ENERGY AUDIT

REPORT

Town of Needham
Department of Public Facilities
1471 Highland Avenue
Needham, Massachusetts 02492
Kate Fitzpatrick

ENERGY AUDIT REPORT

of

NEEDHAM HIGH SCHOOL

609 Webster Street
Needham, Massachusetts 02492

PREPARED BY:

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EMG Project #: 98515.11R-007.268
Date of Report: February 13, 2012
On site Date: September 7 and 9, 2011

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1. CERTIFICATION

EMG has completed an Energy Audit of Needham High School located at 609 Webster Street in Needham, Massachusetts. EMG visited the site on September 7th and 9th, 2011.

The assessment was performed at the Client's request using methods and procedures consistent with ASHRAE Level II Energy Audit and using methods and procedures as outlined in EMG's Proposal.

This report is exclusively for the use and benefit of the Client identified on the first page of this report. The purpose for which this report shall be used shall be limited to the use as stated in the contract between the client and EMG.

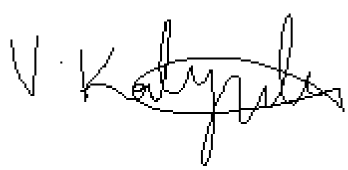
This report is not for the use or benefit of, nor may it be relied upon by any other person or entity, for any purpose without the advance written consent of EMG.

Estimated installation costs are based on EMG's experience on similar projects and industry standard cost estimating tools including *RS Means*. In developing the installed costs, EMG also considered the area correction factors for labor rates for Needham, Massachusetts. Since actual installed costs may vary widely for particular installation based on labor & material rates at time of installation, EMG does not guarantee installed cost estimates and shall in no event be liable should actual installed costs vary from the estimated costs herein. We strongly encourage the owner to confirm these cost estimates independently. EMG does not guarantee the costs savings estimated in this report. EMG shall in no event be liable should the actual energy savings vary from the savings estimated herein.

EMG certifies that EMG has no undisclosed interest in the subject property and that EMG's employment and compensation are not contingent upon the findings or estimated costs to remedy any deficiencies due to deferred maintenance and any noted component or system replacements.

Any questions regarding this report should be directed to Kalyana Vadala at 800.733.0660, ext. 6236.

Prepared by: Kaustubh Anil Chabukswar, CRM
Energy Auditor
Project Manager



Reviewed by: ______________________________
Kalyana Vadala, CEM
Program Manager

2. EXECUTIVE SUMMARY

The purpose of this Energy Audit is to provide Town of Needham and Needham High School with a baseline of energy usage and the relative energy efficiency of the facility and specific recommendations for Energy Conservation Measures. Information obtained from these analyses may be used to support a future application to an Energy Conservation Program, Federal & Utility grants towards energy conservation, support performance contracting, justify a municipal bond funded improvement program, or as a basis for replacement of equipment or systems.

The Needham High School is built in three phases. The older section of the high school was dedicated to the community in 1930 and the new section is constructed and added to the original building between 2004 and 2008. During the course of the recent construction the original building of the school was also renovated. As of now the High School has a total conditioned area of 287,838 Sq.ft. Significant modifications and additions were made to the HVAC system of the High School including installation of new hot water boilers, roof top package units, chilled and hot water circulation pumps and a new chiller. Along with the new HVAC systems the building lighting has been upgraded to energy efficient low wattage T8 lamps and compact fluorescent lamps. Significant energy conservations steps have been taken by installing occupancy sensors in individual classrooms and office spaces.

The study included a review of the building's construction features, historical energy and water consumption and costs, review of the building envelope, HVAC equipment, heat distribution systems, lighting, and the building's operational and maintenance practices.

During the energy audit at the Needham High School EMG found few opportunities for reducing the energy consumption via re-commissioning the existing building control systems.

The most critical opportunities are as follows:

- Relocate the differential pressure sensor at the 2/3rd length downstream of the existing chilled water distribution system; reprogram chilled water pumps
- Install high efficiency lighting and install automatic lighting controls

Summary of Existing Energy Performance

Building's EPA Energy Performance Rating[1]	56
Building's Annual Energy Consumption	19,896,976 kBtu
Total Annual Energy Costs	$583,522

[1]EPA Ratings above 75 may qualify for an Energy Star Performance Rating.

EMG has identified 6 Energy Conservation Measures (ECMs) for this property. The savings for each measure are calculated using standard engineering methods followed in the industry, and detailed calculations for ECM are provided in Appendix for reference. A 10% discount in energy savings was applied to account for the interactive effects amongst the ECMs. In addition to the consideration of the interactive effects, EMG has applied a 15% contingency to the implementation costs to account for potential cost overruns during the implementation of the ECMs.

The following table summarizes the recommended ECMs in terms of description, investment cost, energy consumption reduction, and cost savings.

Summary of Financial Information for Recommended Energy Conservation Measures

Item	Estimate
Total Projected Initial ECM Investment	$73,191 *(In Current Dollars)*
Estimated Annual Cost Savings Related to ECMs	$11,372 *(In Current Dollars)*
Net Effective ECM Payback	6.44 years
Estimated Annual Energy Savings	1%
Estimated Annual Cost Savings	2%

List of Recommended Energy Conservation Measures For Needham High School								
ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Estimated Annual Water Savings	Total Energy Savings	Total Estimated Annual Cost Savings	Simple Payback
			Natural Gas	Electricity				
		$	Therms	kWh	kgal	MMBtu	$	Years
No/Low Cost Recommendations								
1	Reduce Hours of Operation of Chilled Water Circulation Pumps Details: Re-program BMS to Trigger both the chiller and pumps to come on at the same time.	$0	0	483	0	2	$97	0.00
2	Install Energy Savers on Vending, Snack Machines Details: Install Sensor on Vending Machines in Cafeteria & Staff Break Room	$400	0	3220	0	11	$614	0.65
	Totals for No/Low Cost Items	**$400**	**0**	**3,703**	**0**	**13**	**$711**	**0.56**
Capital Cost Recommendations								
1	Install Automatic Lighting Controls Details: Install Photosensors in Classrooms, Hallways and Stairwells	$3,437	0	13319	0	45	$2,540	1.35
2	Re-Commission The Building HVAC Controls Details: Relocate the DP Sensor And Re-Program the Setpoint on the Sensor	$5,350	0	11293	0	39	$2,154	2.48
3	Replace High Intensity Discharge Lamp (HID) with Induction Lighting Details: Replace Exterior Lighting with Induction Lighting	$9,607	0	6831	0	23	$1,411	6.81
4	Replace High Intensity Discharge Lamp (HID) with Induction Lighting Details: Replace Gym Lighting, Exterior Building Lighting and Parking Lighting with Induction Lighting	$44,850	0	28301	0	97	$5,820	7.71
	Total For Capital Cost	**$63,244**	**0**	**59744**	**0**	**204**	**$11,925**	**5.30**
	Interactive Savings Discount @ 10%		0	-6,345		-22	-$1,264	
	Total Contingency Expenses @ 15%	$9,547						
Total for Improvements		**$73,191**	**0**	**57,102**	**0**	**195**	**$11,372**	**6.44**

3. BENCHMARKING/ENERGY PERFORMANCE SUMMARY

3.1. ENERGY STAR PORTFOLIO MANAGER FACILITY SUMMARY

EMG uses the Portfolio Manager tool developed by the Federal Environmental Protection Agency to track relative energy uses of buildings by property type. This tool allows the input of a facility's historic utility data to be compared with normalized data of a large database of its peer facilities.

Based on this analysis, the Needham High School is performing above the national average level.

Facility
Needham: Needham High School
609 Webster Street
Needham, MA 02492

Facility Owner
N/A

Primary Contact for this Facility
Bill Champion
222 Schilling Circle Suite 275
Hunt Valley, MD 21031

General Information

Needham: Needham High School	
Gross Floor Area Excluding Parking: (ft²)	287,838
Year Built	1930
For 12-month Evaluation Period Ending Date:	June 30, 2011

Facility Space Use Summary

School	
Space Type	K-12 School
Gross Floor Area(ft²)	287,838
Open Weekends?[d]	No
Number of PCs[d]	504
Number of walk-in refrigeration/freezer units	2
Presence of cooking facilities[d]	Yes
Percent Cooled	80
Percent Heated[d]	100
Months[e]	N/A
High School?	Yes
School District[e]	N/A

Energy Performance Comparison

	Evaluation Periods		Comparisons		
Performance Metrics	**Current** (Ending Date 06/30/2011)	**Baseline** (Ending Date 06/30/2011)	**Rating of 75**	**Target**	**National Median**
Energy Performance Rating	56	56	75	N/A	50
Energy Intensity					
Site (kBtu/ft²)	69	69	58	N/A	74
Source (kBtu/ft²)	138	138	114	N/A	146
Energy Cost					
$/year	$ 583,521.61	$ 583,521.61	$ 485,437.98	N/A	$ 620,746.12
$/ft²/year	$ 2.03	$ 2.03	$ 1.69	N/A	$ 2.16
Greenhouse Gas Emissions					
$MtCO_2e$/year	1,530	1,530	1,273	N/A	1,628
$kgCO_2e$/ft²/year	5	5	4	N/A	5

3.2. EPA Energy Star Rating

The national energy performance rating is a type of external benchmark that helps energy managers to assess how efficiently their buildings use energy, relative to similar buildings nationwide. The rating system's 1-100 scale allows everyone to understand quickly how a building is performing. For example, a rating of 50 indicates an average energy performance, while a rating of 75 or better indicates top performance. The higher the rating, the better the building is performing. Organizations can evaluate energy performance among the buildings in their portfolio, while also comparing their performance with other similar buildings nationwide. Additionally, building owners and managers can use the performance ratings to help identify buildings that offer the best opportunity for energy improvement and recognition.

To receive the energy performance rating, facility-related data entered into the Portfolio Manager, must adhere to a series of operating and energy use conditions. If one or more of these conditions are not met, the facility will receive "N/A" (Not Available) as a rating. "NA" means that the Portfolio Manager is unable to calculate a rating for that particular period ending date, given the operating and energy use conditions provided.

3.3. Source Energy and Site Energy

Buildings use a variety of forms of energy, including electricity, natural gas, fuel oil, and district steam. In order to provide an un-biased rating, the methodology must add together all of the energy used in a building. To combine energy in an equitable way, the ratings use source energy. Source energy is the energy that is consumed at the site, in addition to the energy used in generation and transmission.

The purpose of the conversion from site energy to source energy is to provide an equitable assessment of building-level energy efficiency. Because billed site energy use includes a combination of primary and secondary forms of energy, a comparison using site energy does not provide an equivalent thermodynamic assessment for buildings with different fuel mixes. In contrast, source energy incorporates all transmission, delivery, and production losses, which accounts for all primary fuel consumption and enables a complete assessment of energy efficiency in a building. When source energy is used to evaluate energy performance, an individual building's performance does not receive either a credit or a penalty for using any particular fuel type.

4. INTRODUCTION

The purpose of this Energy Audit is to provide Needham High School with a baseline of energy usage, the relative energy efficiency of the facility, and specific recommendations for Energy Conservation Measures. Information obtained from these analyses may be used to support a future application to an Energy Conservation Program, Federal and Utility grants towards energy conservation, as well as support performance contracting, justify a municipal bond-funded improvement program, or as a basis for replacement of equipment or systems.

The energy audit consisted of an on site visual assessment to determine current conditions, itemize the energy consuming equipment (i.e. Boilers, Make-Up Air Units, DHW equipment); review lighting systems both exterior and interior; and review efficiency of all such equipment. The study also included interviews and consultation with operational and maintenance personnel. The following is a summary of the tasks and reporting that make up the Energy Audit portion of the report.

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ENERGY AND WATER USING EQUIPMENT

- EMG has surveyed the common areas, office areas, classrooms, maintenance facilities and mechanical rooms to document utility-related equipment, including heating systems, cooling systems, air handling systems and lighting systems.

BUILDING ENVELOPE

- EMG has reviewed the characteristics and conditions of the building envelope, checking insulation values and conditions. This review also includes an inspection of the condition of walls, windows, doors, roof areas, insulation and special use areas. Where we anticipated significant losses, we utilized infrared thermographs to analyze heat loss across the envelope.

RECOMMENDATIONS FOR ENERGY SAVINGS OPPORTUNITIES

- Based on the information gathered during the on site assessment, the utility rates, as well as recent consumption data and engineering analysis, EMG has identified opportunities to save energy and provide probable construction costs, projected energy/utility savings and provide a simple payback analysis.

ANALYSIS OF ENERGY CONSUMPTION

- Based on the information gathered during the on site assessment and a minimum of one year of utility billing history, EMG has conducted an analysis of the energy usage of all equipment, and identified which equipment is using the most energy and what equipment upgrades may be necessary. As a result, equipment upgrades or replacements are identified that may provide a reasonable return on the investment and improve maintenance reliability.

ENERGY AUDIT PROCESS

- Interviewing staff and review plans and past upgrades
- Performing an energy audit for each use type
- Performing a preliminary evaluation of the utility system
- Analyzing findings, utilizing ECM cost-benefit worksheets
- Making preliminary recommendations for system energy improvements and measures
- Estimating initial cost and changes in operating and maintenance costs based on implementation of energy efficiency measures
- Ranking recommended cost measures, based on the criticality of the project and the largest payback

REPORTING

The EMG Energy Audit Report includes:

- A comprehensive study identifying all applicable Energy Conservation Measures (ECMs) and priorities, based on initial cost and payback
- A narrative discussion of building systems/components considered and a discussion of energy improvement options;
- A summary of ECMs including initial costs and simple paybacks based on current utility rates and expected annual savings.

5. FACILITY OVERVIEW AND EXISTING CONDITIONS

5.1. BUILDING OCCUPANCY

The high school is designed for a student population of 1450 along with 150 staff members   Based on the enrollment data provided to EMG, the current student count is 1,449. The normal school operating hours are between 8:00 AM and 3:00PM for students. This is followed by several after school activities that continue until 11:00 PM on some days.

Summary of Facility Operating Hours

	Hours Open to the Public	Hours Open to Employees
Monday-Friday (Winter)	8 AM-5 PM	6 AM-10 PM
Saturday/Sunday (Gym only in winter)	8 AM-6 PM	
Summer (Gym only)	6 AM-8 AM everyday	

5.2. BUILDING ENVELOPE

The building envelope consists of the exterior shell, made up of the walls, windows, roof, and floor. The envelope provides building integrity and separates the exterior from the interior conditioned space.

Based on actual facility architectural drawings provided, the foundations consist of cast-in-place concrete perimeter wall footings with CMU foundation walls. The foundation systems include reinforced concrete column pads. The building has load-bearing, concrete masonry unit walls and interior steel columns. The upper floors and roofs are constructed with steel reinforced concrete with metal decking. The building structure appears to be in good condition.

The school has a combination of pitched and flat roof. The new addition in the school has flat 3-ply built up roof. The older section of the school has a combination of flat and pitched roof. The pitched roof consists of asphalt shingles over asphalt-saturated paper followed by fire retardant plywood sheathing. Most of the sloped and the flat roof are under warranty.

The exterior walls for the high school are of various configurations. Some parts consist of a composition of metal curtain wall followed by ½″ grit, 1.5″ rigid insulation air gap and CMU blocks. The other wall sections consist of mainly of brick veneer followed by 1.5″ right insulation, air gap and CMU block. Since the whole school has been renovated, no air leaks have been reported.

All the windows in the school have been observed to be replaced recently with new energy efficiency double pane, thermally broken argon filled windows. All the windows were observed to be in a good shaped with no reported or observed leaks.

Item	Construction Type
Foundation	Slab on Grade
Structure	Block with Steel Substructure and Concrete Decks
Exterior Walls	Brick veneer and metal panel system with 1.5"rightd insulation
Roof	3 Ply Built-Up flat roof along with sloped roof consisting of asphalt shingles.

The following table describes the observed or reported insulation levels at the property:

Building Element	Observed R-values
Roof/Attic	R - 25
Floors	R - 5
Exterior Walls Above Grade	R - 20

5.3. BUILDING HEATING, VENTILATION, AND AIR-CONDITIONING (HVAC)

System Information:

The HVAC system in the High School consists of four central Burnham built 3,739MBH rated gas-fired hot water boilers, one 320 ton McQuay air cooled chiller and a total of 21 McQuay built roof top units. All the twenty one units are equipped with hot water coils for heating, while eight units have inbuilt DX coils for cooling, five have chilled water loop and rest have no cooling elements in them. The hot water circulation in the building is provided by two VFD controlled, Emerson Motor Company built, 50 Hp NEMA premium efficiency motors rated at 93.6%. The chilled water re-circulation system is powered by two VFD controlled Emerson Motor Company built 40hp pumps rated at 94.5% efficiency.

During the 2004-08 renovation almost all the major HVAC systems in the building was replaced with the existing ceiling suspended VAV duct distribution system, except the art classrooms that still retain the last remaining thirteen unit ventilators. These classrooms are located in the older section of the building also known as building-C. Based on the interaction with the HVAC operator it was learned that the art space had been deemed as a poor air quality zone, due to which the unit vents in the art rooms are fixed for 100% outside air.

System Controls:

The heating season for the school begins from the 1st of October and runs all the way until the end of May. While the cooling season runs from June 1st until September end. All the major heating and cooling systems are controlled by their individual outside air temperature rest control.

In case of the chilled water re-circulation system is programmed to come on once the OA temperature goes over 60F, whereas the chiller comes on only when the OA temperature crosses 62F. This leads to the chilled water re-circulation pumps to run for extra hours at 50% loading during the shoulder months. EMG strongly recommends controlling the re-circulation pumps via the chiller control in place of it having its own OA control. The boilers are programmed to come on once the OA temperature falls below 61.5F.

The packaged RTU's that are equipped with the inbuilt DX coils have an lower OA rest temperature and are programmed to come on for space cooling once the external temperature rises above 40F.

The building heating system is controlled by two control systems. The firing of the boilers is controlled by a separate system and the hot water circulation loop is controlled by the central BMS system. The firing of the boiler is based on the outside air temperature. EMG recommends that the boiler control and the re-circulation system be handled by only one control system.

BMS Control:

The school HVAC system is centrally monitored and controlled by a Lon Makers installed BMS system. This system is programmed to control all the HVAC and exhaust fan operation during the normal school hours. The normal daily hours of operations for HVAC system is from 6:00AM to 5:00PM. In case of heating the heating system runs from 7:00AM to 5:00PM. For after hour events a separate online scheduling system known as "School dude" is via which certain zones that are conditioned by the packaged RTU's could be pre-programmed to come on for a specific duration of time. Currently the central boilers too have their own control system that is based on Outside air temperature. The primary design is such that the classrooms and the other student zones are conditioned by RTU's that have both hot and chilled water coils, whereas the office space, auditoriums, cafeteria etc are conditioned by RTU's with hot water and DX coils so that they can be used for after school hour activities. The gymnasiums, wrestling room and hallways are not cooled but only heated. The periphery walls and windows are lined by fin-tube design hot water radiators. All the roof top units are equipped with economizers. The rooftop units provide 10-25% OA based on the space temperature. Once the space temperature reaches the set point the economizer increases the OA from 10% to 25%.

Heated and cooled air is distributed through ducts to variable air volume (VAV) terminals concealed above the ceilings in the common areas. The heating and cooling system are controlled by thermo-sensors linked to a building automation system.

HVAC System Issues:

The renovation in the high school was executed in a series of phase spread over five years. During these phases new HVAC systems were installed in the new addition whereas the older unit ventilators in the old building were gradually replaced with VAV-duct system in combination with RTU units. Based on the site audit, it appears that there are some issues with the current HVAC system. The major deficiencies that were observed are:

- The differential pressure (DP) sensor that sends the feedback signal to the VFD's that control the re-circulation pumps should be located at 2/3rds downstream of the total loop length. In case of the chilled water loop the location of the DP sensor is way short of the actual location. The primary reason was that the chilled water loop was extended through various phases of renovation and the sensor was not relocated accordingly. This is causing chilled water loop imbalance and rattling of pipes.
- Further due to the extensive pipe network along with a number of 2-way valves, it is extremely difficult to calibrate the set point on the DP sensor so as to vary the speed of the chilled water re-circulation pump via the VFD's. Currently the DP sensors have a fixed set point of 25psi. The existing system is not functioning per the design standard and the above mentioned deficiencies have resulted in system imbalance and water hammering in the pipes in to the mechanical room.
- The third deficiency observed is the tripping of VFDs during power failure. There is 3 second delay between switching from street power to emergency generator mode during power failure and this currently causes the VFDs to trip and reset taking them to default settings. This issue needs to be corrected with the manufacturer.
- Another observed issue was in the programming of the chilled water re-circulation loop. The chilled water re-circulation loop is programmed to come on once the outside air temperature rises above 60F, whereas the chiller comes on only when the OA temperature rises over 62F. This results in the pump running at 50% loading for additional time.

