.

ENERGY STAR® Data Checklist for Commercial Buildings

In order for a building to qualify for the ENERGY STAR, a Professional Engineer (PE) or a Registered Architect (RA) must validate the accuracy of the data underlying the building's energy performance rating. This checklist is designed to provide an at-a-glance summary of a property's physical and operating characteristics, as well as its total energy consumption, to assist the PE or RA in double-checking the information that the building owner or operator has entered into Portfolio Manager.

Please complete and sign this checklist and include it with the stamped, signed Statement of Energy Performance.
NOTE: You must check each box to indicate that each value is correct, OR include a note.

CRITERION	VALUE AS ENTERED IN PORTFOLIO MANAGER	VERIFICATION QUESTIONS	NOTES	☑
Building Name	Hollis Brookline High School	Is this the official building name to be displayed in the ENERGY STAR Registry of Labeled Buildings?		☐
Type	K-12 School	Is this an accurate description of the space in question?		☐
Location	24 Cavalier Court, Hollis, NH 03049	Is this address accurate and complete? Correct weather normalization requires an accurate zip code.		☐
Single Structure	Single Facility	Does this SEP represent a single structure? SEPs cannot be submitted for multiple-building campuses (with the exception of a hospital, k-12 school, hotel and senior care facility) nor can they be submitted as representing only a portion of a building.		☐

Hollis Brookline High School (K-12 School)

CRITERION	VALUE AS ENTERED IN PORTFOLIO MANAGER	VERIFICATION QUESTIONS	NOTES	☑
Gross Floor Area	153,429 Sq. Ft.	Does this square footage include all supporting functions such as kitchens and break rooms used by staff, storage areas, administrative areas, elevators, stairwells, atria, vent shafts, etc. Also note that existing atriums should only include the base floor area that it occupies. Interstitial (plenum) space between floors should not be included in the total. Finally gross floor area is not the same as leasable space. Leasable space is a subset of gross floor area.		☐
Open Weekends?	No	Is this building normally open at all on the weekends? This includes activities beyond the work conducted by maintenance, cleaning, and security personnel. Weekend activity could include any time when the space is used for classes, performances or other school or community activities. If the building is open on the weekend as part of the standard schedule during one or more seasons, the building should select ?yes? for open weekends. The ?yes? response should apply whether the building is open for one or both of the weekend days.		☐
Number of PCs	100	Is this the number of personal computers in the K12 School?		☐
Number of walk-in refrigeration/freezer units	2	Is this the total number of commercial walk-in type freezers and coolers? These units are typically found in storage and receiving areas.		☐
Presence of cooking facilities	Yes	Does this school have a dedicated space in which food is prepared and served to students? If the school has space in which food for students is only kept warm and/or served to students, or has only a galley that is used by teachers and staff then the answer is "no".		☐
Percent Cooled	30 %	Is this the percentage of the total floor space within the facility that is served by mechanical cooling equipment?		☐
Percent Heated	100 %	Is this the percentage of the total floor space within the facility that is served by mechanical heating equipment?		☐
Months	9(Optional)	Is this school in operation for at least 8 months of the year?		☐

High School?	Yes	Is this building a high school (teaching grades 10, 11, and/or 12)? If the building teaches to high school students at all, the user should check 'yes' to 'high school'. For example, if the school teaches to grades K-12 (elementary/middle and high school), the user should check 'yes' to 'high school'.		☐

Energy Consumption

Power Generation Plant or Distribution Utility: Public Service Co of New Hampshire [Northeast Utilities]

Fuel Type: Electricity

Meter: HBHS-Elec (kWh (thousand Watt-hours))
Space(s): Entire Facility
Generation Method: Grid Purchase

Start Date	End Date	Energy Use (kWh (thousand Watt-hours))
01/01/2012	01/31/2012	78,600.00
12/01/2011	12/31/2011	68,800.00
11/01/2011	11/30/2011	64,800.00
10/01/2011	10/31/2011	76,800.00
09/01/2011	09/30/2011	67,800.00
08/01/2011	08/31/2011	54,000.00
07/01/2011	07/31/2011	65,000.00
06/01/2011	06/30/2011	70,600.00
05/01/2011	05/31/2011	64,000.00
04/01/2011	04/30/2011	82,000.00
03/01/2011	03/31/2011	74,800.00
02/01/2011	02/28/2011	82,600.00
HBHS-Elec Consumption (kWh (thousand Watt-hours))		**849,800.00**
HBHS-Elec Consumption (kBtu (thousand Btu))		**2,899,517.60**
Total Electricity (Grid Purchase) Consumption (kBtu (thousand Btu))		**2,899,517.60**
Is this the total Electricity (Grid Purchase) consumption at this building including all Electricity meters?		☐

Fuel Type: Fuel Oil (No. 2)

Meter: HBHS-Oil (Gallons)
Space(s): Entire Facility

Start Date	End Date	Energy Use (Gallons)
01/01/2012	01/31/2012	5,066.10
12/01/2011	12/31/2011	5,137.40
11/01/2011	11/30/2011	0.00
10/01/2011	10/31/2011	0.00
09/01/2011	09/30/2011	0.00
08/01/2011	08/31/2011	0.00
07/01/2011	07/31/2011	0.00
06/01/2011	06/30/2011	0.00
05/01/2011	05/31/2011	3,505.30
04/01/2011	04/30/2011	3,002.30

03/01/2011	03/31/2011	5,010.20
02/01/2011	02/28/2011	4,520.10
HBHS-Oil Consumption (Gallons)		**26,241.40**
HBHS-Oil Consumption (kBtu (thousand Btu))		**3,639,432.89**
Total Fuel Oil (No. 2) Consumption (kBtu (thousand Btu))		**3,639,432.89**
Is this the total Fuel Oil (No. 2) consumption at this building including all Fuel Oil (No. 2) meters?		☐

Additional Fuels	
Do the fuel consumption totals shown above represent the total energy use of this building? Please confirm there are no additional fuels (district energy, generator fuel oil) used in this facility.	☐

On-Site Solar and Wind Energy	
Do the fuel consumption totals shown above include all on-site solar and/or wind power located at your facility? Please confirm that no on-site solar or wind installations have been omitted from this list. All on-site systems must be reported.	☐

Certifying Professional

(When applying for the ENERGY STAR, the Certifying Professional must be the same PE or RA that signed and stamped the SEP.)

Name: ____ Date: ____________

Signature: ______________________________________

Signature is required when applying for the ENERGY STAR.

FOR YOUR RECORDS ONLY. DO NOT SUBMIT TO EPA.

Please keep this Facility Summary for your own records; do not submit it to EPA. Only the Statement of Energy Performance (SEP), Data Checklist and Letter of Agreement need to be submitted to EPA when applying for the ENERGY STAR.

