Energy Conservation Study
Detailed Energy Audit

Town of Marshfield
870 Moraine Street
Marshfield, MA

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1 INTRODUCTION

The purpose of this audit report is to provide the Marshfield Public Schools and Municipal Buildings with a list of energy conservation projects, associated costs and estimated energy savings. The approach taken in this audit includes a thorough walk-thru of the buildings and associated systems and equipment, including both process and building systems. The major areas covered in the audit include the building envelope, process, electrical, lighting, and HVAC systems, and operational and maintenance procedures. A major element of the audit also includes an initial interview and ongoing consultation with operational and maintenance personnel, as well as building occupants. This approach is critical to the quality of the audit process since the input of building personnel is invaluable to the effort to obtain accurate information required for the audit.

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2 BUILDING DESCRIPTION

2.1 Marshfield High School

The Marshfield High School (MHS) is located at 167 Forest Street in Marshfield, Massachusetts. The MHS is comprised of various classrooms, library, cafeteria, offices, gymnasium, and shops. Built in 1973, the two-story brick structure has a gross floor area of approximately 208,000 ft^2. The existing walls consist of 4" face brick and back up blocks. Existing windows are single pane.

Lighting:

The lighting is essentially "energy efficient" with the dominant usage of T8 fluorescent lamps and electronic ballasts. One classroom wing still has older T-12 lighting technology. The majority of classrooms and hallways have occupancy sensors.

HVAC System:

Three Di Dietrich gas-fired hot water boilers located in the main mechanical room deliver heat to the building. Currently all three boilers cycles on/off to maintain boiler water temperature set point which leads to stand-by losses when all three boilers are not required to operate.. The existing boilers, recently installed in 2005, currently have retrofitted burners from the original boilers. These burners, installed in 1994 on the old boilers, were part of a gas conversion project.

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Circulation of hot water throughout the building to air handling units, baseboard and unit ventilators is handled by four hot water pumps. Out of four pumps only two pumps operates at any given time and the other two pumps remain on stand-by. Only one hot water pump is equipped with premium efficiency motor while the other three motors are equipped with standard efficiency motors. In addition to these main circulating pumps, there are several other pumps located throughout the building that serve as booster pumps.

Presently, a single Patterson Kelly High efficiency heater, installed as a part of gas conversion in 1994, generates domestic hot water. The domestic hot water is stored in the two storage tanks. The kitchen has a separate electric booster heater for the dishwasher.

Oil leak through bearing

Many of the building's air handling units are in working order but have already surpassed their useful life of operation. Physically, the air handlers are deteriorating. This condition is evident by the numerous parts that are corroding and failing. Nearly all air handlers in the building are still equipped with original standard efficiency motors. A common solution is to retrofit the units with premium efficiency motors. Trane recommends the replacement of these units to meet the air quality and comfort requirements of the spaces.

Dust inside AHU

As is common through the life of a building, the space served by the air handlers has changed thought the years. This new utilization, not accounted by the original design, can lead to poor air quality in the spaces served by the air handlers.

The office air-handling unit, located in the penthouse, has air conditioning and heating. It is original to the building and will need replacing in the near future. The associated condensing unit appears to be in good condition.
The unit for the library, located adjacent to Office AHU, is also original to the age of building. Its ductwork, insulated with approximately 2 inches of insulation, penetrates the penthouse

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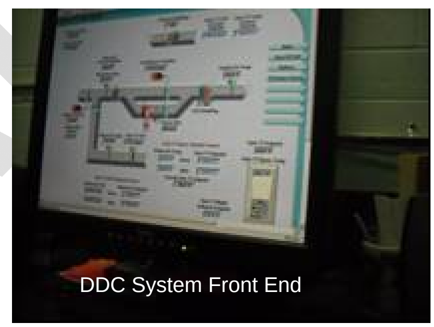
walls and is exposed on the roof. In some locations, the insulation is deteriorating.

The north wing of the high school has two rooftop McQuay central station HVAC units. Both roof top units are mutlizone units with hot & cold deck sections. Mutlizone units were very popular during 1970's. Today this type of system is no longer widely implemented since this type of system is not energy efficient. Each unit has two compressors to handle the cooling load in their respective areas. However, according to maintenance staff, only one compressor is operational on each of the roof top units.

Energy Management System:



DDC System Front End

Currently the building has a combination of direct digital control (DDC) energy management system and an outdated pneumatic control system. The recently installed DDC system in the school controls the majority of classrooms unit ventilators, classroom exhaust fans and some air-handling units. The original pneumatic system controls the existing boiler plant, HVAC units in the shop areas and some air-handling units.

The new DDC system employs various controls strategies such as start/stop, scheduling, CO2 monitoring in the space, space temperature control and other various functions. The DDC system is most effective way to control the HVAC equipment currently available in the market today but it works effectively only if installed on the new HVAC equipment. The current integration of the existing DDC system with 40+ year old equipment is not the correct solution to improve indoor air quality and occupants' comfort.

The existing DDC system does not have alarm functions. This could lead to situations in which maintenance and /or repairs are warranted but maintenance personnel would not be timely informed unless complains were filed by the space occupants. An example of such a situation would be the failure of a motor in a typical classroom unit ventilator. During detailed walk-throughs, various locations yielded carbon dioxide readings that conflicted with what the DDD system was reporting. The DDC system front end was reporting some rooms with a CO_2 levels as low as 20 PPM.

The detailed walk-through also revealed erroneous implementation kitchen hood fan controls. Current fan operation based on CO_2 set point is not a recommended control approach. The VFD on kitchen hood fans modulates the fan speed based on CO_2 level in the exhaust stream.

The existing pneumatic controls in the building are outdated, faulty and require replacement.

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Kitchen Equipment:

The majority of the food prep equipment in the kitchen is gas-fired and has a standing gas pilot. This means that a small gas flame is always on in each piece of equipment that leads to a waste of energy.

In addition to food equipment, the kitchen has one Hobart dishwasher, walk in cooler and freezer and some refrigerators. During the school vacation, standing refrigeration and ice cream machines were on even though they were empty.

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2.2 Furnace Brook Middle School

Furnace Brook Middle School, located at 530 Furnace Road in Marshfield, Massachusetts, currently serves approximately 1,100 students. The building, originally built in the 1960s, underwent a complete renovation in 1999. The original section of the building is a single-story structure. The F Wing, added in 1999, is a two-story structure. The school's footprint is approximately 218,000 square feet and houses grades 6 through 8. The building's exterior walls are constructed of brick on the exterior with back up block. The roof is flat with EPDM membrane on the top with no signs of leaks.

The existing windows are aluminum-framed with double pane glass. The windows appear to be in good condition.

Lighting:

The majority of lighting in the building is T-8 technology. Most of the lighting fixtures are equipped with 32 watt T-8 bulbs and electronic ballast. Gymnasium lighting consists of T-5 fixtures.

The school has 93 skylights, which cover mostly the hallways and gymnasium. Presently, according to maintenance staff, day light harvesting in the hallway areas is impossible due to wiring issues. The hallway lighting in the building operates on a two-switch system, one for the emergency fixtures and one for the remaining fixtures. Maintenance staff currently keeps all the hallway lights on since not all the hallways in the building have skylights.

There are no occupancy sensors currently installed in the school except for the gymnasium.

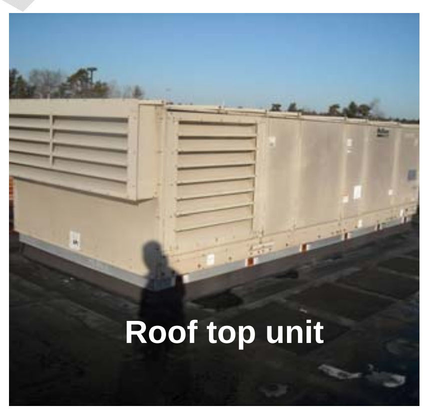
HVAC System:

Hot water production is handled by three Burnham Model V 1120W hot water boilers, rated at 4,979 Mbtus of input All three boiler are equipped with Power Flame Burners, each equipped with 3 HP standard efficiency motor (82.5% efficiency). Currently only two boilers are operational, the remaining boiler is inoperable with cracked sections.

Heating hot water from the boilers is circulated to the HVAC equipment in the building by three 30 HP hot water circulators in the building. The existing pumps are not equipped with variable frequency drives.

The existing hot water piping in the boiler room has three-way control valves that reset the HW temperature based on outside temperature.

Unit ventilators, air handling units and baseboard radiation provide heating and ventilation in the building. The majority of classrooms have unit ventilators that provide heat and fresh air in the space. All the classrooms in the building are connected to common exhaust fan that remove air from the space.


Roof top unit

The Cafeteria, Gymnasium, Kitchen, Auditorium, Media Center, and Administration Wings have their own air-handling units. All the air-handling units are located on the roof except for the Gymnasium units that are located inside the building. The AHUs for Auditorium, Administration Wing and Media Center have DX cooling. All air-handling units in the building are constant volume except for Administration Wing. This unit is a variable air volume system with individual VAV boxes for the offices. The VAV boxes are not equipped with hot water reheat coils.

All the HVAC equipment in the building dates back to the 1999 renovation.

Two Turbo Power gas water heaters, with an input capacity of 1,000,000 btus per hour, produce domestic hot water for the building. Each water heater has a storage capacity of 400 gallons.

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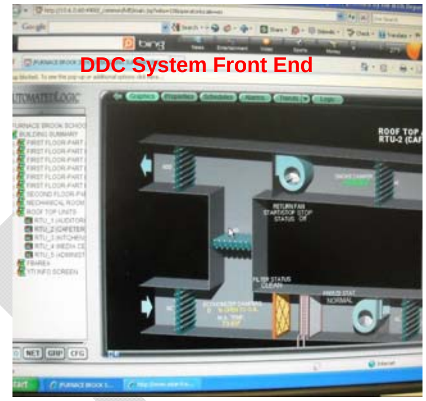
Energy Management System:



Currently the building has an Automated Logic manufactured Direct Digital Control (DDC) energy management system. The DDC system controls all the classrooms unit ventilators, exhaust fans, air-handling units, perimeter radiation, and pumps.