- Infiltration through the unit ventilators is another major concern for the high school. As mentioned above there are a total of 13 unit ventilators serving the art rooms in the building-C. These unit ventilators are old and air leaks have been found around them. The owner may want to consider removing existing unit ventilators and installing VAV system with ceiling enclosed return and supply ducts.

Item	Measured Values
Major Heating system type/capacity	4X Burnham Gas-fired Boilers (3,739MBH O/P and 4691MBH I/P each)
Major Cooling System type/capacity	320 ton air cooled chiller
Heating hot water supply temperature	180 F
Chilled water supply/return temperatures	45F supply temperature, return temperatures varies
Outside Air temperature and Relative Humidity (%) at time of audit	80F (OA Temp), 36% RH
Interior space temperatures & Relative Humidity (RH%)	75.7F, 58.4% (Taken in the library)
Supply Air Temperature (SAT)/Return Air Temperature (RAT)	Supply Air Temperature: 66°F Return Air Temperature: 75°F
Avg. Supply Air rate (CFM/Sq.ft)	0.78 CFM/Sq. ft
Avg. Interior space thermostat set-point	Heating: 69F; Cooling: 74F
Avg. Outside Air rate (% & CFM/Sq.ft or CFM/person)	Varies from section to section

The Mechanical Equipment Schedule in Appendix contains a summary of the HVAC Equipment at the property.

5.4. BUILDING LIGHTING

Needham High school has a number of different interior and exterior lighting systems. The hallways in the building use T-8 and 13 watt compact fluorescent lights. The classrooms use T-8 either in a 2, 3 or 4 bulbs per fixture; the offices use linear and U-tube T-8 light; the cafeteria and kitchen areas use T-8 and 12 watt compact fluorescent; the library uses 13 watt compact fluorescent, T-8 lighting, and 31 watt U-tube lighting; the hallways use T-8 and 13 watt compact fluorescent lights; and the stairwell fixtures are 26 watt compact fluorescent lights. This information is based on the observations during the on site visit and also a review of the architectural drawings.

The majority of lights are used during the school year. This would result in hours of usage based on 36 weeks for the classrooms, offices, library and most facilities. The hallways, exterior lights and the emergency lighting are on during the entire year.

The hallways are controlled by light switches. About 90% of the classrooms and office areas have thermal sensors that are used to control lighting. However, it was observed during the on site visit that less than 5% of the classrooms visited had the sensor functioning; it the majority of classrooms, the light switch was the only operational control device. It is recommended to the client that a further technical analysis should be done to determine why the sensors are not functioning correctly.

Based on observations during the on site visit, photo-sensors should be installed on light fixtures that are near windows in the classrooms. It was noted that since there was sufficient light levels near the windows (400-500), the light fixtures near the windows should only come on when there is not enough natural light. It should be noted that the on site visit was on a rainy and cloudy day. Further, photo-sensors can also be installed on lights in the stairwells that are adjacent to windows. Again the light level readings in these areas in the stairwell were over 750 LUX. It should be noted that this reading, as all the readings taken, was taken on a cloudy and rainy day.

In addition, there were several areas in the hallways and the stairwells where the light fixtures are near windows that provide enough natural light for sufficient light levels. It is recommended that on some of the light fixtures, photo-sensors should be installed.

There are also two gymnasiums – "A" and "B." According to the architectural drawings, both of the gymnasiums use 320 watt metal halide lights. It is recommended that these lights be replaced with induction lighting.

The exterior building lighting includes a number of different wattage metal halide lights; these lights range from 50 watts to 400 watts. The lights that are greater than 100 watts can be replaced with either LED lighting or induction lighting. It was noted during the on site visit that one of the larger metal halide lights (on the side of the building where student parking is located) was on. Since there was another metal halide light of the same size, adjacent to this light fixture, that was not on, it is recommended that the client determine the reason why the timer is not working properly on this specific light fixture.

Space type	Measured Light Levels (Lux/foot candles)	ASHRAE/IESNA Recommended Levels (Lux)
Hallway	200 Lux	100 to 200
Classroom	300 Lux	300 to 750
Offices	200 Lux	200 to 1200
Library	300 Lux	75 to 300
Avg. Building Lighting Density, W/Sq.Ft	0.676 W/Sqft	

Note: 1 foot candle = 10.764 lux

The Lighting Systems Schedules in Appendix contain a summary of the Existing Lighting Systems at the property, along with proposed Lighting Energy Conservation Measures.

5.5. BUILDING ELEVATORS AND CONVEYING SYSTEMS

The high school has a total of four elevators and one wheelchair lift. Two of the elevators serve the new addition. Both the elevators are hydraulic elevators and powered by a 30Hp electric motor. The third elevator serves the original building and is also classified as hydraulic elevator. The fourth elevator serves the auditorium and is meant for disabled individuals.

The elevators have an average rated capacity of 2500lbs and a speed of 100fpm.

5.6. BUILDING DOMESTIC HOT WATER

The common area restrooms have commercial-grade fixtures and accessories, including water closets and lavatories. The toilets consist of flush valves. The typical flush volume was 1.6 GPF. The lavatories are equipped with aerators rated at 2.2 GPM. In addition, some of the science classrooms (chemistry and biology) also have sinks with 2.0 GPM flow ratings.

The domestic hot water to the school is provided by a total of four Precision built gas-fired water heaters. Two of the water heaters with a rated i/p capacity of 700 MBH are located in the main boiler room inside Building-A. The other two domestic hot water heaters are located in the second mechanical room inside Building-D. The other two boilers are rated at 328MBH o/p capacity. All the four domestic hot water boilers are programmed to deliver hot water at 140F. The hot water is further mixed via mixing valves so as to deliver water at 120F at the restroom faucets, 130F in the janitor and 140F in the kitchen faucets.

The DHW's located in the Building-D serve the locker rooms and the restrooms on the older section, while the DHW's in the Building-A serve the newer construction.

DHW type	Gas-fired Units
Storage Tank Capacity	NA
Heating/tank set-point	140F
DHW temperature at faucet	120F
Building faucets, GPM	2.2
Water closets/toilets, GPF	1.6

5.7. BUILDING NATURAL GAS AND ELECTRICITY

Natural Gas

The building is connected to the natural gas utility (Nstar). The gas main on the adjacent public street supplies the natural gas service. The gas meter and regulators are located in outside the mechanical room housing the main boilers. The gas distribution piping within the building is malleable steel (black iron). The facility is master-metered for natural gas.

Electricity

The electrical supply lines run underground pad-mounted transformer to an interior-mounted electrical meter. The main electrical service size is 750 amps, 480/277-volt, three-phase, four-wire alternating current (AC). A step-down transformer is located in the main electrical room. The electrical wiring is copper, installed in metallic conduit. Circuit breaker panels are located throughout the building. The facility is master-metered for electricity.

Backup Generator

A natural gas-engine-driven emergency electrical generator is located outside the main boiler room. The generator provides back-up power for elements of the fire and life safety systems.

Electrical Transformer Type (Wye, Delta)	Delta
Mounting	Pad-mounted
Location	Exterior
Main Building Electric service	750 Amps
Primary Volts	480V
Secondary Volts	
Phase	3 Phase
Wire	4 Wire
Amp	750 Amps
On site Generator (Y/N)	Yes
Generator Capacity, KVA	
Generator Fuel Type	Natural Gas

Electric Meter type (Master/Sub/Direct)	Direct	**Natural Gas Meter type (Master/Sub/Direct)**	Direct
Meter Location	Mechanical Room	**Meter Location**	Exterior
Main meter number	09293796	**Main meter number**	NA

6. UTILITY ANALYSIS

Establishing the energy baseline begins with an analysis of the utility cost and consumption of the building. Utilizing the historical energy data and local weather information, we evaluate the existing utility consumption and assign it to the various end-uses throughout the buildings. The Historical Data Analysis breaks down utilities by consumption, cost and annual profile.

This data is analyzed, using standard engineering assumptions and practices. The analysis serves the following functions:

- Allows our engineers to benchmark the energy and water consumption of the facilities against consumption of efficient buildings of similar construction, use and occupancy.
- Generates the historical and current unit costs for energy and water
- Provides an indication of how well changes in energy consumption correlate to changes in weather.
- Reveals potential opportunities for energy consumption and/or cost reduction. For example, the analysis may indicate that there is excessive, simultaneous heating and cooling, which may mean that there is an opportunity to improve the control of the heating and cooling systems.

By performing this analysis and leveraging our experience, our engineers prioritize buildings and pinpoint systems for additional investigation during the site visit, thereby maximizing the benefit of their time spent on site and minimizing time and effort by the customer's personnel.

Based upon the utility information provided about the Needham High School, the following energy rates are utilized in determining existing and proposed energy costs.

Utility Rates used for Cost Analysis

Electricity (Blended Rate)	Natural Gas
$0.19/kWh	$1.08/therm

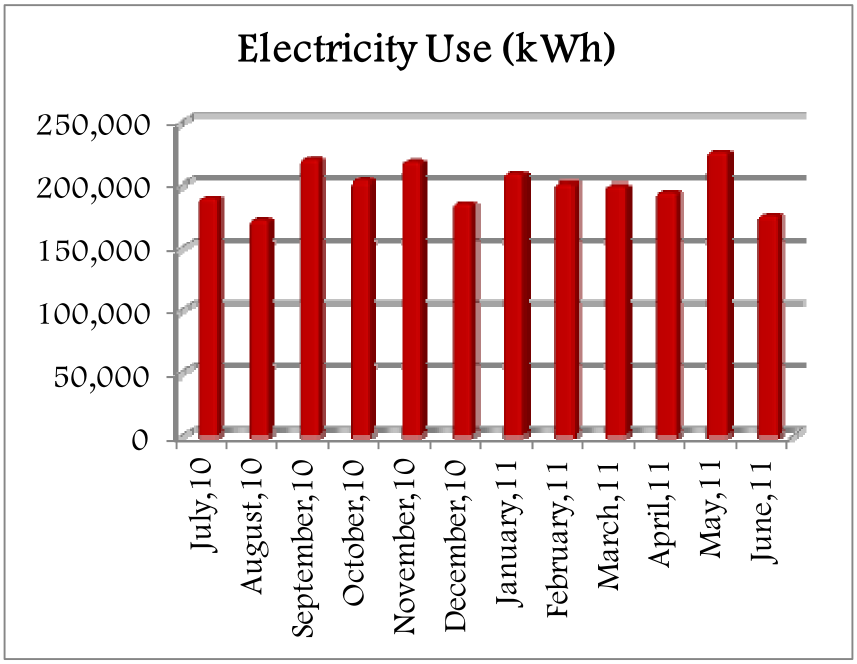
The data analyzed provides the following information: 1) breakdown of utilities by consumption, 2) cost and annual profile, 3) baseline consumption in terms of energy/utility at the facility, 4) the Energy Use Index, or Btu/sq ft, and cost/sq ft. For multiple water meters, the utility data is combined to illustrate annual consumption for each utility type.

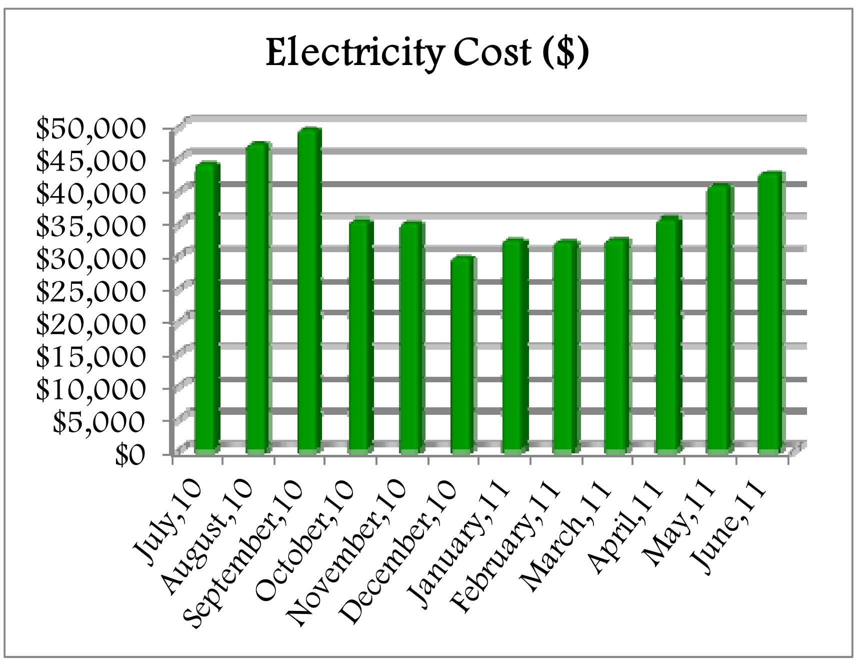
6.1. ELECTRICITY

Nstar satisfies the electricity requirements of the facility. The rise in the electricity usage during the summer months is due to the use of electric driven air-conditioning equipment. The lighting is a large component of the electrical base-load because of both the number and inefficiency of fixtures and bulbs.

Based on the 2010-11 electric usage & costs, the average price paid during the year was $0.19 per kWh. The total annual electricity consumption for the 12-month period analyzed is 2,396,476kWh for a total cost of $457,005.

Billing Month	Consumption (kWh)	Unit Cost/kWh	Total Cost
July,10	189,988	$0.23	$44,009
August,10	171,808	$0.27	$47,204
September,10	220,708	$0.22	$49,505
October,10	203,608	$0.17	$35,435
November,10	218,708	$0.16	$35,110
December,10	185,248	$0.16	$29,599
January,11	208,768	$0.16	$32,375
February,11	201,568	$0.16	$32,119
March,11	199,828	$0.16	$32,418
April,11	194,368	$0.18	$35,654
May,11	226,648	$0.18	$40,784
June,11	175,228	$0.24	$42,794
Total	**2,396,476**	**$0.19**	**$457,005**


Electricity Use (kWh)
250,000
200,000
150,000
100,000
50,000
0
July,10
August,10
September,10
October,10
November,10
December,10
January,11
February,11
March,11
April,11
May,11
June,11


Electricity Cost ($)
$50,000
$45,000
$40,000
$35,000
$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$0
July,10
August,10
September,10
October,10
November,10
December,10
January,11
February,11
March,11
April,11
May,11
June,11

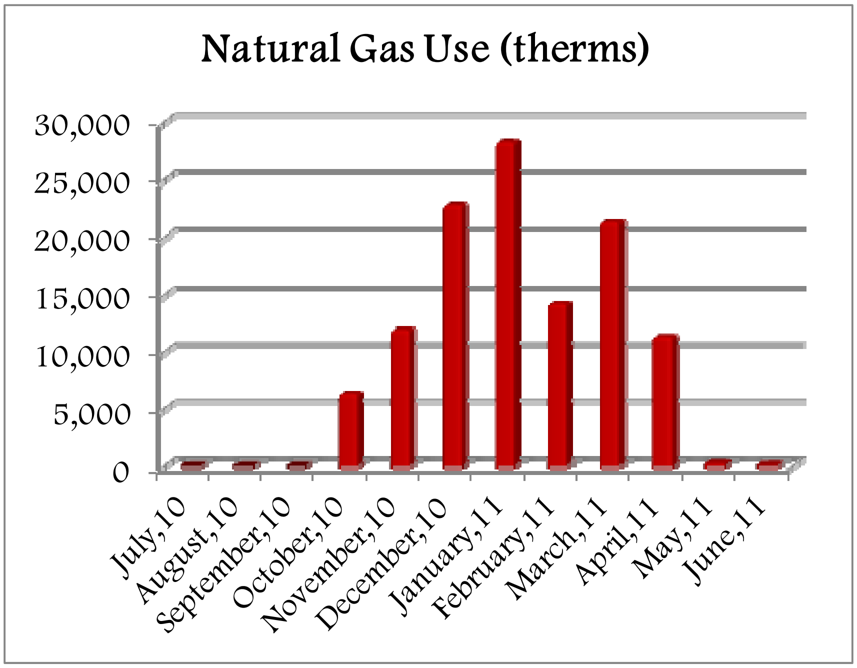
6.2. NATURAL GAS

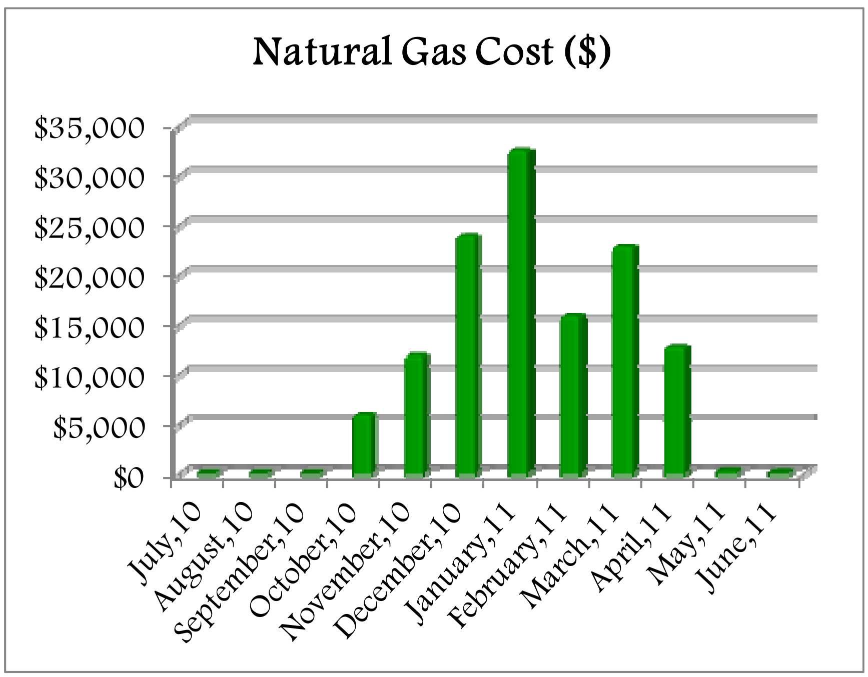
The natural gas requirements of the facility are satisfied by Nstar. The rise in the natural gas usage during the winter months is due to the use of natural gas driven heating equipment. The base-load for the building consists of the domestic hot potable water boiler along with some of the kitchen appliances.

Based on the 2010-11 natural gas usage & costs, the average price paid during the year was $1.08 per therm. The total annual natural gas consumption for the 12-month period analyzed is 117,202 for a total cost of $126,515.