Facility
Hollis Brookline High School
24 Cavalier Court
Hollis, NH 03049

Facility Owner
Town of Hollis
7 Monument Square
Hollis, NH 03049

Primary Contact for this Facility
Troy Brown
7 Monument Square
Hollis, NH 03049

General Information

Hollis Brookline High School	
Gross Floor Area Excluding Parking: (ft^2)	153,429
Year Built	1995
For 12-month Evaluation Period Ending Date:	January 31, 2012

Facility Space Use Summary

Hollis Brookline High School	
Space Type	K-12 School
Gross Floor Area(ft^2)	153,429
Open Weekends?	No
Number of PCs	100
Number of walk-in refrigeration/freezer units	2
Presence of cooking facilities	Yes
Percent Cooled	30
Percent Heated	100
Months[o]	9
High School?	Yes
School District[o]	N/A

Energy Performance Comparison

	Evaluation Periods		Comparisons		
Performance Metrics	**Current** (Ending Date 01/31/2012)	**Baseline** (Ending Date 04/30/2008)	**Rating of 75**	**Target**	**National Median**
Energy Performance Rating	85	60	75	N/A	50
Energy Intensity					
Site (kBtu/ft²)	43	64	49	N/A	63
Source (kBtu/ft²)	87	117	101	N/A	129
Energy Cost					
$/year	$ 207,604.60	$ 240,197.42	$ 240,143.28	N/A	$ 307,120.37
$/ft²/year	$ 1.35	$ 1.57	$ 1.56	N/A	$ 2.00
Greenhouse Gas Emissions					
$MtCO_2e$/year	589	847	681	N/A	871
$kgCO_2e/ft^2$/year	4	6	5	N/A	6

More than 50% of your building is defined as K-12 School. Please note that your rating accounts for all of the spaces listed. The National Median column presents energy performance data your building would have if your building had a median rating of 50.

Notes:
o - This attribute is optional.
d - A default value has been supplied by Portfolio Manager.

APPENDIX H

Renewable Energies Screening Worksheets

RENEWABLE ENERGY SCREENING SUMMARY

Building/Facility:	Hollis-Brookline High School	Location:	Hollis, NH
Gross Area (sf):	153,429	Date:	3/16/2012
Use Category:	K-12 School	EUI (kBtu/sf/yr):	87
Heating Fuel(s):	Oil (No. 2)	PM Grade:	85
Heating System(s):	Hydronic	Cooling System(s):	Limited (DX Coils)

RE Technology	Score (out of 70 pts.)	Grade	Notes/Comments
Geothermal Heating/Cooling	59.0	84%	Closed-loop GSHP system.
Roof Photovoltaic	57.0	81%	Large system 30kw - 75kw.
Ground Photovoltaic	55.0	79%	Large system 30kw - 75kw.
Biomass Heating	54.5	78%	Pellet feed system recommended.
Wind Turbine Generator	54.5	78%	Permit requirements are height dependent.
Solar DHW	53.5	76%	DHW demand should be confirmed.
Solar Thermal	52.5	75%	Medium-temperature system.
Combined Heat & Power	49.0	70%	75kW system.

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	Hollis-Brookline High School	Location:	Hollis, NH
Gross Area (sf):	153,429	Date:	3/16/2012
Use Category:	K-12 School	EUI (kBtu/sf/yr):	87
Heating Fuel(s):	Oil (No. 2)	PM Grade:	85
Heating System(s):	Hydronic	Cooling System(s):	Limited (DX Coils)

Technology: **Geothermal Heating & Cooling**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	4.5	Well demonstrated technology but does require engineering design.
2	Expected service life/durability	4.5	Well field and loop system has +50 year service life. Equipment has +20 yr service life.
3	Geographical considerations	4.5	Abundant geothermal energy reserves.
4	Energy demand	4.5	Heating and cooling energy consumption is high.
5	Facility/systems conditions	4.5	Existing system and spacial considerations are met.
6	Facility/systems compatibility	4.5	Existing system and spacial considerations are met.
7	Permitting constraints	5	No special permitting required for a closed-loop system (open-loop would require state permit and is not recommended).
8	Abutter concerns	5	Abutters with water supply wells can be sensitive to geothermal wells but a closed-loop system will have no impact.
9	Capital investment	2.5	High capital cost.
10	O&M requirements	4.5	Very low O&M except routine equipment maintenance.
11	Financial incentives	2.5	Limited incentives in NH.
12	Owner initiatives	4	Owner is open to renewable options.
13	CO2e emissions	4.5	The building currently uses a high amount of oil.
14	Public awareness/education	4	Moderately high public use. Information could be displayed in the building so users are aware of geothermal system.
	Total Score:	**59**	
	Total Possible Score:	**70**	
	Grade:	**84%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	Hollis-Brookline High School	Location:	Hollis, NH
Gross Area (sf):	153,429	Date:	3/16/2012
Use Category:	K-12 School	EUI (kBtu/sf/yr):	87
Heating Fuel(s):	Oil (No. 2)	PM Grade:	85
Heating System(s):	Hydronic	Cooling System(s):	Limited (DX Coils)

Technology: **Roof-Mounted Solar PV**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	5	Well demonstrated technology with more efficient panel systems in development.
2	Expected service life/durability	3.5	Expected service life of collector panels is 15 years.
3	Geographical considerations	3.5	Limited solar availability in New England.
4	Energy demand	5	High grid electrical demand.
5	Facility/systems conditions	5	Ample amount of south facing roof space.
6	Facility/systems compatibility	5	Ample amount of south facing roof space; newer electrical system
7	Permitting constraints	2.5	Utility grid connection permit is long-lead and may require a designed/engineered system.
8	Abutter concerns	5	School setback from all abutting properties and roads.
9	Capital investment	2.5	High capital cost.
10	O&M requirements	3.5	Increased roof maintenance and panel replacement.
11	Financial incentives	3	Limited incentives in NH.
12	Owner initiatives	4.5	Owner is open to renewable options.
13	CO2e emissions	4.5	Electrical source energy in NH has lower than average CO2 emissions.
14	Public awareness/education	4.5	Moderately high public use facility, would be visible on school grounds.
	Total Score:	**57**	
	Total Possible Score:	**70**	
	Grade:	**81%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	Hollis-Brookline High School	Location:	Hollis, NH
Gross Area (sf):	153,429	Date:	3/16/2012
Use Category:	K-12 School	EUI (kBtu/sf/yr):	87
Heating Fuel(s):	Oil (No. 2)	PM Grade:	85
Heating System(s):	Hydronic	Cooling System(s):	Limited (DX Coils)

