Agency: Commerce, Community and Economic Development
Grants to Municipalities (AS 37.05.315)
Grant Recipient: Craig **Federal Tax ID:** 926000139
Project Title: **Project Type:** Equipment and Materials

Craig - City Schools Replacement Freezer and Cooler

State Funding Requested: $15,000 **House District:** 34 / Q
One-Time Need

Brief Project Description:

Replace existing freezer and walk in cooler used to store food used for school meals.

Funding Plan:

Total Project Cost:	$15,000
Funding Already Secured:	($0)
FY2015 State Funding Request:	($15,000)
Project Deficit:	$0

Detailed Project Description and Justification:

Schools are emphasizing more fresh ingredients in meals prepared at the schools for students. The kitchen at the Craig Elementary School prepares meals for students at Craig Elementary, Craig Middle School and Craig High School. Craig City School District currently has 283 students enrolled in the high school, middle school and elementary school. The school district also operates a correspondence program and alternative high school for another 276 students.The transition from traditional dry and canned ingredients to more fresh meat, fish and produce has resulted in insufficient storage space in the current aging freezer and cooler. A new freezer and walk-in cooler will increase food storage capacity and will decrease operational costs associated with maintaining the existing system. The project includes purchase of refrigerator and freezer equipment and modification of the existing space at the Craig Elementary School to accommodate the larger equipment.

Project Timeline:

If funding is approved the building will be modified and the equipment purchased in 2015.

Entity Responsible for the Ongoing Operation and Maintenance of this Project:

Craig City School District - Maintenance Staff

Grant Recipient Contact Information:

Name:	Jack Walsh
Title:	District Superintendent
Address:	100 School Road Craig, Alaska 99921
Phone Number:	(907)826-3274
Email:	jwalsh@craigschools.com

For use by Co-chair Staff Only:
$15,000 Approved
11:55 AM 5/13/2014

Contact Name: Reid Magdanz
Contact Number: 465-3306

Has this project been through a public review process at the local level and is it a community priority? [X] Yes [ ] No

Contact Name: Reid Magdanz
Contact Number: 465-3306

For use by Co-chair Staff Only:

11:55 AM 5/13/2014

Craig City School District
Jack Walsh, Superintendent

P.O. Box 800 Craig, Alaska 99921
www.craigschools.com
Phone (907)826.3274, FAX (907) 826.3322

CCSD is dedicated to providing a meaningful, comprehensive, and engaging education to all students, so they participate responsibly in the global society.

February 3, 2014

Senator Bert Stedman
State Capitol Room 30
Juneau AK, 99801

Representative Jonathan Kreiss-Tomkins
State Capitol Room 426
Juneau, AK 99801

Dear Senator Stedman and Representative Kreiss-Tomkins,
Thank you for considering our requests to include the Craig City School District capital projects on your list of priorities for the CAPSIS system submission from Craig. I believe that our unified voice on these projects will help our Legislators and Governor understand the importance of these projects to this community.

I wanted to address the request for the new freezer need, as it is a newer request. Over the last few years as school districts have been changing menus to meet new federal and state nutritional standards, and get involved in the purchase of Alaska grown products, including fish and produce, we have experienced the need for greater storage capacity. The new freezers will not only increase our capacity, but they will also be much more energy efficient than our current freezers which have older motors and issues with the seals on doors.

Our school board has been aware of this need from reports provided during their monthly meetings. In recent discussions with our Nutrition and Physical Activity Committee, members heard of our need to update and upgrade this capacity and identified this as a change they supported. We are hopeful that the State Legislature might help us accomplish this goal in the current Legislative Session.

We appreciate your continued support of our district and our needs. Our common interests, to provide the best possible programs and opportunities for the students of Craig, is something we truly believe the city and state can get behind.

Sincerely,

Jack Walsh

Energy Audit

Craig High School

Craig City School District

Final Report
October 2011

Funded by:

Alaska Housing
FINANCE CORPORATION

Prepared by:

Alaska Energy Engineering LLC

25200 Amalga Harbor Road
Juneau, Alaska 99801

Tel/Fax: 907.789.1226
jim@alaskaenergy.us

Table of Contents

Audit Team

The energy audit is performed by Alaska Energy Engineering LLC of Juneau, Alaska. The audit team consists of:

- Jim Rehfeldt, P.E., Energy Engineer
- Jack Christiansen, Energy Consultant
- Brad Campbell, Energy Auditor
- Loras O'Toole P.E., Mechanical Engineer
- Will Van Dyken P.E., Electrical Engineer
- Curt Smit, P.E., Mechanical Engineer
- Philip Iverson, Construction Estimator
- Karla Hart, Technical Publications Specialist
- Jill Carlile, Data Analyst
- Grayson Carlile, Energy Modeler

Section 1

Executive Summary

An energy audit of the Craig High School was performed by Alaska Energy Engineering LLC. The investment grade audit was funded by Alaska Housing Finance Corporation (AHFC) to identify opportunities to improve the energy performance of public buildings throughout Alaska.

Craig High School is a 52,219 square foot building that contains offices, classrooms, commons, a library, a gym, an auditorium, a shop, and mechanical support spaces.

Building Assessment

The following summarizes our assessment of the building.

Envelope

The building ventilation and heating systems are designed to only work efficiently and effectively if the building envelope is tightly sealed. The design and construction of the building envelope and the rooftop ductwork penetrations have resulted in a very poorly sealed building. Significant energy losses and operational concerns exist in the second floor fan room spaces and the unfinished second floor space, including:

- An unused 20" diameter opening through the insulated roof on the northwest end of the building for exhaust fan EF-8 which was never installed.
- A 6' x 12' uninsulated portion of the ceiling with a 1-1/2' x 3' opening at the peak of the roof in the fan room adjacent to the auditorium.
- Insufficient plenum return openings for AHU-1 through the second floor on the south side.
- Unsealed duct work penetrations through the roof of the building.
- The building design which utilizes a steel beam and corrugated roofing underlayment adds to the difficulty of sealing the building envelope.

Improper roof penetration sealing around exhaust duct penetrations also raises a concern with drawing exhaust from the restrooms back into the second floor space where it can mix with classroom return air and then be redistributed throughout the classrooms by AHU-1.

Proper AHU-1 operation for the heating and ventilating of classroom spaces requires that the unfinished second floor acts as a return plenum to move return air from the classrooms to AHU-1. Outside air infiltration through the unnecessary rooftop openings combined with poor ductwork sealing efforts causes mixing of the warm return air with colder outside air, thereby reducing the return air temperature to AHU-1 and increasing the heating demand on the unit. Energy will be saved if the building envelop leakage issues are corrected.

When AHU-1 is off and not pulling air from the second floor space, warm air from the second floor is leaking through the unsealed roof penetrations. As the warm air passing through the openings cools, it can condense within the roof penetration space and cause water damage above the corrugated roofing base and below the roof insulation. This appears to be happening at multiple locations in the attic and could reduce the life of the building envelope.

AHU-1 supply and return air flows should be balanced and verified through retro-commissioning once the building envelope is sealed to ensure efficient operations.

- The holes cut in the second story floor to provide an air path from the first floor return plenum appear to be too small and may be requiring AHU-1 return fan to operate at an increased electrical demand. Since the building envelope is excessively leaky, the undersized plenum return openings cause more outside air to be being pulled into the second floor space. This was quantified on the DDC by seeing a substantial drop in return air temperature from the first floor to AHU-1, the result of which will increase the heating demand of AHU-1. Larger floor openings will result in reduced flow restrictions on the return air and thereby reduce heating loads of AHU-1 and should decrease the electrical loading of AHU-1 return fan.
- The return air silencers in the fan room wall are also undersized, which is causing the return fan to operate at higher speeds and energy consumption.

Exterior doors are not thermally broken. Future exterior door replacement selection should include this feature. Weather stripping on exterior doors is in need of replacement throughout.

Some exterior wall shingles appeared to be damaged or missing as a result of recent building pressure washing efforts.

The roof penetrations around MAU-1 in the shop space are not sealed. Air is flowing through the unsealed opening and condensation is occurring.

Exhaust fans are being operated after the AHU's turn off. This may be putting a negative pressure on the spaces within the building envelope and compounding the outside air infiltration issues.

Several of the second floor exhaust fans were not installed and the remaining fans were not installed properly on their concrete bases.

A fire sprinkler main passes directly through the center of the EF-6 discharge duct. This is reducing fan efficiency and may be a code violation.

The gable awning over the south gym entrance does not have gutters. As a result the drainage path for rainwater is along the wall and down the rock face. Damage may occur to the rock face and grouting as a result.

On a positive note, there are very few windows in the north exterior wall and none in the east exterior wall, thus reducing heat loss on walls that have minimal solar gain.

Heating System

The building is heated by two fuel oil boilers that provide heat to five air handling unit systems, a make-up air unit in the shop, fan coil units, and perimeter hydronic systems. Maintenance staff are very actively managing the boiler run times to minimize fuel consumption where possible due to normal boiler inefficiencies. The boilers are currently being operated at 120°F in an effort to conserve energy, however this will decrease the life of the stack and the temperature should be raised to the normal operating band. Several of the boiler loop circulation pump motors have failed and have been replaced with less efficient models. These should be upgraded to premium efficiency motors. The remainder of the fuel oil boiler heating system appears to be in good condition; however fairly simple improvements, outlined in Section 3, can be made to improve its effectiveness and efficiency.

Ventilation System

The building ventilation systems consists of five large air handling units located in two interior fan rooms and one make-up air roof top unit that provide conditioned air within the building envelope. In addition to the large air handling units there are fifteen exhaust fans mounted throughout the building and on the roof top for the purposes of cooling spaces, improving building air quality, kitchen operations, and fume hood exhaust air flow in the science labs.

The building air handling units and the DDC system do not appear to have been properly commissioned following construction.

The air handling unit that provides heating and ventilation for the classrooms was brought on-line recently through efforts by maintenance staff and a DDC programmer. The remaining systems should be corrected in a similar fashion and a retro-commissioning effort should be performed for the entire building upon completion of repairs and right-sizing efforts for ventilation requirements.

Locker room air handling unit AHU-4 was turned off and under repair during the audit visit.

The AHU-5 fan belt shield is off and should be reinstalled.

The air handling units are considerably over-sized for Craig, Alaska. The sizing is more appropriate for a warmer, sunny climate that operates through the summer and experiences high solar gain. The air flows should be “right-sized” and the systems rebalanced to save energy.

Space	Existing CFM/sqft	Optimal CFM/sqft	% Oversized
Auditorium	2.54	1.5	69%
Gym	1.72	1.1	56%
Commons	2.49	1.6	56%
Classrooms	Varies	1.0	-

Given the oversized ventilation system, consolidation would further optimize air handling and reduce energy costs. Whole-building optimization is beyond the scope of this energy audit but is recommended if the ventilation EEMs are pursued.