Natural Gas Consumption and Cost Data

Billing Month	Natural gas Consumption (Therms	Unit Cost/therm	Total Cost
July,10	0	$0.00	$30
August,10	0	$0.00	$30
September,10	0	$0.00	$30
October,10	6,420	$0.94	$6,010
November,10	11,993	$0.99	$11,905
December,10	22,880	$1.05	$23,950
January,11	28,427	$1.14	$32,503
February,11	14,277	$1.12	$15,991
March,11	21,352	$1.07	$22,839
April,11	11,410	$1.11	$12,719
May,11	319	$1.10	$352
June,11	124	$1.25	$155
Total	**117,202**	$1.08	**$126,515**

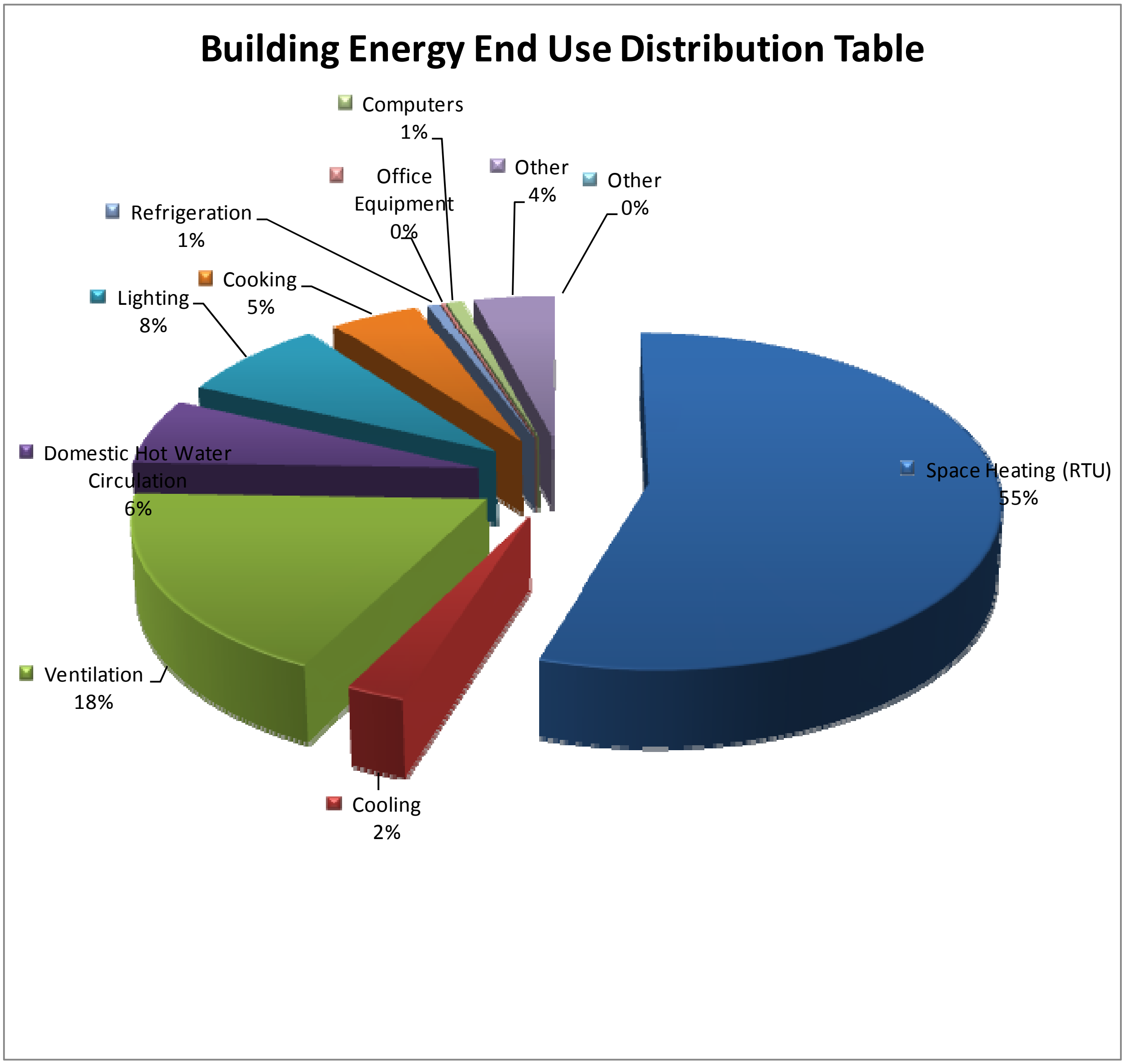

Natural Gas Use (therms)
30,000
25,000
20,000
15,000
10,000
5,000
0
July,10
August,10
September,10
October,10
November,10
December,10
January,11
February,11
March,11
April,11
May,11
June,11


Natural Gas Cost ($)
$35,000
$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$0
July,10
August,10
September,10
October,10
November,10
December,10
January,11
February,11
March,11
April,11
May,11
June,11

7. END USE ENERGY DISTRIBUTION

Following table shows the annual end-use energy distribution by component for FY 2011 (base year) for Needham High School.

Components of Annual Energy Use						
	Electricity (1 kWh = 3.412 kBtu)			Natural Gas		
	kWh	kBtu	Cost	therms	kBtu	Cost
Space Heating (RTU)	287,577	981,213	$54,840.59	*99,622*	9,958,185	$107,548
Cooling	141,392	482,430	$26,963.29		0	$0
Ventilation	1,054,449	3,597,781	$201,082.17		0	$0
Domestic Hot Water Circulation	28,758	98,121	$5,484.06	*11,720*	1,171,551	$12,653
Lighting	479,295	1,635,355	$91,400.99		0	$0
Cooking	95,859	327,071	$18,280.20	*5,860*	585,776	$6,326
Refrigeration	35,947	122,652	$6,855.07		0	$0
Office Equipment	10,065	34,342	$1,919.42		0	$0
Computers	47,930	163,536	$9,140.10		0	$0
Other	215,683	735,910	$41,130.44		0	$0
Other	0	0	$0.00	*0*	0	$0
Total	**2,396,955**	8,178,411	$457,096.3	***117,202***	11,715,512	$126,528


Building Energy End Use Distribution Table
Computers 1%
Office Equipment 0%
Other 4%
Other 0%
Refrigeration 1%
Cooking 5%
Lighting 8%
Domestic Hot Water Circulation 6%
Space Heating (RTU) 55%
Ventilation 18%
Cooling 2%

8. ENERGY CONSERVATION MEASURES (ECM)

EMG has identified a total of 6 Energy Conservation Measures (ECMs) for this property. All the ECMs are broken into two major categories:

1. **No/Low Cost Recommendations**: No/Low cost is defined as any project with initial investment of less than $1000
2. **Capital Cost Recommendations**: Capital cost defined as any project with initial investment greater than $ 1000

EMG screens ECMs using two financial methodologies. ECMs which are considered financially viable must meet both criteria.

1. Simple Payback Period –The number of years required for the cumulative value of energy or water cost savings less future non-fuel or non-water costs to equal the investment costs of the building energy or water system, without consideration of discount rates. ECMs with a payback period greater than the Expected Useful Life (EUL) of the project are not typically recommended, as the cost of the project will not be recovered during the lifespan of the equipment. These ECMs are recommended for implementation during future system replacement. At that time, replacement may be evaluated based on the premium cost of installing energy efficient equipment.

$$Simple\ Payback = \frac{Initial\ Cost}{Annual\ Savings}$$

2. Savings-to-Investment Ratio (SIR) – The savings-to-investment ratio is the ratio of the present value savings to the present value costs of an energy or water conservation measure. The numerator of the ratio is the present value over the estimated useful life (EUL) of net savings in energy or water and non-fuel or non-water operation and maintenance costs attributable to the proposed energy or water conservation measure. The denominator of the ratio is the present value of the net increase in investment and replacement costs less salvage value attributable to the proposed energy or water conservation measure. It is recommended that energy efficiency recommendations should be based on a calculated SIR, with larger SIRs receiving a higher priority. A project is typically only recommended if SIR is greater than or equal to 1.0, unless other factors outweigh the financial benefit.

$$SIR = \frac{Present\ Value\ (Annual\ Savings, i\%, EUL)}{Initial\ Cost}$$

Key Metrics to Benchmark the Subject Property's Energy Usage Profile

- Building Site Energy Use Intensity - The sum of the total site energy use in thousand of Btu per unit of gross building area. Site energy accounts for all energy consumed at the building location only not the energy consumed during generation and transmission of the energy to the site.
- Building Source Energy Use Intensity – The sum of the total source energy use in thousand of Btu per unit of gross building area. Source energy is the energy consumed during generation and transmission in supplying the energy to your site.
- Building Cost Intensity - This metric is the sum of all energy use costs in dollars per unit of gross building area.
- Greenhouse Gas Emissions - Although there are numerous gases that are classified as contributors to the total for Greenhouse Emissions, the scope of this energy audit focuses on carbon dioxide (CO_2). Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement).

Site Energy Use Intensity (EUI)	Rating	
Current Site Energy Use Intensity (EUI)	69	kBtu/ft2
Post ECM Site Energy Use Intensity (EUI)	68	kBtu/ft2
Source Energy Use Intensity (EUI)	Rating	
Current Source Energy Use Intensity (EUI)	138	kBtu/ft2
Post ECM Source Energy Use Intensity (EUI)	135	kBtu/ft2
Building Cost Intensity (BCI)	Rating	
Current Building Cost Intensity	2.03	/ft2
Post ECM Building Cost Intensity	1.99	/ft2

Summary of the Greenhouse Gas Reductions from Recommended Energy Conservation Measures

The following table provides a summary of the projected Greenhouse Gas Emissions reductions as a result of the recommended Energy Conservation Measures:

Greenhouse Gas Emissions Reduction	Rating	
Estimated kWh Reduction	57102	kWh
Total CO_2 Emissions Reduced	19	$MtCO_2/yr$
Total Cars Off The Road (Equivalent)*	3	
Total Acres of Pine Trees Planted (Equivalent)*	4	

*Equivalent reductions per DOE emissions calculation algorithms.

The following table describes each recommended ECM in terms of initial investment, electricity and natural gas savings, water savings, annual energy cost and maintenance savings, payback and SIR.

List of Recommended Energy Conservation Measures For Needham High School											
ECM #	Description of ECM	Projected Initial Investment	Estimated Annual Energy Savings		Estimated Cost Savings	Estimated Annual O&M Savings	Total Estimated Annual Cost Savings	Simple Payback	S.I.R.	Life Cycle Savings	Expected Useful Life (EUL)
			Natural Gas	Electricity							
		$	Therms	kWh	$	$	$	Years		$	Years
No/Low Cost Recommendations											
1	Reduce Hours of Operation of Chilled Water Circulation Pumps Details: Re-program BMS to Trigger both the chiller and pumps to come on at the same time.	$0	0	483	$92	$5	$97	0.00	N/A	$0	0.00
2	Install Energy Savers on Vending, Snack Machines Details: Install Sensor on Vending Machines in Cafeteria & Staff Break Room	$400	0	3,220	$614	$0	$614	0.65	7.03	$2,412	5.00
Totals for No/Low Cost Items		**$400**	**0**	**3,703**	**$706**	**$5**	**$711**	**0.56**			
Capital Cost Recommendations											
1	Install Automatic Lighting Controls Details: Install Photosensors in Classrooms, Hallways and Stairwells	$3,437	0	13,319	$2,540	$0	$2,540	1.35	8.82	$26,885	15.00
2	Re-Commission The Building HVAC Controls Details: Relocate the DP Sensor And Re-Program the Setpoint on the Sensor	$5,350	0	11,293	$2,154	$0	$2,154	2.48	3.43	$13,020	10.00
3	Replace High Intensity Discharge Lamp (HID) with LED Lighting Details: Replace Exterior Lighting with LED Lighting	$9,607	0	6,831	$1,303	$109	$1,411	6.81	2.02	$9,773	20.00
4	Replace High Intensity Discharge Lamp (HID) with Induction Lighting Details: Replace Gym Lighting, Exterior Building Lighting and Parking Lighting with Induction Lighting	$44,850	0	28,301	$5,397	$423	$5,820	7.71	1.03	$1,187	10.00
Total For Capital Cost		**$63,244**	**0**	**59,744**	**$11,393**	**$532**	**$11,925**	**5.30**			
	Interactive Savings Discount @ 10%		0	-6,345	-$1,210	-$54	-$1,264				
	Total Contingency Expenses @ 15%	$9,547									
Total for Improvements		**$73,191**	**0**	**57,102**	**$10,889**	**$483**	**$11,372**	**6.44**			

If all of the above mentioned ECM's are implemented, NEEDHAM HIGH SCHOOL could potentially save approximately $11, 372 per year with an investment of $73,191, yielding a net effective payback of 6.44 years.

8.1. ECM Calculation Assumptions

EMG has made the following assumptions in calculation of the Energy Conservation Measures.

- The facility occupancy is assumed to be 1,600 people.
- Annual Heating Equipment Operating Hours are derived from actual consumption and equipment input rates to be 2,397hours/year
- Annual Cooling Equipment Operating Hours are derived from actual consumption and equipment input rates to be 678 hours/year.

8.2. No/Low Cost ECM Descriptions

EMG has identified 2 No/Low Cost Energy Conservation Measures (ECMs) for this property. This includes all measures which can be implemented below the cost threshold of $1,000. The following paragraphs describe each of these ECMs along with the initial installed costs, annual energy savings, and payback periods.

8.2.1. Control the Chilled Water Re-Circulation Pump Motors And Chillers With Single OA Control

Currently the chilled water re-circulation pumps and the chiller are operating on separate outside air reset temperature set points. Based on the current BMS settings, the chilled water recirculation pumps are programmed to turn on and run at 50% loading when the outside air temperature reaches 60F. Both the chilled water pumps are controlled by VFD's and operate in a lead lag mode. At the same time the chiller is programmed to turn on only when the outside temperature rises above 62F. The idea behind the setting is to ensure that the chilled water is kept circulating before the chiller comes on.
EMG recommends that the settings in the BMS be changed so as to ensure both the chillers and pumps come on at the same time and the motor slowly ramp up its speed. It is estimated that the pumps run for approximately 60 additional hours than the chiller due to this difference. The proposed ECM shall result in an annual energy savings of 483kWh.
The reprogramming of the BMS can be done under the existing mechanical maintenance contract.

8.2.2. Install Vend Misers on Beverage Vending Machines

Vending machines are usually designed to operate all day round irrespective of the occupancy level in the office. This means that the vending machines operate for more than 12 hours a day when not required in case of commercial establishments.

In the case of Needham High School there are two beverage vending machines located in the cafeteria and the staff break-room. EMG recommends installing vend misers on these vending machines, which will automatically reduce the running time of these machines during weekends and unoccupied hours. There are two types of vend misers; one has a timer in it, which is programmed to turn off or tune down the vending machines after the office hours and bring it back up an hour before the office opens. The other is a motion sensor based system that tunes down the machines upon detecting no-occupancy for a pre-programmed duration of time. In the case of vending machines storing chilled products, the vend miser does not turn off the machine entirely, but reduces the operating time of the compressor, such that the machine maintains the products at a minimum tolerable temperature.

The proposed ECM shall result in an annual energy savings of 3,220kWh.

8.3. Capital Cost ECM Descriptions

EMG has identified 4 Capital Cost Energy Conservation Measures (ECMs) for this property. This list includes recommended measures which have an estimated implementation cost of greater than $1000. The following paragraphs describe each of these ECMs, in addition to their initial installed costs, annual energy savings, and payback periods.

8.3.1. Install Photosensors in Classrooms, Hallways and Stairwells

One of the best ways to save energy is to turn off lights that are not needed. This saves energy, as well as extends the replacement time on lamps. (While frequent switching may in some cases shorten lamp life, the savings in electrical power will more than compensate).

The operating time of lighting systems can be reduced either automatically or manually. Automated controls are more reliable for ensuring that energy savings are achieved. Local switches can be labeled to encourage occupants to turn off lights when leaving an area. Individual switches in perimeter offices permit occupants to reduce lighting levels on sunny days. Sophisticated lighting control systems are available, but they are costly to retrofit. They should be considered when the lighting system is being replaced. With the exception of security lights, storeroom lighting can be placed on timed switches that shut off after the selected interval. All exterior lighting, as well as interior lighting in glass-enclosed vestibules, should be placed on photocell and/or timer control.

EMG has observed few opportunities to install photo sensors in common area like the main stair well at the junction of the building B and C, cafeteria and some of the classrooms that can benefit from direct sunlight. It is estimated that the school can save approximately, 13,319kWh of electricity annually by the use of photo sensors.

8.3.2. Recommission the Building Energy Management System And Relocate The Differnetial Pressure Sensor in the Chilled Water Loop

Based on the detailed energy audit performed on the Needham High School, EMG has concluded that the school has significant energy conservation opportunities via building HVAC re-commissioning. As mentioned in the HVAC section EMG has identified a few major commissioning related errors in the existing HVAC setup.

The chilled water loop has been extended in phases throughout the school. At the same time the location of the differential pressure (DP) sensor that provides the feed back to the VFD's was not moved accordingly. The DP sensor ideally should be located at 2/3^{rds} downstream of the total loop length. Further due to the extensive pipe network along with a number of 2-way valves, it is extremely difficult to calibrate the set point on the DP sensor so as to vary the speed of the chilled water re-circulation pump via the VFD's. Currently the DP sensors have a fixed set point of 25psi. The existing system is not been reported to perform as per the design standard and the above mentioned deficiencies has resulted in system imbalance and water hammering in the pipes close to the boiler room. In order to prevent the bypass valve and any of the two way valves from blowing up, the valves in the unit ventilators at the farthest end of the building have been completely opened, thus artificially balancing the loop.

Thus EMG recommends repositioning the DP sensor in the chilled water loop at the appropriate location and reprogramming the BMS system to change the existing fixed set point on the DP sensor to floating head set point. This shall result in additional flexibility for the systems to handle sudden pressure built-up due to closing of multiple valves simultaneously. In addition to this EMG also recommends re-balancing all the air ducts and ensuring that the thermostat sensors are reporting the right readings.

The proposed ECM is estimated to result in an annual energy savings of 11,293kWh annually.

8.3.3. Replace External Pole Lights And Wall Packs With Induction Fixtures

Exterior and site lighting at the Needham High School is currently provided by a mixture High Intensity Discharge (HID) lighting with High-Pressure Sodium (HPS) lamps, Metal Halide (MH) lamps and exterior, incandescent halogen spotlights. Significant savings in terms energy usage as well as in life-cycle performance terms (longer lamp life with more consistent quality of light due to a much slower degradation of the individual lamps) can be achieved by employing more energy efficient induction lighting technologies.

EMG recommends the replacement of the current 100 watt high pressure sodium lamps with 45 watt induction lamps, the 175 watt metal halide lamps with 65 watt induction lamps.

Long Service Life: up to 100,000 hrs (3-4 times the lamp life of HID Lamps)

Energy Saving: save up to 60% compared to metal halides

Instant On/Off: no waiting time between re-strike

High Efficiency: lighting efficiency >70-80lm/w

Wide Selection of Color Temperature: 2720K- 6500K

Optional Dimmable Ballast for Integrated Control: linearly dimmable to 30%

It is estimated that the school can save an estimated 6,831kWh of electricity annually.

8.3.4. Replace Metal Hallides in Gymnasium With Induction Lamps

An induction light is similar to a fluorescent light in that mercury in a gas fill inside the bulb is excited; emitting UV radiation that in turn is converted into visible white light by the phosphor coating on the bulb. Like fluorescent, the phosphor coating determines the color qualities of the light. Fluorescent lamps use electrodes to strike the arc and initiate the flow of current through the lamp, which excites the gas fill. Each time voltage is supplied by the ballast and the arc is struck, the electrodes degrade a little, eventually causing the lamp to fail. Induction lamps do not use electrodes. Instead of ballast, the system uses a high-frequency generator with a power coupler.

The generator produces a radio frequency magnetic field to excite gas fill. With no electrodes, the lamp lasts longer. Induction lamps, in fact, last up to 100,000 hours, with the lamp producing 70% of its light output at 60,000 hours. In other words, their rated life is 5-13 times longer than metal halide (7,500 to 20,000 hours at 10 hours/start).

Induction lamps are ideally suited for high-ceiling applications where the lamps are difficult, costly or hazardous to access. They are also ideally suited for such applications where the advantages of fluorescent lighting are sought but a light source is needed that can start and operate efficiently in extremely cold temperatures. As a result, induction lighting is a suitable for a wide range of applications, including not only warehouses, industrial buildings, cafeterias, gymnasiums, etc., but also signage, tunnels, bridges, roadways, outdoor area and security fixtures, parking garages, public spaces, and freezer and cold storage lighting.

The increased costs occurs in the induction systems themselves – which could be 5 to 6 times more than metal halide systems, and also in new fixtures, which can inflate payback periods and reduce return on investment. But you also generally get a 30% reduction in capital and operating costs immediately from the reduced number of fixtures made possible by the higher light output. You also get 15% more efficiency just because the induction system (lamp and electronic ballast) is more efficient. Apply that over ten years plus reduced replacement and maintenance costs compared to metal halide and other HID lamps and suddenly it makes a lot of sense to go into induction lighting systems.

- Long Service Life: up to 100,000hrs (5 times the lamp life of Metal Halides)
- Energy Saving: save up to 40% compared to metal halides, 13 times more efficient than incandescent light bulbs, and up to twice as efficient as compact fluorescent lights
- Instant On/Off: no waiting time between re-strike
- High Efficiency: lighting efficiency >80lm/w
- High Lumens Maintenance: >70% after 60,000 hrs
- Wide Selection of Color Temperature:2720K- 6500K
- High Power Factor Ballast: λ>0.95
- Flicker-free : high frequency (250KHz) creates a better and more comfortable light for users and prevents eye injury when viewed directly
- Optional Dimmable Ballast for Integrated Control: linearly dimmable to 30%

EMG recommends replacing the 320W MH lights in both the gymnasium and the 250W MH lights in the parking lot with 165W induction lamps, while replacing the exterior 400W wall packs with 250W induction lamps. The proposed ECM shall result in an annual energy savings of approximately 28,301kWh.

9. IMPLEMENTION OF AN OPERATIONS AND MAINTENANCE PLAN

The quality of the maintenance and the operation of the facility's energy systems have a direct effect on its overall energy efficiency. Energy-efficiency needs to be a consideration when implementing facility modifications, equipment replacements, and general corrective actions. The following is a list of activities that should be performed as part of the routine maintenance program for the property. These actions, which have been divided into specific and general recommendations, will insure that the energy conservation measures identified in this report will remain effective. The following general recommendations should be continued or implemented.