Technology: **Ground-Mounted Solar PV**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	5	Well demonstrated technology with more efficient panel systems in development.
2	Expected service life/durability	3	Expected service life of collector panels is 15 years.
3	Geographical considerations	3.5	Limited solar availability in New England.
4	Energy demand	5	High grid electrical demand.
5	Facility/systems conditions	5	Newer facility and systems.
6	Facility/systems compatibility	4.5	Multiple areas where system could be installed.
7	Permitting constraints	2.5	Utility grid connection permit is long-lead and may require a designed/engineered system.
8	Abutter concerns	5	School not visible from abutting properties.
9	Capital investment	3	High capital cost.
10	O&M requirements	3.5	Vegetative cutting and panel replacement.
11	Financial incentives	2.5	Limited incentives in NH.
12	Owner initiatives	4	Owner is open to renewable options.
13	CO2e emissions	4.5	Electrical source energy is NH has lower than average CO2 emissions.
14	Public awareness/education	4	Moderately high public use.
	Total Score:	**55**	
	Total Possible Score:	**70**	
	Grade:	**79%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility: Hollis-Brookline High School
Location: Hollis, NH
Gross Area (sf): 153,429
Date: 3/16/2012
Use Category: K-12 School
EUI (kBtu/sf/yr): 87
Heating Fuel(s): Oil (No. 2)
PM Grade: 85
Heating System(s): Hydronic
Cooling System(s): Limited (DX Coils)

Technology: **Biomass Heating Systems (wood, chips, pellets)**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	4	Well demonstrated technology. Some woodchip and pellet feed units are newer technology.
2	Expected service life/durability	4	Expected service life is 20 yrs.
3	Geographical considerations	3	Limited fuel in Southern NH.
4	Energy demand	4.5	Heating energy is high in the building.
5	Facility/systems conditions	4	Woodchips/pellets could be stored inside or outside building.
6	Facility/systems compatibility	4	Woodchips/pellets could be stored inside or outside building.
7	Permitting constraints	5	No special permits required.
8	Abutter concerns	4	Systems are located inside building. Wood or chip feedstock located outside could be a concern.
9	Capital investment	4	Low capital cost.
10	O&M requirements	3.5	Wood and woodchip units require constant attending and feedstock must be sourced. Pellet systems with hoppers are less intensive and feedstock is commercially available.
11	Financial incentives	2.5	Limited incentives.
12	Owner initiatives	4.5	Owner is highly interested biomass heating.
13	CO2e emissions	3.5	Biomass does emit CO2 but the net reduction from the oil system will be significant.
14	Public awareness/education	4	Moderately high public use. Information could be displayed in the building so users are aware of biomass heating system.
	Total Score:	**54.5**	
	Total Possible Score:	**70**	
	Grade:	**78%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	Hollis-Brookline High School	Location:	Hollis, NH
Gross Area (sf):	153,429	Date:	3/16/2012
Use Category:	K-12 School	EUI (kBtu/sf/yr):	87
Heating Fuel(s):	Oil (No. 2)	PM Grade:	85
Heating System(s):	Hydronic	Cooling System(s):	Limited (DX Coils)

Technology: **Wind Turbine Generator**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	4.5	A well demonstrated technology but proper site selection is critical.
2	Expected service life/durability	3.5	Some turbine units have proven unreliable (design flaws). Selection of a reputable manufacturer is critical.
3	Geographical considerations	3	Limited wind energy but a feasibility study is required.
4	Energy demand	5	Electric energy consumption is high.
5	Facility/systems conditions	5	Newer building and electrical systems.
6	Facility/systems compatibility	5	Newer building and electrical systems.
7	Permitting constraints	3	Special permits are required depending on the height of the pole-mounted turbine. Roof-mounted turbines may be practical however they provide less energy.
8	Abutter concerns	2.5	Pole-mounted turbines have a large visual impact.
9	Capital investment	3.5	Moderate capital cost.
10	O&M requirements	3.5	Routine maintenance required. Units are subject to damage from elements.
11	Financial incentives	3	Limited incentives in NH.
12	Owner initiatives	4	Owner is open to renewable options.
13	CO2e emissions	4	Electrical source energy is NH has lower than average CO2 emissions.
14	Public awareness/education	5	High visibility.
	Total Score:	**54.5**	
	Total Possible Score:	**70**	
	Grade:	**78%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	Hollis-Brookline High School	Location:	Hollis, NH
Gross Area (sf):	153,429	Date:	3/16/2012
Use Category:	K-12 School	EUI (kBtu/sf/yr):	87
Heating Fuel(s):	Oil (No. 2)	PM Grade:	85
Heating System(s):	Hydronic	Cooling System(s):	Limited (DX Coils)

Technology: **Solar Domestic Hot Water**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	4	Well demonstrated technology although system design and function can vary.
2	Expected service life/durability	3	Expected service life of heating panels is 15 years.
3	Geographical considerations	3.5	Limited solar availability in New England.
4	Energy demand	4.5	Expected DHW demand is low.
5	Facility/systems conditions	4	No large storage currently on site.
6	Facility/systems compatibility	4	No large storage currently on site.
7	Permitting constraints	5	No special permitting required.
8	Abutter concerns	5	Low visibility/impact.
9	Capital investment	2.5	High capital cost.
10	O&M requirements	4	Panel replacement and normal DHW system maintenance.
11	Financial incentives	2.5	Limited incentives in NH.
12	Owner initiatives	4	Owner is open to renewable options.
13	CO2e emissions	3.5	Moderate reduction of oil use based on DHW demand.
14	Public awareness/education	4	Moderately high public use.
	Total Score:	**53.5**	
	Total Possible Score:	**70**	
	Grade:	**76%**	

RENEWABLE ENERGY SCREENING WORKSHEET

Building/Facility:	Hollis-Brookline High School	Location:	Hollis, NH
Gross Area (sf):	153,429	Date:	3/16/2012
Use Category:	K-12 School	EUI (kBtu/sf/yr):	87
Heating Fuel(s):	Oil (No. 2)	PM Grade:	85
Heating System(s):	Hydronic	Cooling System(s):	Limited (DX Coils)

Technology: **Solar Thermal HVAC**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	3.5	Well demonstrated technology but supply limited. More efficient than regular PV.
2	Expected service life/durability	4	Expected service life of system is 20 years.
3	Geographical considerations	3	Limited solar availability in New England.
4	Energy demand	5	Heating and cooling high.
5	Facility/systems conditions	5	Existing mechanical system could be incorporated into system.
6	Facility/systems compatibility	4	Considerable space required but could be made available. Plumbing complex to protect against freezing.
7	Permitting constraints	2.5	Utility grid connection permit is long-lead and may require a designed/engineered system.
8	Abutter concerns	5	School not visible from abutting properties.
9	Capital investment	2	High capital cost.
10	O&M requirements	3	Vegetative cutting for ground mount, roof maintenance for roof mount, panel replacement.
11	Financial incentives	2.5	Limited incentives in NH.
12	Owner initiatives	4	Owner is open to renewable options.
13	CO2e emissions	4	Electrical source energy is NH has lower than average CO2 emissions.
14	Public awareness/education	5	High visibility depending on placement.
	Total Score:	**52.5**	
	Total Possible Score:	**70**	
	Grade:	**75%**	