The new DDC system performs various controls strategies such as start/stop, scheduling, economizer cooling, hot water reset, space temperature control and other various functions. The existing system does not have demand control ventilation function based on CO_2 level in the space.

The existing system is 10 years old and there has not had any significant updates to its software.

Kitchen Equipment:

The majority of the food preparation equipment in the kitchen is gas fired each with a standing pilot.

Additionally, the kitchen has one Hobart dishwasher, a walk-in cooler, a walk-in freezer and some refrigerators. During the school vacation, standing refrigeration and ice cream machines were on even when empty.

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2.3 Martinson Elementary School

Martinson Elementary School, located at 257 Forest Street in Marshfield, Massachusetts, originally built in the 1960s and then renovated in 1963, is a single story building that currently serves approximately 508 students during the school year. The gross area of the school is approximately 94,800 square feet and houses grades 1 through 5. The building's exterior walls are brick on the exterior with back up block. The roof is flat with EPDM membrane on the top with no signs of leaks.

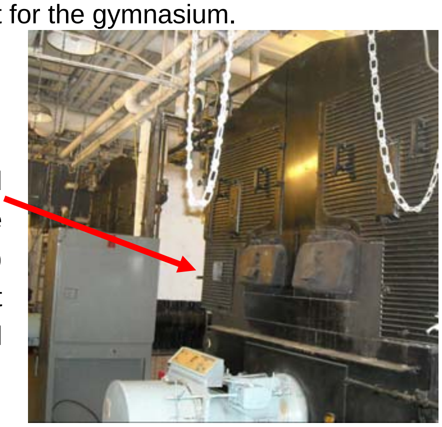
The existing windows are aluminum-framed with double pane glass. The windows appear to be in good condition.

Lighting:

The majority of lighting in the building is T-8 technology. Most of the lighting fixtures are equipped with 32 watt T-8 bulbs and electronic ballast. The Gymnasium lighting consists of T-5 fixtures.

The school has 93 skylights, which cover mostly the hallways and the gymnasium. The maintenance staff in the school turns off the hallway lighting whenever there is plenty of day light available.

There are no occupancy sensors currently installed in the school except for the gymnasium.



HVAC System:

Two original H B Smith Millis 17 cast iron sectional steam boilers, rated at 4,554 Mbtus of input, produce low-pressure steam to heat the building. Both boilers are equipped with Industrial Combustion (IC) Burners. The 1999 retrofit replaced the original HVAC equipment except for the existing boilers, which are 1963 vintage. These oversized

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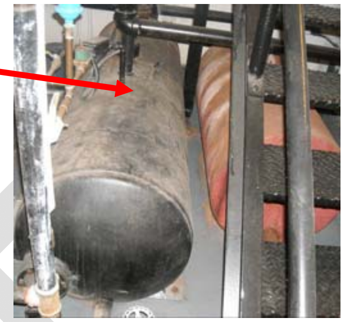
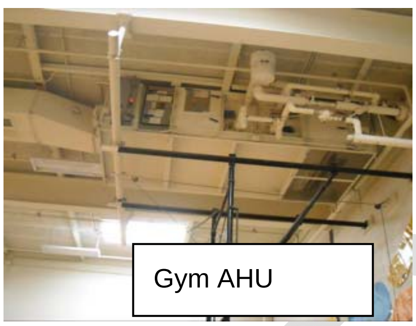
boilers far exceed for the total heating requirement for the building. This leads to significant amounts of stand-by losses.



The condensate-receiving tank for the boiler in which all the condensate from the system is collected is not insulated which leads to a waste of energy.

A ceiling-mounted air-handling unit located in the boiler room provides the combustion air for the boiler room. Boiler operation cycles this unit on and off.

Unit ventilators, air-handling units and baseboard radiation provide heating and ventilation in the building. The majority of classrooms have unit ventilators that provide heat and fresh air in the space.
A network of interconnected common exhaust fans removes air from the classroom spaces.



The Cafeteria, Gymnasium, Kitchen, Art Room, Music Room and Auditorium, have their own air-handling units. All the air-handling units are located inside the building except for Cafeteria and Kitchen units, which are located on the roof.

All the HVAC equipment in the building dates back the 1999 renovation of the building.

A single 500 MBH capacity gas fired water heater produces domestic hot water for the building and is stored by one 119 gallons capacity storage tank.

Energy Management System:

Currently the building has an out dated Invensys manufactured Direct Digital Control (DDC) energy managementsystem. The DDC system controls all the boilers, classrooms unit ventilators, exhaust fans, air-handling units, and perimeter radiation.

The DDC system employs various controls strategies such as start/stop, scheduling, space temperature control and other various functions. The existing system does not have a demand control ventilation function based on CO2 level in the space.

The existing system is 10 years old and still has Windows 98 platform. The current system does not have any graphic capabilities and does not have any ability to perform energy savings functions such as demand control ventilation, optimum start/stop, supply air temperature reset etc.

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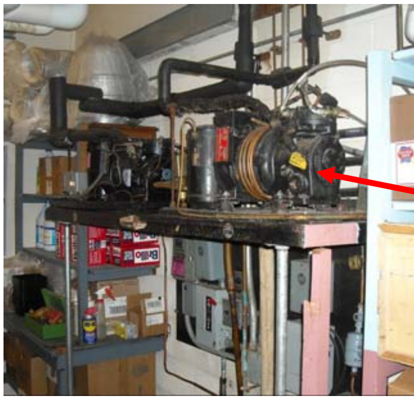
Kitchen Equipment:



The majority of food preparation equipment in the kitchen is gas fired. The m majority of kitchen appliances have an electric pilot.

In addition to food preparation equipment, the kitchen has one dishwasher, walk-in cooler, walk-in freezer and some refrigerators. The walk-in refrigerator utilizes city water for cooling. This one-pass system dumps the water down the drain once it cold the unit. Trane recommendation is to convert this water-cooled unit to an air-cooled unit.

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2.4 South River Elementary School

South River Elementary School, located at 59 Hatch Street in Marshfield, Massachusetts, and originally built in 1953 currently serves approximately 449 students during the school year. The gross area of the school is approximately 62,790 square feet and houses grades 1 through 5. The exterior wall consists of a red brick exterior with back-up concrete masonry unit (CMU). The walls lack insulation and the brick appears to be in good condition. The floors are concrete slab finished with composite tile. The roofs are pitched gable-type over the main building and flat roof over the later addition. Roof insulation over the original building is 'blown-in" cellulose type installed between the ceiling joists in the attic sometime in the early 80's. The average insulation depth observed was 10 inches, which has an approximate R-value of R-25. It is assumed that at least 2 1/2 inches of polyisocyanurate rigid insulation was installed over the flat roofs during the 2006 re-roofing.

Windows are dark bronze aluminum (mostly operable) with insulating glass.

Lighting:

The majority of lighting in the building is T-8 technology. Most of the lighting fixtures are equipped with 32 watt T-8 bulbs and electronic ballast. The gymnasium lighting consists of T-5 fixtures.

There are no occupancy sensors currently installed in the school except for the gymnasium.

HVAC System:

The boiler room houses three cast iron sectional H. B. Smith 44 Mills boilers that appear to be consistent with the original building construction. The boilers employ an Industrial Combustion dual fuel burner and operate on natural gas only. Although disconnected from each burner, the old fuel oil piping and transfer set are currently present and abandoned in place. The existing capacity of the three boilers is well in excess of the building demand and during the coldest of winter days one boiler is capable of maintaining comfortable heating conditions.

Each boiler generates low-pressure steam (approximately 10 psi) and distributed to a common overhead header. All steam piping throughout the entire boiler room appears to be Schedule 40 black steel insulated with fiberglass insulation.

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A single floor mounted condensate receiver collects condensate returned from the general building heating apparatus. The boiler feed water unit currently does not have any insulation.

Breeching from the boilers is through a welded black steel ducting system covered with either calcium silicate or asbestos insulation with canvas jacket. The exterior surfaces of the breeching had slight surface soiling a common condition for the application.

Combustion air for the entire boiler room enters through two wall-mounted intake louvers located approximately 10 ft. above the floor. The louvers lack motor operated dampers and remain open during all operating conditions. This set up could potentially freeze piping within the boiler room.

Steam and condensate distribution for the building is in a series of underground trenches circulating beneath the entire building generally running along the exterior of the building. All piping is accessible in the trench through hatch covers located on the main floor.

The Gymnasium/Auditorium is served by an air-handling unit located above the ceiling of the space.

The kitchen contains two galvanized steel painted canopy hoods located over the two individual cooking areas.
Each exhaust hood merges into a common exhaust system and connects to a floor mounted exhaust fan then discharging in an exterior wall mounted louver approximately 8 feet above grade.
The air-handling unit is of the 100% outside air design and is equipped with a supply fan, steam heating coil with valve control, and filters.

The cafeteria employs an air-handling unit located above the ceiling of an adjacent storage space. There is no return air provided for the system. Currently maintenance staff operates the unit only during lunch hours.

Unit ventilators located through the school's classrooms provide heating and ventilation in the spaces. All unit ventilators in the building are more that 60 years old and are ideal candidates for replacement.

Energy Management System:

The current automatic temperature control system is of the

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pneumatic design.
Existing pneumatic controls are original to the building and outdated. According to maintenance personnel, the existing pneumatic system provides very minimum control of HVAC system. The current system does not provide energy savings strategies, such as scheduling, demand control ventilation, ventilation set back, night set back etc.

Kitchen Equipment:

The majority of the food preparation equipment in the kitchen is gas fired with each with a standing pilot.

In addition to food equipment, the kitchen contains one dishwasher, a walk-in cooler, walk-in freezer, and additional refrigerators. The existing dishwasher is inoperable and abandoned in place.