Building Envelope

1. Windows inspected monthly for damaged panes and failed thermal seals
2. Automatic door closing mechanisms repaired and adjusted as needed

Heating and Cooling

1. The burners cleaned and fuel/air ratios optimized during routine maintenance checks
2. Boiler and/or Chiller tubes inspected and cleaned annually
3. Control valves and dampers checked for functionality monthly and repaired, when needed
4. Equipment inspected for worn or damaged parts as part of a monthly maintenance check
5. Ductwork visually inspected and checked for leaks or damaged insulation as part of a annual maintenance check
6. Air dampers operating correctly
7. Test and balance completed annually to ensure heating uniform throughout the spaces
8. Evaporator coils and condenser coils regularly checked and cleaned for RTU
9. Air filters inspected monthly and replaced prior to excessive visual buildup
10. Replace all VTAC-9 VFD with new VFD's capable of handling sudden power loss without tripping

Domestic Hot Water

1. Domestic hot water heater temperature set to the minimum temperature required
2. Hot water piping checked routinely for damaged insulated and leaks
3. Tank-type water heaters flushed monthly

Lighting

1. Only energy-efficient replacement lamps used and in-stock for replacement(28W T8 lamps)
2. Walls clean and bright to maximize lighting effectiveness
3. Timers and/or photocells operating correctly on exterior lighting (external lights along building-D)
4. Replace all metal halide lamps with induction lamps
5. Switch of gymnasium lights when not needed

Existing Equipment and Replacements

1. Refrigerator and freezer doors closed and sealed correctly
2. Kitchen exhaust fans only used when needed or timers installed to limit operation
3. Office/computer equipment either in the "sleep" or "off" mode when not used
4. All other recommended equipment specific preventive maintenance actions conducted
5. Usage demands on the building/equipment not changed significantly since the original building commissioning or the most recent retro-commissioning

10. APPENDICES

APPENDIX A:
PHOTOGRAPHIC RECORD

DUE DILIGENCE FOR THE
LIFE CYCLE OF REAL ESTATE

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-007.268 **Project Name: Needham High School**

Photo #1:	Front View

Photo #2:	Building Exterior

Photo #3:	Building Exterior

Photo #4:	Building Exterior

Photo #5:	Building Exterior

Photo #6:	Building Exterior

DUE DILIGENCE FOR THE
LIFE CYCLE OF REAL ESTATE

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-007.268 **Project Name: Needham High School**

Photo #7: Building Exterior

Photo #8: Building Exterior

Photo #9: Building Exterior

Photo #10: Building Exterior

Photo #11: Building Exterior

Photo #12: Building Exterior

DUE DILIGENCE FOR THE
LIFE CYCLE OF REAL ESTATE

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-007.268 **Project Name: Needham High School**

Photo #13:	Building Exterior

Photo #14:	Building Exterior

Photo #15:	Min Cafeteria

Photo #16:	School Vending Machines

Photo #17:	Kitchen Equipments

Photo #18:	Kitchen- Oven, Gas Range Steamer

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-007.268 **Project Name: Needham High School**

Photo #19:	Main School Office

Photo #20:	Main Library

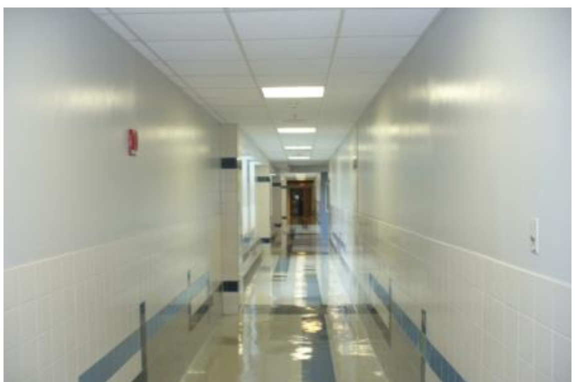


Photo #21:	Typical internal Hallway

Photo #22:	Typical Hallway With Exterior Wall, Note: Hot Water Radiator System

Photo #23:	Art Room

Photo #24:	Typical Room With Large Double Pane

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-007.268 **Project Name: Needham High School**

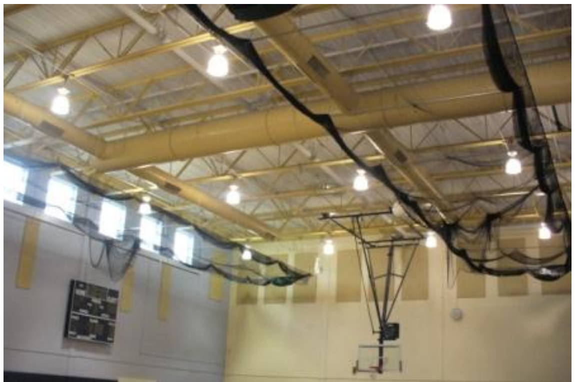


Photo #25:	New Gym

Photo #26:	Older Gym

Photo #27:	Sensor used in classrooms and offices. Most were not working during the onsite visit

Photo #28:	Library – large light fixture have (3) 31 watt U-tube lights

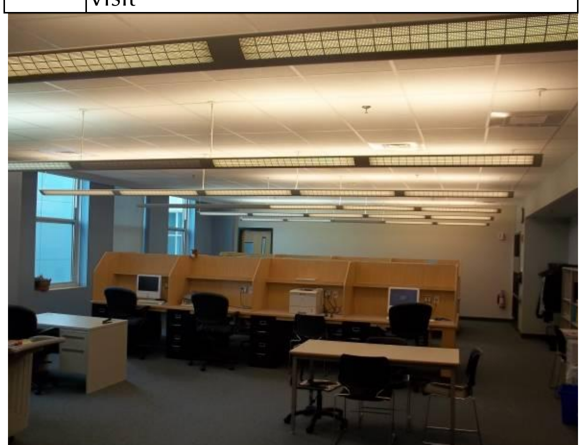


Photo #29:	Computer lab/classroom with T-8 lighting

Photo #30:	Conference room with T-8 lighting

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-007.268 **Project Name: Needham High School**

Photo #31: Boy's restroom

Photo #32: Sinks in restroom

Photo #33: Main Boiler Room (4x Boilers)

Photo #34: Expansion Tanks for Boilers

Photo #35: Boiler Control System

Photo #36: Main Hot Water Circulation Pumps

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-007.268 **Project Name: Needham High School**

Photo #37:	Main Chilled Water Circulation Pumps

Photo #38:	VFD's Controlling The Chilled and Hot Water Circulation Pumps

Photo #39:	Domestic Hot Water Boilers Serving The New Part of the School

Photo #40:	Main Air Cooled Chiller

Photo #41:	Main Natural Gas Meter

Photo #42:	Electrical Meter

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-007.268 **Project Name: Needham High School**

Photo #43:	Water Meter

Photo #44:	Main Backup Generator

Photo #45:	Electrical Transformer

Photo #46:	Domestic Hot Water Boiler (2X) Serves Older Section of the School

Photo #47:	Typical Old Fan Coil Units (13X)

Photo #48:	Typical Roof Top Unit

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-007.268 **Project Name: Needham High School**

Photo #49:	Kitchen Exhaust

Photo #50:	Chemistry Room Exhaust

Photo #51:	Condensing Unit & RTU. Note: Insulation over the refrigerant pipe was missing

Photo #52:	New Roof Installed in 2010

Photo #53:	Side Elevation

Photo #54:	Unit 19 Serving Older Section

EMG PHOTOGRAPHIC RECORD

Project No.: 98515.11R-007.268 **Project Name: Needham High School**

Photo #55: Typical Thermostat

Photo #56: Cafeteria Sensor

Photo #57: Hydraulic Elevator Machinery

Photo #58: Typical Elevator (Total 4x of different capacity)

Photo #59: Main Electrical Panel

Photo #60: Typical HPS External Light

APPENDIX B:
THERMAL PHOTOGRAPHIC RECORD

EMG

DUE DILIGENCE FOR THE
LIFE CYCLE OF REAL ESTATE

EMG THERMAL PHOTOGRAPHIC RECORD

Project No.: 98515.11R-007.268 **Project Name: Needham High School**

Photo #1:	External-IR

Photo #2:	External-IR

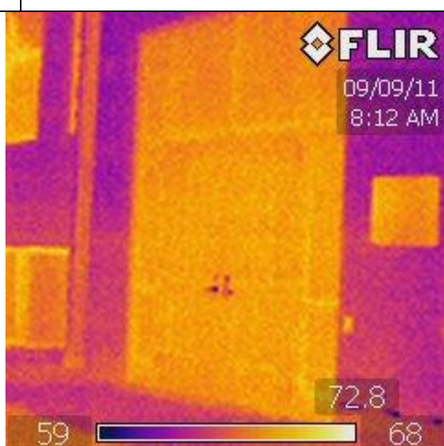


Photo #3:	External-IR

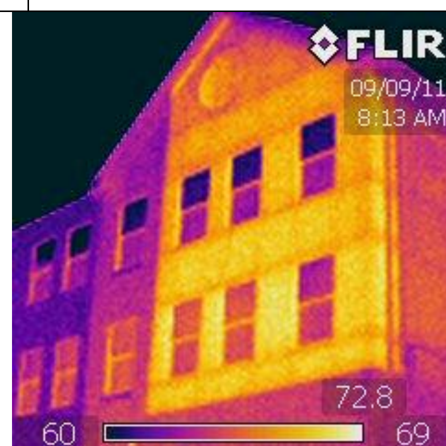


Photo #4:	External-IR

Photo #5:	External-IR

Photo #6:	External-IR

EMG

DUE DILIGENCE FOR THE
LIFE CYCLE OF REAL ESTATE

EMG THERMAL PHOTOGRAPHIC RECORD

Project No.: 98515.11R-007.268 **Project Name: Needham High School**

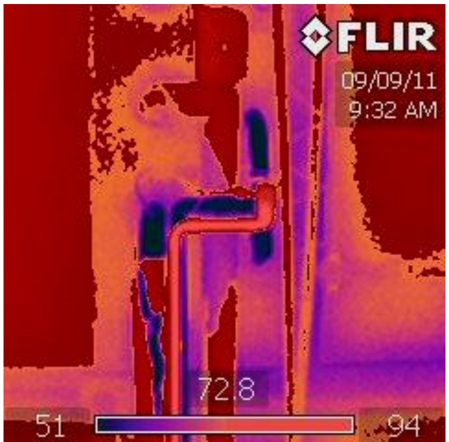


Photo #7:	Exposed Refrigerant Line

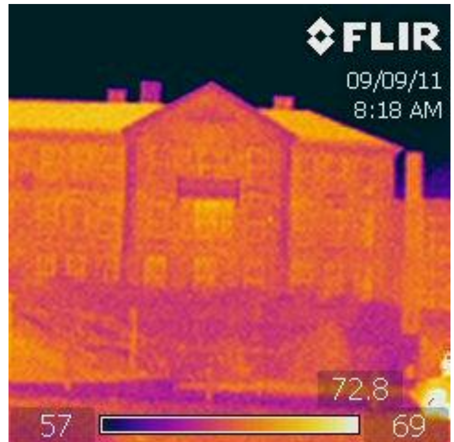


Photo #8:	External-IR

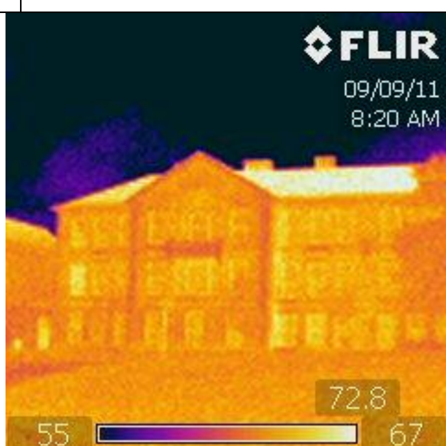


Photo #9:	External-IR

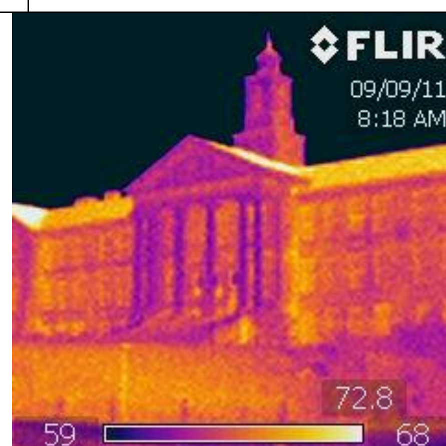


Photo #10:	External-IR

APPENDIX C:
SITE PLAN

Site Plan

EMG	**Source:** WWW.bing.com	**Project Number:** 98515.11R-007.268
		Project Name: Needham High School
N	The north arrow indicator is an approximation of 0° North.	**On-Site Date:** September 9, 2011

APPENDIX D:
RECORDS OF COMMUNICATION

RECORD OF COMMUNICATION

Date:	7th and 9th of September 2011	Time:	8:00 AM
Project Number:	98515.11R-007.268	Recorded by:	Kaustubh Anil Chabukswar, Field Observer/Project Manager
Project Name:	Needham High School		

Communication with: **Jack Hastings**

of: **Needham Township**

Phone: **N/A**

Communication via:

X **Telephone Conversation**

X **Discussions During Site Assessment**

X **Office Visitation/Meeting at:**

Other:

RE:

Summary of Communication:

APPENDIX E:
GLOSSARY OF TERMS

Glossary of Terms and Acronyms

ECM – Energy Conservation Measures are projects recommended to reduce energy consumption. These can be No/Low cost items implemented as part of routine maintenance or Capital Cost items to be implemented as a capital improvement project.

Initial Investment – The estimated cost of implementing an ECM project. Estimates typically are based on R.S. Means Construction cost data and Industry Standards.

Annual Energy Savings – The reduction in energy consumption attributable to the implementation of a particular ECM. These savings values do not include the interactive effects of other ECMs.

Cost Savings – The expected reduction in utility or energy costs achieved through the corresponding reduction in energy consumption by implementation of an ECM.

Simple Payback Period –The number of years required for the cumulative value of energy or water cost savings less future non-fuel or non-water costs to equal the investment costs of the building energy or water system, without consideration of discount rates.

EUL – Expected Useful Life is the estimated lifespan of a typical piece of equipment based on industry accepted standards.

RUL – Remaining Useful Life is the EUL minus the effective age of the equipment and reflects the estimated number of operating years remaining for the item.

SIR - The savings-to-investment ratio is the ratio of the present value savings to the present value costs of an energy or water conservation measure. The numerator of the ratio is the present value of net savings in energy or water and non-fuel or non-water operation and maintenance costs attributable to the proposed energy or water conservation measure. The denominator of the ratio is the present value of the net increase in investment and replacement costs less salvage value attributable to the proposed energy or water conservation measure. It is recommended that energy-efficiency recommendations be based on a calculated SIR, with larger SIRs receiving a higher priority. A project typically is recommended only if the SIR is greater than or equal to 1.0, unless other factors outweigh the financial benefit.

Life Cycle Cost - The sum of the present values of (a) Investment costs, less salvage values at the end of the study period; (b) Non-fuel operation and maintenance costs: (c) Replacement costs less salvage costs of replaced building systems; and (d) Energy and/or water costs.

Life Cycle Savings – The sum of the estimated annual cost savings over the EUL of the recommended ECM, expressed in present value dollars.

Building Site Energy Use Intensity - The sum of the total site energy use in thousand of Btu per unit of gross building area. Site energy accounts for all energy consumed at the building location only not the energy consumed during generation and transmission of the energy to the site.

Building Source Energy Use Intensity – The sum of the total source energy use in thousand of Btu per unit of gross building area. Source energy is the energy consumed during generation and transmission in supplying the energy to your site.

Building Cost Intensity - This metric is the sum of all energy use costs in dollars per unit of gross building area.

Greenhouse Gas Emissions - Although there are numerous gases that are classified as contributors to the total for Greenhouse Emissions, the scope of this energy audit focuses on carbon dioxide (CO_2). Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement).

APPENDIX F:
MECHANICAL EQUIPMENT INVENTORY

Equipment Search Results

Item Number Description Location Tag Number	Model Number Serial Number Manufacturer Area Description	Date Placed in Service Removed from Service Supplier Area Number	Warranty Date Days until Expiration Last Reading Reading Measureme	Notes
ACCU3 NHS CONDENSER UNIT Needham High School	RCS036CYY FBOUO50600862 00 McQuay	B- BUILDING		CONDENSER UNIT FOR RTU-6
AHU-1 NHS Air Handling Unit Needham High School	McQuay	LOADING DOCK		FILTER 20X24X2 = 3 20X20X2 = 3
AHU-3 NHS Air Handling Unit Needham High School	McQuay	LOCKER ROOM		FILTERS 16X25X2 = 1
BLR-1 NHS Hot Water Boiler Needham High School	V1119 Burnham	Boiler Room		GAS
BLR-1-BUR NHS Burner Needham High School	R10.2-G-50 64783255 Gordon-Piatt	BLR-1		GAS
BLR-2 NHS Hot Water Boiler Needham High School	V1119 Burnham	Boiler Room		GAS
BLR-2-BUR NHS Burner Needham High School	R10.2-G-50 64817581 Gordon-Piatt	BLR-2		GAS
BLR-3 NHS Hot Water Boiler Needham High School	V1119 Burnham	Boiler Room		GAS
BLR-3-BUR NHS Burner Needham High School	R10.2-G-50 64817577 Gordon-Piatt	BLR-3		GAS

Equipment Search Results

Item Number / Description / Location / Tag Number	Model Number / Serial Number / Manufacturer / Area Description	Date Placed in Service / Removed from Service / Supplier / Area Number	Warranty Date / Days until Expiration / Last Reading / Reading Measureme	Notes
BLR-4 NHS Hot Water Boiler Needham High School	V1119 Burnham	 Boiler Room		GAS
BLR-4-BUR NHS Burner Needham High School	R10.2-G-50 64783254 Gordon-Piatt	 BLR-4		GAS
CW/P7 NHS CW PUMPS Needham High School	R357 Emmerson	 Boiler Room		40HP
CW/P8 NHS CW PUMPS Needham High School	R357 Emmerson	 Boiler Room		40HP
EF-10 NHS Roof Exhaust Fan Needham High School	 Cook	 Roof		BELT AP23 4L250
EF-12 NHS Roof Exhaust Fan Needham High School	 Cook	 Roof		BELT AP25 4L270
EF-17 NHS Roof Exhaust Fan Needham High School	 Cook	 Roof		BELT
EF-18 NHS Roof Exhaust Fan Needham High School	 Cook	 Roof		BELT 4L190
EF-21 NHS Roof Exhaust Fan Needham High School	 Cook	 Roof		BELT 4L190

Equipment Search Results

Item Number Description Location Tag Number	Model Number Serial Number Manufacturer Area Description	Date Placed in Service Removed from Service Supplier Area Number	Warranty Date Days until Expiration Last Reading Reading Measureme	Notes
EF-22 NHS Roof Exhaust Fan Needham High School	Cook	Roof		BELT 4L220
EF-24 NHS Roof Exhaust Fan Needham High School	Cook	Roof		BELT 3L190
EF-25 NHS Roof Exhaust Fan Needham High School	Cook	Roof		BELT AP25 4L270
EF-28 NHS Roof Exhaust Fan Needham High School	Cook	Roof		BELT 4L230
EF-29 NHS Roof Exhaust Fan Needham High School	Cook	Roof		BELT 4L230
EF-30 NHS Roof Exhaust Fan Needham High School	Cook	Roof		BELT 4L230 A21
EF-31 NHS Roof Exhaust Fan Needham High School	Cook	Roof		BELT AP23 4L250
EF-32 NHS Roof Exhaust Fan Needham High School	Cook	Roof		BELT 4L230
EF-35 NHS Roof Exhaust Fan Needham High School	Cook	Roof		BELT 4L190

Equipment Search Results

Item Number / Description / Location / Tag Number	Model Number / Serial Number / Manufacturer / Area Description	Date Placed in Service / Removed from Service / Supplier / Area Number	Warranty Date / Days until Expiration / Last Reading / Reading Measureme	Notes
EF-37 NHS Roof Exhaust Fan Needham High School	Cook	Roof		BELT 4L230
EF-9 NHS Roof Exhaust Fan Needham High School	Cook	Roof		BELT 3L220
FCU-1 NHS Needham High School		Kitchen		
FCU-2 NHS Needham High School		Faculty Dining Room		
HW-BURN1 NHS Burner Needham High School	J30A.10 POWER FLAME	Boiler Room		GAS
HW-BURN2 NHS Burner Needham High School	J30A.10 POWER FLAME	Boiler Room		GAS
HW-BURN3 NHS Burner Needham High School	J30A.10 POWER FLAME	NORTH MECH		GAS
HW-BURN4 NHS Burner Needham High School	J30A.10 POWER FLAME	NORTH MECH		GAS
HW-TANK1 NHS Dom. Hot Water Heater Needham High School	FBWX-46L425PCP700-N PRECISION	Boiler Room		GAS