RENEWABLE ENERGY SCREENING WORKSHEET

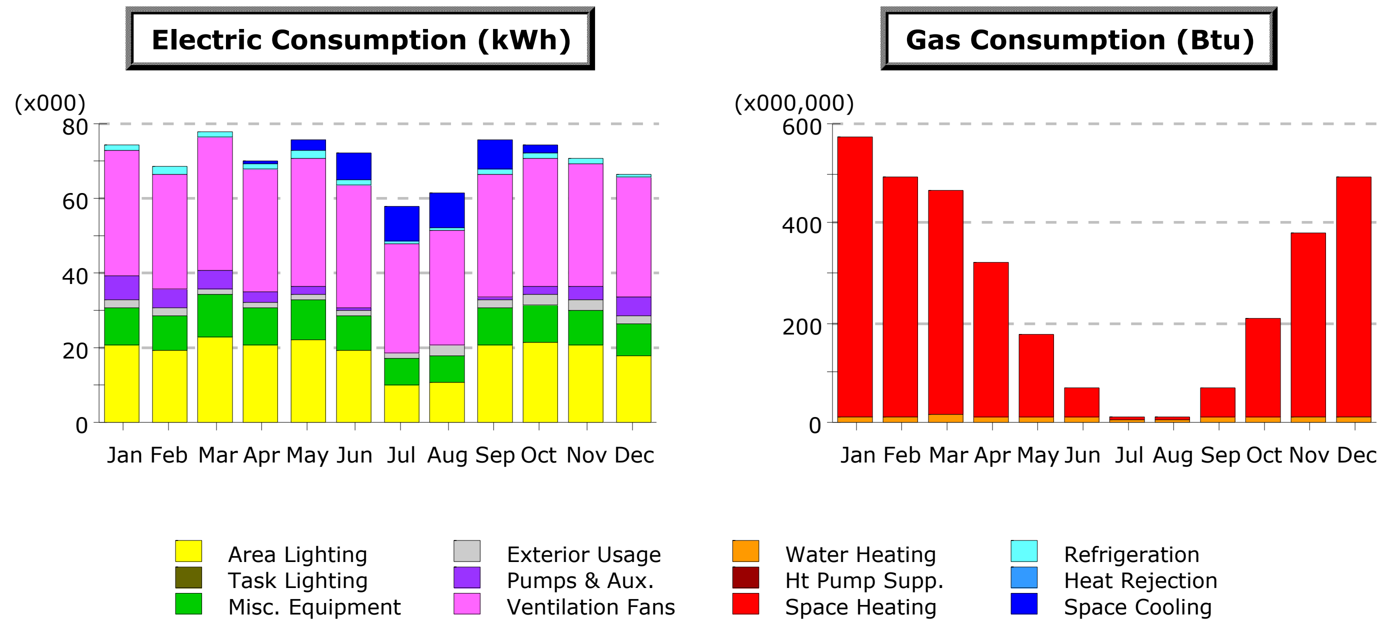
Building/Facility:	Hollis-Brookline High School	Location:	Hollis, NH
Gross Area (sf):	153,429	Date:	3/16/2012
Use Category:	K-12 School	EUI (kBtu/sf/yr):	87
Heating Fuel(s):	Oil (No. 2)	PM Grade:	85
Heating System(s):	Hydronic	Cooling System(s):	Limited (DX Coils)

Technology: **Combined Heat & Power System**

No.	Criteria	Score (1-5 pts.)	Notes/Comments
1	Demonstrated technology	5	Smaller CHP units are relatively new technology. Larger units (+75kW) are more reliable.
2	Expected service life/durability	3.5	Expected service life for a small CHP unit is 10 yrs. Large CHPs have a 20 yr. service life.
3	Geographical considerations	4	NH has a low electrical energy cost.
4	Energy demand	5	Electric energy consumption is high.
5	Facility/systems conditions	5	Newer building
6	Facility/systems compatibility	1	No renewables currently on site.
7	Permitting constraints	5	No special permits required.
8	Abutter concerns	5	Modern CHPs are relatively quiet and would be inside of the building.
9	Capital investment	2.5	High capital cost.
10	O&M requirements	2	Frequent maintenance required. Large system manufacturers require that they complete maintenance for warranty validation.
11	Financial incentives	2	Limited incentives.
12	Owner initiatives	4	Owner is open to renewable options
13	CO2e emissions	1	CHPs consume a large amount of fuel and emissions relative to the re-used energy.
14	Public awareness/education	4	Moderately high public use. Information could be displayed in the building so users are aware of CHP system. However CHP is not entirely renewable.
	Total Score:	**49**	
	Total Possible Score:	**70**	
	Grade:	**70%**	

APPENDIX I

eQUEST® Energy Efficiency Measure Modeling



Electric Consumption (kWh x000)

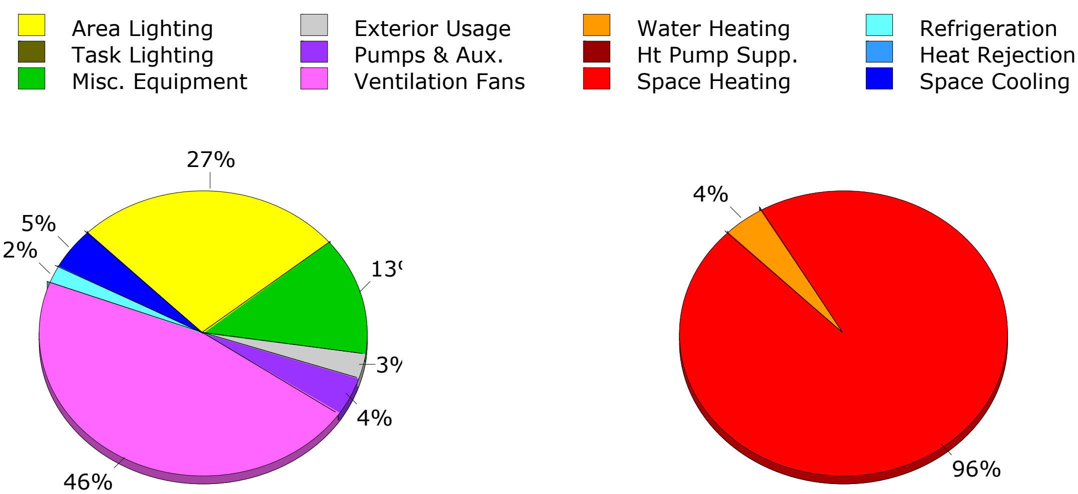
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.00	-	0.01	0.39	3.12	7.39	9.73	9.58	8.12	2.14	0.21	0.06	40.74
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	1.57	1.49	1.80	1.57	1.72	1.42	0.54	0.62	1.57	1.65	1.57	1.18	16.69
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	33.57	30.87	35.26	32.67	34.57	32.69	29.46	30.66	32.69	33.96	32.71	31.57	390.68
Pumps & Aux.	6.13	5.41	5.06	3.04	2.04	0.86	0.14	0.14	0.89	2.62	3.68	5.04	35.03
Ext. Usage	2.32	1.78	1.97	1.91	1.36	1.32	1.36	2.22	2.15	2.22	2.24	2.32	23.15
Misc. Equip.	9.90	9.25	10.86	9.81	10.54	9.51	6.84	7.32	9.80	10.22	9.78	8.47	112.31
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	20.68	19.44	23.11	20.56	22.30	18.96	10.06	10.87	20.56	21.49	20.54	18.04	226.61
Total	74.17	68.23	78.07	69.95	75.65	72.14	58.12	61.40	75.78	74.30	70.72	66.68	845.21