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2.5 Daniel Webster Elementary School

Daniel Webster Elementary School is located at 1456 Ocean Street in Marshfield, Massachusetts and serves approximately 449 students. Originally built in 1970 the building has an approximate gross area of 57,715 square feet and houses grades 1 through 5. The exterior wall consists of a red brick exterior with back-up concrete masonry unit (CMU). The walls do not contain any insulation and the brick appears to be in good condition. Floors are concrete slab finished with composite tile. Roofs are generally fiat in the center portion and pitched front-to-back above the classroom areas. Typical windows are non-insulated single-glazed units with painted steel frames original to the building.

Lighting System:

The school lighting is essentially already “energy efficient” with a dominant utilization of T8 fluorescent lamps and electronic ballasts. There are no occupancy sensors currently installed in the school. The existing gymnasium lights are T5 fixtures with electronic ballast.

HVAC System:

Original to the building and approximately 45 years old, two Power Master fire tube boilers generate heat for the school. Each boiler is equipped with a dual fuel burner that can utilize number two oil or natural gas. Recently fuel oil consumption was stopped the boilers

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presently operate on natural gas only. Each boiler generates low-pressure steam (approximately 10 psi) controlled by individual pressure stats on each boiler. The capacity of each boiler is approximately 100 hp, and one boiler is capable of maintaining peak building demand with the second boiler on standby.

Steam is distributed to a common overhead header for secondary distribution to two individual air-handling units located within the boiler room. Other equipment includes a domestic hot water heat exchanger taken out of service, a booster domestic hot water heat exchanger that had been serving kitchen equipment, also taken out of service, and a primary heat exchanger, which generates heating hot water for distribution to heating equipment throughout the entire building.

Condensate, which is returned from heat exchanger and air handling units in the boiler room, is collected in a floor-mounted condensate receiver boiler feed water unit.

Heating hot water produced by steam to HW heat exchanger is distributed by a base-mounted primary and standby circulators equipped with original motors.

A ceiling mounted air-handler located in the boiler room currently serves the Cafeteria

A single stainless steel canopy hood that covers the entire cooking area and noted to have proper mounting height serves in kitchen. The kitchen hood discharge is through a roof-mounted up-blast exhaust fan through welded steel exhaust ducts.

An air-handling unit, ceiling mounted in the boiler room, serves the primary activity area. The unit includes a low-pressure steam heating coil, supply fans, return air ductwork and filters. Wall louvers located adjacent to the combustion air louvers introduce outside air into the system. Located within the primary activity area, and hence served by this system, is a computer classroom. There is no thermostat provided for independent temperature control, and there were no return air openings to allow air to flow back to the air handling system.

The media center is provided with one wall-mounted unit ventilator located along the exterior wall.

The heating and ventilation in the gymnasium is provided with a single air-handling unit located in a mechanical space adjacent to the gymnasium, above the corridor ceiling. The overall age of the unit appeared to be consistent with the age of the building - approximately 45 years old - and generally reaching its maximum serviceable life. There was no economizer control, or relief hoods to

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allow for 100% outside air.

The building classrooms are provided with wall-mounted unit ventilator located along the exterior wall. These unit ventilators are provided with an outside air intake louver for ventilation air, hot water heating coil with valve control, filters, and supply fans. Adjacent to the unit ventilators are varying lengths of fin tube radiation. The overall condition of the unit ventilators and fin tube radiation is noted to be antiquated and in poor condition. Many of the units are dirty and slightly damaged.

Located within the closet in each classroom is an exhaust register to remove ventilation air through galvanized sheet metal exhaust ductwork to an exhaust fan located in the gymnasium mechanical space, as well as a central focal fan located above the ceiling in the opposite classroom, each of which discharge through a wall-mounted louver.

A ceiling-mounted classroom unit ventilator with horizontal discharge configuration provides heating and ventilation in the administration area.

Each office located along the exterior wall is provided with fin tube radiation, each of which is controlled by individual wall-mounted pneumatic thermostats.

Energy Management System:

The automatic temperature control system is of the pneumatic design. Existing pneumatic controls are original to the building and outdated. According to maintenance staff, the existing pneumatic system provides very minimum controllability of HVAC system. The current system does not provide energy savings strategies, such as scheduling, demand control ventilation, ventilation set back, night set back etc.

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Kitchen Equipment:

The majority of food preparation equipment in the kitchen is gas fired each with standing gas pilots.

In addition to food preparation equipment, the kitchen has one dishwasher, a walk-in cooler, a walk-in freezer and some refrigerators. The walk-in refrigerator uses city water for cooling. This is a one-pass system and the water is dumped down the drain after it cools the unit. Trane's recommendation is to convert the water-cooled unit to an air-cooled unit.

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2.6 Eames Way Elementary School

Eames Way Elementary School is located at 164 Eames Way in Marshfield, Massachusetts and is occupied by approximately 373 students. The building was built in 1961 and renovated in 1994. The gross area of the school is approximately 40,020 square feet and houses grades 1 through 5. The exterior wall consists of a red brick exterior with back-up concrete masonry unit (CMU). The walls are not insulated. The roof over the center portion of the building is a pitched gable-type covered with asphalt shingles and drains to exterior gutters and downspouts located along the front of the building. The remaining portion of the building is a flat EPDM fully adhered rubber membrane type with internal roof drains. Typical windows are non-insulated single-glazed units with painted steel frames original to the building.

Lighting System:

The school lighting is essentially already “energy efficient” with a dominant usage of T8 fluorescent lamps and electronic ballasts. There are no occupancy sensors currently installed in the school. The existing gymnasium lights are T5 fixtures with electronic ballast.

HVAC System:

The heat in the building is provided by (2) cast iron sectional H. B. Smith 44 Mills boilers that appear to be consistent with the original building construction and approximately 45 years old. The boilers are provided with an Industrial Combustion dual fuel burner that operates on natural gas only. Each boiler is provided with a duel low water cut off and all operating and safety controls and generates low-pressure steam at approximately 10 psi that is controlled by individual pressure stats on each boiler.

Condensate, returned from the general building heating apparatus, is collected in two floor mounted condensate receivers and boiler feed water units, both of which are uninsulated.

Each boiler is provided with an induced draft fan and barometric damper to assist in combustion gas flow. The entire system is operating satisfactorily.

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Combustion air for the entire boiler room is introduced through a single wall mounted intake louver located approximately 10 ft. above the floor. This louver has motor operated dampers that appear to be interlocked with the boiler burner units but do not appear operate.

Steam and condensate distribution for the building is accomplished through a series of underground trenches and crawlspaces circulating beneath the entire building.

The heat and ventilation in the cafeteria is provided with a vertical discharge air-handling unit located in a confined mechanical space between the Cafeteria and adjacent connecting corridor.

The kitchen area has single stainless steel canopy hood that completely covers the entire cooking area. The kitchen hood discharge is through a roof mounted up-blast exhaust fan through a welded steel exhaust duct.

Located in an adjacent mechanical space is a vertical discharge make up air unit providing approximately 50% of the required exhaust air to the kitchen. The unit is provided with the steam heating coil, filters, and a supply fan. , Outside air is drawn from a wall-mounted louver, and return air is drawn at the base of the unit. The unit is currently not in use by kitchen staff.

The heating and ventilation in the gymnasium is provided with three wall-mounted unit ventilators located along the exterior wall. Also located within the gymnasium is a single wall-mounted exhaust register that connects to an individual roof-mounted exhaust fan. This set up is intended to maintain minimum ventilation air.

The building's classrooms are provided with wall-mounted unit ventilators located along the exterior wall.

The overall condition of the unit ventilators is noted to be antiquated and in poor condition with many of the units slightly dirty and damaged. The outside air dampers for the unit ventilators are sliding plate type. Due to the grease and dust accumulated over the years the dampers are stuck open to return air, which means the majority of unit ventilators in the building do not bring any outside air. The source of the outside air for the classrooms is infiltration through original drafty windows.

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The administration area is provided with a central exhaust system made up of galvanized sheet metal ductwork with various ceiling registers connected to a roof mounted exhaust fan. All registers were noted to have slight surface soiling. The exhaust fan, however, does operate and seems maintain exhaust airflow.

Each office located along the exterior wall is provided with fin tube radiation controlled by individual wall mounted pneumatic thermostats. Each office is provided with operable windows for ventilation air along with the mechanical exhaust to generate airflow. All systems are consistent with the age of the building. All equipment was noted to have surface soiling.

Energy Management System:

The automatic temperature control system is of the pneumatic design. Existing pneumatic controls are original to the building and outdated. According to maintenance staff, existing pneumatic system provides very minimum controllability of HVAC system. The current system does not provide energy savings strategies, such as scheduling, demand control ventilation, ventilation set back, night set back etc.

Pneumatic Control Panel

Kitchen Equipment:

The majority of food equipment in the kitchen is gas fired with appliances having standing gas pilots. In addition to food equipment, the kitchen has one dishwasher, a walk-in cooler, a walk-in freezer and some refrigerators.

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2.7 Governor Winslow Elementary School

Governor Winslow Elementary School is located at 60 Regis Road in Marshfield, Massachusetts and is occupied by approximately 373 students. The building was built in 1969. Currently the school is undergoing a renovation of its HVAC systems. The gross area of the school is approximately 65,790 square feet and houses grades 1 through 5. The Governor Winslow Elementary School is a single-story structure, roughly 12, feet high, with a red brick veneer with non-insulated backup concrete block (cmu). A 2' -0" high precast concrete accent band extends from the top of the brick to the bottom of the roof along the perimeter of the administration portion of the building. The roofs covering the classroom areas have a center ridge that slopes from front to back to external gutters. The roof located over the center portion is relatively flat and drains to internal roof drains.

The flooring is a concrete slab-on-grade finished with composite tile. The windows are painted steel sashes original to the building with non-insulated single glazing. Exterior doors are insulated fiberglass reinforced plastic.

Lighting System:

The school lighting is essentially already "energy efficient" with a dominant usage of T8 fluorescent lamps and electronic ballasts. There are no occupancy sensors currently installed in the school. The existing gymnasium lights are T5 fixtures with electronic ballast.