Equipment Search Results

Item Number Description Location Tag Number	Model Number Serial Number Manufacturer Area Description	Date Placed in Service Removed from Service Supplier Area Number	Warranty Date Days until Expiration Last Reading Reading Measureme	Notes
HW-TANK2 NHS Dom. Hot Water Heater Needham High School	FBWX-46L425PCP700-N PRECISION	Boiler Room		GAS
HW-TANK3 NHS Dom. Hot Water Heater Needham High School	FBWX-46L425PCP700-N PRECISION	NORTH MECH		GAS
HW-TANK4 NHS Dom. Hot Water Heater Needham High School	FBWX-46L425PCP700-N PRECISION	NORTH MECH		GAS
HW/P5 NHS HW PUMP Needham High School	R363 Emmerson	Boiler Room		50HP
HW/P6 NHS HW PUMP Needham High School	R363 Emmerson	Boiler Room		50HP
KILN 1 Kiln Needham High School				
P BLR1 NHS Circulation Pump Needham High School		Boiler Room Above Boiler		
P BLR2 NHS Circulation Pump Needham High School		Boiler Room Above Boiler		
P BLR3 NHS Circulation Pump Needham High School		Boiler Room Above Boiler		

Equipment Search Results

Item Number / Description / Location / Tag Number	Model Number / Serial Number / Manufacturer / Area Description	Date Placed in Service / Removed from Service / Supplier / Area Number	Warranty Date / Days until Expiration / Last Reading / Reading Measureme	Notes
P BLR4 NHS Circulation Pump Needham High School		Boiler Room Above Boiler		
RTU-1 NHS ROOFTOP W/CW Needham High School	RAH077CSY FBOUO50600853 02 McQuay	A BUILDING		FILTERS 16X25X2 =33 16X20X2 = 11 BELTS 5VX730 = 2
RTU-10 NHS Roof Top Unit Needham High School	RDS708BY FBOUO80501466 03 McQuay	GIRLS/BOYS		FILTERS 20X25X2 = 6 BELT B65 = 1
RTU-11 NHS Roof Top Unit Needham High School	RDS045CSY FBOUO70800934 00 McQuay	B GYM		FILTERS 16X25X2 = 10 16X20X2 = 10 BELTS BX83 = 1
RTU-12 NHS ROOFTOP W/CW Needham High School	RDS708BY FBOUO80501784 03 McQuay	D BUILDING		FILTERS 20X25X2 = 6 BELTS A59 = 1 A61 = 1
RTU-13 NHS Roof Top Unit Needham High School	RDS802CYY FBOUO80501826 00 McQuay	D BUILDING		FILTERS 16X25X2 = 10 16X20X2 = 10 BELTS BX83 = 1
RTU-14 NHS Package Heating & Cooling Needham High School	AION	C BUILDING		FILTERS 16X20X2 = 6 BELTS B40 = 1 BX62 = 1
RTU-15 NHS Roof Top Unit Needham High School	RDS800CYY FBOUO10600682 00 McQuay	MUSIC AREA		FILTERS 16X25X2 = 10 16X20X2 = 10 BELTS A-61 = 1
RTU-16 NHS RTU W/CONDENSE Needham High School	RDS708BY FBOUO10600693 03 McQuay	C BUILDING		FILTERS 20X25X2 = 6 BELTS B63 = 2 A63 = 2

Equipment Search Results

Item Number Description Location Tag Number	Model Number Serial Number Manufacturer Area Description	Date Placed in Service Removed from Service Supplier Area Number	Warranty Date Days until Expiration Last Reading Reading Measureme	Notes
RTU-17 NHS RTU W/CONDENSE Needham High School	Trane	AUDITORIUM		FILTERS 16X25X2 = 4 16X20X2 = 8 BELTS B47 = 2 B67
RTU-18 NHS RTU W/CONDENSE Needham High School	Trane	AUDITORIUM		FILTERS 16X25X2 = 4 16X20X2 = 8 BELTS B47 = 2 B67
RTU-19 NHS Roof Top Unit Needham High School	Trane	WRESTLING RM.		FILTERS 16X20X2 = 4 BELTS A48 = 1 5L560 = 1
RTU-2 NHS Package Heating & Cooling Needham High School	RPS036CLY FBOUO50600854 00 McQuay	A BUILDING		FILTERS 16X25X2 =10 16X20X2 = 10 BELTS B87 = 2
RTU-20 NHS Roof Top Unit Needham High School	Trane	A GYM		FILTERS 16X25X2 = 8 16X20X2 = 4 BELTS B54 - 2 B56
RTU-21 NHS Roof Top Unit Needham High School	K00G15158A Trane	A GYM		FILTERS 16X25X2 = 8 16X20X2 = 4 BELTS B54 - 2 B56
RTU-3 NHS Package Heating & Cooling Needham High School	RPS050CSY FBOUO50600860 02 McQuay	A BUILDING		FILTERS 16X25X2 = 21 16X20X2 = 7 BELTS BX82 = 2
RTU-4 NHS ROOFTOP W/CW Needham High School	RAH077CSY FBOUO50600856 02 McQuay	A BUILDING		FILTERS 16X25X2 = 33 16X20X2 = 11 BELTS BX70 =3
RTU-5 NHS ROOFTOP W/CW Needham High School	RAH047CSY FBOUO61100383 02 McQuay	B BUILDING		FILTERS 16X25X2 = 21 16X20X2 = 7 BELTS BX80 = 2

Equipment Search Results

Item Number Description Location Tag Number	Model Number Serial Number Manufacturer Area Description	Date Placed in Service Removed from Service Supplier Area Number	Warranty Date Days until Expiration Last Reading Reading Measureme	Notes
RTU-6 NHS Package Heating & Cooling Needham High School	RFS036CLY FBOUO50600858 00 McQuay	B BUILDING		FILTERS 16X25X2 =10 16X20X2 = 10 BELTS A84 = 2 A
RTU-7 NHS Package Heating & Cooling Needham High School	RPS050CSY FBOUO61100553 02 McQuay	B- BUILDING		FILTERS 16X25X2 = 21 16X20X2 = 7 BELTS B85 = 2
RTU-8 NHS Roof Top Unit Needham High School	RDS800CYY FBOUO50600855 00 McQuay	A BUILDING		FILTERS 16X25X2 = 10 16X20X2 = 10 BELTS A59 = 1 5
RTU-9 NHS Package Heating & Cooling Needham High School	RPS045CSY FBOUO70800935 02 McQuay	C BUILDING		FILTERS 16X25X2 = 21 16X20X2 = 7 BELTS BX82 = 2
UV-1 NHS Unit Ventilator Needham High School	UAVS4907AZ66R23AN2261B1 American Air Filter	ROOM 807A		FILTERS = 10X481/2X1
UV-10 NHS Unit Ventilator Needham High School	UAVS4810AZ66S23AN2261B1 American Air Filter	ROOM 907B		FILTERS = 10X481/2X1
UV-11 NHS Unit Ventilator Needham High School	UAVS4810AZ66S23AN2261B1 American Air Filter	ROOM 909A		FILTERS = 10X481/2X1
UV-12 NHS Unit Ventilator Needham High School	UAVS4810AZ66S23AN2261B1 American Air Filter	ROOM 909B		FILTERS = 10X481/2X1
UV-13 NHS Unit Ventilator Needham High School	UAVS4810AZ66S23AN2261B1 American Air Filter	ROOM 910		FILTERS = 10X481/2X1

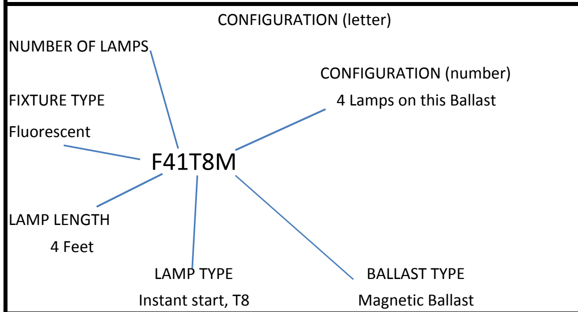
Equipment Search Results

Item Number Description Location Tag Number	Model Number Serial Number Manufacturer Area Description	Date Placed in Service Removed from Service Supplier Area Number	Warranty Date Days until Expiration Last Reading Reading Measureme	Notes
UV-2 NHS Unit Ventilator Needham High School	UAVS4810AZ66S23AN2261B1 American Air Filter	ROOM 807B		FILTERS = 10X481/2X1
UV-3 NHS Unit Ventilator Needham High School	UAVS4907AZ66R23AN2261B1 American Air Filter	ROOM 810		FILTERS = 10X361/2X1
UV-4 NHS Unit Ventilator Needham High School	UAVS4907AZ66R23AN2261B1 American Air Filter	ROOM 901A		FILTERS = 10X361/2X1
UV-5 NHS Unit Ventilator Needham High School	UAVS4907AZ66R23AN2261B1 American Air Filter	ROOM 901B		FILTERS = 10X361/2X1
UV-6 NHS Unit Ventilator Needham High School	UAVS4907AZ66R23AN2261B1 American Air Filter	ROOM 902		FILTERS = 10X301/2X1
UV-7 NHS Unit Ventilator Needham High School	UAVS4810AZ66S23AN2261B1 American Air Filter	ROOM 903A		FILTERS = 10X481/2X1
UV-8 NHS Unit Ventilator Needham High School	UAVS4810AZ66S23AN2261B1 American Air Filter	ROOM 903B		FILTERS = 10X481/2X1
UV-9 NHS Unit Ventilator Needham High School	UAVS4810AZ66S23AN2261B1 American Air Filter	ROOM907A		FILTERS = 10X481/2X1

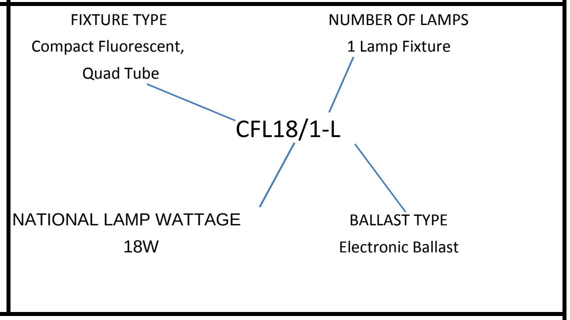
APPENDIX G:
LIGHTING SYSTEMS SCHEDULES

Fixture Code Legend and Notes

Sample Linear Fluorescent Fixture Code



Sample of Other Fixture Code:



Code Explanations

Fixture Type

CF	Compact Fluorescent
CFD	Compact Fluorescent, double-D shape
CFS	Compact Fluorescent, Spiral
CFT	Compact Fluorescent, Twin tube (including "Biaxial" fixtures)
CFQ	Compact Fluorescent, Quad tube
ECF	Exit sign, Compact Fluorescent
EI	Exit sign, Incandescent
ELED	Exit sign, LED
F	Fluorescent, linear
FC	Fluorescent, Circline
FU	Fluorescent, U-tube
H	Halogen
HLV	Halogen, Low Voltage
HPS	High Pressure Sodium
I	Incandescent
LED	Light Emitting Diode (LED) traffic signal
MH	Metal Halide
MHPS	Metal Halide, Pulse Start
MV	Mercury Vapor
QL	Induction

Lamp Type

for fluorescent fixtures

A	"F25T12" - 25 watt, 4ft, T12 lamp
IL or T8	T8, Instant start
SIL	T8, Instant start, Super 30 watt
SSIL or T8N	T8, rapid start, Super 28 watt
L	T8, rapid start
T5	T5, standard
T5HO	T5, standard, High output lamp
T12	T12, Energy efficient
EH	T12, Energy efficient, High output lamp
EI	T12, Energy efficient, Instant start
EV	T12, Energy efficient, Very high output
T12M	T12, Standard magnetic
SIL	T12, Standard, Instant start
HO	T12, Standard, High output lamp
SV	T12, Standard, Very high output lamp
T	T10, Standard

Ballast Type

for fluorescent fixtures

E	Electronic
M	Standard magnetic

Configuration (letter)

T	Tandem wired fixture
DL	Delamped fixture, i.e. some lamps permanently removed but ballasts remain

Configuration (number)

for delamped fixtures

Number signifies the total number of ballasts in the fixture: e.g. An "F42EEID2" is an "F44EE" with two lamps removed so that there is one extaneous ballast

for tandem wired ballasts

Number signifies the total number of lamps being run by the ballast: e.g. An "F42LLIT4" would indicate that a four-lamp ballast is wired to run two-lamp fixtures.

with no preceding letter

Number indicates the number of ballasts in an ambiguous multiple ballast fixture: e.g. An "F43ILU2" indicates a three-lamp fixture with two ballasts (as is often the case if there is A/B switching).

Notes:
1) The column labeled Watts/Fixtures in the data table includes ballast loads.
2) The fixture wattage values represent an average value, rounded to the nearest whole watt.

Existing Facilities Program Lighting Form:

Performance Based

Project Number:	98515.11R-007.268
Facility Name:	Needham High School
Project Manager	Kaustubh
Date: ##	Square Footage (ft2) 286666

Existing Control Legend	
LS	Light Switch
PS	Photosensor
TM	Timer
MS	Motion/Occupancy Sensor
EC	Emergency Control

INSTRUCTIONS Coding Legend		
CF	Compact Fluorescent	I
F	Fluorescent, linear	LED
H	Halogen	MH
HPS	High Pressure Sodium	MV
I	Incandescent	QL

PRE-INSTALLATION

Line Item	ECM	Type of ECM Code (Refer to ECM Code Worksheet)	Additional ECM Code (if applicable)	Floor	Area Description	Light Reading (Record if ECM)	Usage	Usage	Existing Control	Pre Fixt. No.	Pre Fixt Code (Refer to Wattable Table Worksheet)	Pre Watts / Fixt	Pre kW / Space	Baseline Annual Hours	Annual kWh Consumed
Integer line number	(Type 'ECM' for lighting retrofit)	ECM CODE Worksheet Link	For two ECMs in one line item	Floor fixture is on	Description of location that matches site map	Lux	hrs/ week	Wks/Yr	control device (refer to legend above)	# of existing fixtures	TypWattage Table	Watts/Fixt from Wattage Table	(Pre Watts/Fixt) * (Pre Fixt No.)	Existing annual hours used	(PreFixt #*PreWatts/Fixt * Baseline Hrs)
1					Hallway Lighting	150	50	52	LS	297	F42T8	59	17.52	2,600	45,560
2					Hallway Lighting	400	50	36	LS	444	CFT13/2	31	13.76	1,800	24,775
3	ECM	PS			Classroom Lighting	500	40	36	MS	100	F42T8	59	5.90	1,440	8,496
4					Classroom Lighting	150	40	36	MS	1,227	F42T8	59	72.39	1,440	104,246
5					Classroom Lighting		40	36	MS	67	FU3T8	89	5.96	1,440	8,587
6	ECM	PS			Main Entrance Stairwell	750	168	50	EC	27	F42T8	59	1.59	8,400	13,381
7	ECM	RB			Gym A	300-400	30	36	LS	35	MH320	365	12.78	1,080	13,797
8	ECM	RB			Gym B		30	36	LS	10	MH320	365	3.65	1,080	3,942
9					Auditorium		10	30	LS	20	I60/1	60	1.20	300	360
10					Auditorium - Stage area		5	30	LS	6	F42T8	59	0.35	150	53
11					Fitness & weight Rooms		30	36	MS	90	F42T8	59	5.31	1,080	5,735
12					Locker Room areas		20	36	MS	48	F43T8	89	4.27	720	3,076
13					Cafeteria	130	30	36	LS	50	F42T8	59	2.95	1,080	3,186
14					Cafeteria	120	30	36	LS	21	CFT13/2	31	0.65	1,080	703
15	ECM	PS			Cafeteria	600	30	36	LS	9	CFT13/2	31	0.28	1,080	301
16	ECM	PS			Cafeteria	700	30	36	LS	9	F22T8	33	0.30	1,080	321
17					Kitchen area	150	40	36	LS	30	F44T8	112	3.36	1,440	4,838
18	ECM	PS			Kitchen area	650	40	36	LS	5	F44T8	112	0.56	1,440	806
19					Kitchen area	150	40	36	LS	17	F43T8	89	1.51	1,440	2,179
20					Math and Science	130	40	36	LS	18	F43T8	89	1.60	1,440	2,307
21					Math and Science	160	40	36	LS	11	FU3ILL	89	0.98	1,440	1,410
22					Library	300	40	36	LS	18	FU2ILL	59	1.06	1,440	1,529
23					Library	350	40	36	LS	27	FU3ILL	89	2.40	1,440	3,460
24					Library	300	40	36	MS	18	F42T8	59	1.06	1,440	1,529
25					Library		40	36	MS	10	CFT13/2	31	0.31	1,440	446
26					Library		40	36	MS	6	F44T8	112	0.67	1,440	968
27					Guidance area		40	36	MS	38	F22T8	33	1.25	1,440	1,806
28	ECM	PS			Guidance area		40	36	MS	6	F22T8	33	0.20	1,440	285
29					Guidance area		40	36	MS	4	F42T8	59	0.24	1,440	340
30					Stairwells		168	52	EC	150	CFQ26/2	66	9.90	8,736	86,486
31					Restrooms		20	36	MS	40	F22T8	33	1.32	720	950
32					Exit Lighting		168	52	EC	110	ELED5/2	10	1.10	8,736	9,610
33	ECM	RB			Parking Lighting		80	52	TM	33	MH250	295	9.74	4,160	40,498
34	ECM	RB			Pole Lighting		80	52	TM	13	MH100	128	1.66	4,160	6,922
35					Exterior Bldg Lighting		80	52	TM	6	CFQ26/2	66	0.40	4,160	1,647
36	ECM	RB			Exterior Bldg Lighting		80	52	TM	2	MH400	458	0.92	4,160	3,811
37					Exterior Bldg Lighting		80	52	TM	21	MH50	72	1.51	4,160	6,290
38	ECM	RB			Exterior Bldg Lighting		80	52	TM	5	MH175	215	1.08	4,160	4,472
39					Exterior Bldg Lighting		80	52	TM	8	MH70	95	0.76	4,160	3,162
40	ECM	PS			Stairwells	750	168	52	LS	20	CFQ26/2	66	1.32	8,736	11,532
									Total Pre Fixt.	**3,076**		**Total Pre kW**	**194**	**kWh Consumed**	**433,802**

PRE-INSTALLATION

Line Item	ECM	Type of ECM Code (Refer to ECM Code Worksheet)	Additional ECM Code (if applicable)	Floor	Area Description	Light Reading (Record if ECM)	Usage	Usage	Existing Control	Pre Fixt. No.	Pre Fixt Code (Refer to Wattable Table Worksheet)	Pre Watts / Fixt	Pre kW / Space	Baseline Annual Hours	Annual kWh Consumed
Integer line number	(Type 'ECM' for lighting retrofit)	ECM CODE Worksheet Link	For two ECMs in one line item	Floor fixture is on	Description of location that matches site map	Lux	hrs/ week	Wks/Yr	control device (refer to legend above)	# of existing fixtures	TypWattage Table	Watts/Fixt from Wattage Table	(Pre Watts/Fixt) * (Pre Fixt No.)	Existing annual hours used	(PreFixt #*PreWatts/Fixt * Baseline Hrs)
												Light Intensity	0.676	**Usage Intensity**	1.51
													Watt/ ft2		KWh / ft2

Existing Facilities Program Lighting Form:

Performance Based

Existing Control Legend	
LS	Light Switch
PS	Photosensor
T	Timer
MS	Motion Sensor
EC	Emergency Control

INSTRUCTIONS Coding Legend			
CF	Compact Fluorescent	I	Incandescent
F	Fluorescent, linear	LED	Light Emitting Diode
H	Halogen	MH	Metal Halide
HPS	High Pressure Sodium	MV	Mercury Vapor
I	Incandescent	QL	Induction