Gas Consumption (Btu x000,000)

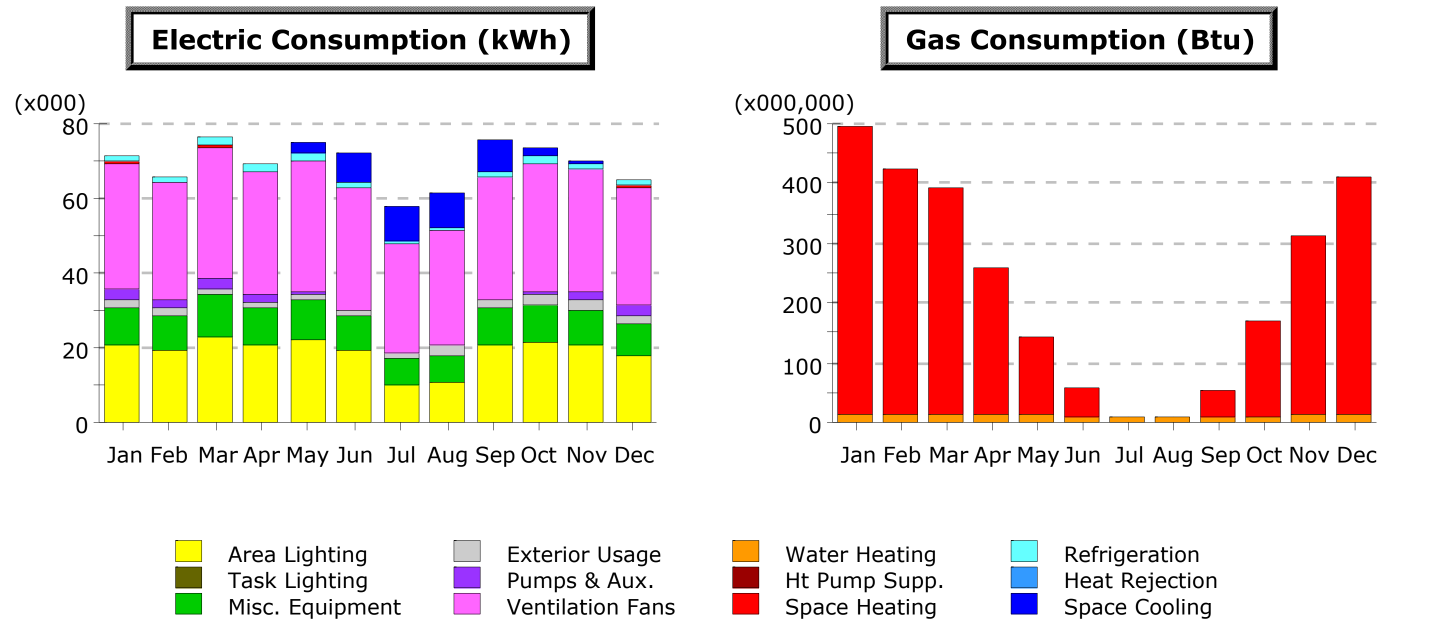
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	561.5	479.8	451.8	306.6	162.3	58.2	2.5	1.8	57.6	200.3	368.0	479.5	3,129.8
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	12.9	12.5	14.9	13.1	13.2	10.9	6.8	7.2	10.1	11.0	11.3	11.2	135.2
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	574.4	492.4	466.7	319.7	175.5	69.1	9.3	9.0	67.6	211.3	379.3	490.7	3,265.0

Annual Energy Consumption by Enduse

	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	40.74	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	16.69	-	-	-
Space Heat	-	3,129.8	-	-
HP Supp.	-	-	-	-
Hot Water	-	135.2	-	-
Vent. Fans	390.68	-	-	-
Pumps & Aux.	35.03	-	-	-
Ext. Usage	23.15	-	-	-
Misc. Equip.	112.31	-	-	-
Task Lights	-	-	-	-
Area Lights	226.61	-	-	-
Total	845.21	3,265.0	-	-



Electricity | **Natural Gas**



Electric Consumption (kWh x000)

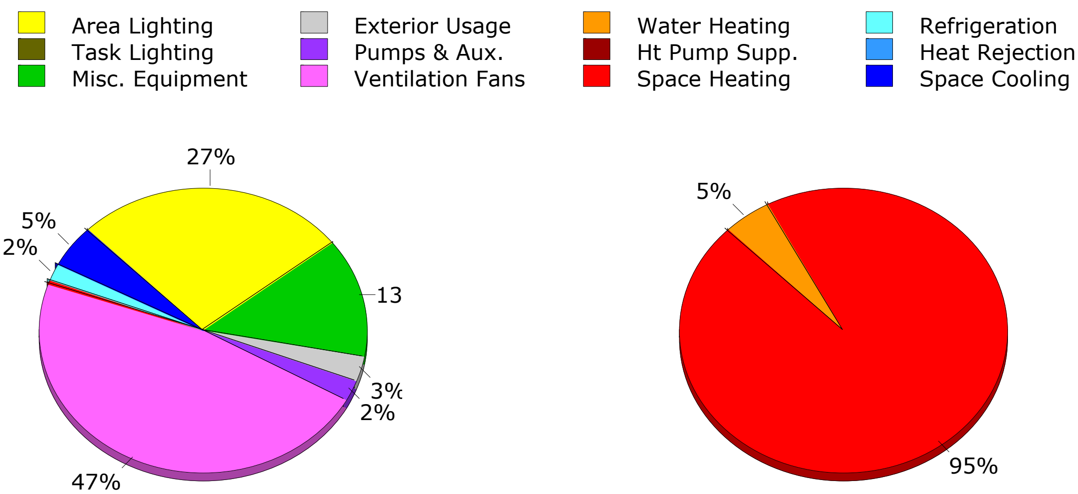
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.00	-	0.01	0.39	3.12	7.39	9.73	9.58	8.12	2.14	0.21	0.06	40.74
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	1.57	1.49	1.80	1.57	1.72	1.42	0.54	0.62	1.57	1.65	1.57	1.18	16.69
Space Heat	0.61	0.51	0.48	0.32	0.18	0.07	0.00	0.00	0.07	0.22	0.39	0.54	3.40
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	33.57	30.87	35.26	32.67	34.57	32.69	29.46	30.66	32.69	33.96	32.71	31.57	390.68
Pumps & Aux.	2.88	2.61	2.72	2.14	1.14	0.51	0.12	0.13	0.56	1.40	2.37	2.68	19.25
Ext. Usage	2.32	1.78	1.97	1.91	1.36	1.32	1.36	2.22	2.15	2.22	2.24	2.32	23.15
Misc. Equip.	9.90	9.25	10.86	9.81	10.54	9.51	6.84	7.32	9.80	10.22	9.78	8.47	112.31
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	20.68	19.44	23.11	20.56	22.30	18.96	10.06	10.87	20.56	21.49	20.54	18.04	226.61
Total	71.53	65.95	76.21	69.37	74.93	71.86	58.10	61.39	75.51	73.30	69.80	64.86	832.83