HVAC System:

The buildings heating system employs two Cleaver Brooks fire tube boilers, both of which were installed during the original construction approximately 35 years ago. Each boiler is provided with a dual fuel burner that can handle number two and natural gas. Recently, however, the fuel oil has been disconnected and the boilers presently operate on natural gas only. Each boiler generates low-pressure steam at approximately 10 psi of pressure, which is controlled by individual pressure stats on each boiler. Each boiler is provided with all operating and safety controls, and both are operating in satisfactory condition, maintaining adequate heat during peak periods. The capacity of each boiler is approximately 100 hp, and one boiler is capable of maintaining peak building demand with the second boiler on standby.

The low-pressure steam generated by each boiler is distributes to a common overhead header for secondary distribution to three individual air handling units, one of which is located within the boiler room.

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Also in the boiler is a domestic hot water heat exchanger that appears to have been taken out of service, and a primary heat exchanger, which generates heating hot water for distribution to heating equipment throughout the entire building. All heat exchangers are insulated with fiberglass insulation with a canvas jacket.

Heating hot water is circulated throughout the boiler room and building through a schedule 40 black steel piping system with fiberglass insulation. Heating hot water is distributed by in-line primary and standby circulators made up of three individual zones. The circulators were noted to be in average condition with slight to moderate surface soiling and contamination and with slight damage to the jacket of the piping insulation.

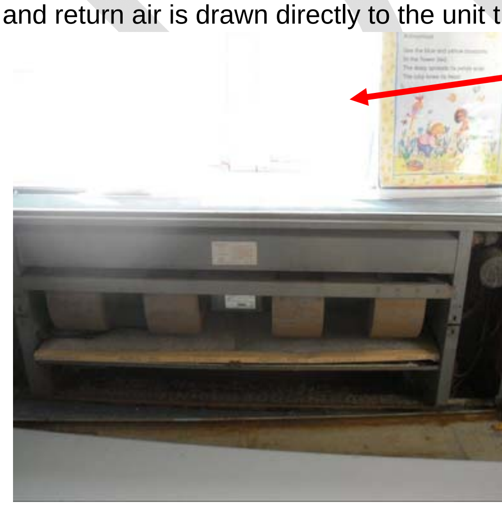
The Primary Activity Area is provided with a ceiling mounted air-handling unit located in the boiler room. This system includes a low-pressure steam heating coil, supply fans, return air ductwork, filters, and outside air drawn in through a wall louver adjacent to the combustion air louver. A single wall-mounted pneumatic thermostat controls the unit.

The Cafetorium is provided with an air-handling unit located in a machine room located above the corridor between the gymnasium and the Cafetorium.

Make-up air for the kitchen area is provide by the same air handling unit which provides ventilation air to the Cafetorium, through a series of side wall registers located adjacent to the hood.

The media center is provided with one ceiling-mounted unit ventilator located above the ceiling in an adjacent storage room that is controlled by a pneumatic thermostat. Located along the exterior wall is a continuous length of hot water fin tube radiation, which is also controlled by the same wall-mounted pneumatic thermostat.

The gymnasium is provided with a single air-handling unit located in a mechanical space adjacent to the gymnasium above the corridor ceiling. This unit is provided with a supply fan, filters and heating hot water coil with valve control. Outside ventilation, air drawn through at the rear of the unit through a wall louver, and return air is drawn directly to the unit through two individual return air registers.



The building classrooms are provided with wall-mounted unit ventilators located along the exterior wall. These unit ventilators are provided with an outside air intake louver for ventilation air, hot water heating coil with valve control, filters and supply fans. The overall condition of the unit ventilators is noted to be antiquated and in poor condition, with many of the units soiled and slightly damaged.

All HVAC equipment in the building is consistent with the age of the building (approximately 35 years old) and will need replacement.

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Kitchen Equipment:

The majority of the food preparation equipment in the kitchen is gas fired with appliances having a gas pilot. In addition to food equipment, the kitchen has one dishwasher, a walk-in cooler, a walk-in freezer and some refrigerators. The walk in refrigerator uses city water for cooling. The water is dumped down the drain after it cools the unit in this one- pass system. Trane's recommendation is to convert this water-cooled unit to an air-cooled unit.

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2.8 Marshfield Town Hall

The Marshfield Town Hall is located at 870 Moraine Street in Marshfield, Massachusetts. The building provides office space for various city departments and administration officials. The original two-story brick structure was built in 1976 and has a gross floor area of approximately 20,000 ft^2. The Town Hall's operating hours are from Monday to Friday from 8:30 AM to 7:30 PM.

The existing walls are made of exterior wood siding with back up concrete block. The existing windows are aluminum single glaze.

Lighting:

Most of the lighting in the Town Hall is already T8 fluorescent lamps and electronic ballasts.

HVAC System:

The heating plant consists of one Weil McLain hot water boiler that uses natural gas. The existing boiler is equipped with an atmospheric burner. The age of the existing boiler is original to building. Three water pumps handle the heating hot water circulation from the boiler to the building. Hot water pumps C1 and C2 circulate water through AC-1 and AC-2 respectively while pump C3 circulates water through PTAC units and fin tube radiation.

A total of thirty-seven (37) Portable Air Conditioning Units (PTAC) and two (2) air-handler units (AC-1 & AC-2) provide the heating and cooling in the building. Direct expansion (DX) cooling is provided to AC-1 and AC-2 by two remote condensing units located on the roof. AC-1 and AC-2 provide heating and cooling in the hallways and stairs.

Additionally, there are three gas fired make up air units that serve the selectman's meeting room and hearing rooms.

There are currently no centralized controls for the HVAC system present in the building. Temperature in the individual offices is control by manual thermostat located on each PTAC unit. AC-1, AC-2 and the make up air units are controlled by a time clock. Throughout its life, several modifications to the space resulted in temperature zoning issues in the building. According to staff, some areas are very cold while some areas are very hot. These issues developed since no modifications were made to the HVAC systems.

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2.9 Ventress Library

The Ventress Library is located at 1827 Ocean Street in Marshfield, Massachusetts. The single-story brick structure, which once served as a supermarket, was converted into the library in 1984 and has a gross floor area of approximately 18,500 ft^2. The library's operating hours are Monday - Thursday, 10:00am - 8:00 pm and Friday and Saturday, 10:00am - 4:00 pm.

Lighting:

Lighting in library is combination of T-8 fixtures and metal halide fixtures. The main reading hall and plan room have 350-watt MH p-start Up-light fixtures. In the center of library, a sizeable skylight provides day lighting to the space. Currently day lighting is not utilized by the library.

HVAC System:

Four (4) Trane gas-fired roof top units equipped with DX cooling deliver heating and air conditioning in the library. Control for all four roof top units is provided by individual space thermostat located in the space. Out of four thermostats, only one is the programmable type while the rest are the manual type. Currently the supply fan for each of the roof top units cycle on/off based on space temperature. Heat for the mezzanine is provided by a gas-fired unit heater. In addition to the gas-fired rooftop units, electric baseboard is utilized for perimeter heating.

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Programmable Thermostat

2 .10 DPW Garage

The DPW Garage is located at 35 Parsonage Street in Marshfield, Massachusetts. The single story steel building was built in 1970 and has a gross floor area of approximately 23,000 ft^2. One-half of the DPW garage is being utilized as a garage for public works vehicles while the other section is utilized for the vehicle maintenance shop and storage. The garage also houses a small office space and a break area. Exterior walls are steel sheet with 2” to 3” of insulation. Deteriorating insulation was noted in several locations throughout the facility.

Lighting:

Majority of lighting in DPW garage is T-8 fixtures.

HVAC System:

Ceiling-mounted gas-fired unit heaters, cycled on and off based on space temperature, located throughout the building provide heating. Currently space temperature set point is maintained at approximately 60˚F. The office space in the building is heated with electric baseboard heat. The break room is served by a fan coil unit equipped with a hot water coil. A gas-fired water heater located in the break room generates the hot water for the fan coil and domestic hot water for the bathrooms.

The office area in the building has cooling which is provided by a DX air handling unit located above the ceiling area.

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2 .11 South River Fire Station

The South River Fire Station is located at 60 South River Street in Marshfield, Massachusetts. The two-story building originally built in the 1970s underwent a renovation and an addition in 1999. The building has a gross floor area of approximately 12,000 ft^2. The first floor of the building houses vehicle bays and an administrative office area. The second floor houses bunkrooms, exercise room, kitchen, shower room and an activity lounge.

Exterior walls are face brick with back up blocks. The windows are aluminum frame with double pane glass. There are eight overhead doors, six of which are old and need replacement.

Lighting:

The majority of the lighting in Fire Station is T-8 fixtures. Lighting fixtures in the garage area are equipped with motion sensors.

HVAC System:

Ceiling-mounted unit heaters equipped with hot water coils located throughout the space provide heating in the vehicle bay area. The existing unit heaters are cycled on and off based on space temperature. Currently space temperature set point is approximately 60˚F. The office space and second floor in the building is heated with a combination of hot water baseboard heating and forced air heating. The forced air heat system is comprised of three air handling units located in the attic area. All three air-handling units are equipped

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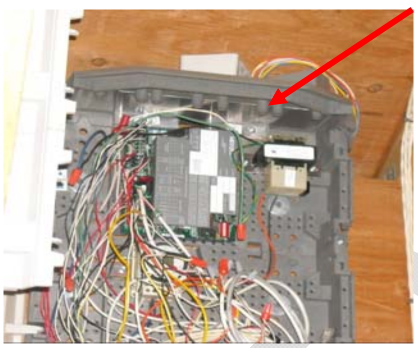
with DX coils for cooling. The condensing units for the DX coils are located on the flat roof section of the building.

The heating hot water for the building is produced by a single Burnham boiler rated for 959 MBH output and is located in the boiler room in the backside of the building. The boiler is utilizing natural gas as primary fuel source. Hot water from the boiler plant to building is delivered by two (2) 2-HP circulators located in the boiler room. Currently no VFDs have been installed on the hot water pumps.