Project Name: 98515.11R-007.268

Facility Name: Needham High School

Date: ## Project Manager Kaustubh

PRE-INSTALLATION / POST-INSTALLATION

Line Item	ECM	Type of ECM Code (Refer to ECM Code Worksheet)	Additional ECM Code (if applicable)	Floor	Area Description	Light Reading (Record if ECM)	Usage	Baseline Annual Hours	Existing Control	Pre Fixt. No.	Pre Fixt Code	Post Fixt No.	Post Fixt Code (Refer to Wattable Table Worksheet)	Post Watts/ Fixt	Proposed Weekly Hours	Proposed Annual Weeks	Proposed Control	kW Saved	Annual kWh Saved
Integer line number	(Type 'ECM" if applied)	ECM CODE Worksheet Link	For two ECMs in one line item	Floor fixture is on	Description of location that matches site map	Lux (link to light standards)	hrs/ week	Existing annual hours for the usage group	Pre-installation control device	# of existing fixtures	TypWattage Table Link	# of existing fixtures	TypWattage Table	Watts/Fixt from Wattage Table	hrs / wk	Wks/Yr	Post-installation control device	Pre kW/Space - Post kW/Space	(PreFixt #*PreWatts/Fixt * Baseline Hrs) - (PostFixt#*PostWatts/Fixt * Proposed Hours)
Ex.		*RB*		*10*	*Men's Room*		*5*	*3,000*	*Light Switch*	*3*	*F44T12*	*3*	*F42T8*	*59*			*Motion Sensor*	*0.26*	*765*
3	ECM	PS - Install Photo Sensor	#N/A	-	Classroom Lighting	500	40	1,440	MS	100	F42T8	100	F42T8	59	30.00	40.00	PS	0.00	1,416
6	ECM	PS - Install Photo Sensor	#N/A	-	Main Entrance Stairwell	750	168	8,400	EC	27	F42T8	27	F42T8	59	80.00	52.00	PS	0.00	6,754
7	ECM	RB - Replace Bulb	#N/A	-	Gym A	300-400	30	1,080	LS	35	MH320	35	QL165	170	30.00	36.00	LS	6.83	7,371
8	ECM	RB - Replace Bulb	#N/A	-	Gym B	-	30	1,080	LS	10	MH320	10	QL165	170	30.00	36.00	LS	1.95	2,106
15	ECM	PS - Install Photo Sensor	#N/A	-	Cafeteria	600	30	1,080	LS	9	CFT13/2	9	CFT13/2	31	15.00	36.00	PS	0.00	151
16	ECM	PS - Install Photo Sensor	#N/A	-	Cafeteria	700	30	1,080	LS	9	F22T8	9	F22T8	33	15.00	36.00	PS	0.00	160
18	ECM	PS - Install Photo Sensor	#N/A	-	Kitchen area	650	40	1,440	LS	5	F44T8	5	F44T8	112	25.00	36.00	PS	0.00	302
28	ECM	PS - Install Photo Sensor	#N/A	-	Guidance area	-	40	1,440	MS	6	F22T8	6	F22T8	33	20.00	36.00	PS	0.00	143
33	ECM	RB - Replace Bulb	#N/A	-	Parking Lighting	-	80	4,160	TM	33	MH250	33	QL165	170	80.00	52.00	TM	4.13	17,160
34	ECM	RB - Replace Bulb	#N/A	-	Pole Lighting	-	80	4,160	TM	13	MH100	13	LED45	54	80.00	52.00	TM	0.96	4,002
36	ECM	RB - Replace Bulb	#N/A	-	Exterior Bldg Lighting	-	80	4,160	TM	2	MH400	2	QL250	258	80.00	52.00	TM	0.40	1,664
38	ECM	RB - Replace Bulb	#N/A	-	Exterior Bldg Lighting	-	80	4,160	TM	5	MH175	5	LED65	79	80.00	52.00	TM	0.68	2,829
40	ECM	PS - Install Photo Sensor	#N/A	-	Stairwells	750	168	8,736	LS	20	CFQ26/2	26	CFQ26/2	66	80.00	52.00	PS	-0.40	4,393
									Total Pre Fixt.	**274**		**280**	**Total Post kW**	**1,294.00**			**Total kW Saved**	**14.55**	**48,451.00**

APPENDIX H:
ECM CALCULATIONS

UIC	**Reduce Hours of Operation of Chilled Water Circulation Pumps**	
EAM1	**Details: Re-program BMS to Trigger both the chiller and pumps to come on at the same time.**	
Enter The Number of Motors	1	
Type of Current Supplied	Three Phase Current	
Enter Horse Power of existing motor:	40	hp
Enter Excess Hours of Operation:	60	Hrs
Enter Existing Name Plate Efficiency:	94.6%	
Enter VFD Controlled Motor Speed:	50.0%	
Peak kW savings with Premium Motor:	8.05	kW
Annual kWh Savings From All Premium Motors:	483.00	kWh
Electricity Cost/kWh:	**$0.19**	per kWh
Estimated Annual Cost Savings From Energy:	$92.11	$$
Estimated Annual O &M Savings:	$4.61	$$
Estimated annual cost savings:	$96.71	$$
Estimated cost to re-program BMS:	$0	$$
Total Replacement Cost	$0	$$
Simple Payback:	0.00	Yrs
Type of Recommendation	No/Low Cost ECM Recommendation	

UIC	Install Energy Savers on Vending, Snack Machines
EAC8	Details: Install Sensor on Vending Machines in Cafeteria & Staff Break Room

No. of Vending Machines:	2.00	Qty	No. of Beverage Cooling Machines:	0.00	Qty
No. of Snack Machines	0.00	Qty			

Vending Machines (Cold Beverage Vending Machines)		
Estimated Annual kWh Consumption of Vending Machine:	3500.00	kWh
Estimated Annual kWh of Vending Machine With VendMiser:	1890.00	kWh
Total annual kWh savings:	1610.00	kWh
Total Annual kWh Savings for All Vending Machines:	3220.00	kWh
Beverage Cooling Machines		
Estimated Annual kWh Consumption of Beverage Cooling Machine:	2300.00	kWh
Estimated Annual kWh of Cooling Machine With CoolerMiser:	1610.00	kWh
Total Annual kWh savings:	690.00	kWh
Total Annual kWh Savings For All Cooling Machines:	0.00	kWh
Snack Vending Machines		
Estimated Annual kWh Consumption of Individual Snack Machine:	873.60	kWh
Estimated Annual kWh of Individual Snack Machines With VendMiser:	366.91	kWh
Total Annual kWh savings:	506.69	kWh
Total Annual kWh Savings For All Water Fountain Coolers:	0.00	kWh
Cost Analysis		
Total estimated annual kWh savings withEnergy Misers:	**3220.00**	kWh
Cost/kWh:	**$0.19**	
Estimated Cost of Vendmiser/ Vending Machine:	$200	
Estimated Cost of Coolermiser/ Water cooler:	$190	
Estimated Cost of Vendmiser/ Snack Machine:	$70	
Estimated total installed cost of all VendMisers:	**$400**	
Estimated Total Annual Electricity Savings Using VendingMisers and CoolerMisers:	**$614**	
Simple Payback:	0.65	years

Type of Recommendation No/Low Cost ECM Recommendation

UIC	Install Automatic Lighting Controls		
EAL5	Details: Install Photosensors in Classrooms, Hallways and Stairwells		
	Type of Sensor	Internal Photosensors	
Step: 1	Total Number of Sensors	40	
Step: 2	Purchase Cost/Lighting Control Sensors	$15	
Step: 3	Installation Cost /Sensor	$65	
Step:4	Total Installation Costs	$3,436.80	
Step:5	Total Energy Savings	13319.00	kWh
Step:6	Electric Tariff Rate	**$0.19**	$
Step:7	Total Cost Savings	$2,539.92	
Step:8	Simple Pay Back Period	1.35	Years
Type of Recommendation		Capital Cost ECM Recommendation	

UIC	Re-Commission The Building HVAC Controls		
EAC10	Details: Relocate the DP Sensor And Re-Program the Setpoint on the Sensor		
	Enter the Total Area of The Facility	286,666	SqFt
	Select the Type of Heating Fuel:	Natural Gas	*(Select)*
	Estimated Annual Heating Fuel Consumption:	0	Therms
	Is the Property Cooled?	Yes	*(Select)*
	Estimated Annual Electrical Energy Consumed For Cooling:	141,160	kWh
	Estimated Energy Savings From Re-Commissioning on Building Systems: *(LBNL 2009 Report on Building Commissioning)*	8%	
	Estimated Heating Energy Saving Post Re-Commissioning:	0	Therms
	Estimated Cooling Energy Saving Post Re-Commissioning:	11,293	kWh
	Average Heating Fuel Rate Paid By The Property:	$1.08	$/Therm
	Average Electrical Rate Paid By The Property:	$0.19	$/kWh
	Annual Energy Cost Savings:	$2,154	$
	Estimated Cost For Re-Commissioning The Facility: *(LBNL 2009 Report on Building Commissioning)*	$5,350	$
	Simple Payback Period:	2.48	Yrs
	Type of Recommendation	Capital Cost ECM Recommendation	

UIC	**Replace High Intensity Discharge Lamp (HID) with Induction Lighting**		
EAL10	**Details: Replace Exterior Lighting with Induction Lighting**		
Step:1	Number of 100-150W HID Lamps Replaced by 45W Induction	**13**	
	Number of 150-200W HID Lamps Replaced by 65W Induction	**5**	
	Number of 200-250W HID Lamps Replaced by 90W Induction	**0**	
	Installation Cost Analysis		
Step:2	Are the fixture(s) also being replaced? (Y/N)	N	
	Subtotal Cost of 45 Watt Induction Retrofit	$6,045	$$
Step:3	Are the fixture(s) also being replaced? (Y/N)	N	
	Subtotal Cost of 65 Watt Induction Retrofit	$2,900	$$
Ste:4	Are the fixture(s) also being replaced? (Y/N)	Y	
	Subtotal Cost of 90 Watt Induction Retrofit	$0	$$
Step:5	**Estimated Total Cost For Retrofit**	$9,607	$$
	Energy & Cost Saving Analysis		
Step:6	Estimated Annual Energy Savings	6831.00	kwh
Step:7	Current Electric Price Per kWh	$0.19	$$
Step:8	Estimated Annual Energy Savings In Dollars	$1,302.66	$$
Step:9	Existing Annual Usage *(For O&M Savings)*	4000	hrs
	Proposed Annual Usage Post Retrofit *(For O&M Savings)*	4000	hrs
	Estimated Annual O&M Savings	$108.67	$$
Step:10	Total Estimated Annual Cost Savings *(Energy & O&M Savings)*	$1,411	$$
Step:10	Simple Pay back Period	6.81	Yrs
Type of Recommendation	Capital Cost ECM Recommendation		

NOTE: Induction Lamps contain 3 to 4 times the life of HID lamps where significant Operation and Maintanence Savings are attained through minimizing frequency of bulb and ballast replacements

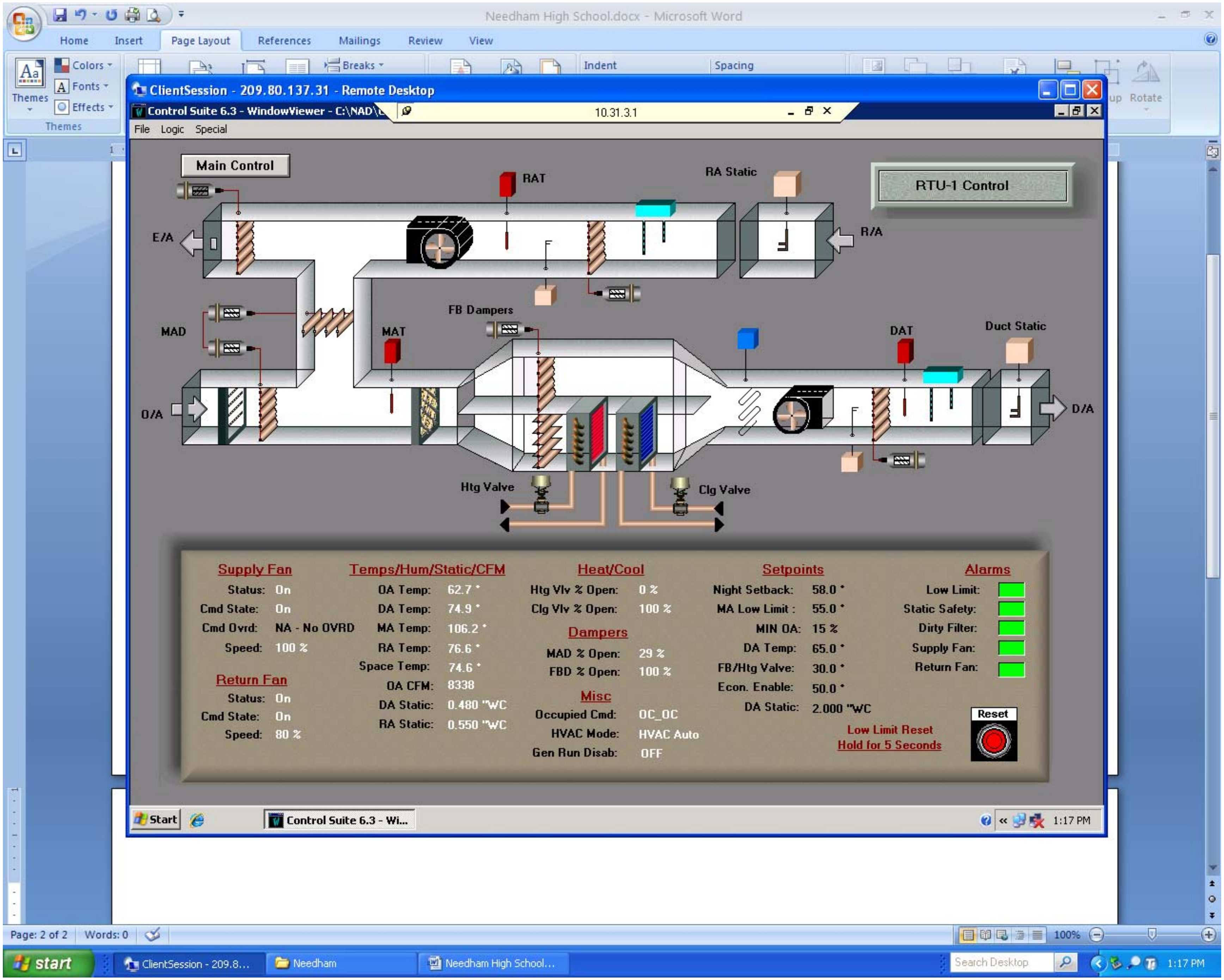
UIC	**Replace High Intensity Discharge Lamp (HID) with Induction Lighting**
EAL9	**Details: Replace Gym Lighting, Exterior Building Lighting and Parking Lighting with Induction**

Step:1	Number of 60-100W HID Lamps Replaced by 40W Induction	0	
	Number of 100-150W HID Lamps Replaced by 70W Induction	0	
	Number of 150-200W HID Lamps Replaced by 85W Induction	**0**	
	Number of 200-250W HID Lamps Replaced by 120W Induction	**0**	
	Number of 250-300W HID Lamps Replaced by 165W Induction	**33**	
	Number of 300-400W HID Lamps Replaced by 250W Induction	**47**	
	Number of 1000W HID Lamps Replaced by (2)300W Induction Lamps	**0**	
	Installation Cost Analysis		
Step:2	Subtotal Cost of 40 Watt Induction Self Ballast Retrofit	$0	
Step:3	Subtotal Cost of 70 Watt Induction Retrofit	$0	
Step:4	Subtotal Cost of 85 Watt Induction Retrofit	$0	
Step:5	Subtotal Cost of 120 Watt Induction Retrofit	$0	
Step:6	Subtotal Cost of 165 Watt Induction Retrofit	$15,675	
Step:7	Subtotal Cost of 250 Watt Induction Retrofit	$26,085	
Step:8	Subtotal Cost of 300 Watt Induction Retrofit	$0	
Step:9	**Total Cost For Retrofit**	$44,850	
	Energy & Cost Saving Analysis		
Step:10	Estimated Annual Energy Savings	28301.00	kwh
Step:11	Current Electric Price Per kWh	$0.19	$
Step:12	Estimated Annual Cost Savings	$5,397	
Step:13	Existing Annual Usage *(For O&M Savings)*	1100	hrs
	Proposed Annual Usage Post Retrofit *(For O&M Savings)*	1100	hrs
	Estimated Annual O&M Savings	$423	$$
Step:14	Total Estimated Annual Cost Savings *(Energy & O&M Savings)*	$5,820	$$
Step:15	Simple Pay back Period	7.71	Yrs
	Type of Recommendation	Capital Cost ECM Recommendation	

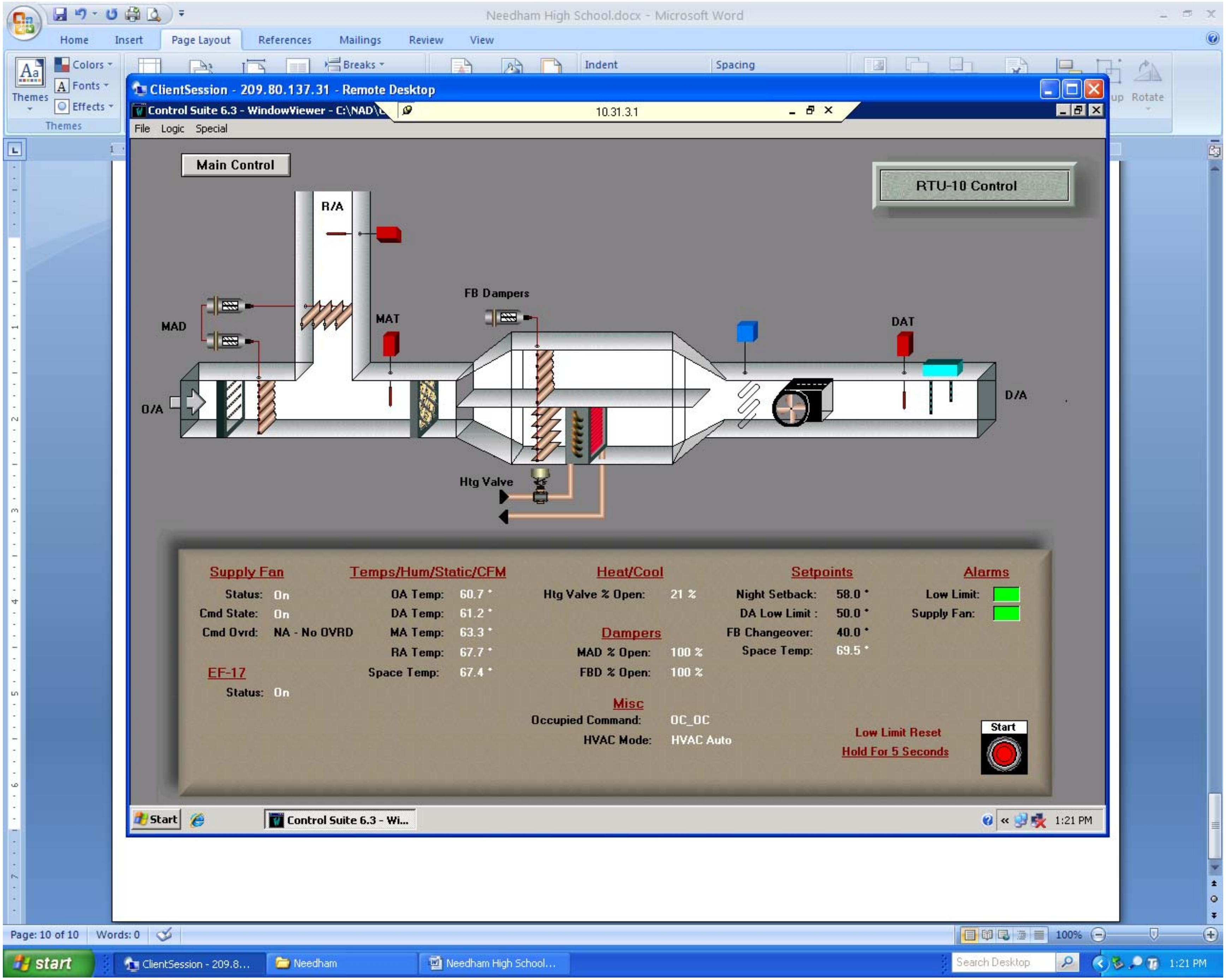
NOTE: Induction Lamps contain 3 to 4 times the life of HID lamps where significant Operation and Maintanence Savings are attained through minimizing frequency of bulb and ballast replacements