Domestic Hot Water System

An oil-fired hot water heater supplies domestic hot water. When the heater reaches the end of its service life, it is recommended to replace it with an indirect heater connected to the boiler heating system and a smaller oil-fired heater for summer use when the boilers are off.

Lighting

Interior lighting primarily consists of T8 and metal halide lighting. Exterior lighting consists primarily of metal halide lighting. The interior lighting schedule and all exterior lighting, including parking lot lighting, is controlled by staff. As a result, lighting operational hours and subsequent electrical demand is being kept to a minimum.

Energy Efficiency Measures (EEMs)

All buildings have opportunities to improve their energy efficiency. The energy audit revealed numerous opportunities in which an efficiency investment will result in a net reduction in long-term operating costs.

Behavioral and Operational EEMs

The following EEMs require behavioral and operational changes in the building use. The savings are not readily quantifiable but these EEMs are highly recommended as low-cost opportunities that are a standard of high performance buildings.

- EEM-1: Weather-strip Doors
- EEM-2: Adjust Double Door Closures
- EEM-3: Repair Window Weather Stripping
- EEM-4: Replace Failed Window Glazing
- EEM-5: Seal Building Envelope
- EEM-6: Server Room Heat Recovery

High and Medium Priority EEMs

The following EEMs are recommended for investment. They are ranked by life cycle savings to investment ratio (SIR). This ranking method places a priority on low cost EEMs which can be immediately funded, generating energy savings to fund higher cost EEMs in the following years. Negative values, in parenthesis, represent savings.

		25 Year Life Cycle Cost Analysis			
	Investment	**Operating**	**Energy**	**Total**	**SIR**
High Priority					
EEM-7: Turn Off Standby Boiler	$200	$0	($78,700)	($78,500)	393.5
EEM-8: Install Pipe Insulation	$900	$0	($46,000)	($45,100)	51.1
EEM-9: Replace Aerators	$1,400	$0	($67,400)	($66,000)	48.1
EEM-10: Perform Boiler Combustion Test	$700	$4,600	($21,200)	($15,900)	23.7
EEM-11: Upgrade Motors to Premium Efficiency	$2,700	$0	($9,400)	($6,700)	3.5
Medium Priority					
EEM-12: Optimize Gym AHU-5	$55,000	$0	($166,600)	($111,600)	3.0
EEM-13: Upgrade Transformer	$23,600	$0	($68,100)	($44,500)	2.9
EEM-14: Replace Exit Signs	$3,300	($1,300)	($7,100)	($5,100)	2.5
EEM-15: Increase AHU-1 Return Air Path	$4,000	$0	($10,000)	($6,000)	2.5
EEM16-: Install Valves on Unit Heaters	$4,400	$0	($9,500)	($5,100)	2.2
EEM-17: Install Modulating Boiler Burners	$33,700	$15,400	($84,600)	($35,500)	2.1
EEM-18: Optimize Auditorium AHU-3	$62,800	$0	($124,100)	($61,300)	2.0
EEM-19: Optimize Heating System	$90,600	($15,400)	($154,800)	($79,600)	1.9
EEM-20: Optimize Commons AHU-4	$59,700	$0	($98,200)	($38,500)	1.6
EEM-21: Install Boiler Room Heat Recovery	$23,100	$4,600	($41,500)	($13,800)	1.6
EEM-22: Reduce Locker Room Lighting	$7,100	($600)	($8,600)	($2,100)	1.3
Totals*	**$373,200**	**$7,300**	**($995,800)**	**($615,300)**	**2.6**

* The analysis is based on each EEM being independent of the others. While it is likely that some EEMs are interrelated, an isolated analysis is used to demonstrate the economics because the audit team is not able to predict which EEMs an Owner may choose to implement. If several EEMs are implemented, the resulting energy savings is likely to differ from the sum of each EEM projection.

Summary

It is the assessment of the energy audit team that the Craig High School staff are very focused on lowering energy consumption at the facility in their daily operations. Unfortunately, energy efficiency is unattainable due to a substandard building envelope and oversized air handling units that are operating with non-optimal control sequences that were not properly commissioned. This has resulted in a situation that cannot be corrected by operational modifications alone.

Outlined within the report are recommendations for building envelope sealing efforts, modifications to the air handling systems and control sequences, and subsequent building retro-commissioning. The energy audit revealed other opportunities for improving the energy performance of the Craig High School as well. It is recommended that the behavioral and high priority EEMs be implemented now to generate energy savings from which to fund the medium priority EEMs.

Another avenue to consider is to borrow money from AHFCs revolving loan fund for public buildings. AHFC will loan money for energy improvements under terms that allow for paying back the money from the energy savings. More information on this option can be found online at http://www.ahfc.us/loans/akeerlf_loan.cfm.

Section 2

Introduction

This report presents the findings of an energy audit of Craig High School located in Craig, Alaska. The purpose of this investment grade energy audit is to evaluate the infrastructure and its subsequent energy performance to identify applicable energy efficiencies measures (EEMs).

The energy audit report contains the following sections:

- Introduction: Building use and energy consumption.
- Energy Efficiency Measures: Priority ranking of the EEMs with a description, energy analysis, and life cycle cost analysis.
- Description of Systems: Background description of the building energy systems.
- Methodology: Basis for how construction and maintenance cost estimates are derived and the economic and energy factors used for the analysis.

BUILDING USE

Craig High School is a 52,219 square foot building that contains offices, classrooms, commons, a library, a gym, an auditorium, a shop, and mechanical support spaces. The building is occupied by 95 students and 10 staff members. It is used in the following manner:

- Offices and Classrooms: 7:30 am – 3:30 pm (M-F)
- Commons: 7:00 am – 10:00 pm (M-F), 3:00pm – 9:00pm (S-Su)
- Gym 8:00 am – 10:00 pm (M-F)), 3:00pm – 9:00pm (S-Su)
- Auditorium 12:00 pm – 3:00 pm (M-F)
- Fans: 7:30 am – 4:00 pm (M-F)

History

This building was constructed in 2000.

Energy Consumption

The building energy sources include an electric service and a fuel oil tank. Fuel oil is used for the majority of the heating loads while electricity serves all other loads, including domestic hot water and a limited amount of space heating. The following table shows annual energy use and cost.

Annual Energy Consumption and Cost

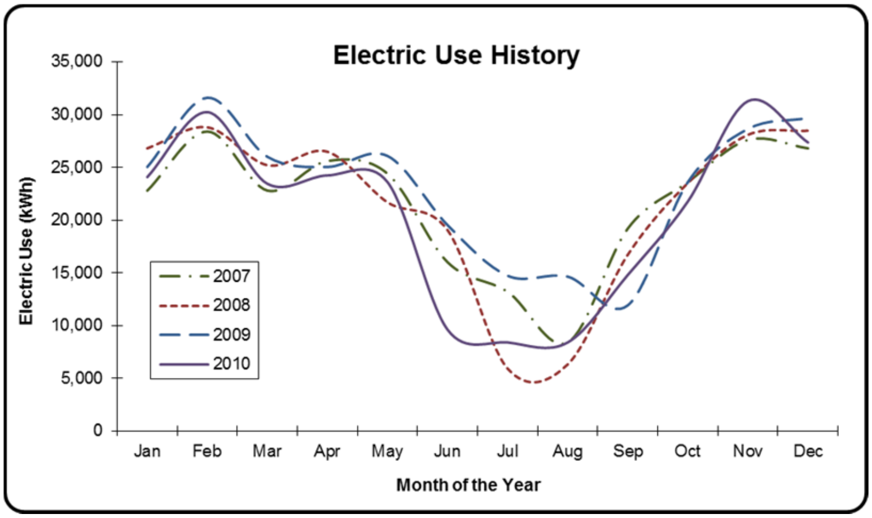
Source	Consumption		Cost	Energy, MMBtu	
Electricity	259,880	kWh	$69,100	890	27%
Fuel Oil	18,100	Gallons	$61,900	2,460	73%
Totals	-		$131,000	3,350	100%

Electricity

This chart shows electrical energy use from 2007 to 2010.

Use has been fairly consistent over the last four years.

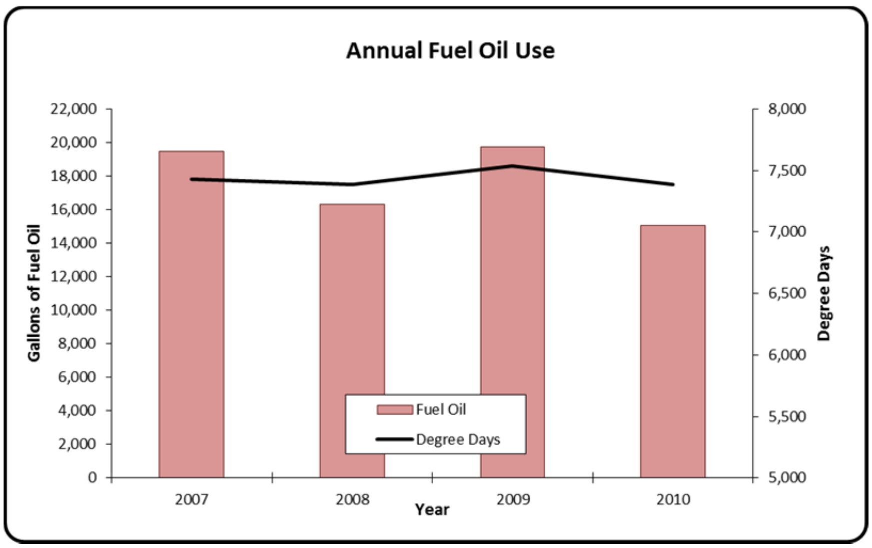
The effective cost—energy costs plus demand charges—is 26.6¢ per kWh.



Fuel Oil

This chart shows heating energy use from 2007 to 2010.

The chart compares annual use with the heating degree days which is a measurement of the demand for energy to heat a building. A year with a higher number of degree days reflects colder outside temperatures and a higher heating requirement.



Fuel oil use dropped in 2010 due to lower heating degree days and efforts by operating staff to reduce energy consumption. Fuel oil use is likely to increase in 2011 due to bringing AHU-1 into service.

> The current cost of fuel oil in Craig is $3.89 per gallon. Assuming a fuel oil conversion efficiency of 70%, oil heat costs $40.12 per MMBtu. The current cost of electricity is 26.6¢ per kWh. Assuming an electric conversion efficiency of 95%, electric heat costs $82.00 per MMBtu. As such, fuel oil heat is much less expensive than electric heat.

Section 3

Energy Efficiency Measures

The following energy efficiency measures (EEMs) were identified during the energy audit. The EEMs are priority ranked and, where applicable, subjected to energy and life cycle cost analysis. Appendix B contains the energy and life cycle cost analysis spreadsheets.