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	483.7	410.7	378.4	243.9	128.1	45.7	1.7	1.2	43.6	158.0	300.0	401.4	2,596.5
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	12.9	12.5	14.9	13.1	13.2	10.9	6.8	7.2	10.1	11.0	11.3	11.2	135.2
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	496.6	423.2	393.3	257.0	141.3	56.6	8.6	8.4	53.6	169.0	311.3	412.6	2,731.6

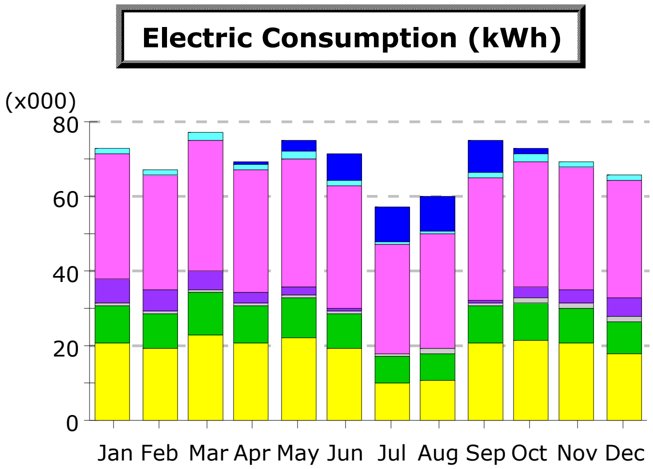
Annual Energy Consumption by Enduse

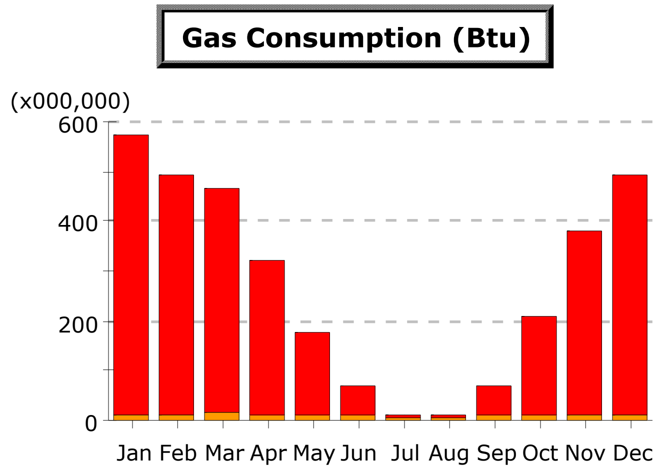
	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	40.74	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	16.69	-	-	-
Space Heat	3.40	2,596.5	-	-
HP Supp.	-	-	-	-
Hot Water	-	135.2	-	-
Vent. Fans	390.68	-	-	-
Pumps & Aux.	19.25	-	-	-
Ext. Usage	23.15	-	-	-
Misc. Equip.	112.31	-	-	-
Task Lights	-	-	-	-
Area Lights	226.61	-	-	-
Total	832.83	2,731.6	-	-



Electricity

Natural Gas





Electric Consumption (kWh x000)

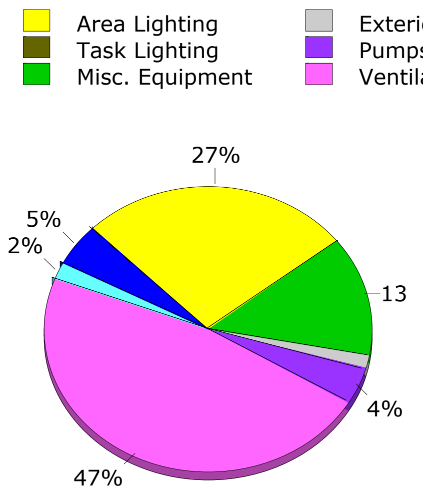
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.00	-	0.01	0.39	3.12	7.39	9.73	9.58	8.12	2.14	0.21	0.06	40.74
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	1.57	1.49	1.80	1.57	1.72	1.42	0.54	0.62	1.57	1.65	1.57	1.18	16.69
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	33.57	30.87	35.26	32.67	34.57	32.69	29.46	30.66	32.69	33.96	32.71	31.57	390.68
Pumps & Aux.	6.13	5.41	5.06	3.04	2.04	0.86	0.14	0.14	0.89	2.62	3.68	5.04	35.03
Ext. Usage	1.18	0.91	1.00	0.97	0.69	0.67	0.69	1.13	1.09	1.13	1.14	1.18	11.80
Misc. Equip.	9.90	9.25	10.86	9.81	10.54	9.51	6.84	7.32	9.80	10.22	9.78	8.47	112.31
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	20.68	19.44	23.11	20.56	22.30	18.96	10.06	10.87	20.56	21.49	20.54	18.04	226.61
Total	73.03	67.36	77.11	69.02	74.98	71.49	57.45	60.31	74.72	73.21	69.62	65.54	833.85

Gas Consumption (Btu x000,000)

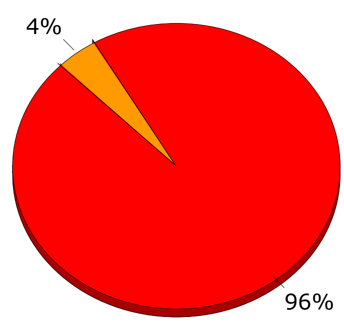
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	561.5	479.8	451.8	306.6	162.3	58.2	2.5	1.8	57.6	200.3	368.0	479.5	3,129.8
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	12.9	12.5	14.9	13.1	13.2	10.9	6.8	7.2	10.1	11.0	11.3	11.2	135.2
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	574.4	492.4	466.7	319.7	175.5	69.1	9.3	9.0	67.6	211.3	379.3	490.7	3,265.0