The controls for the HVAC equipment are provided by Johnson Controls Metasys system. The system provides very little controls and cannot perform several energy savings strategies. During the walkthrough, control wiring was discovered to have been poorly done and was not professionally installed

The DHW for the facility is produced by a single 100 gallon Bradford White Model 100T883N water heater with an input capacity of 88,000 btuh per hour.

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2 .12 Marshfield Animal Shelter

The Marshfield Animal Shelter is located at 156 Clay Pit Road in Marshfield, Massachusetts. The single-story building has an approximate floor area of 1,000 ft^2. The facility contains office space for Animal Control Officers, a sick room and holding areas for cats and kennels for dogs. The operating hours are Tuesdays, 9 to 10 AM; Thursdays, 4 to 6 PM; and Saturdays, 10 AM to 12 PM.

Exterior walls are vinyl with back up blocks. The windows are aluminum frame with double pane glass.

Lighting:

The majority of lighting in the Marshfield Animal Shelter is equipped with T-12 fixtures.

HVAC System:

The facility is heated and cooled by a Rheem gas fired furnace equipped with a DX cooling coil matched with a Trane XB outdoor condensing unit. The system cycles based on space temperature and the space temperature set point is maintained at around 66˚F by a non-programmable wall mounted thermostat.

The domestic hot water (DHW) is produced by an electric water heater and serves the facility's bathroom.

2 .13 Marshfield Transfer Station

The Marshfield Transfer Station is located at 23 Clay Pit Road in Marshfield, Massachusetts. The facility is composed of three (3) individual buildings: an all-metal Tipping Building, a Maintenance Building and a small Scale House. The Tipping Building has an approximate floor area of 3,300 ft^2, the Maintenance Building has an approximate floor area of 2,400 ft^2 and the Scale House has an approximate floor area of 60 ft^2.

Exterior walls for the Scale House are face brick with back up blocks. The Maintenance Building is a prefabricated metal building with 2 inches of insulation while the Tipping Building is an all-metal building without any insulation. The windows for the Scale House and Maintenance Building are aluminum frame with single pane glass. The

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Tipping Building has three (3) overhead doors while the Maintenance Building has two (2) roll up doors.

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Lighting:

The majority of lighting in Transfer station is equipped with T-12 fixtures.

HVAC Systems:

The Tipping Building does not have any heating or cooling associated with it.
A ceiling mounted Modine gas-fired industrial unit heater heats the Maintenance Building's garage area while the office and break room areas are served by fin tube radiation and cooled by a window mounted air conditioning unit. The Scale House uses electric heat for occupant comfort.

A 40-gallon Ruud Model EP40 electric water heater produces the DHW for the Maintenance Building.

2 .14 Harbormaster

The Harbormaster is located at 100 Central St. Brant Rock, in Marshfield, Massachusetts. The small-prefabricated mobile type building has an approximate area of 320 ft^2 and serves mainly as office space.

Exterior walls are sheet metal with approximately one (1) inch of insulation. The windows are aluminum frame with single pane glass.

Lighting:

The lighting in the Harbormaster's office is equipped with T-12 fixtures.

HVAC System:

The Harbormaster's Office employs a Bard Wall-Mount ™ Air Conditioner to provide cooling and utilizes electric heat. An electric water heater produces the domestic hot water (DHW) for the Harbormaster's Office.

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2 .15 Marshfield Senior Center

The Marshfield Senior Center is located at 230 Webster Street in Marshfield, Massachusetts. The two-story building was built in the early 2200s and has a gross floor area of approximately 12,600 ft^2. The Center provides many varied services and programs such as exercise, weight & strength training, yoga, bridge, computer club, painting, drawing, crafts, quilting, knitting, creative writing, mah-jongg, cribbage, pinochle, coffee hours, movies, educational seminars, walking club, health screening clinics, pedi care, income tax assistance, senior golf, diabetes support group and fuel applications.

The second floor of the facility is unfinished and is used currently used for storage.

Exterior walls construction is vinyl siding, with portions of face brick veneer on the lower section of the walls, with approximately six (6) inches of fiberglass insulation. The windows are aluminum frame with double pane glass.

Lighting:

The majority of lighting in The Senior Center is equipped T-8 fixtures.

HVAC System:

The Senior Center is equipped with a gas-fired Multi temp boiler system composed of three independent boiler modules with an approximately combined output rating of 900 MBH. Two boiler sections handle the heating load for the various air-handler hot water coils, wall heaters, convectors and hot water cabinet heaters throughout the facility. The third boiler is dedicated to domestic hot water (DHW) production along with an indirect fired water heater (Ruud Model G-76) with a 76-gallon storage tank. The heating system utilizes two (2) 1 ½ horsepower circulator pumps to distribute water throughout the facility.

The Senior Center is equipped with ten (10) Carrier (Model 38BR/FC4B) air cooled DX split systems to provide cooling to the space. The split systems vary from 2-5 tons in terms of cooling capacities and have their associated condensing units located outside the facility. Wall-mounted thermostats in their respective areas control the heating and cooling systems.

The kitchen portion of the Center utilizes a Rezor (Model SCE200) Make-Up Air located in the attic area.

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2 .16 Massasoit Fire Station

Massasoit Fire Station is located at 21 Massasoit Avenue in Marshfield, Massachusetts. The two-story building was built in 1950. The building has a gross floor area of approximately 3,820 ft^2. The first floor of the building houses vehicle bay and administrative office area. The second floor houses bunk rooms, exercise room, and shower room.

Exterior walls are for the garage area is comprised of concrete blocks. The windows are single pane glass. There are total of three overhead doors.

Lighting:

Majority of lighting in Fire Station is equipped with T-8 fixtures. Lighting fixture in garage area is equipped with motion sensors.

HVAC System:

Heating in the vehicle bay area is provide with ceiling mounted unit heaters equipped with hot water coils located throughout the space. Existing unit heaters cycles on and off based on space temperature. Currently space temperature set point is maintained around 60˚F. Office space and second floor in the building is heated with hot water radiators.

The heating hot water for the building is produced by (1) American Standard Model C43 boiler located in the boiler room in the backside of the building. The boiler is rated for 480 MBH of input. The boiler is utilizing natural gas as primary fuel source. Hot water from the boiler plant to building is delivered by three (3) 1/12-HP circulator located in the boiler room.

Currently there is no energy management system installed in the building. Temperature in the space is controlled by manual thermostat.

The DHW is produced by a gas fired water heater with input capacity of 26,000 btuh per hour. The tank has total hot water storage capacity 30 gallons.

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2 .17 Waste Water Treatment Plant

Waste Water Treatment Plant is located at Joseph Drieback in Marshfield, Massachusetts. The two-story building was built in 1999. The building has a gross floor area of approximately 16,000 ft^2. The first floor of the building houses office area, maintenance storage, and lunchroom. The second floor houses laboratories and sludge press room.

Exterior walls are face brick with back up concrete blocks. The windows are metal frame with double pane glass.

Lighting:

Majority of lighting in building is equipped with T-8 fixtures.

HVAC System:

Heating in the building is provided with one Burnham Model V1114 steam boiler located in the basement section of the building. The boiler is rated for 2730 MBH of output. The boiler is equipped with gas-fired burner manufactured by Power Flame.

Heat in first floor and second floor is mainly distributed by fin tube baseboard in the building. The sludge pressroom has two ceiling mounted unit heater. The basement section of the building has central air handling unit, which is manufactured by Carrier. The unit brings 100% outside air and is equipped with steam heating coil, supply fan and filter section. Currently, the AHU operates only during summer time and does not operate at all during the wintertime.

Cooling for the first and second floor is provided with (1) Carrier rooftop unit located on the roof of the building. The unit operates only during summer time. The rooftop unit is controlled by Honeywell thermostat located on the second floor of the unit. The thermostat is not programmable and can be replaced by programmable thermostat if chemicals in the building do not need to be maintained at certain temperature.

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3 ENERGY USE PROFILE

The following tables outline the electrical and gas usage history for the past year.

Marshfield High School

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/18/2009	2/17/2009	120,032	237
2/17/2009	3/18/2009	111,520	429
3/18/2009	4/16/2009	117,600	429
4/16/2009	5/18/2009	107,728	477
5/18/2009	6/17/2009	107,184	463
6/17/2009	7/19/2009	84,608	372
7/19/2009	8/17/2009	80,160	315
8/17/2009	9/16/2009	98,720	429
9/16/2009	10/18/2009	114,784	439
10/18/2009	11/17/2009	114,400	418
11/17/2009	12/16/2009	114,672	241
Total		1,171,408	4,012

Marshfield High School (Account 2)

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/16/2009	2/17/2009	21	
2/17/2009	3/18/2009	20	
3/18/2009	4/16/2009	19	
4/16/2009	5/18/2009	26	
5/18/2009	6/17/2009	24	
6/17/2009	7/17/2009	24	
7/17/2009	8/17/2009	24	
8/17/2009	9/16/2009	43	
9/16/2009	10/16/2009	119	
10/16/2009	11/17/2009	141	
11/17/2009	12/16/2009	143	
Total		604	0

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Daniel Webster Elementary School

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/14/2009	2/14/2009	20,880	84
2/14/2009	3/14/2009	16,320	76.8
3/14/2009	4/14/2009	20,000	76.8
4/14/2009	5/14/2009	17,280	78.4
5/14/2009	6/14/2009	18,560	72
6/14/2009	7/14/2009	11,360	69.6
7/14/2009	8/14/2009	8,240	36.8
8/14/2009	9/14/2009	9,520	64
9/14/2009	10/14/2009	14,800	76
10/14/2009	11/14/2009	19,440	74.4
11/14/2009	12/14/2009	17,680	77.6
Total		174,080	786.4