The EEMs will be grouped into the following prioritized categories:

- Behavioral or Operational: EEMs that require minimal capital investment but require operational or behavioral changes. The EEMs provide a life cycle savings but an analysis is not performed because the guaranteed energy savings is difficult quantify.
- High Priority: EEMs that require a small capital investment and offer a life cycle savings. Also included in this category are higher cost EEMs that offer significant life cycle savings.
- Medium Priority: EEMs that require a significant capital investment to provide a life cycle savings. Many medium priority EEMs provide a high life cycle savings and offer substantial incentive to increase investment in building energy efficiency.
- Low Priority: EEMs that will save energy but do not provide a life cycle savings.

BEHAVIORAL OR OPERATIONAL

The following EEMs are recommended for implementation. They require behavioral or operational changes that can occur with minimal investment to achieve immediate savings. These EEMs are not easily quantified by analysis because they cannot be accurately predicted. They are recommended because they offer a life cycle savings, represent good practice, and are accepted features of high performance buildings.

EEM-1: Weather-strip Doors

Purpose: The weather stripping on most of the singe-wide exterior doors is in poor condition and the double-door weather stripping system on the center support bars is ineffective. Energy will be saved if doors are properly weather-stripped to reduce infiltration.

Scope: Replace weather stripping on exterior doors.

EEM-2: Adjust Double Door Closures

Purpose: The front doors are not completely closing due to weather stripping interference and improper door closure adjustment. Energy would be saved if the automatic closures are properly adjusted following the repair or replacement of the weather stripping to ensure complete door sealing.

Scope: Repair or replace weather stripping and adjust double-door automatic closures for proper sealing.

EEM-3: Repair Window Weather Stripping

Purpose: Weather stripping has been obviously damaged on several of the operable windows. Energy will be saved if all of the operable windows are fully opened to inspect weather stripping and repairs are made as needed.

Scope: Inspect and repair operable window weather stripping.

EEM-4: Replace Failed Window Glazing

Purpose: The glazing has failed on the upper section of a window on the north wall of the northwest classroom. Energy will be saved if the failed glazing is replaced.

Scope: Replace failed glazing section.

EEM-5: Seal Building Envelope

Purpose: The design and construction of the building envelope and the rooftop ductwork penetrations have resulted in a very poorly sealed building. Significant energy losses and operational concerns exist in the second floor fan room spaces and the unfinished second floor space as outlined in the Executive Summery. Energy will be saved and building longevity may be increased if these discrepancies are repaired

Scope: Perform the following envelope repairs:

i. Seal and insulate the 20” diameter opening through the insulated roof on the northwest end of the building where exhaust fan EF-8 was supposed to be installed.
ii. Seal and insulate the 6’ x 12’ uninsulated portion of the ceiling, to include the 1½’ x 3’ opening at the peak of the roof in the main air handler unit space above the auditorium
iii. Seal all duct work penetrations through the roof of the building.

EEM-6: Server Room Heat Recovery

Purpose: The server room contains 3 switches, 1 server, some additional heat generating electrical equipment, and also has heat gain through the floor. Maintenance staff informed the audit team that this space gets too warm. Energy will be saved if the additional heat in this space is delivered to AHU-1 in the adjacent space for recirculation through the school.

Scope: Install a grill in the south and north walls of the server space so that second floor plenum return air can be transferred to AHU-1 through the server room.

HIGH PRIORITY

The following EEMs are recommended for implementation because they are low cost measures that have a high savings to investment ratio. The EEMs are listed from highest to lowest priority. Negative values, in parenthesis, represent savings.

EEM-7: Turn off Standby Boiler

Purpose: Only one boiler is required to meet the heating load, yet both are operated and kept warm. Energy will be saved by closing the valve in the return main, thus isolating the standby boiler.

Scope: Close the valve on the return main and shut off the standby boiler.

Annual Costs			Life Cycle Costs				
Operating	Energy	Total	Investment	Operating	Energy	Total	SIR
$0	($2,780)	($2,780)	$200	$0	($78,700)	($78,500)	393.5

EEM-8: Install Pipe Insulation

Purpose: An 8' section of 6" pipe, a 12' section of 4" pipe, and a 12' section of 2 ½" pipe, all on the boiler system expansion U-bends in the second floor space, are uninsulated. Energy will be saved if these sections of boiler supply and return piping are optimally insulated.

Scope: Install insulation on uninsulated boiler supply and return piping.

Annual Costs			Life Cycle Costs				
Operating	Energy	Total	Investment	Operating	Energy	Total	SIR
$0	($1,620)	($1,620)	$900	$0	($46,000)	($45,100)	51.1

EEM-9: Replace Aerators

Purpose: Energy and water will be saved by replacing the aerators on the lavatories and showerheads with low-flow models.

Scope: Replace aerators on lavatories and showerheads with water-conserving fixtures.

Annual Costs			Life Cycle Costs				
Operating	Energy	Total	Investment	Operating	Energy	Total	SIR
$0	($3,430)	($3,430)	$1,400	$0	($67,400)	($66,000)	48.1

EEM-10: Perform Boiler Combustion Test

Purpose: Operating the boiler with an optimum amount of excess air will improve combustion efficiency. Annual cleaning followed by a combustion test is recommended.

Scope: Annually clean and perform a combustion test on the boiler.

Annual Costs			Life Cycle Costs				
Operating	Energy	Total	Investment	Operating	Energy	Total	SIR
$240	($750)	($510)	$700	$4,600	($21,200)	($15,900)	23.7

EEM-11: Upgrade Motors to Premium Efficiency

Purpose: Premium efficiency motors should be used for equipment that operates during school hours. A motor efficiency of 60 % is low enough to warrant replacement before a motor fails. Energy will be saved if pump P-4B and P-7 motors and the AHU-2 return fan motor are all replaced with premium efficiency motors.

Scope: Replace pump P-4B and P-7 motors and AHU-2 return fan motor with premium efficiency motors.

Annual Costs			Life Cycle Costs				
Operating	Energy	Total	Investment	Operating	Energy	Total	SIR
$0	($480)	($480)	$2,700	$0	($9,400)	($6,700)	3.5

MEDIUM PRIORITY

Medium priority EEMs require planning and a higher level of investment. They are recommended because they offer a life cycle savings. The EEMs are listed from highest to lowest priority. Negative values, in parenthesis, are savings.

EEM-12: Optimize Gym AHU-5

Purpose: The gym AHU-5 is oversized by a factor of 56%, consuming additional energy to run the fan. In addition, the unit supplies more outside air than required, which results in higher heating demands. Energy will be saved if the system controls are optimized.

Scope: Perform the following control modifications and retro-commission:

i. Install a variable speed drive on the supply fan to reduce air flow and modulate air flow with cooling loads.

ii. Add a CO2 sensor to control and reduce outside air flow while maintaining adequate indoor air quality.

iii. Reset the supply air temperature with gym temperature.

Annual Costs			Life Cycle Costs				
Operating	Energy	Total	Investment	Operating	Energy	Total	SIR
$0	($6,620)	($6,620)	$55,000	$0	($166,600)	($111,600)	3.0

EEM-13: Replace Transformer

Purpose: The 150 kVA transformer in electrical room 137 is not TP-1 rated. Energy will be saved if this less-efficient transformer is replaced with an energy efficient model that complies with NEMA Standard TP 1-2001.

Scope: Replace less-efficient transformer with a NEMA Standard TP 1-2001compiant model.

Annual Costs			Life Cycle Costs				
Operating	Energy	Total	Investment	Operating	Energy	Total	SIR
$0	($3,470)	($3,470)	$23,600	$0	($68,100)	($44,500)	2.9

EEM-14: Replace Exit Signs

Purpose: The exit signs utilize two 7.7 watt tungsten bulbs. Energy will be saved if the exit signs are replaced with self-luminescent signs.

Scope: Replace the eleven existing exit signs with self-luminescent exit signs.

Annual Costs			Life Cycle Costs				
Operating	Energy	Total	Investment	Operating	Energy	Total	SIR
($70)	($360)	($430)	$3,300	($1,300)	($7,100)	($5,100)	2.5

EEM-15: Increase AHU-1 Return Air Path

Purpose: The return air path for AHU-1 travels through holes in the floor deck above and silencers in the wall of the fan room. The free area of these openings is too small, which is creating high pressure loss and causing the return fan to work harder to pull the air back to AHU-1. This is also causing outside air to be pulled into the building through the leaky envelope. Energy will be saved, and the building pressure will be better regulated, if the return air path openings are increased in size.

Scope: Double the size of the return air floor openings. Remove the silencers and double the size of the wall openings.

Annual Costs			Life Cycle Costs				
Operating	Energy	Total	Investment	Operating	Energy	Total	SIR
$0	($510)	($510)	$4,000	$0	($10,000)	($6,000)	2.5

EEM-16: Install Automatic Valves on Unit Heaters

Purpose: Energy will be saved if the seven wall and ceiling mounted unit heaters have an automatic valve that shuts off the heating flow when heat is not needed. Currently the coils in the unit heaters are continuously hot and the thermostat turns on the fan to supply the heat to the room. When heat is not needed, convective heat loss from the coil occurs; some of the heat loss may be useful, but a large percentage is not.

Scope: Install automatic valves in the heating supply to each unit heater and control them from the fan thermostat.

Annual Costs			Life Cycle Costs				
Operating	Energy	Total	Investment	Operating	Energy	Total	SIR
$0	($330)	($330)	$4,400	$0	($9,500)	($5,100)	2.2

EEM-17: Install Modulating Boiler Burners

Purpose: The boiler burners do not incorporate modulating burner controls. Energy will be saved if the boiler firing rate modulated as necessary.

Scope: Install modulating burners on the boilers.

Annual Costs			Life Cycle Costs				
Operating	Energy	Total	Investment	Operating	Energy	Total	SIR
$800	($2,990)	($2,190)	$33,700	$15,400	($84,600)	($35,500)	2.1

EEM-18: Optimize Auditorium AHU-3

Purpose: The auditorium AHU-3 is currently operated from 7:30 am to 4:00 pm. However, the auditorium is only used for classes from 12:00 pm to 3:00 pm.

AHU-3 is oversized by a factor of 69%, consuming additional energy to run the fan. In addition, the unit supplies more outside air than required, which results in higher heating demands. Energy will be saved if the system controls are optimized.

Scope: Perform the following control modifications and retro-commission AHU-3:

i. Install a variable speed drive on the supply and return fans to reduce air flow and modulate air flow with cooling loads.

ii. Add a CO_2 sensor to control and reduce outside air flow while maintaining adequate indoor air quality.

iii. Reset the cold deck temperature with auditorium temperature.