Annual Energy Consumption by Enduse

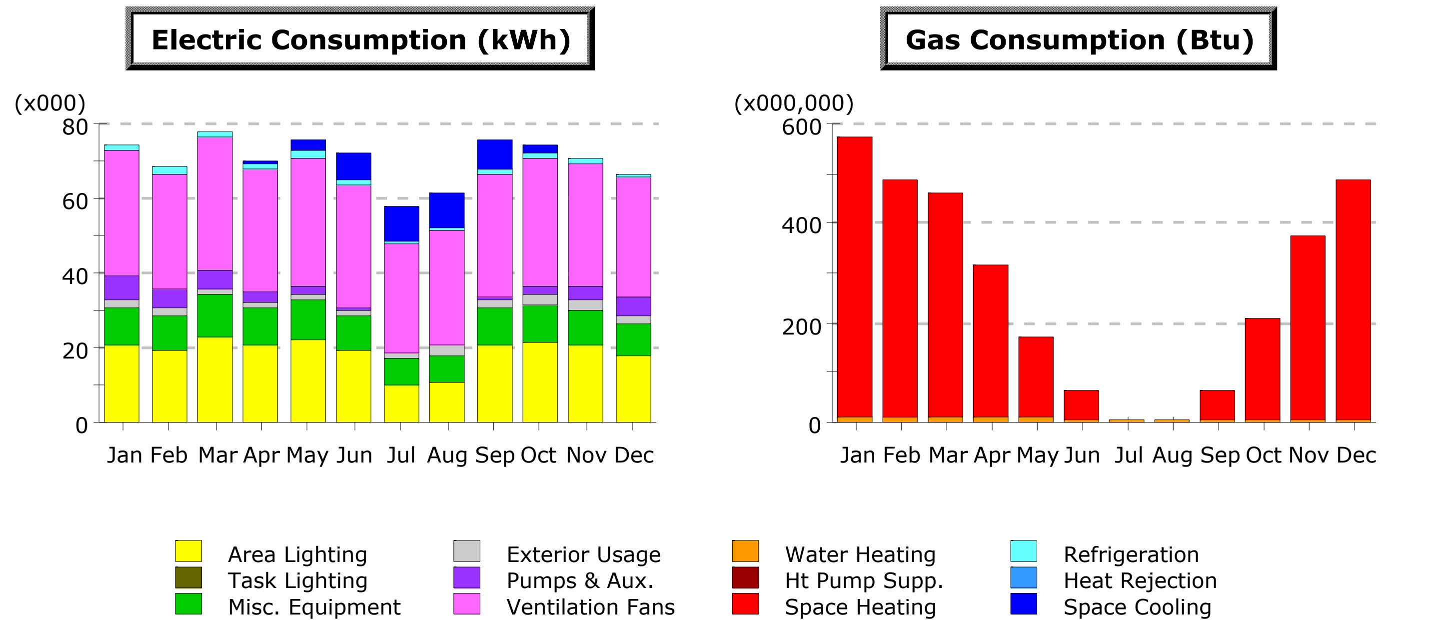
	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	40.74	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	16.69	-	-	-
Space Heat	-	3,129.8	-	-
HP Supp.	-	-	-	-
Hot Water	-	135.2	-	-
Vent. Fans	390.68	-	-	-
Pumps & Aux.	35.03	-	-	-
Ext. Usage	11.80	-	-	-
Misc. Equip.	112.31	-	-	-
Task Lights	-	-	-	-
Area Lights	226.61	-	-	-
Total	833.85	3,265.0	-	-



Electricity



Natural Gas



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.00	-	0.01	0.39	3.12	7.39	9.73	9.58	8.12	2.14	0.21	0.06	40.74
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	1.57	1.49	1.80	1.57	1.72	1.42	0.54	0.62	1.57	1.65	1.57	1.18	16.69
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	33.57	30.87	35.26	32.67	34.57	32.69	29.46	30.66	32.69	33.96	32.71	31.57	390.68
Pumps & Aux.	6.13	5.41	5.06	3.04	2.04	0.86	0.14	0.14	0.89	2.62	3.68	5.04	35.03
Ext. Usage	2.32	1.78	1.97	1.91	1.36	1.32	1.36	2.22	2.15	2.22	2.24	2.32	23.15
Misc. Equip.	9.90	9.25	10.86	9.81	10.54	9.51	6.84	7.32	9.80	10.22	9.78	8.47	112.31
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	20.68	19.44	23.11	20.56	22.30	18.96	10.06	10.87	20.56	21.49	20.54	18.04	226.61
Total	74.17	68.23	78.07	69.95	75.65	72.14	58.12	61.40	75.78	74.30	70.72	66.68	845.21

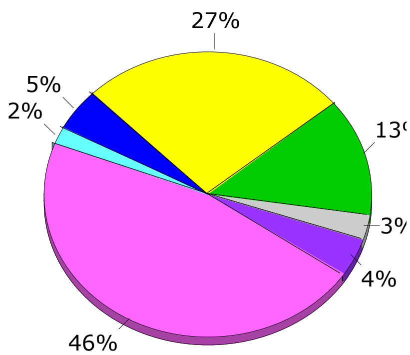
Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	561.5	479.8	451.8	306.6	162.3	58.2	2.5	1.8	57.6	200.3	368.0	479.5	3,129.8
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	9.1	8.9	10.7	9.3	9.4	7.8	4.7	5.0	7.2	7.8	7.9	7.9	95.7
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	570.6	488.7	462.5	315.9	171.7	66.0	7.2	6.8	64.7	208.1	375.9	487.4	3,225.6

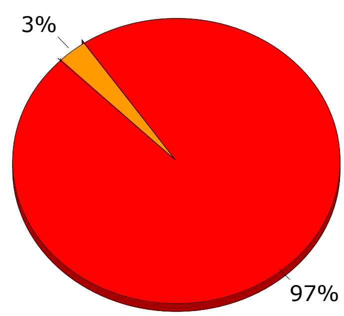
Annual Energy Consumption by Enduse

	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	40.74	-	-	-
Heat Reject.	-	-	-	-
Refrigeration	16.69	-	-	-
Space Heat	-	3,129.8	-	-
HP Supp.	-	-	-	-
Hot Water	-	95.7	-	-
Vent. Fans	390.68	-	-	-
Pumps & Aux.	35.03	-	-	-
Ext. Usage	23.15	-	-	-
Misc. Equip.	112.31	-	-	-
Task Lights	-	-	-	-
Area Lights	226.61	-	-	-
Total	845.21	3,225.6	-	-

Area Lighting
Task Lighting
Misc. Equipment
Exterior Usage
Pumps & Aux.
Ventilation Fans
Water Heating
Ht Pump Supp.
Space Heating
Refrigeration
Heat Rejection
Space Cooling