Governor Winslow Elementary School

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/14/2009	2/14/2009	22,080	89.6
2/14/2009	3/14/2009	17,440	88.0
3/14/2009	4/14/2009	20,320	84.8
4/14/2009	5/14/2009	18,240	88.0
5/14/2009	6/14/2009	20,000	86.4
6/14/2009	7/14/2009	12,480	86.4
7/14/2009	8/14/2009	10,560	27.2
8/14/2009	9/14/2009	14,240	76.8
9/14/2009	10/14/2009	19,680	83.2
10/14/2009	11/14/2009	23,200	91.2
11/14/2009	12/14/2009	20,960	92.8
Total		199,200	894.4

Eames Elementary School

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/14/2009	2/14/2009	16,640	58.4
2/14/2009	3/14/2009	12,640	55.2
3/14/2009	4/14/2009	13,680	49.6
4/14/2009	5/14/2009	11,520	51.2
5/14/2009	6/14/2009	12,160	44.8
6/14/2009	7/14/2009	9,520	40.8
7/14/2009	8/14/2009	8,960	22.4
8/14/2009	9/14/2009	11,440	45.6
9/14/2009	10/14/2009	13,120	52.8
10/14/2009	11/14/2009	14,560	51.2
11/14/2009	12/14/2009	14,000	54.4
Total		138,240	526.4

Martinson Elementary School

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/14/2009	2/14/2009	43,760	151.2
2/14/2009	3/14/2009	34,080	146.4
3/14/2009	4/14/2009	39,040	139.2
4/14/2009	5/14/2009	38,320	146.4
5/14/2009	6/14/2009	40,880	148.8
6/14/2009	7/14/2009	26,560	126.4
7/14/2009	8/14/2009	23,840	81.6
8/14/2009	9/14/2009	30,240	128.8
9/14/2009	10/14/2009	40,240	140
10/14/2009	11/14/2009	45,120	154.4
11/14/2009	12/14/2009	40,080	138.4
Total		402,160	1,501.6

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South River Elementary School

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/14/2009	2/14/2009	18,800	68.8
2/14/2009	3/14/2009	14,400	66.4
3/14/2009	4/14/2009	16,720	67.2
4/14/2009	5/14/2009	15,280	66.4
5/14/2009	6/14/2009	16,480	66.4
6/14/2009	7/14/2009	8,320	60.8
7/14/2009	8/14/2009	5,680	24.0
8/14/2009	9/14/2009	12,160	64.0
9/14/2009	10/14/2009	17,040	68.8
10/14/2009	11/14/2009	18,400	65.6
11/14/2009	12/14/2009	17,040	68.0
Total		160,320	686.4

Furnace Brook Middle School

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/14/2009	2/14/2009	71,680	276.0
2/14/2009	3/14/2009	52,080	247.2
3/14/2009	4/14/2009	57,920	254.4
4/14/2009	5/14/2009	52,240	250.4
5/14/2009	6/14/2009	66,240	300.8
6/14/2009	7/14/2009	33,200	234.4
7/14/2009	8/14/2009	33,280	174.4
8/14/2009	9/14/2009	46,080	275.2
9/14/2009	10/14/2009	56,960	274.4
10/14/2009	11/14/2009	66,080	273.6
11/14/2009	12/14/2009	61,600	273.6
Total		597,360	2,834.4

School Admin Annex – Seth Ventress

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/14/2009	2/14/2009	851	3.7
2/14/2009	3/14/2009	426	2.7
3/14/2009	4/14/2009	431	2.0
4/14/2009	5/14/2009	345	1.3

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5/14/2009	6/14/2009	442	3.9
6/14/2009	7/14/2009	593	6.5
7/14/2009	8/14/2009	845	7.4
8/14/2009	9/14/2009	774	6.4
9/14/2009	10/14/2009	837	13.2
10/14/2009	11/14/2009	3,149	36.4
11/14/2009	12/14/2009	3,448	24.2
Total		12,141	107.7

School Admin Building

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/14/2009	2/14/2009	4,397	16.8
2/14/2009	3/14/2009	3,099	13.6
3/14/2009	4/14/2009	3,100	13.8
4/14/2009	5/14/2009	2,359	13.6
5/14/2009	6/14/2009	2,218	12.2
6/14/2009	7/14/2009	2,262	13.8
7/14/2009	8/14/2009	3,377	17.1
8/14/2009	9/14/2009	3,041	15.9
9/14/2009	10/14/2009	2,271	13.6
10/14/2009	11/14/2009	2,337	12.7
11/14/2009	12/14/2009	2,145	11.9
Total		30,606	155.0

Animal Shelter

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/19/2009	2/18/2009	416	
2/18/2009	3/19/2009	455	
3/19/2009	4/17/2009	470	
4/17/2009	5/19/2009	568	
5/19/2009	6/18/2009	508	
6/18/2009	7/20/2009	580	
7/20/2009	8/18/2009	687	
8/18/2009	9/17/2009	753	
9/17/2009	10/19/2009	453	
10/19/2009	11/18/2009	422	
11/18/2009	12/17/2009	436	
Total		5,748	0

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Fire Station - Massasoit

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/20/2009	2/19/2009	1,571	
2/19/2009	3/20/2009	1,383	
3/20/2009	4/21/2009	1,255	
4/21/2009	5/20/2009	1,060	
5/20/2009	6/19/2009	1,119	
6/19/2009	7/21/2009	1,373	
7/21/2009	8/19/2009	1,669	
8/19/2009	9/18/2009	1,289	
9/18/2009	10/20/2009	1,181	
10/20/2009	11/19/2009	1,127	
11/19/2009	12/18/2009	1,195	
Total		14,222	0

Fire Station – Main

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/19/2009	2/18/2009	2,089	
2/18/2009	3/19/2009	1,603	
3/19/2009	4/17/2009	1,232	
4/17/2009	5/20/2009	1,192	
5/20/2009	6/18/2009	1,204	
6/18/2009	7/20/2009	1,985	
7/20/2009	8/18/2009	2,391	
8/18/2009	9/18/2009	1,951	
9/18/2009	10/19/2009	1,040	
10/19/2009	11/18/2009	1,062	
11/18/2009	12/17/2009	1,065	
Total		16,814	0

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Fire Station – South River

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/14/2009	2/14/2009	9239	22.1
2/14/2009	3/14/2009	8157	20.2
3/14/2009	4/14/2009	8206	21.8
4/14/2009	5/14/2009	8796	27.4
5/14/2009	6/14/2009	11184	31.1
6/14/2009	7/14/2009	12236	28.6
7/14/2009	8/14/2009	15507	37.8
8/14/2009	9/14/2009	14391	35.6
9/14/2009	10/14/2009	10565	28
10/14/2009	11/14/2009	9195	23.2
11/14/2009	12/14/2009	8114	23
Total		115,590	298.8

Harbor Master Office

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/20/2009	2/19/2009	2,276	
2/19/2009	3/20/2009	1,994	
3/20/2009	4/21/2009	1,608	
4/21/2009	5/20/2009	496	
5/20/2009	6/19/2009	411	
6/19/2009	7/21/2009	501	
7/21/2009	8/19/2009	679	
8/19/2009	9/18/2009	479	
9/18/2009	10/20/2009	803	
10/20/2009	11/19/2009	889	
11/19/2009	12/18/2009	1,592	
Total		11,728	0

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Police Station

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/14/2009	2/14/2009	10,320	26.4
2/14/2009	3/14/2009	8,120	24.8
3/14/2009	4/14/2009	9,880	22.8
4/14/2009	5/14/2009	9,560	22.4
5/14/2009	6/14/2009	9,920	21.6
6/14/2009	7/14/2009	11,320	28.8
7/14/2009	8/14/2009	11,440	27.2
8/14/2009	9/14/2009	11,080	25.2
9/14/2009	10/14/2009	10,120	25.6
10/14/2009	11/14/2009	10,640	27.6
11/14/2009	12/14/2009	12,160	28.4
Total		114,560	280.8

Senior Center

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/14/2009	2/14/2009	10000	38.4
2/14/2009	3/14/2009	7920	36.8
3/14/2009	4/14/2009	9840	42.4
4/14/2009	5/14/2009	10160	56.0
5/14/2009	6/14/2009	11280	57.6
6/14/2009	7/14/2009	11440	53.6
7/14/2009	8/14/2009	13920	66.4
8/14/2009	9/14/2009	13200	66.4
9/14/2009	10/14/2009	11680	56.0
10/14/2009	11/14/2009	10640	39.2
11/14/2009	12/14/2009	9760	36.8
Total		119,840	549.6

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Town Hall

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/14/2009	2/14/2009	19,040	52.8
2/14/2009	3/14/2009	15,680	46.4
3/14/2009	4/14/2009	16,960	46.4
4/14/2009	5/14/2009	15,200	60.8
5/14/2009	6/14/2009	15,360	57.6
6/14/2009	7/14/2009	14,720	52.8
7/14/2009	8/14/2009	21,760	84.8
8/14/2009	9/14/2009	19,680	89.6
9/14/2009	10/14/2009	14,880	56.0
10/14/2009	11/14/2009	16,320	51.2
11/14/2009	12/14/2009	15,680	44.8
Total		185,280	643.2

Ventress Library

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/20/2009	2/19/2009	1,457	
2/19/2009	3/20/2009	1,326	
3/20/2009	4/21/2009	1,289	
4/21/2009	5/20/2009	1,066	
5/20/2009	6/19/2009	1,015	
6/19/2009	7/21/2009	1,066	
7/21/2009	8/19/2009	1,059	
8/19/2009	9/18/2009	1,201	
9/18/2009	10/20/2009	1,405	
10/20/2009	11/19/2009	1,216	
11/19/2009	12/18/2009	1,151	
Total		13,251	0.0

Ventress Library (2nd Account)

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/14/2009	2/14/2009	20,320	49.6
2/14/2009	3/14/2009	17,760	43.2
3/14/2009	4/14/2009	18,400	40.0
4/14/2009	5/14/2009	11,680	49.6
5/14/2009	6/14/2009	7,840	48.0
6/14/2009	7/14/2009	8,160	60.8
7/14/2009	8/14/2009	12,160	54.4
8/14/2009	9/14/2009	11,200	54.4
9/14/2009	10/14/2009	7,840	43.2
10/14/2009	11/14/2009	16,320	40.0
11/14/2009	12/14/2009	16,000	40.0
Total		147,680	523.2