Annual Costs			Life Cycle Costs				
Operating	Energy	Total	Investment	Operating	Energy	Total	SIR
$0	($5,420)	($5,420)	$62,800	$0	($124,100)	($61,300)	2.0

EEM-19: Optimize Heating System

Purpose: The heating system has a capacity of 150 Btuh/sqft which is five times larger than typical for a school building. A heating system optimization analysis is needed to right-size the system and increase its efficiency. Opportunities include reducing the size of the boilers by removing sections and combining the distribution loops into one set of pumps.

Scope: Optimize the heating system by recalculating the building heating loads, reducing boiler size and serving the distribution loops into one set of pumps. This should be performed after the AHU EEMs have been implemented, which will reduce heating loads.

Annual Costs			Life Cycle Costs				
Operating	Energy	Total	Investment	Operating	Energy	Total	SIR
($800)	($6,410)	($7,210)	$90,600	($15,400)	($154,800)	($79,600)	1.9

EEM-20: Optimize Commons AHU-2

Purpose: The Commons AHU-2 is oversized by a factor of 56%, consuming additional energy to run the fan. In addition, the unit supplies more outside air than required, which results in higher heating demands. Energy will be saved if the system controls are optimized.

Scope: Perform the following control modifications and retro-commission:

i. Install a variable speed drive on the supply and return fans to reduce and modulate air flow with cooling loads.

ii. Add a CO_2 sensor to control and reduce outside air flow while maintaining adequate indoor air quality.

iii. Reset the supply air temperature with commons temperature.

Annual Costs			Life Cycle Costs				
Operating	Energy	Total	Investment	Operating	Energy	Total	SIR
$0	($4,060)	($4,060)	$59,700	$0	($98,200)	($38,500)	1.6

EEM-21: Install Boiler Room Heat Recovery

Purpose: The boiler room uses inlet and outlet grills to exhaust air outside the space. Energy will be saved if the heat generated from the boiler room is transferred to the adjacent shop room.

Scope: Install a heat recovery unit to transfer boiler room heat to the adjacent shop space.

Annual Costs			Life Cycle Costs				
Operating	Energy	Total	Investment	Operating	Energy	Total	SIR
$240	($900)	($660)	$23,100	$4,600	($41,500)	($13,800)	1.6

EEM-22: Reduce Locker Room Lighting

Purpose: Lighting controls for the gym locker rooms are by key switch-only. This requires the space to be lit throughout the entire period the gym is open, regardless of use. Energy will be saved if a motion detector is installed in the shower space and another in the restroom space to minimize unnecessary lighting hours. A 10-minute delay time is recommended for the occupancy sensor.

Scope: Install a motion detector in the shower space and in the restroom space to control locker room lighting.

Annual Costs			Life Cycle Costs				
Operating	Energy	Total	Investment	Operating	Energy	Total	SIR
($30)	($530)	($560)	$7,100	($600)	($8,600)	($2,100)	1.3

LOW PRIORITY

Low priority EEMs do not offer a life cycle energy savings and are not recommended.

EEM-23: Add Arctic Entry

Purpose: A significant amount of infiltration and heat loss is occurring because the main entrance does not have an arctic entry. The existing design lends itself well to this addition without compromising building aesthetics.

Scope: Install an arctic entry.

Analysis: Previous analyses have shown that an arctic entrance is cost effective for new construction. However, adding an arctic entrance is not cost effective for this retro-fit application.

Section 4

Description of Systems

ENERGY SYSTEMS

This section provides a general description of the building systems. Energy conservation opportunities are addressed in Section 3, Energy Efficiency Measures.

Building Envelope

The following table summarizes the existing envelope.

Building Envelope

Component	Description (inside to outside)	R-value Existing	R-value Optimal
Exterior Wall	1/2" Gyp. Bd, 1" Rmax, 6" steel studs w/ R-19 batt, ½" plywood	R-16	R-26
Roof	Corrugated Metal Roof Deck, 8" EPS rigid insulation, metal roofing	R-34	R-46
Floor Slab	4" Concrete slab-on-grade	R-15	R-10
Foundation	8" concrete with 2" rigid insulation on interior surface	R-10	R-20
Windows	Fiberglass; double pane	R-1.5	R-5
Doors	Aluminum along the front entry, remaining doors are steel, all w/o thermal break, glazing where used is double pane	R-1.5	R-5

Domestic Hot Water System

An oil fired direct hot water heater supplies domestic hot water to the fixtures. The fixtures do not have water-conserving aerators.

Automatic Control System

The building has a DDC system to control the operation of the heating and ventilation systems, however the systems do not appear to have been properly installed and commissioned following construction. It is recommended that the maintenance staff continue working with DDC programming support to improve heating and ventilation control capabilities as outlined in this report.

Lighting

Interior lighting primarily consists of T8 and metal halide lighting. Exterior lighting consists primarily of metal halide lighting. The interior lighting schedule and all exterior lighting - to include the parking lot lighting, is controlled by staff. Thanks to staff diligence, lighting operational hours and subsequent electrical demand are kept to a minimum.

Electric Equipment

Commercial kitchen equipment for food preparation is located in the food prep area.

Heating System

The building is heated by two fuel oil boilers that provide heat to five air handling unit systems, a make-up air unit in the shop, unit heaters, and perimeter hydronic systems. The heating system has the following pumps:

- P-1A and P-1B are the circulation pumps for boilers 1 and 2.
- P-2 is the domestic hot water circulation pump.
- P-3A and P-3B are the perimeter heat pumps.
- P-4A and P-4B are the shop heating pumps.
- P-5A and P-5B are the AHU supply heating coil pumps.
- P-6 is the MAU-1 heating coil pump.
- P-7 is the AHU-1 heating coil pump.
- P-8 is the AHU-2 pre-heating coil pump.
- P-9 is the AHU-2 heating coil pump.
- P-10 is the AHU-3 preheat coil pump.
- P-11 is the AHU-3 hot deck coil pump.
- P-12 is the AHU-4 heating coil pump.
- P-13 is the AHU-5 heating coil pump.

Ventilation Systems

Area	Fan System	Description
Classrooms	AHU-1	Variable volume air handling unit consisting of a heating coil, mixing box, filter section, supply fan, and return air fan
Commons Area	AHU-2	Constant volume air handling unit consisting of a pre-heating coil, heating coil, mixing box, filter section, supply fan, and return air fan
Auditorium	AHU-3	Constant volume air handling unit consisting of a pre-heating coil, heating coil, mixing box, filter section, supply fan, and return air fan
Locker Room	AHU-4	Constant volume air handling unit consisting of a heating coil, mixing box, filter section, and a supply fan
Gymnasium	AHU-5	Constant volume air handling unit consisting of a heating coil, mixing box, filter section, supply fan, and return air fan
Shop	MAU-1	3,680 cfm 3 HP constant volume make up air fan
Rest Room/Janitor	EF-1	1,420 cfm 755 watt constant volume in-line cabinet exhaust fan
Locker Room	EF-2	1,515 cfm 1/3 HP constant volume backward inclined centrifugal exhaust fan
Kitchen	EF-3	190 cfm constant volume kitchen exhaust hood
Art Classroom	EF-4	1,680 cfm ½ HP constant volume belt drive roof exhauster
Restroom	EF-5	100 cfm 80 W ceiling exhaust fan
Science Classroom	EF-6	4,190 cfm ¾ HP constant volume backward inclined centrifugal exhaust fan
Science Room Fume Hood	EF-7	1,200 cfm 1/3 HP constant volume belt drive roof exhauster
Math Classroom	EF-8	1,500 cfm ¼ HP constant volume backward inclined centrifugal exhaust fan (Not Installed)
Home Ec Classroom	EF-9	1,970 cfm 1/3 HP constant volume backward inclined centrifugal exhaust fan
Home Ec Cooktop Exhaust	EF-10	190 cfm kitchen hood exhaust
Home Ec Cooktop Exhaust	EF-11	190 cfm kitchen hood exhaust
Home Ec Cooktop Exhaust	EF-12	190 cfm kitchen hood exhaust
Home Ec Cooktop Exhaust	EF-13	190 cfm kitchen hood exhaust
Pressbox	EF-14	250 cfm 83 watt inline cabinet exhaust fan
Science/Prep General Exhaust	EF-15	750 cfm ¼ HP constant volume backward inclined centrifugal exhaust fan
Welding Exhaust Fan	CS-1	1800 cfm 1.5 HP constant volume backward inclined centrifugal exhaust fan
Weld Station Hood	CS-2	800 cfm vertical hood
Vehicle Exhaust System	CS-3	850 cfm ¾ HP constant volume backward inclined centrifugal exhaust fan

Section 5

Methodology

Information for the energy audit was gathered through on-site observations, review of construction documents, and interviews with operation and maintenance personnel. The EEMs are evaluated using energy and life cycle cost analyses and are priority ranked for implementation.

Energy Efficiency Measures

Energy efficiency measures are identified by evaluating the building's energy systems and comparing them to systems in modern, high performance buildings. The process for identifying the EEMs acknowledges the realities of an existing building that was constructed when energy costs were much lower. Many of the opportunities used in modern high performance buildings—highly insulated envelopes, variable capacity mechanical systems, heat pumps, daylighting, lighting controls, etc.—simply cannot be economically incorporated into an existing building.

The EEMs represent practical measures to improve the energy efficiency of the buildings, taking into account the realities of limited budgets. If a future major renovation project occurs, additional EEMs common to high performance buildings should be incorporated.

Life Cycle Cost Analysis

The EEMs are evaluated using life cycle cost analysis which determines if an energy efficiency investment will provide a savings over a 25-year life. The analysis incorporates construction, replacement, maintenance, repair, and energy costs to determine the total cost over the life of the EEM. Future maintenance and energy cash flows are discounted to present worth using escalation factors for general inflation, energy inflation, and the value of money. The methodology is based on the National Institute of Standards and Technology (NIST) Handbook 135 – Life Cycle Cost Analysis.

Life cycle cost analysis is preferred to simple payback for facilities that have long—often perpetual—service lives. Simple payback, which compares construction cost and present energy cost, is reasonable for short time periods of 2-4 years, but yields below optimal results over longer periods because it does not properly account for the time value of money or inflationary effects on operating budgets. Accounting for energy inflation and the time value of money properly sums the true cost of facility ownership and seeks to minimize the life cycle cost.

Construction Costs

The cost estimates are derived based on a preliminary understanding of the scope of each EEM as gathered during the walk-through audit. The construction costs for in-house labor are $60 per hour for work typically performed by maintenance staff and $110 per hour for contract labor.

The cost estimate assumes the work will be performed as part of a larger renovation or energy efficiency upgrade project. When implementing EEMs, the cost estimate should be revisited once the scope and preferred method of performing the work has been determined. It is possible some EEMs will not provide a life cycle savings when the scope is finalized.

Maintenance Costs

Maintenance costs are based on in-house or contract labor using historical maintenance efforts and industry standards. Maintenance costs over the 25-year life of each EEM are included in the life cycle cost calculation spreadsheets and represent the level of effort to maintain the systems.