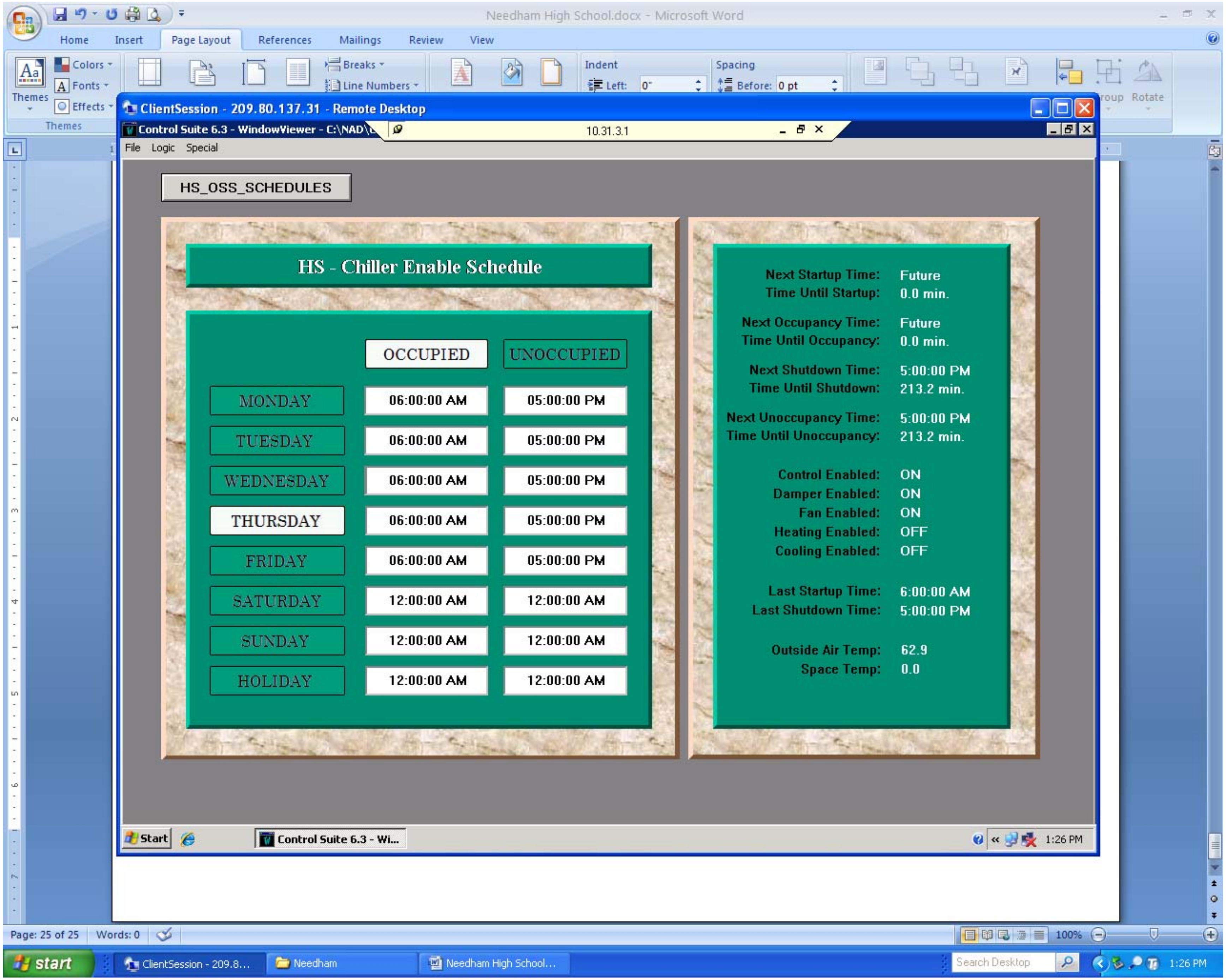
APPENDIX I:
SUPPORTING DOCUMENTS

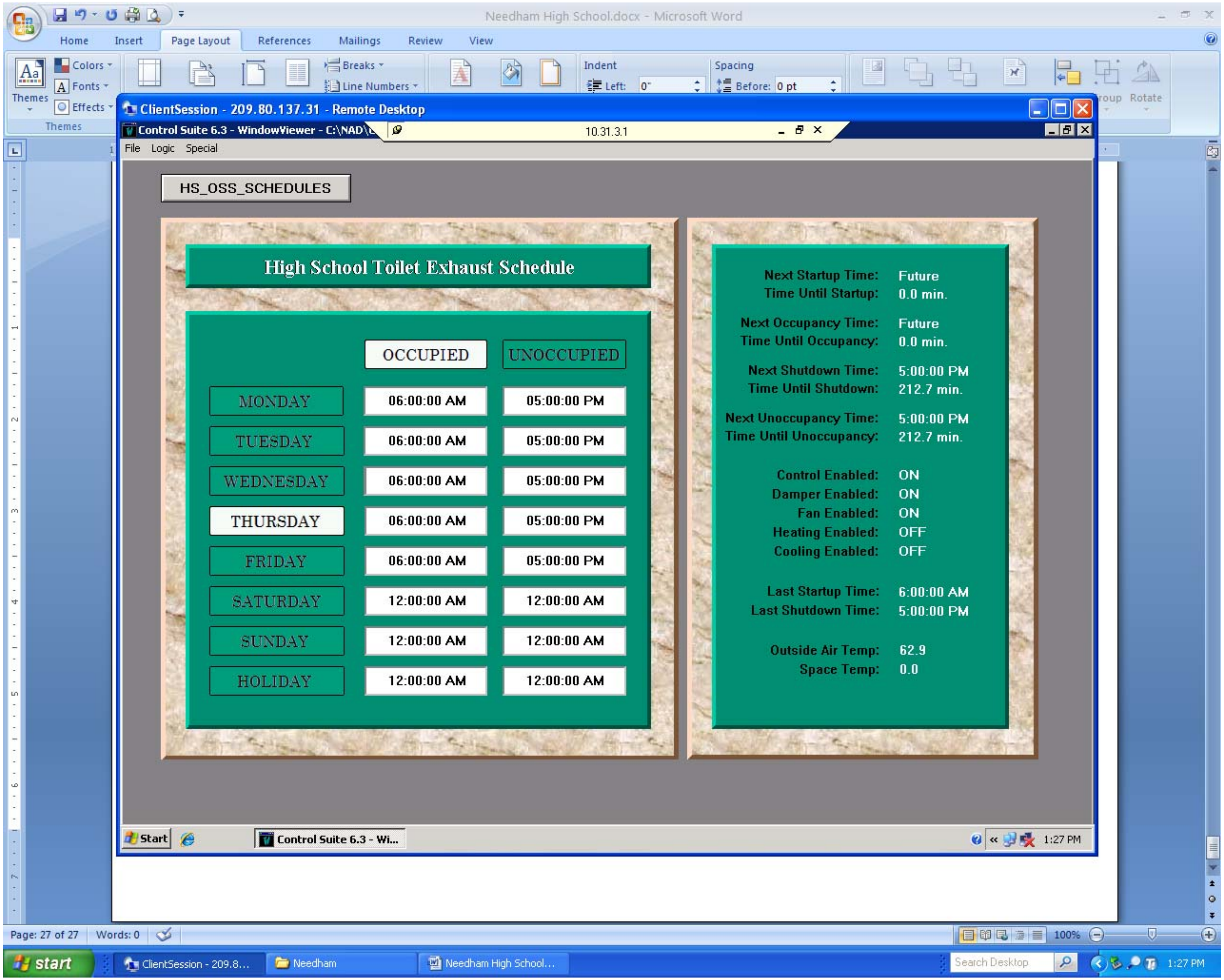
ClientSession - 209.80.137.31 - Remote Desktop
Control Suite 6.3 - WindowViewer
10.31.3.1
File Logic Special
NEEDHAM HIGH SCHOOL
Log Off
Scheduler
RTU-1 Control
RTU-2 Control
RTU-3 Control
RTU-4 Control
RTU-5 Control
RTU-6 Control
RTU-7 Control
RTU-8 Control
RTU-9 Control
RTU-10 Control
OSS Schedule
Global Ovrds
Trends
RTU-11 Control
RTU-12 Control
RTU-13 Control
RTU-14 Control
RTU-15 Control
RTU-16 Control
RTU-17 Control
RTU-18 Control
RTU-19 Control
RTU-20 Control
RTU-21 Control
Alarm Management
Building Selection
A & B Sec. Heat
Hot Water System
A & B Exhaust Fans
C Sec. Heat
Chilled Water System
C & D Exhaust Fans
D Sec. Heat
Building-A
Lower Level
Ground Floor
1st Floor
2nd Floor
Building-B
Ground Floor
1st Floor
2nd Floor
Building-C
1st Floor
2nd Floor
3rd Floor
Building-D
1st Floor
2nd Floor
Start
Control Suite 6.3 - Wi...
1:16 PM
start
ClientSession - 209.8...
Needham
Needham High School...
Search Desktop
1:16 PM

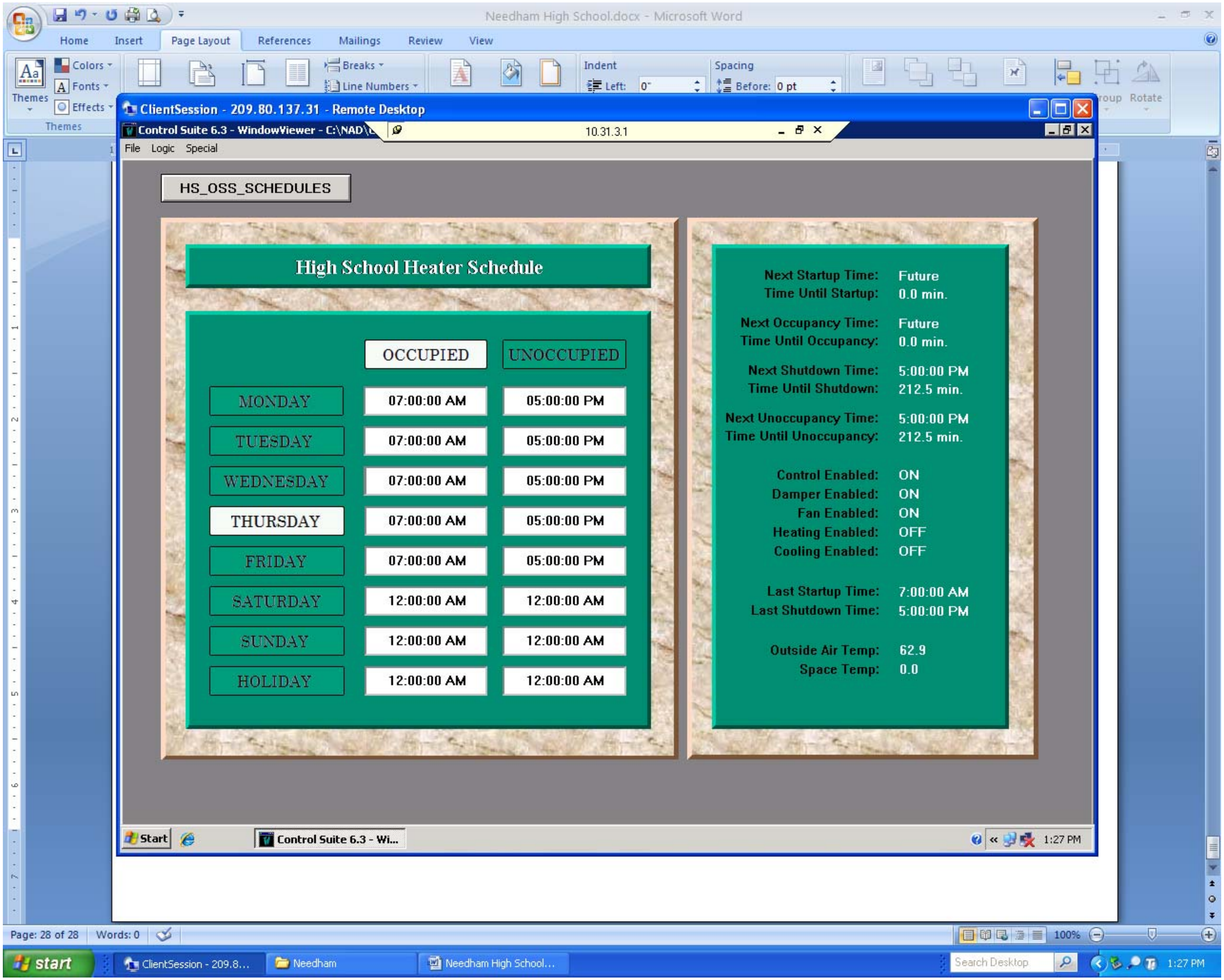


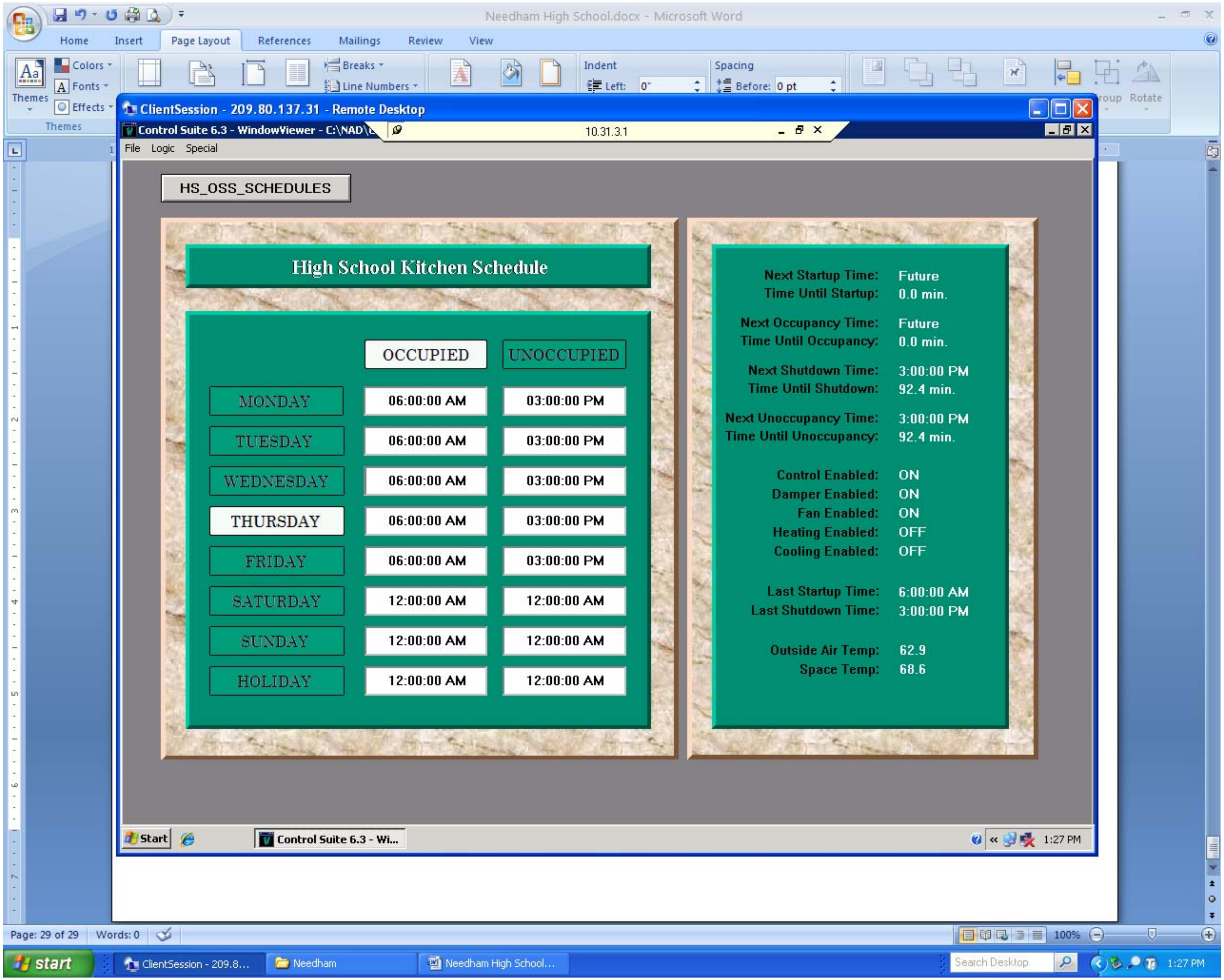
Needham High School.docx - Microsoft Word
ClientSession - 209.80.137.31 - Remote Desktop
Control Suite 6.3 - WindowViewer
10.31.3.1
File Logic Special
Main Control
RTU-1 Control
RAT
RA Static
E/A
R/A
MAD
MAT
FB Dampers
DAT
Duct Static
O/A
D/A
Htg Valve
Clg Valve
Supply Fan
Status: On
Cmd State: On
Cmd Ovrd: NA - No OVRD
Speed: 100 %
Return Fan
Status: On
Cmd State: On
Speed: 80 %
Temps/Hum/Static/CFM
OA Temp: 62.7 °
DA Temp: 74.9 °
MA Temp: 106.2 °
RA Temp: 76.6 °
Space Temp: 74.6 °
OA CFM: 8338
DA Static: 0.480 "WC
RA Static: 0.550 "WC
Heat/Cool
Htg Vlv % Open: 0 %
Clg Vlv % Open: 100 %
Dampers
MAD % Open: 29 %
FBD % Open: 100 %
Misc
Occupied Cmd: OC_OC
HVAC Mode: HVAC Auto
Gen Run Disab: OFF
Setpoints
Night Setback: 58.0 °
MA Low Limit : 55.0 °
MIN OA: 15 %
DA Temp: 65.0 °
FB/Htg Valve: 30.0 °
Econ. Enable: 50.0 °
DA Static: 2.000 "WC
Alarms
Low Limit:
Static Safety:
Dirty Filter:
Supply Fan:
Return Fan:
Reset
Low Limit Reset
Hold for 5 Seconds
Start
Control Suite 6.3 - Wi...
1:17 PM
Page: 2 of 2 Words: 0
start
ClientSession - 209.8...
Needham
Needham High School...