Highway Department Garage

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/14/2009	2/14/2009	12,520	25.2
2/14/2009	3/14/2009	9,640	25.2
3/14/2009	4/14/2009	9,120	22.0
4/14/2009	5/14/2009	7,600	20.4
5/14/2009	6/14/2009	7,680	20.8
6/14/2009	7/14/2009	7,200	22.8
7/14/2009	8/14/2009	8,080	20.8
8/14/2009	9/14/2009	8,160	21.2
9/14/2009	10/14/2009	7,240	20.8
10/14/2009	11/14/2009	8,600	22.4
11/14/2009	12/14/2009	9,480	26.0
Total		95,320	247.6

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Highway Department Garage (2nd Account)

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/20/2009	2/19/2009	414	
2/19/2009	3/20/2009	380	
3/20/2009	4/21/2009	391	
4/21/2009	5/20/2009	290	
5/20/2009	6/19/2009	236	
6/19/2009	7/21/2009	193	
7/21/2009	8/19/2009	92	
8/19/2009	9/18/2009	18	
9/18/2009	10/20/2009	0	
10/20/2009	11/19/2009	10	
11/19/2009	12/18/2009	0	
Total		2,024	0.0

Sewer Treatment 1

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/19/2009	2/19/2009	178,540	279.0
2/19/2009	3/19/2009	159,740	283.0
3/19/2009	4/20/2009	180,340	299.0
4/20/2009	5/19/2009	155,780	289.0
5/19/2009	6/17/2009	155,180	272.0
6/17/2009	7/21/2009	198,020	354.0
7/21/2009	8/19/2009	177,540	348.0
8/19/2009	9/15/2009	158,820	324.0
9/15/2009	10/19/2009	172,740	288.0
10/19/2009	11/18/2009	155,380	272.0
11/18/2009	12/15/2009	146,840	269.0
Total		1,838,920	3,277.0

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Rec Coast Guard

Date From	To Date	Use (kWh)	Use - Demand (kW)
1/14/2009	2/14/2009	1,928	8.8
2/14/2009	3/14/2009	1,665	8.0
3/14/2009	4/14/2009	1,645	5.6
4/14/2009	5/14/2009	1,281	6.0
5/14/2009	6/14/2009	1,130	5.0
6/14/2009	7/14/2009	887	6.9
7/14/2009	8/14/2009	1,294	7.1
8/14/2009	9/14/2009	1,098	7.2
9/14/2009	10/14/2009	833	6.8
10/14/2009	11/14/2009	1,160	4.5
11/14/2009	12/14/2009	1,324	7.2
Total		14,245	73.1

Natural Gas 2009

Marshfield High School

Month	Days	Therms
1/14/2009	29	25,250
2/12/2009	29	23,698
3/13/2009	31	19,080
4/13/2009	29	16,740
5/12/2009	31	6,212
6/12/2009	33	1,096
7/15/2009	30	878
8/14/2009	32	678
9/15/2009	29	811
10/14/2009	29	1,181
11/12/2009	29	9,408
12/11/2009	35	10,783
Total	366	115,815

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Daniel Webster Elementary School

Month	Days	Therms
1/14/2009	29	6,349
2/12/2009	29	5,999
3/13/2009	31	5,017
4/13/2009	30	4,375
5/13/2009	30	1,618
6/12/2009	33	455
7/15/2009	30	155
8/14/2009	32	92
9/15/2009	29	134
10/14/2009	29	380
11/12/2009	29	2,093
12/11/2009	35	2,555
Total	366	29,222

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Governor Winslow Elementary School

Month	Days	Therms
1/14/2009	29	7,321
2/12/2009	29	7,059
3/13/2009	31	6,045
4/13/2009	30	4,704
5/13/2009	30	2,022
6/12/2009	33	703
7/15/2009	30	289
8/14/2009	32	216
9/15/2009	29	257
10/14/2009	29	329
11/12/2009	29	3,878
12/11/2009	35	3,878
Total	366	36,701

Eames Elementary School

Month	Days	Therms
1/14/2009	29	6,021
2/12/2009	29	4,305
3/13/2009	31	1,691
4/13/2009	29	167
5/12/2009	31	73
6/12/2009	33	62
7/15/2009	30	63
8/14/2009	32	417
9/15/2009	29	2,354
10/14/2009	29	4,532
11/12/2009	29	6,378
12/11/2009	35	8,751
Total	366	34,814

Martinson Elementary School

Month	Days	Therms
1/14/2009	34	12,532
2/12/2009	29	11,669
3/13/2009	29	9,632
4/13/2009	31	7,620
5/12/2009	29	2,862
6/12/2009	31	1,417
7/15/2009	33	269
8/14/2009	30	113
9/15/2009	32	185
10/14/2009	29	883
11/12/2009	29	5,592
12/11/2009	29	6,556
Total	365	59,330

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South River Elementary School

Month	Days	Therms
1/14/2009	29	10,960
2/12/2009	29	8,242
3/13/2009	31	6,302
4/13/2009	30	5,464
5/13/2009	30	2,178
6/12/2009	33	734
7/15/2009	30	207
8/14/2009	32	72
9/15/2009	29	144
10/14/2009	29	1,746
11/12/2009	29	5,592
12/11/2009	35	6,248
Total	366	47,889

Furnace Brook Middle School

Month	Days	Therms
1/30/2009	32	1,634
2/26/2009	27	388
3/30/2009	32	117
4/29/2009	30	113
5/27/2009	28	402
6/29/2009	33	1,498
7/30/2009	31	4,479
8/28/2009	29	9,608
9/29/2009	32	11,640
10/27/2009	28	10,774
11/24/2009	28	6,578
12/29/2009	35	3,964
Total	365	51,195

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School Admin Annex – South Ventress

Please note that an incomplete 12-month consecutive billing was not provided for this facility

Month	Days	Therms
6/30/2008	30	5
7/30/2008	30	3
8/29/2008	32	4
9/30/2008	29	51
10/29/2008	27	361
11/25/2008	34	712
12/29/2008	30	742
1/28/2009	29	1,722
2/26/2009	32	1,333
3/30/2009	29	925
4/28/2009	29	6
5/27/2009	8	5
Total	339	5,869

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Animal Shelter

Month	Days	Therms
1/28/2009	29	149
2/26/2009	32	116
3/30/2009	29	93
4/28/2009	29	47
5/27/2009	34	9
6/30/2009	30	7
7/30/2009	29	7
8/28/2009	32	7
9/29/2009	28	7
10/27/2009	28	17
11/24/2009	35	30
12/29/2009	31	111
Total	366	600

Fire Station - Massasoit

Month	Days	Therms
1/29/2009	28	753
2/26/2009	32	560
3/30/2009	30	546
4/29/2009	29	267
5/28/2009	32	108
6/29/2009	31	105
7/30/2009	29	91
8/28/2009	32	80
9/29/2009	28	97
10/27/2009	28	183
11/24/2009	36	227
12/30/2009	29	637
Total	364	3,654

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Fire Station – Main

Month	Days	Therms
1/28/2009	30	550
2/27/2009	31	455
3/30/2009	29	373
4/28/2009	29	174
5/27/2009	34	48
6/30/2009	30	40
7/30/2009	29	37
8/28/2009	32	32
9/29/2009	29	39
10/28/2009	30	88
11/27/2009	32	145
12/29/2009	31	402
Total	366	2,383

Fire Station – Main (2nd Account)

Month	Days	Therms
1/28/2009	30	6
2/27/2009	31	0
3/30/2009	29	0
4/28/2009	29	1
5/27/2009	34	2
6/30/2009	30	3
7/30/2009	29	1
8/28/2009	32	2
9/29/2009	29	1
10/28/2009	30	1
11/27/2009	32	2
12/29/2009	31	3
Total	366	22

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Fire Station – South River

Month	Days	Therms
1/29/2009	28	1,562
2/26/2009	32	1,256
3/30/2009	29	1,034
4/28/2009	29	583
5/27/2009	33	389
6/29/2009	31	446
7/30/2009	29	366
8/28/2009	32	273
9/29/2009	28	409
10/27/2009	28	455
11/24/2009	35	515
12/29/2009	30	1,155
Total	364	8,443

Police Station

Month	Days	Therms
1/29/2009	28	1,182
2/26/2009	32	948
3/30/2009	30	934
4/29/2009	28	543
5/27/2009	33	303
6/29/2009	31	269
7/30/2009	29	189
8/28/2009	32	62
9/29/2009	28	44
10/27/2009	28	263
11/24/2009	35	432
12/29/2009	30	908
Total	364	6,077

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Senior Center

Month	Days	Therms
1/29/2009	28	1,911
2/26/2009	32	1,461
3/30/2009	30	1,238
4/29/2009	29	652
5/28/2009	32	311
6/29/2009	31	264
7/30/2009	29	160
8/28/2009	33	104
9/30/2009	27	264
10/27/2009	28	506
11/24/2009	36	664
12/30/2009	29	1,726
Total	364	9,261

Town Hall

Month	Days	Therms
1/29/2009	28	3145
2/26/2009	32	2431
3/30/2009	30	2196
4/29/2009	28	1278
5/27/2009	33	54
6/29/2009	31	23
7/30/2009	29	22
8/28/2009	32	19
9/29/2009	28	23
10/27/2009	28	691
11/24/2009	35	1327
12/29/2009	30	2753
Total	364	13,962

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Ventress Library

Month	Days	Therms
1/29/2009	28	1988
2/26/2009	32	1505
3/30/2009	28	986
4/27/2009	30	436
5/27/2009	33	104
6/29/2009	31	47
7/30/2009	29	23
8/28/2009	32	19
9/29/2009	28	29
10/27/2009	28	322
11/24/2009	35	356
12/29/2009	30	1355
Total	364	7,170

Highway Department Garage

Month	Days	Therms
1/29/2009	28	3,166
2/26/2009	32	2,499
3/30/2009	30	2,308
4/29/2009	28	1,014
5/27/2009	33	193
6/29/2009	31	103
7/30/2009	29	35
8/28/2009	32	0
9/29/2009	28	10
10/27/2009	28	412
11/24/2009	35	759
12/29/2009	30	2,416
Total	364	12,915

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Sewer Treatment

Month	Days	Therms
1/14/2009	29	838
2/12/2009	89	309
5/12/2009	64	144
7/15/2009	30	0
8/14/2009	32	10
9/15/2009	29	10
10/14/2009	29	10
11/12/2009	29	21
12/11/2009	35	10
Total	366	1,352

Alamo

Month	Days	Therms
1/29/2009	28	322
2/26/2009	32	227
3/30/2009	30	201
4/29/2009	28	85
5/27/2009	33	20
6/29/2009	31	14
7/30/2009	29	3
8/28/2009	32	3
9/29/2009	28	4
10/27/2009	28	20
11/24/2009	35	46
12/29/2009	30	158
Total	364	1,103

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Rec Coast Guard

Month	Days	Therms
39,841	29	266
39,870	32	246
39,902	29	252
39,931	29	144
39,960	34	65
39,994	30	21
40,024	32	11
40,056	29	13
40,085	29	20
40,114	28	81
40,142	34	90
40,176	31	234
Total	366	1,443

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4 ENERGY CONSERVATION MEASURES & FACILITY IMPROVEMENT MEASURES

The following table outlines the energy conservation measures for the school buildings.