Energy Analysis

The energy performance of an EEM is evaluated within the operating parameters of the building. A comprehensive energy audit would rely on a computer model of the building to integrate building energy systems and evaluate the energy savings of each EEM. This investment grade audit does not utilize a computer model, so energy savings are calculated with factors that account for the dynamic operation of the building. Energy savings and costs are estimated for the 25-year life of the EEM using appropriate factors for energy inflation.

Prioritization

Each EEM is prioritized based on the life cycle savings to investment ratio (SIR) using the following formula:

Prioritization Factor = Life Cycle Savings / Capital Costs

This approach factor puts significant weight on the capital cost of an EEM, making lower cost EEMs more favorable.

Economic Factors

The following economic factors are significant to the findings.

- Nominal Interest Rate: This is the nominal rate of return on an investment without regard to inflation. The analysis uses a rate of 5%.
- Inflation Rate: This is the average inflationary change in prices over time. The analysis uses an inflation rate of 2%.
- Economic Period: The analysis is based on a 25-year economic period with construction beginning in 2010.

Fuel Oil

Fuel oil currently costs $3.42 per gallon for a seasonally adjusted blend of #1 and #2 fuel oil. The analysis is based on 6% fuel oil inflation which has been the average for the past 20-years.

Electricity

Electricity is supplied by Alaska Power and Telephone. The building is billed for electricity under Alaska Power Company Bulk Power A-3 rate. This rate charges for both electrical consumption (kWh) and peak electric demand (kW). Electrical consumption is the amount of energy consumed and electric demand is the rate of consumption.

Alaska Power Company Bulk Power A-3	Rate
Electricity ($ / kWh)	$0.0786
Cost of Power Adjustment ($ / kWh)	$0.1534
Demand ($ / kW)	$7.00
Customer Charge ($ / mo.)	$140.86

Summary

The following table summarizes the energy and economic factors used in the analysis.

Summary of Economic and Energy Factors

Factor	Rate or Cost	Factor	Rate or Cost
Nominal Discount Rate	5%	Electricity	$0.274/kwh
General Inflation Rate	2%	Electricity Inflation	3%
Fuel Oil Cost (2012)	$4.12/gal	Fuel Oil Inflation	6%

Appendix A

Energy and Life Cycle Cost Analysis

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Basis

Economic

Study Period (years)	25	Nominal Discount Rate	5%	General Inflation	3%

Energy

	2011 $/gal	Fuel Inflation	2012 $/gal		
Fuel Oil	$3.89	6%	$4.12		
Electricity	$/kWh (2011)	$/kW (2011)	Inflation	$/kWh (2012)	$/kW (2012)
w/ Demand Charges	$0.232	$7.00	3%	$0.239	$7.21
w/o Demand Charges	$0.266	-	3%	$0.274	-

EEM-7: Turn Off Standby Boiler

Energy Analysis

Boiler	Input MBH	Loss %	Loss MBH	Hours, exist	Hours, new	kBtu	η boiler	Gallons
B-1	3,893	0.50%	19	5,760	2,500	-63,454	68%	-674

Life Cycle Cost Analysis	Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs					
Stage boiler operation	0	2	ea	$100	$200
Annual Costs					
Manually sequence lead/standby boilers	1 - 25			$60.00	$0
Energy Costs					
Fuel Oil	1 - 25	-674	gal	$4.12	($78,745)
Net Present Worth					($78,500)

EEM-8: Install Pipe Insulation

Energy Analysis

Service	Size	Length	Bare BTUH	Insul BTUH	Factor	kBtu	η boiler	Gallons
Heating	2.50	12	221	19	50%	-10,617	68%	-113
Heating	4.00	12	279	23	50%	-13,455	68%	-143
Heating	6.00	8	402	30	50%	-13,035	68%	-138
								-394

Life Cycle Cost Analysis		Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs						
Pipe Insulation	2-1/2"	0	12	lnft	$13	$156
	4"	0	12	lnft	$17	$204
	6"	0	8	lnft	$20	$160
Estimating contingency		0			15%	$78
Overhead & profit		0			30%	$179
Design fees		0			10%	$78
Project management		0			8%	$68
Energy Costs						
Fuel Oil		1 - 25	-394	gal	$4.12	($46,050)
Net Present Worth						($45,100)

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EEM-9: Replace Aerators

Energy Analysis

Fixture	Gallons per Use: Existing	Gallons per Use: Proposed	Uses/day	Days	Water,Gals	% HW	kBTU	kWh
Showerhead	20.0	10.0	30.0	180	-54,000	80%	-28,823	-8,448
Lavatories	0.3	0.2	300	180	-9,720	80%	-5,188	-1,521
					-63,720			-9,968

Life Cycle Cost Analysis	Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs					
Replace lavatory aerators	0	19	ea	$35	$665
Replace showerhead	0	22	ea	$35	$770
Energy Costs					
Water	1 - 25	-64	kgals	$10.960	($13,728)
Electric Energy (Effective Cost)	1 - 25	-9,968	kWh	$0.274	($53,686)
Net Present Worth					($66,000)

EEM-10: Perform Boiler Combustion Test

Energy Analysis

Annual Gal	% Savings	Savings, Gal
18,100	-1.0%	-181

Life Cycle Cost Analysis	Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs					
Purchase combustion analyzer	0	1	LS	$700	$700
Annual Costs					
Combustion test	1 - 25	4	hrs	$60.00	$4,628
Energy Costs					
Fuel Oil	1 - 25	-181	gal	$4.12	($21,155)
Net Present Worth					($15,800)

EEM-11: Upgrade Motors to Premium Efficiency

Energy Analysis

Number	HP	ηold	ηnew	kW	Hours	kWh
2	0.33	60.0%	77.0%	-0.08	1,530	-128
1	3	80.5%	89.5%	-0.20	8,760	-1,764
				-0.3		-1,893

Life Cycle Cost Analysis	HP	Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs	HP					
Replace motor	0.33	0	2	LS	550	$1,100
Replace motor	3	0	1	LS	1,080	$1,080
Estimating contingency		0			25%	$545
Energy Costs						
Electric Energy		1 - 25	-1,893	kWh	$0.239	($8,890)
Electric Demand		1 - 25	-3	kW	$7.21	($485)
Net Present Worth						($6,600)

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EEM-12: Optimize Gym AHU-5

Energy Analysis

Ventilation Savings

Case	SA CFM	% OSA	OSA CFM	ΔT	Hours	kBtu	η boiler	Gallons
Existing	-19,300	10%	-1,930	30	1,530	-95,674	68%	-1,016
New	11,000	5%	550	30	1,530	27,265	68%	289
			-1,380					-726

Fan Savings

Case	CFM	ΔP	η, fan	BHP	η, motor	kW	Hours	kWh
Existing	-19,300	2.0	50%	-12.1	91.7%	-9.9	1,530	-15,118
New	11,000	1.5	50%	5.2	91.7%	4.2	1,530	6,462
						-5.7		-8,656

Life Cycle Cost Analysis	Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs					
Install SF VFD	0	1	LS	$15,000	$15,000
Control modifications - CO2 sensor, revise sequence	0	1	LS	$15,000	$15,000
Commissioning	0	1	LS	$5,000	$5,000
Estimating contingency	0			15%	$5,250
Overhead & profit	0			15%	$6,038
Design fees	0			10%	$4,629
Project management	0			8%	$4,073
Energy Costs					
Electric Energy	1 - 25	-8,656	kWh	$0.239	($40,659)
Electric Demand	1 - 25	-51	kW	$7.21	($7,216)
Fuel Oil	1 - 25	-1,016	gal	$4.12	($118,730)
Net Present Worth					($111,600)

EEM-13: Upgrade Transformer

Energy Analysis

Location	kVA	ηold	ηnew	KW	kWh
	150	97.8%	98.9%	-1.65	-14,454

Life Cycle Cost Analysis		Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs						
Replace transformer, kVA	150	0	1	LS	$15,300	$15,300
Overhead & profit		0			30%	$4,590
Design fees		0			10%	$1,989
Project management		0			8%	$1,750
Energy Costs						
Electric Energy		1 - 25	-14,454	kWh	$0.239	($67,896)
Electric Demand		1 - 25	-1.7	kW	$7.21	($234)
Net Present Worth						($44,500)

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EEM-14: Replace Exit Signs

Energy Analysis

Number	Watts, exist	Watts,new	kW	kWh
11	15	0	-0.2	-1,445

Lamp Replacement

# Fixtures	# Lamps	Life, hrs	Lamps//yr	$/lamp	Labor/lamp
11	-2	20,000	-10	$2	$5.00

Life Cycle Cost Analysis	Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs					
Replace exit light	0	11	LS	$300	$3,300
Annual Costs					
Lamp replacement	1 - 25	-10		$7.00	($1,301)
Energy Costs					
Electric Energy	1 - 25	-1,445	kWh	$0.239	($6,790)
Electric Demand	1 - 25	-2	kW	$7.21	($281)
Net Present Worth					($5,100)

EEM-15: Increase AHU-1 Return Air Path

Energy Analysis

Fan Savings

Case	CFM	ΔP	η, fan	BHP	η, motor	kW	Hours	kWh
Existing	12,000	-2.0	55%	-6.9	91.7%	-5.6	1,530	-8,545
New	12,000	1.5	55%	5.1	91.7%	4.2	1,530	6,409
						-1.4		-2,136

Life Cycle Cost Analysis	Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs					
Increase ceiling openings	0	1	LS	$2,000	$2,000
Remove silensers; increase wall openings	0	1	LS	$2,000	$2,000
Energy Costs					
Electric Energy	1 - 25	-2,136	kWh	$0.239	($10,035)
Net Present Worth					($6,000)

EEM16-: Install Valves on Unit Heaters

Energy Analysis

Loss, BTUH	Number	Factor	Loss, kBTU	Boiler Effic	Fuel, gals
-1,250	7	10%	-7,665	70%	-81

Life Cycle Cost Analysis	Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs					
Install automatic valves and connect to fan wiring	0	7	ea	$350	$2,450
Estimating contingency	0			15%	$368
Overhead & profit	0			30%	$845
Design fees	0			10%	$366
Project management	0			8%	$322
Energy Costs					
Fuel Oil	1 - 25	-81	gal	$4.12	($9,480)
Net Present Worth					($5,100)

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EEM-17: Install Modulating Boiler Burners

Energy Analysis

Annual Gal	% Savings	Savings, Gal
18,100	-4.0%	-724

Life Cycle Cost Analysis	Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs					
Install modulating burner	0	2	LS	$9,500	$19,000
Estimating contingency	0			15%	$2,850
Overhead & profit	0			30%	$6,555
Design fees	0			10%	$2,841
Project management	0			8%	$2,500
Annual Costs					
Burner maintenance	1 - 25	2	LS	$400.00	$15,427
Energy Costs					
Fuel Oil	1 - 25	-724	gal	$4.12	($84,618)
Net Present Worth					($35,400)