Needham High School.docx - Microsoft Word
Home
Insert
Page Layout
References
Mailings
Review
View
Colors
Fonts
Effects
Themes
Breaks
Indent
Spacing
Rotate
ClientSession - 209.80.137.31 - Remote Desktop
Control Suite 6.3 - WindowViewer - C:\NAD\
10.31.3.1
File
Logic
Special
Main Control
RTU-10 Control
R/A
MAD
MAT
FB Dampers
DAT
O/A
D/A
Htg Valve
Supply Fan
Status: On
Cmd State: On
Cmd Ovrd: NA - No OVRD
EF-17
Status: On
Temps/Hum/Static/CFM
OA Temp: 60.7 °
DA Temp: 61.2 °
MA Temp: 63.3 °
RA Temp: 67.7 °
Space Temp: 67.4 °
Heat/Cool
Htg Valve % Open: 21 %
Dampers
MAD % Open: 100 %
FBD % Open: 100 %
Misc
Occupied Command: OC_OC
HVAC Mode: HVAC Auto
Setpoints
Night Setback: 58.0 °
DA Low Limit : 50.0 °
FB Changeover: 40.0 °
Space Temp: 69.5 °
Alarms
Low Limit:
Supply Fan:
Low Limit Reset
Hold For 5 Seconds
Start
Start
Control Suite 6.3 - Wi...
1:21 PM
Page: 10 of 10
Words: 0
100%
start
ClientSession - 209.8...
Needham
Needham High School...
Search Desktop
1:21 PM

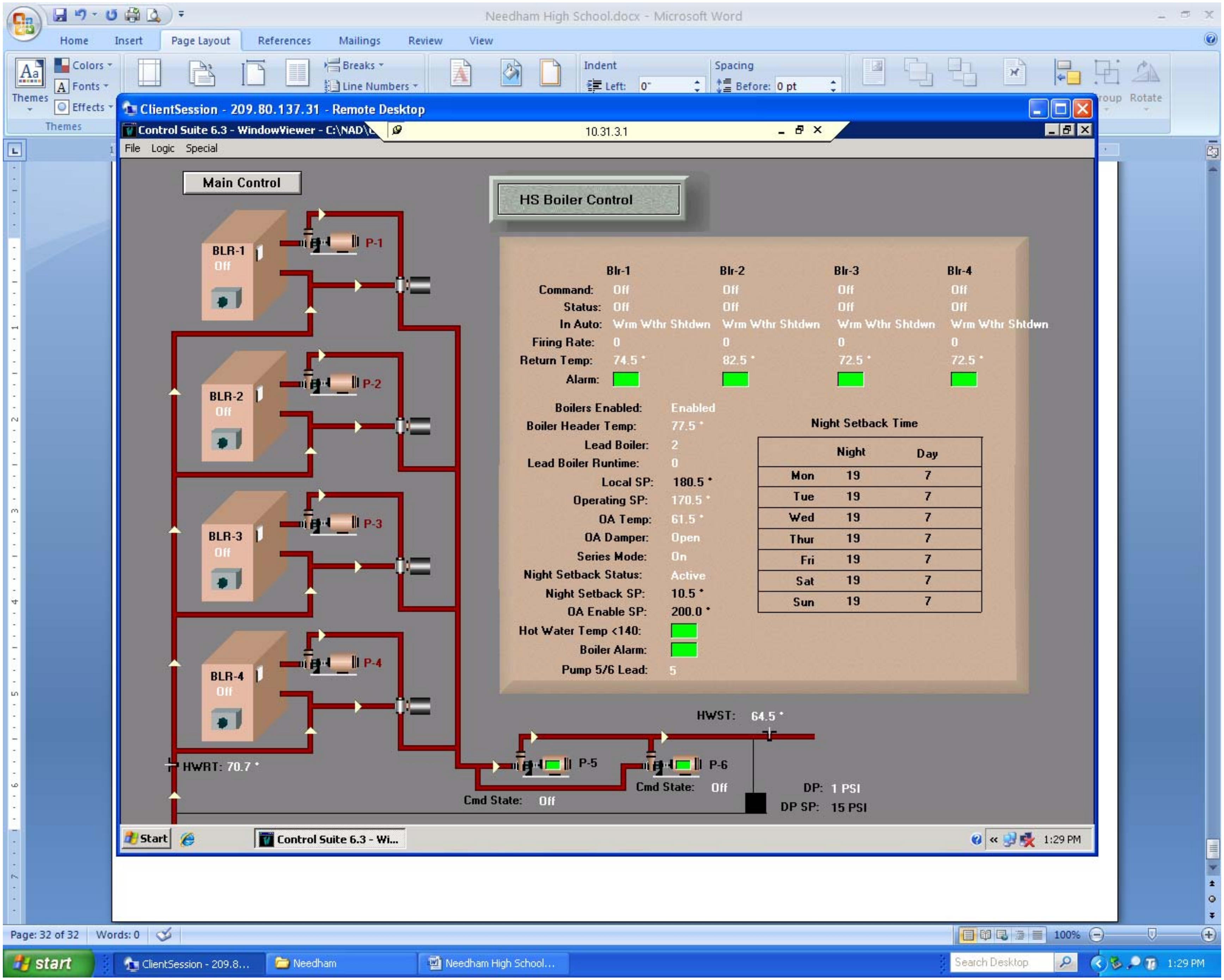

Needham High School.docx - Microsoft Word
ClientSession - 209.80.137.31 - Remote Desktop
Control Suite 6.3 - WindowViewer
10.31.3.1
HS_OSS_SCHEDULES
HS - Chiller Enable Schedule
OCCUPIED
UNOCCUPIED
MONDAY 06:00:00 AM 05:00:00 PM
TUESDAY 06:00:00 AM 05:00:00 PM
WEDNESDAY 06:00:00 AM 05:00:00 PM
THURSDAY 06:00:00 AM 05:00:00 PM
FRIDAY 06:00:00 AM 05:00:00 PM
SATURDAY 12:00:00 AM 12:00:00 AM
SUNDAY 12:00:00 AM 12:00:00 AM
HOLIDAY 12:00:00 AM 12:00:00 AM
Next Startup Time: Future
Time Until Startup: 0.0 min.
Next Occupancy Time: Future
Time Until Occupancy: 0.0 min.
Next Shutdown Time: 5:00:00 PM
Time Until Shutdown: 213.2 min.
Next Unoccupancy Time: 5:00:00 PM
Time Until Unoccupancy: 213.2 min.
Control Enabled: ON
Damper Enabled: ON
Fan Enabled: ON
Heating Enabled: OFF
Cooling Enabled: OFF
Last Startup Time: 6:00:00 AM
Last Shutdown Time: 5:00:00 PM
Outside Air Temp: 62.9
Space Temp: 0.0
1:26 PM
Page: 25 of 25
Words: 0

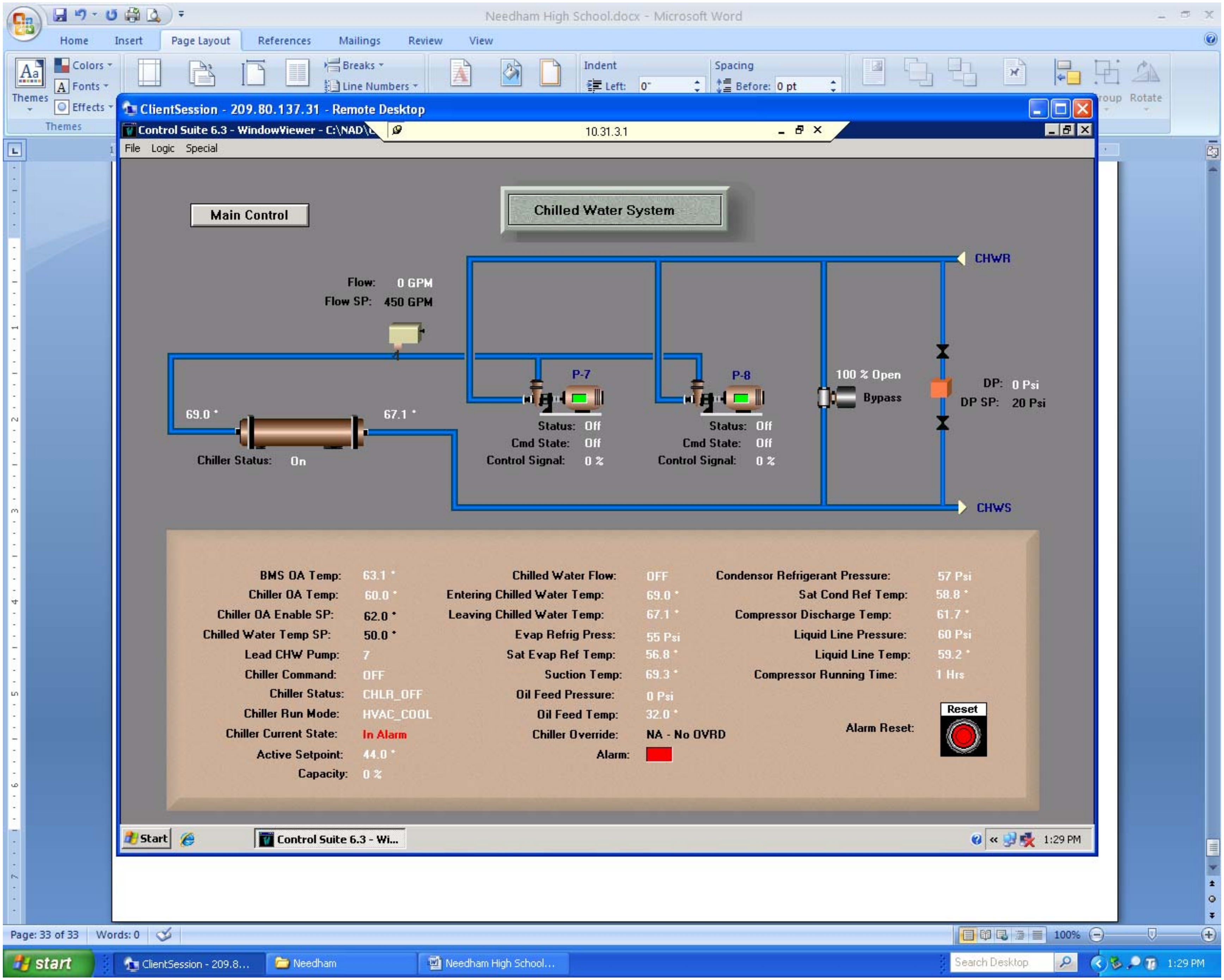

Needham High School.docx - Microsoft Word
ClientSession - 209.80.137.31 - Remote Desktop
Control Suite 6.3 - WindowViewer
10.31.3.1
File Logic Special
HS_OSS_SCHEDULES
High School Toilet Exhaust Schedule
OCCUPIED
UNOCCUPIED
MONDAY 06:00:00 AM 05:00:00 PM
TUESDAY 06:00:00 AM 05:00:00 PM
WEDNESDAY 06:00:00 AM 05:00:00 PM
THURSDAY 06:00:00 AM 05:00:00 PM
FRIDAY 06:00:00 AM 05:00:00 PM
SATURDAY 12:00:00 AM 12:00:00 AM
SUNDAY 12:00:00 AM 12:00:00 AM
HOLIDAY 12:00:00 AM 12:00:00 AM
Next Startup Time: Future
Time Until Startup: 0.0 min.
Next Occupancy Time: Future
Time Until Occupancy: 0.0 min.
Next Shutdown Time: 5:00:00 PM
Time Until Shutdown: 212.7 min.
Next Unoccupancy Time: 5:00:00 PM
Time Until Unoccupancy: 212.7 min.
Control Enabled: ON
Damper Enabled: ON
Fan Enabled: ON
Heating Enabled: OFF
Cooling Enabled: OFF
Last Startup Time: 6:00:00 AM
Last Shutdown Time: 5:00:00 PM
Outside Air Temp: 62.9
Space Temp: 0.0
Control Suite 6.3 - Wi...
1:27 PM
Page: 27 of 27 Words: 0

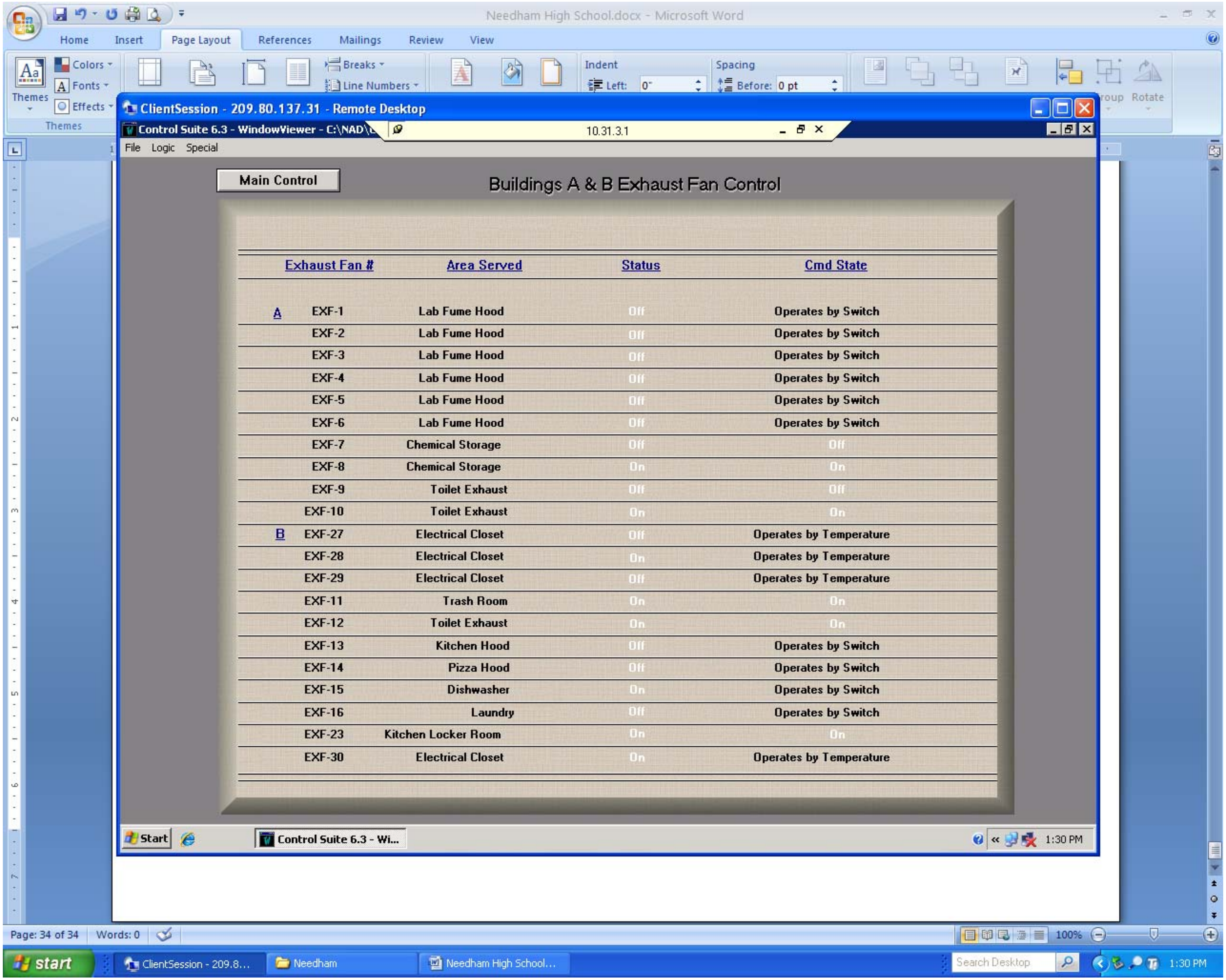

Needham High School.docx - Microsoft Word
ClientSession - 209.80.137.31 - Remote Desktop
Control Suite 6.3 - WindowViewer
10.31.3.1
File Logic Special
HS_OSS_SCHEDULES
High School Heater Schedule
OCCUPIED
UNOCCUPIED
MONDAY 07:00:00 AM 05:00:00 PM
TUESDAY 07:00:00 AM 05:00:00 PM
WEDNESDAY 07:00:00 AM 05:00:00 PM
THURSDAY 07:00:00 AM 05:00:00 PM
FRIDAY 07:00:00 AM 05:00:00 PM
SATURDAY 12:00:00 AM 12:00:00 AM
SUNDAY 12:00:00 AM 12:00:00 AM
HOLIDAY 12:00:00 AM 12:00:00 AM
Next Startup Time: Future
Time Until Startup: 0.0 min.
Next Occupancy Time: Future
Time Until Occupancy: 0.0 min.
Next Shutdown Time: 5:00:00 PM
Time Until Shutdown: 212.5 min.
Next Unoccupancy Time: 5:00:00 PM
Time Until Unoccupancy: 212.5 min.
Control Enabled: ON
Damper Enabled: ON
Fan Enabled: ON
Heating Enabled: OFF
Cooling Enabled: OFF
Last Startup Time: 7:00:00 AM
Last Shutdown Time: 5:00:00 PM
Outside Air Temp: 62.9
Space Temp: 0.0
Page: 28 of 28 Words: 0
1:27 PM



Needham High School.docx - Microsoft Word
ClientSession - 209.80.137.31 - Remote Desktop
Control Suite 6.3 - WindowViewer - C:\NAD\
10.31.3.1
File Logic Special
HS_OSS_SCHEDULES
High School Kitchen Schedule
OCCUPIED
UNOCCUPIED
MONDAY 06:00:00 AM 03:00:00 PM
TUESDAY 06:00:00 AM 03:00:00 PM
WEDNESDAY 06:00:00 AM 03:00:00 PM
THURSDAY 06:00:00 AM 03:00:00 PM
FRIDAY 06:00:00 AM 03:00:00 PM
SATURDAY 12:00:00 AM 12:00:00 AM
SUNDAY 12:00:00 AM 12:00:00 AM
HOLIDAY 12:00:00 AM 12:00:00 AM
Next Startup Time: Future
Time Until Startup: 0.0 min.
Next Occupancy Time: Future
Time Until Occupancy: 0.0 min.
Next Shutdown Time: 3:00:00 PM
Time Until Shutdown: 92.4 min.
Next Unoccupancy Time: 3:00:00 PM
Time Until Unoccupancy: 92.4 min.
Control Enabled: ON
Damper Enabled: ON
Fan Enabled: ON
Heating Enabled: OFF
Cooling Enabled: OFF
Last Startup Time: 6:00:00 AM
Last Shutdown Time: 3:00:00 PM
Outside Air Temp: 62.9
Space Temp: 68.6
Start
Control Suite 6.3 - Wi...
1:27 PM
Page: 29 of 29 Words: 0
start
ClientSession - 209.8...
Needham
Needham High School...


Needham High School.docx - Microsoft Word
ClientSession - 209.80.137.31 - Remote Desktop
Control Suite 6.3 - WindowViewer
10.31.3.1
File Logic Special
Main Control
HS Boiler Control
BLR-1 Off
BLR-2 Off
BLR-3 Off
BLR-4 Off
P-1
P-2
P-3
P-4
P-5
P-6
Blr-1 Blr-2 Blr-3 Blr-4
Command: Off Off Off Off
Status: Off Off Off Off
In Auto: Wrm Wthr Shtdwn Wrm Wthr Shtdwn Wrm Wthr Shtdwn Wrm Wthr Shtdwn
Firing Rate: 0 0 0 0
Return Temp: 74.5 ° 82.5 ° 72.5 ° 72.5 °
Alarm:
Boilers Enabled: Enabled
Boiler Header Temp: 77.5 °
Lead Boiler: 2
Lead Boiler Runtime: 0
Local SP: 180.5 °
Operating SP: 170.5 °
OA Temp: 61.5 °
OA Damper: Open
Series Mode: On
Night Setback Status: Active
Night Setback SP: 10.5 °
OA Enable SP: 200.0 °
Hot Water Temp <140:
Boiler Alarm:
Pump 5/6 Lead: 5
Night Setback Time
Night Day
Mon 19 7
Tue 19 7
Wed 19 7
Thur 19 7
Fri 19 7
Sat 19 7
Sun 19 7
HWST: 64.5 °
HWRT: 70.7 °
Cmd State: Off
Cmd State: Off
DP: 1 PSI
DP SP: 15 PSI
Control Suite 6.3 - Wi...
1:29 PM
Page: 32 of 32 Words: 0
ClientSession - 209.8...
Needham
Needham High School...


Needham High School.docx - Microsoft Word
ClientSession - 209.80.137.31 - Remote Desktop
Control Suite 6.3 - WindowViewer
10.31.3.1
File Logic Special
Main Control
Chilled Water System
CHWR
Flow: 0 GPM
Flow SP: 450 GPM
P-7
P-8
100 % Open
Bypass
DP: 0 Psi
DP SP: 20 Psi
69.0 °
67.1 °
Status: Off
Cmd State: Off
Control Signal: 0 %
Chiller Status: On
CHWS
BMS OA Temp: 63.1 °
Chiller OA Temp: 60.0 °
Chiller OA Enable SP: 62.0 °
Chilled Water Temp SP: 50.0 °
Lead CHW Pump: 7
Chiller Command: OFF
Chiller Status: CHLR_OFF
Chiller Run Mode: HVAC_COOL
Chiller Current State: In Alarm
Active Setpoint: 44.0 °
Capacity: 0 %
Chilled Water Flow: OFF
Entering Chilled Water Temp: 69.0 °
Leaving Chilled Water Temp: 67.1 °
Evap Refrig Press: 55 Psi
Sat Evap Ref Temp: 56.8 °
Suction Temp: 69.3 °
Oil Feed Pressure: 0 Psi
Oil Feed Temp: 32.0 °
Chiller Override: NA - No OVRD
Alarm:
Condensor Refrigerant Pressure: 57 Psi
Sat Cond Ref Temp: 58.8 °
Compressor Discharge Temp: 61.7 °
Liquid Line Pressure: 60 Psi
Liquid Line Temp: 59.2 °
Compressor Running Time: 1 Hrs
Alarm Reset:
Reset
Page: 33 of 33 Words: 0
1:29 PM



Main Control

Buildings A & B Exhaust Fan Control

	Exhaust Fan #	Area Served	Status	Cmd State
A	EXF-1	Lab Fume Hood	Off	Operates by Switch
	EXF-2	Lab Fume Hood	Off	Operates by Switch
	EXF-3	Lab Fume Hood	Off	Operates by Switch
	EXF-4	Lab Fume Hood	Off	Operates by Switch
	EXF-5	Lab Fume Hood	Off	Operates by Switch
	EXF-6	Lab Fume Hood	Off	Operates by Switch
	EXF-7	Chemical Storage	Off	Off
	EXF-8	Chemical Storage	On	On
	EXF-9	Toilet Exhaust	Off	Off
	EXF-10	Toilet Exhaust	On	On
B	EXF-27	Electrical Closet	Off	Operates by Temperature
	EXF-28	Electrical Closet	On	Operates by Temperature
	EXF-29	Electrical Closet	Off	Operates by Temperature
	EXF-11	Trash Room	On	On
	EXF-12	Toilet Exhaust	On	On
	EXF-13	Kitchen Hood	Off	Operates by Switch
	EXF-14	Pizza Hood	Off	Operates by Switch
	EXF-15	Dishwasher	On	Operates by Switch
	EXF-16	Laundry	Off	Operates by Switch
	EXF-23	Kitchen Locker Room	On	On
	EXF-30	Electrical Closet	On	Operates by Temperature