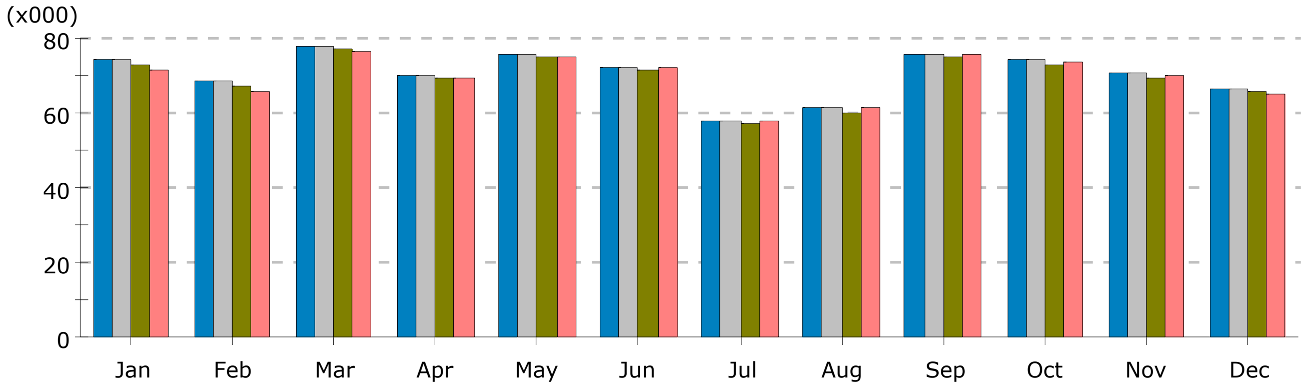


Electricity



Natural Gas

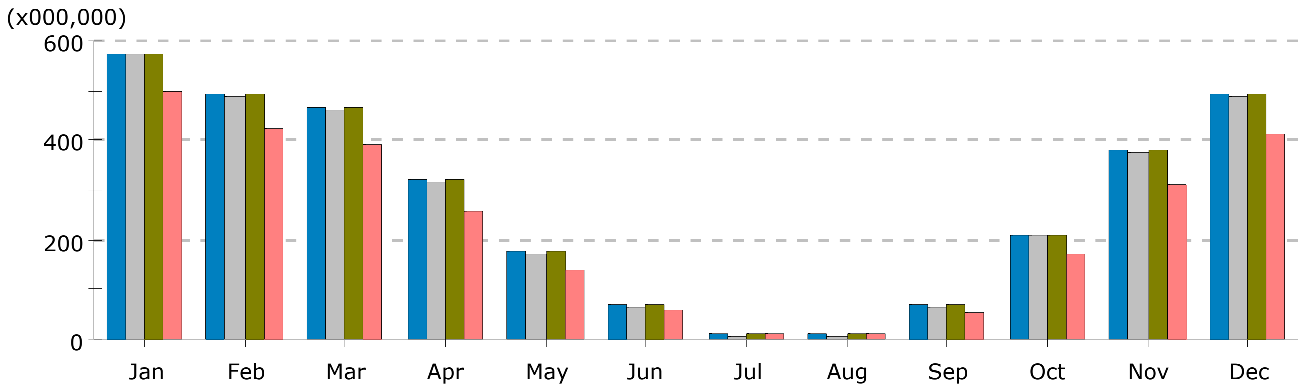
Electric Consumption (kWh)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Run 1.	74.17	68.23	78.07	69.95	75.65	72.14	58.12	61.40	75.78	74.30	70.72	66.68	845.21
Run 2.	74.17	68.23	78.07	69.95	75.65	72.14	58.12	61.40	75.78	74.30	70.72	66.68	845.21
Run 3.	73.03	67.36	77.11	69.02	74.98	71.49	57.45	60.31	74.72	73.21	69.62	65.54	833.85
Run 4.	71.53	65.95	76.21	69.37	74.93	71.86	58.10	61.39	75.51	73.30	69.81	64.86	832.83
Run 5.													

1. Hollis Brookline High School - Baseline Design (03/13/12 @ 12:09)
2. Hollis Brookline High School dhw - Baseline Design (03/13/12 @ 12:10)
3. Hollis Brookline High School exterior lighting - Baseline Design (03/13/12 @ 12:10)
4. Hollis Brookline High School boiler - Baseline Design (03/13/12 @ 12:12)

Gas Consumption (Btu)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Run 1.	574.4	492.4	466.7	319.7	175.5	69.1	9.3	9.0	67.6	211.3	379.3	490.7	3,265.0
Run 2.	570.6	488.7	462.5	315.9	171.7	66.0	7.2	6.8	64.7	208.1	375.9	487.4	3,225.6
Run 3.	574.4	492.4	466.7	319.7	175.5	69.1	9.3	9.0	67.6	211.3	379.3	490.7	3,265.0
Run 4.	496.6	423.2	393.3	257.0	141.3	56.6	8.6	8.4	53.6	169.0	311.3	412.6	2,731.6
Run 5.													

APPENDIX J

Cost Estimates

BUDGETARY COST ESTIMATE

Facility: **Hollis-Brookline High School**

Date: **3/21/2012**

EEM	Design + Engineering	Installed Cost				Construction Management	Contingency (15%)	Total Investment
		Pricing Unit	Price	Qty	Subtotal			
Replace larger electrical transformers with high efficiency units (4).	$ 1,500	EA	$ 9,100	4	**$ 36,400**	$ 3,640	$ 6,231	**$47,771**
Install pressure actuated dampers on all exhaust fans.	$ 500	EA	$ 1,320	7	**$ 9,240**	$ 924	$ 1,600	**$12,264**
Replace walk-in freezer condensers with high efficiency units (3).	$ 500	EA	$ 1,320	3	**$ 3,960**	$ 396	$ 728	**$5,584**
Replace three (3) existing boilers with two (2) 90% efficient modulating oil-fired units. Retain third unit as backup. Install VFD controllers on pumps.	$ 7,500	EA	$ 213,000	1	**$ 213,000**	$ 21,300	$ 36,270	**$278,070**
Install DDC demand controllers on all AHUs.	$ 500	EA	$ 1,400	11	**$ 15,400**	$ 1,540	$ 2,616	**$20,056**
Replace the split A/C units on rooftop (3) supplying the AHUs with high-efficiency units.	$ 500	EA	$ 5,200	3	**$ 15,600**	$ 1,560	$ 2,649	**$20,309**
Install a hybrid heating system consisting of a ground-source heat pump system (geothermal) augmented by the existing oil-fired boilers during peak heating demand (10% of heating frequency).	$ 22,000	EA	$ 385,000	1	**$ 385,000**	$ 38,500	$ 66,825	**$512,325**
Replace the existing DHW boiler with electric condensing tank unit and connect to PSNH HEATSMART meter.	$ 2,500	EA	$ 18,500	1	**$ 18,500**	$ 1,850	$ 3,428	**$26,278**
Install vestibule storefront entry in gymnasium/auditorium lobby.	$ 4,500	EA	$ 13,400	1	**$ 13,400**	$ 1,340	$ 2,886	**$22,126**
Install energy recovery units and VFD motor controllers on existing AHUs (11).	$ 3,700	EA	$ 10,830	11	**$ 119,130**	$ 11,913	$ 20,211	**$154,954**
Replace exterior light fixtures (wallpacks and OH) with LED units (41) (PSNH SmartSTART Program).	$ 500	EA	$ 800	41	**$ 32,800**	$ 3,280	$ 5,487	**$42,067**