EEM-18: Optimize Auditorium AHU-3

Energy Analysis

Ventilation Savings

Case	SA CFM	% OSA	OSA CFM	ΔT	Hours	kBtu	η boiler	Gallons
Existing	-13,100	10%	-1,310	30	1,530	-64,939	68%	-690
New	8,000	10%	800	30	720	18,662	68%	198
			-510					-491

Fan Savings

Case	CFM	ΔP	η, fan	BHP	η, motor	kW	Hours	kWh
SF, exist	-13,100	2.0	50%	-8.2	91.7%	-6.7	1,530	-10,261
SF, new	8,000	1.5	50%	3.8	91.7%	3.1	720	2,212
RF, exist	-13,100	1.0	50%	-4.1	89.5%	-3.4	1,530	-5,257
RF, new	8,000	0.5	50%	1.3	89.5%	1.0	720	755
						-6.0		-12,551

Life Cycle Cost Analysis	Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs					
Install SF and RF VFD	0	2	LS	$10,000	$20,000
Control modifications - CO2 sensor, pressure sensor, revise sequence	0	1	LS	$15,000	$15,000
Commissioning	0	1	LS	$5,000	$5,000
Estimating contingency	0			15%	$6,000
Overhead & profit	0			15%	$6,900
Design fees	0			10%	$5,290
Project management	0			8%	$4,655
Energy Costs					
Electric Energy	1 - 25	-12,551	kWh	$0.239	($58,958)
Electric Demand	1 - 25	-54	kW	$7.21	($7,681)
Fuel Oil	1 - 25	-491	gal	$4.12	($57,429)
Net Present Worth					($61,200)

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EEM-19: Optimize Heating System

Energy Analysis

Boiler Efficiency

Boilers	Input MBH	Loss %	Loss MBH	Hours, exist	kBtu	η boiler	Gallons
-2	3,988	0.75%	-60	3,600	-215,341	68%	-2,286
2	2,292	0.75%	34	3,600	123,750	68%	1,314
			-25		-91,591		-973

Pumping Efficiency

	GPM	ΔP	η, pump	BHP	η, motor	kW	Hours	kWh
Primary Pumps								
	-590	32	65%	-9.8	91%	-8.1	3,600	-28,999
	229	15	65%	1.8	91%	1.5	3,600	5,280
Secondary Pumps								
	-68	24	60%	-0.9	86%	-0.8	3,600	-2,873
	-44	14	55%	-0.4	70%	-0.4	3,600	-1,454
	-350	26	65%	-4.7	89%	-4.0	3,600	-14,291
	229	26	55%	3.7	89%	3.1	3,600	11,059
						-8.7		-31,279

Life Cycle Cost Analysis	Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs					
Optimization Analysis	0	1	LS	$14,000	$14,000
Reduce boiler size	0	80	hrs	$150	$12,000
Repipe heating loops	0	1	LS	$25,000	$25,000
Estimating contingency	0			15%	$7,650
Overhead & profit	0			30%	$17,595
Design fees	0			10%	$7,625
Project management	0			8%	$6,710
Annual Costs					
Pump maintenance	1 - 25	-4	LS	$200.00	($15,427)
Energy Costs					
Electric Energy	1 - 25	-31,279	kWh	$0.062	($38,257)
Electric Demand	1 - 25	-104	kW	$10.83	($22,202)
Fuel Oil	1 - 25	-973	gal	$3.42	($94,379)
Net Present Worth					($79,700)

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Craig High School

EEM-20: Optimize Commons AHU-4

Energy Analysis

Ventilation Savings

Case	SA CFM	% OSA	OSA CFM	ΔT	Hours	kBtu	η boiler	Gallons
Existing	-10,470	15%	-1,571	30	1,530	-77,853	68%	-827
New	6,000	10%	600	30	1,530	29,743	68%	316
			-971					-511

Fan Savings

Case	CFM	ΔP	η, fan	BHP	η, motor	kW	Hours	kWh
SF, exist	-10,470	1.8	50%	-5.9	91.7%	-4.8	1,530	-7,381
SF, new	6,000	1.2	50%	2.3	91.7%	1.8	1,530	2,820
RF, exist	-10,471	0.8	50%	-2.6	89.5%	-2.2	1,530	-3,361
RF, new	6,000	0.4	50%	0.8	89.5%	0.6	1,530	963
						-4.5		-6,960

Life Cycle Cost Analysis	Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs					
Install SF and RF VFD	0	2	LS	$9,000	$18,000
Control modifications - CO2 sensor, pressure sensor, revise sequence	0	1	LS	$15,000	$15,000
Commissioning	0	1	LS	$5,000	$5,000
Estimating contingency	0			15%	$5,700
Overhead & profit	0			15%	$6,555
Design fees	0			10%	$5,026
Project management	0			8%	$4,422
Energy Costs					
Electric Energy	1 - 25	-6,960	kWh	$0.239	($32,692)
Electric Demand	1 - 25	-41	kW	$7.21	($5,802)
Fuel Oil	1 - 25	-511	gal	$4.12	($59,703)
Net Present Worth					($38,500)

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EEM-21: Install Boiler Room Heat Recovery

Energy Analysis

Heat Recovery

Boiler gph	Jacket Loss	MBH	Hours	Loss, kBtu	Factor	Recovery, kBtu	η boiler	Gallons
28	-1.0%	-39	4,000	-155,120	50%	-77,560	84%	-667

Fan Energy

MBH	ΔT	CFM	ΔP	η, fan	# Fans	Hours	kW	kWh
39	25	1,436	1.50	35%	2	5,000	1.4	7,221

Life Cycle Cost Analysis	Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs					
700 CFM HRV	0	1	LS	$7,500	$7,500
Ductwork	0	1	LS	$4,000	$4,000
Electrical	0	1	LS	$1,500	$1,500
Estimating contingency	0			15%	$1,950
Overhead & profit	0			30%	$4,485
Design fees	0			10%	$1,944
Project management	0			8%	$1,710
Annual Costs					
HRV maintenance	1 - 25	4	hrs	$60.00	$4,628
Energy Costs					
Electric Energy	1 - 25	7,221	kWh	$0.239	$33,921
Electric Demand	1 - 25	17.3	kW	$7.21	$2,456
Fuel Oil	1 - 25	-667	gal	$4.12	($77,917)
Net Present Worth					($13,800)

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EEM-22: Reduce Locker Room Lighting

Energy Analysis

Electric Savings

Fixture	Number	Hours, exist	Hours, new	watts, fixture	kWh
2T8	36	2,000	1,000	74	-2,650
CFL	14	2,000	1,000	30	-419
					-3,068

Added Heating Load

kWh	Factor	kBtu	η boiler	Gallons
3,068	45%	4,711	68%	50

Lamp Replacement

Type	# Fixtures	# Lamps	Life, hrs	Lamps//yr	$/lamp	Labor/lamp
2T8	36	-2	36,000	-2	$3	$5.00
CFL	14	-1	8,000	-2	$6	$2.00

Life Cycle Cost Analysis	Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs					
Install occupancy sensors	0	4	LS	$1,000	$4,000
Estimating contingency	0			15%	$600.00
Overhead & profit	0			30%	$1,380.00
Design fees	0			10%	$598
Project management	0			8%	$526
Annual Costs					
Existing lamp replacement, 2T8	1 - 25	-2	lamps	$8.00	($309)
Existing lamp replacement, CFL	1 - 25	-2	lamps	$8.00	($270)
Energy Costs					
Electric Energy	1 - 25	-3,068	kWh	$0.239	($14,413)
Fuel Oil	1 - 25	50	gal	$4.12	$5,846
Net Present Worth					($2,000)

Appendix B

Energy and Utility Data

Craig High School

ELECTRIC RATE

Alaska Power Company Bulk Power A-3	Craig Hydaburg Thorn Bay
Electricity ($ / kWh)	$0.0786
Cost of Power Adjustment ($ / kWh)	$0.1534
Demand ($ / kW)	$7.00
Customer Charge ($ / mo)	$140.86
Sales Tax (%)	0.0%

ELECTRICAL CONSUMPTION AND DEMAND

Month	2007		2008		2009		2010		Average
	kWh	kW	kWh	kW	kWh	kW	kWh	kW	
Jan	22,800	90	26,800	90	25,040	94	24,080	97	24,680
Feb	28,400	90	28,800	90	31,600	94	30,240	84	29,760
Mar	22,800	90	25,200	90	26,000	97	23,440	86	24,360
Apr	25,600	90	26,480	82	25,040	93	24,240	88	25,340
May	24,400	80	21,680	85	26,080	88	23,600	82	23,940
Jun	16,000	70	19,040	80	19,520	79	9,600	70	16,040
Jul	13,200	40	5,920	34	14,720	38	8,400	53	10,560
Aug	8,400	30	6,320	30	14,640	50	8,400	53	9,440
Sep	19,200	70	16,720	74	11,920	85	14,800	76	15,660
Oct	23,600	90	23,520	88	23,600		21,760	85	23,120
Nov	27,600	80	28,080	94	28,640	97	31,280	86	28,900
Dec	26,800	90	28,480	96	29,680	97	27,360	92	28,080
Total	258,800		257,040		276,480		247,200		259,880
Average	21,567	76	21,420	78	23,040	83	20,600	79	21,657
Load Factor	39%		38%		38%		36%		79

ELECTRIC BILLING DETAILS Electrical costs are based on the current electric rates.

Month	2009				2010				% Change
	Energy	Demand	Cust & Tax	Total	Energy	Demand	Cust & Tax	Total	
Jan	$5,809	$659	$141	$6,609	$5,587	$678	$141	$6,405	-3.1%
Feb	$7,331	$655	$141	$8,127	$7,016	$588	$141	$7,745	-4.7%
Mar	$6,032	$682	$141	$6,854	$5,438	$605	$141	$6,184	-9.8%
Apr	$5,809	$649	$141	$6,599	$5,624	$616	$141	$6,381	-3.3%
May	$6,051	$617	$141	$6,809	$5,475	$571	$141	$6,187	-9.1%
Jun	$4,529	$554	$141	$5,224	$2,227	$493	$141	$2,861	-45.2%
Jul	$3,415	$268	$141	$3,824	$1,949	$370	$141	$2,459	-35.7%
Aug	$3,396	$353	$141	$3,890	$1,949	$370	$141	$2,459	-36.8%
Sep	$2,765	$595	$141	$3,501	$3,434	$532	$141	$4,106	17.3%
Oct	$5,475	$0	$141	$5,616	$5,048	$594	$141	$5,783	3.0%
Nov	$6,644	$678	$141	$7,463	$7,257	$605	$141	$8,003	7.2%
Dec	$6,886	$678	$141	$7,704	$6,348	$644	$141	$7,132	-7.4%
Total	$ 64,143	$ 6,387	$ 1,690	$ 72,221	$ 57,350	$ 6,664	$ 1,690	$ 65,705	-9.0%
Average	$ 5,345	$ 532	$ 141	$ 6,018	$ 4,779	$ 555	$ 141	$ 5,475	-9.0%
Cost ($/kWh)				$0.261	87%	10%	3%	$0.266	1.8%

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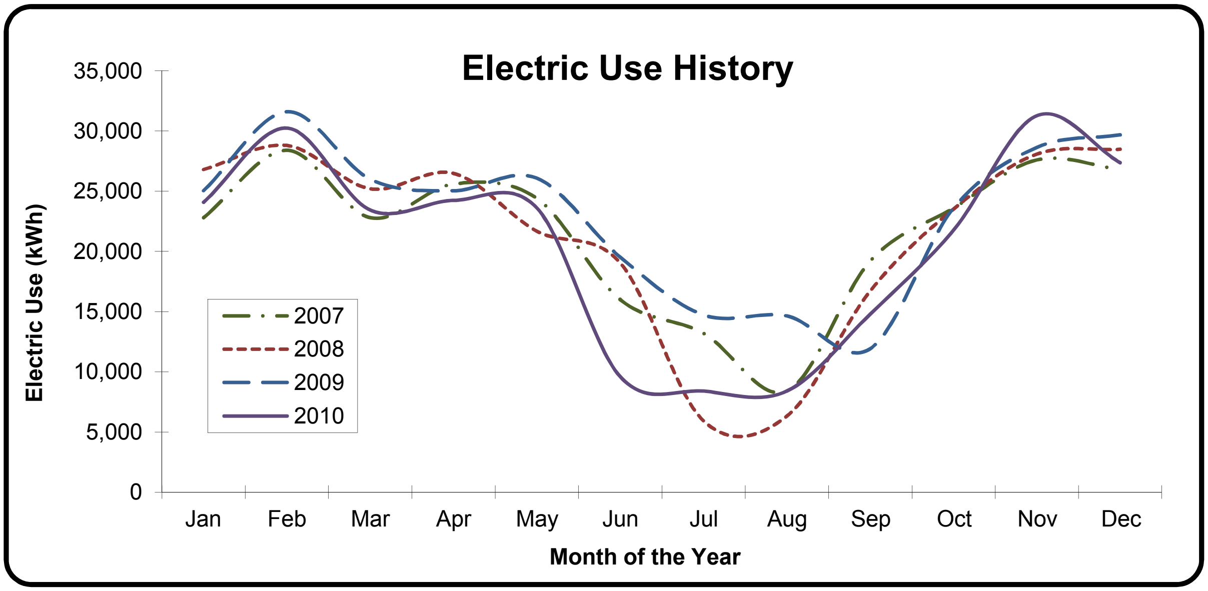
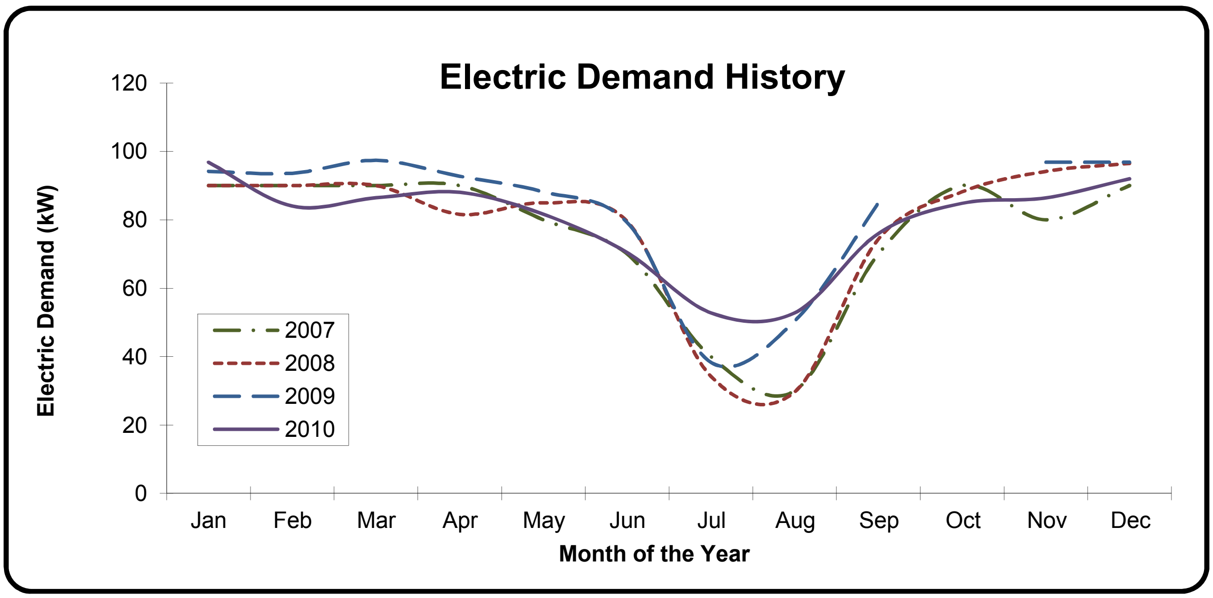
Craig High School





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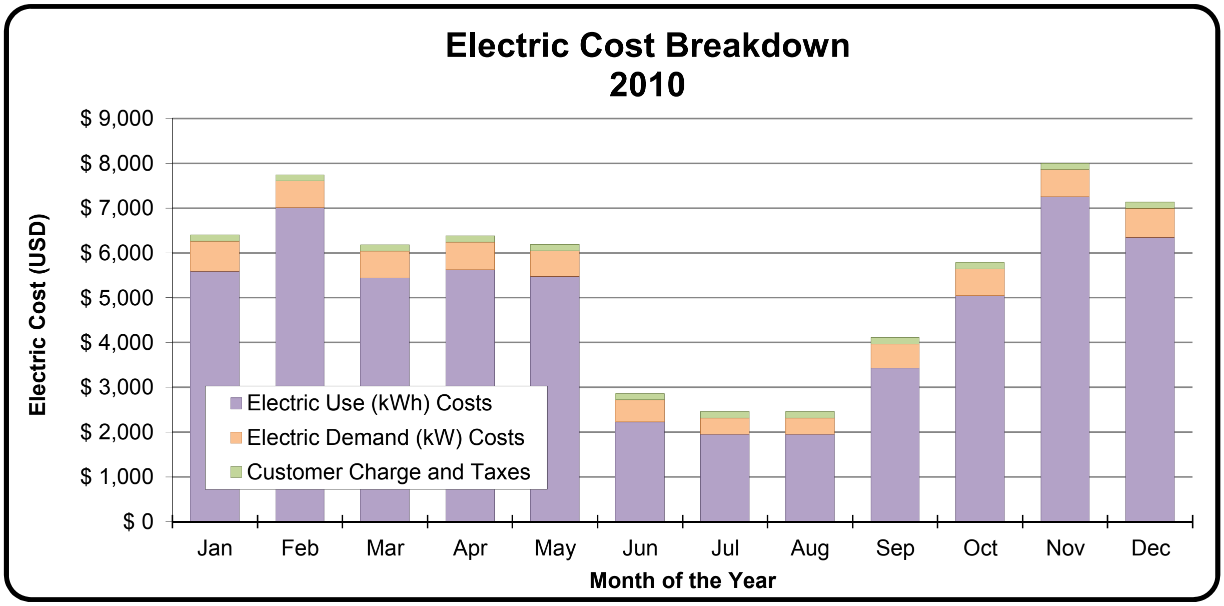
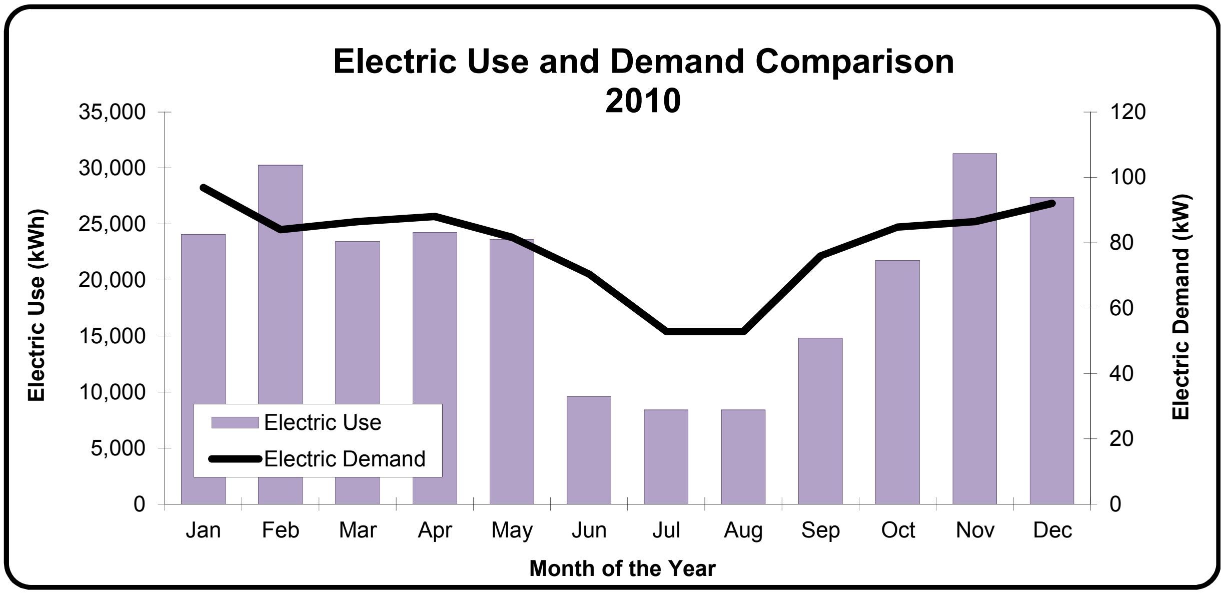
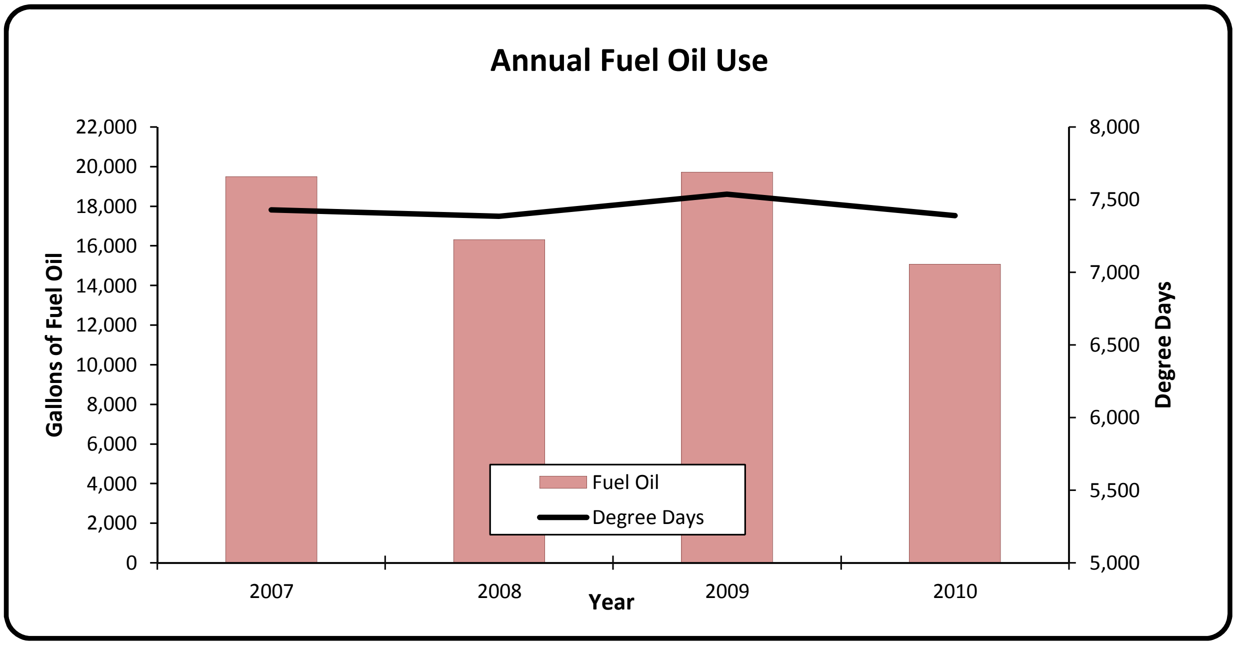




Craig High School



Year	Fuel Oil	Degree Days
2,007	19,489	7,430
2,008	16,321	7,385
2,009	19,727	7,538
2,010	15,072	7,390

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Craig High School

Energy	Cost	$/MMBTU
Fuel Oil	$3.89	$40.12
Electricity	$0.266	$82.00

Area	ECI	EUI
44,492	$2.94	75

Annual Energy Consumption and Cost

Source	**Consumption**		**Cost**	**Energy, MMBtu**	
Electricity	259,880	kWh	$69,100	890	27%
Fuel Oil	18,100	Gallons	$61,900	2,460	73%
Totals	-		$131,000	3,350	100%

Appendix C

Equipment Data

Craig High School - Major Equipment Inventory

Unit ID	Location	Function	Make	Model	Capacity	Motor HP / Volts / RPM / Effic	Notes
B-1	Boiler Room	Boiler	Weil McClain	1388	3270 MBH		
B-2	Boiler Room	Boiler	Weil McClain	1388	3270 MBH		
P-1A	Mechanical 136	Boiler Circulation Pump	Armstrong	4x4x8 4380		10 HP/ 208 V/ 1750 RPM/ 90.2%	pump running 14 psi in 24 psi out
P1-B	Mechanical 136	Boiler Circulation Pump	Armstrong	4x4x8 4380		10 HP/ 208 V/ 1750 RPM/ 90.2%	
P-2	Mechanical 136	Domestic Hot Water Circulation	Armstrong	Astro 50-B		100 W/ 115 V/ 3000 RPM	
P-3A	Mechanical 136	Perimeter Heat	Armstrong	2x2x6 4380		1 HP/ 208 V/ 1725 RPM/ 82.5%	
P-3B	Mechanical 136	Perimeter Heat	Armstrong	2x2x6 4380		1 HP/ 208 V/ 1725 RPM/ 82.5%	
P-4A	Mechanical 136	Shop Heat	Armstrong	1.5B 1050-001		1/3 HP/ 115 V/ 1725 RPM/ 60%	no efficiency rating
P-4B	Mechanical 136	Shop Heat	Armstrong	1.5B 1050-001		1/3 HP/ 115 V/ 1725 RPM/ 60%	
P-5A	Mechanical 136	AHU Heating Coil	Armstrong	4x4x8 4380		5 HP/ 208 V/ 1725 RPM/ 89.5%	
P-5B	Mechanical 136	AHU Heating Coil	Armstrong	4x4x8 4380		5 HP/ 208 V/ 1725 RPM/ 89.5%	
P-6	Shop 141	MAU-1 Heating Coil	Armstrong	No Data		1/4 HP/ 115/ 1725 RPM	
P-7	Mechanical 140B	AHU-1 Heating Coil	Armstrong	1.5B 1050-002		1/3 HP/ 115 V/ 1725 RPM/ 60%	
P-8	Mechanical 160-B	AHU-2 Preheat Coil	Armstrong	No Data		1/4 HP/ 115/ 1725 RPM	

Craig High School - Major Equipment Inventory

Unit ID	Location	Function	Make	Model	Capacity	Motor HP / Volts / RPM / Effic	Notes
P-9	Mechanical 160-B	AHU-2 Heating Coil	Armstrong	1.33 1030-003		1/4 HP/ 115/ 1725 RPM	
P-10	Mechanical 160-B	AHU-3 Preheat Coil	Armstrong	No Data		1/6 HP/ 115 V/ 1725 RPM	
P-11	Mechanical 160-B	AHU-3 Hot Deck Coil	Armstrong	No Data		1/6 HP/ 115 V/ 1725 RPM	
P-12	Mechanical 160-B	AHU-4 Heating Coil	Armstrong	No Data		1/6 HP/ 115 V/ 1725 RPM	
P-13	Mechanical 160-B	AHU-5 Heating Coil	Armstrong	No Data		3/4 HP/ 208 V/ 1140 RPM/ 75.5%	
	Mechanical 160-B	Domestic Hot Water Heater	AO Smith	COF 140-255	255,000 BTU/HR	1/7 HP/ 115 V	140 gal/ direct fuel oil heater
	Electric 137	Transformer	Square D	150T85HIS	150 KVA	150 degrees C temp rise	non TPI rated
AHU-1	Room 203	Classroom AHU	Scott Springfield	HQ-280-AHU-23400-H			
SF-1	Room 203	Supply Fan			23,420 CFM	30 HP/ 208 V/ 1760 RPM/ 90.7%	
RF-1	Room 203	Return Fan			23,420 CFM	7.5 HP/ 208 V/ 1760 RPM/ 88/5%	
AHU-2	Room 106-C	Commons AHU	Scott Springfield	H2-125-AHU-10502H			
SF-2	Room 106-C	Supply Fan			10,470 CFM	10 HP/ 208 V/ 1760 RPM/ 89.5%	
RF-2	Room 106-C	Return Fan			10,470 CFM	3 HP/ 208 V/ 1725 RPM/ 86.5%	
AHU-3	Room 106-C	Auditorium AHU	Scott Springfield	AQ-150-AHU-13100-H			

Craig High School - Major Equipment Inventory							
Unit ID	Location	Function	Make	Model	Capacity	Motor HP / Volts / RPM / Effic	Notes
SF-3	Room 106-C	Supply Fan			13,100 CRM	10 HP/ 208 V/ 1760 RPM/ 89.5%	
RF-3	Room 106-C	Return Fan			13,100 CRM	3 HP/ 208 V/ 1725 RPM/ 86.5%	
AHU-4	Room 106-C	Locker Room AHU	Scott Springfield	HQ-15-AHU-1200-H	1,250 CFM	3 HP/ 208 V/ 1750 RPM/ 86.5%	
AHU-5	Room 106-C	Gymnasium AHU	Scott Springfield	HQ-230-AHU-19300-H			
SF-5	Room 106-C	Supply Fan			19,300 CFM	15 HP/ 208 V/ 1760 RPM/ 91%	
RF-5	Room 106-C	Return Fan			19,300 CFM	7.5 HP/ 208 V/ 1560 RPM/ 88/5%	
MAU-1	Shop	Make-Up Air			3,680 CFM	3 HP/ 208 V/1740 RPM/ 86.5%	
EF-1	Restroom	Exhaust			1,420 CFM	not available	
EF-2	Locker	Exhaust	Loren Cook	165 CPV	1,515 CFM	1/2 HP/ 115 V/ 1725 RPM	
EF-3	Kitchen	Exhaust	Nutone	RL6330WW	190 CFM	not available	
EF-4	Art Room	Exhaust			1,680 CFM	not available	
EF-5	Restroom	Exhaust			100 CFM	not available	
EF-6	Science Room	General Exhaust	Loren Cook	245CPV	4,190 CFM	3/4 HP/ 208 V/ 1725 RPM	
EF-7	Seience Room	Fume Hood			1,200 CFM	not available	

Craig High School - Major Equipment Inventory

Unit ID	Location	Function	Make	Model	Capacity	Motor HP / Volts / RPM / Effic	Notes
EF-8	Math Room	General Exhaust			1,500 CFM	not available	
EF-9	Home Economics	General Exhaust	Loren Cook	180 CPV	1,970 CFM	1/3 HP/ 115 V/ 1725 RPM	
EF-10	Home Economics	Cooktop Exhaust	Nutone		190 CFM	not available	
EF-11	Home Economics	Cooktop Exhaust	Nutone		190 CFM	not available	
EF-12	Home Economics	Cooktop Exhaust	Nutone		190 CFM	not available	
EF-13	Home Economics	Cooktop Exhaust	Nutone		190 CFM	not available	
EF-14	Press Box	Ventilation			250 CFM	not available	
EF-15	Science Prep	General Exhaust	Loren Cook	100 CPV	750 CFM	1/2 HP/ 115 V/ 1725 RPM	
CS-1	Welding Shop	Exhaust Fan	CAR-MON	CMB-20	1,800 CFM	1.5 HP/ 208 V	
CS-2	Welding Shop	Welding Hood	CAR-MON	FH-34	800 CFM	not available	
CS-3	Welding Shop	Vehicle Exhaust System	CAR-MON	LO-X56W	850 CFM	3/4 HP/ 208 V	

Abbreviations

AHU	Air handling unit
BTU	British thermal unit
BTUH	BTU per hour
CBJ	City and Borough of Juneau
CMU	Concrete masonry unit
CO2	Carbon dioxide
CUH	Cabinet unit heater
DDC	Direct digital controls
DHW	Domestic hot water
EAD	Exhaust air damper
EEM	Energy efficiency measure
EF	Exhaust fan
Gyp Bd	Gypsum board
HVAC	Heating, Ventilating, Air-conditioning
HW	Hot water
HWRP	Hot water recirculating pump
KVA	Kilovolt-amps
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light emitting diode
MBH	1,000 Btu per hour
MMBH	1,000,000 Btu per hour
OAD	Outside air damper
RAD	Return air damper
RF	Return fan
SIR	Savings to investment ratio
SF	Supply fan
UV	Unit ventilator
VAV	Variable air volume
VFD	Variable frequency drive