Building ECM	Guaranteed Savings	% Total Util. Cost	Guaranteed kWh Saved	kW Saved	Therms Saved	Water Gallons
High School						
VFD for HW Pumps	$12,053	2.9%	87,124	131	-	
New AHUs and Uvs with new EMS	$31,122	7.6%	20,149	(4)	20,714	
Multizone to VAV Conversion	$17,581	4.3%	111,117	89	2,016	
New Windows	$23,794	5.8%	13,459	1	15,997	
Building Envelope Improvement	$5,966	3.0%	-	-	4,323	
Automatic Control valve for Boilers	$1,656	1.0%			1,200	
Dust Collector System	$1,100	0.7%	6,839		-	
Lighting Retrofit	$26,450	35.2%	189,869	71	(2,971)	
Kitchen Hood Controls	$2,263	1.4%	1,195		1,500	
Destratification Fan	$1,751	1.1%	(4,049)		1,655	
Efficient Motors	$839		5,213			
New Burner Motor Controller	$2,792		-		2,023	
Walk in Cooler and Freezer Controls	$1,415	1.9%	8,794			
Total Savings	**$104,988**	25.6%	417,456	288	28,438	

Building ECM	Guaranteed Savings	% Total Util. Cost	Guaranteed kWh Saved	kW Saved	Therms Saved	Water Gallons
Middle School						
New Condensing Boiler	$5,227	2.6%	-	-	4,430	
VFD on HW Pumps	$6,652	3.3%	42,616	143	-	
New EMS System	$12,793	6.4%	9,919	107	9,230	
Building Envelope Improvement	$1,669	0.8%	-	-	1,210	
Solar Track Lighting	$4,290	5.7%	26,665	-	-	
Lighting Retrofit	$9,285	12.3%	65,330		(889)	
Kitchen Hood Controls	$2,752	1.7%	5,648		1,336	
Walk in Cooler and Freezer Controls		0.0%	1,987			
Total Savings	**$42,669**	21.3%	152,165	250	15,316	

Building ECM	Guaranteed Savings	% Total Util. Cost	Guaranteed kWh Saved	kW Saved	Therms Saved	Water Gallons
Martinson						
New Boilers	$14,931	9.2%	8,204	16	10,243	
EMS Upgrade	$14,701	9.1%	2,067	52	10,583	
Kitchen Hood Controls	$1,292	0.8%	978		822	
Building Envelope Improvement	$4,764	2.4%	-	-	3,453	
Lighting Retrofit	$4,186	5.6%	29,456	-	(401)	

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Walk in Cooler and Freezer Controls	$660	0.9%	4,100	-	-	
Water Cooled Condenser for Walk in Refrigerator	$1,434	0.9%	(817)	-	-	262,080
Total Savings	**$41,968**	26.0%	43,988	68	24,699	262,080

Building ECM	Guaranteed Savings	% Total Util. Cost	Guaranteed kWh Saved	kW Saved	Therms Saved	Water Gallons
DWES						
Boiler Replacement	$9,098	12.1%	4,598	13	6,272	
VFD on HW Pumps	$2,291	3.0%	15,359	29	-	
EMS Upgrade and New HVAC	$10,466	13.9%	12,944	58	6,258	
Window Replacement	$4,750	6.3%	2,800	4	3,243	
Building Envelope Improvement	$482	0.6%	518	1	301	
Lighting Retrofit	$3,745	5.0%	26,350	-	(359)	
Walk in Cooler and Freezer Controls	$515	0.7%	3,202	-	-	
Kitchen Hood Controls	$1,608	1.0%	652		1,089	
Efficient Motors for HW Pumps	$514	0.7%	3,195	-	-	
Water Cooled Condenser for Walk in Refrigerator	$1,434	1.9%	(817)			262,080
Total Savings	**$34,903**	46.4%	68,802	106	16,804	262,080

Building ECM	Guaranteed Savings	% Total Util. Cost	Guaranteed kWh Saved	kW Saved	Therms Saved	Water Gallons
Eames Way						
New Windows	$14,682	19.7%	2,427	4	10,703	
Boiler Replacement	$6,244	8.4%	-	-	4,666	
New EMS and Unit Ventilators	$9,590	12.8%	28,118	(2)	4,238	
LED Parking Lot Light	$2,500	3.3%	16,126	51	-	
Lighting Retrofit	$770	1.0%	5,416	-	(74)	
Walk In Cooler Freezer Controls	$740	1.0%	4,597	-	-	
Building Envelope Improvement	$1,693	0.8%	-	-	1,227	
Kitchen Hood Controls	$1,492	0.9%	968		968	
Total Savings	**$37,711**	50.5%	57,652	52	21,729	

Building ECM	Guaranteed Savings	% Total Util. Cost	Guaranteed kWh Saved	kW Saved	Therms Saved	Water Gallons
South River Elem						
New Boiler	$17,784	15.4%	-	-	13,290	
New EMS and HVAC Equipment	$16,032	13.9%	8,794	13	11,016	
Building Envelope Improvement	$1,145	1.0%	263	-	828	
Lighting Retrofit	$4,587	6.1%	32,274	-	(439)	
Walk In Cooler and Freezer Control	$886	1.2%	5,505	-	-	
Kitchen Hood Controls	$2,700	1.7%	434		1,906	
Total Savings	**$43,134**	37.5%	47,271	13	26,601	

Building	Guaranteed	% Total	Guaranteed kWh	kW	Therms	Water

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ECM	Savings	Util. Cost	Saved	Saved	Saved	Gallons
All Buildings						
Computer Network Controller	$18,970		117,900	-	-	
Total Savings	**$18,970**		117,900	-	-	

Building ECM	Guaranteed Savings	% Total Util. Cost	Guaranteed kWh Saved	kW Saved	Therms Saved	Water Gallons
Governor Winslow						
Water Cooled Condenser for Walk in Refrigerator	$1,434	1.6%	(817)	-	-	262,080
Total Savings	**$1,434**	1.6%	(817)	-	-	
Grand Total / Avg.	**$325,778**	**29.0%**	**904,416**	**776**	**133,588**	

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The following table outlines the energy conservation measures for the town buildings.

Building ECM	Guaranteed Savings	% Total Util. Cost	Guaranteed kWh Saved	kW Saved	Therms Saved
Town Hall					
Boiler Replacement	$5,577	10.5%	3,285	(39)	3,846
VAV Conversion	$11,094	20.9%	48,872	(51)	3,266
Building Envelope Improvement	$356	0.7%	363	2	214
Lighting Retrofit	$1,855	3.5%	11,526	-	
Total Savings	**$18,881**	35.6%	64,046	(88)	7,326

Building ECM	Guaranteed Savings	% Total Util. Cost	Guaranteed kWh Saved	kW Saved	Therms Saved
Senior Center					
New Condensing Boiler	$2,175	6.1%	192	0	1,556
VFD on HW Pumps	$721	2.0%	4,908	7	-
New EMS System with New HVAC Units	$12,710	35.8%	41,090	167	4,460
Lighting Retrofit	$1,357	3.8%	8,431	-	
Kitchen Hood Controls	$0	0.0%	-	-	-
Walk In Cooler and Freezer Controls	$0	0.0%	-	-	-
Building Envelope Improvements	$14	0.0%	-	-	11
Total Savings	**$16,962**	47.7%	54,621	174	6,027

Building ECM	Guaranteed Savings	% Total Util. Cost	Guaranteed kWh Saved	kW Saved	Therms Saved
Library					
New EMS System	$6,427	14.7%	11,418	(27)	3,596
Building Envelope Improvement	$230	0.5%	120	2	147
Lighting Retrofit	$3,518	9.9%	21,866	-	
Total Savings	**$10,176**	23.2%	33,404	(25)	3,743

Building ECM	Guaranteed Savings	% Total Util. Cost	Guaranteed kWh Saved	kW Saved	Therms Saved
South River Fire Station					
Boiler and DHW heater Replacement	$2,161	6.1%	-	-	1,566
VFD on HW Pumps	$388	1.1%	2,531	7	-
EMS Upgrade	$2,634	7.4%	18,463	11	(0)
Over Head Doors	$0	0.0%	-	-	-
Lighting Retrofit	$2,974	8.4%	18,482	-	
Building Envelope Improvements	$652	1.8%	-	-	473
Total Savings	**$8,157**	23.0%	39,477	18	1,566

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Building ECM	Guaranteed Savings	% Total Util. Cost	Guaranteed kWh Saved	kW Saved	Therms Saved
DPW Garage					
Over Head Doors	$3,767	10.6%	5,189	29	2,102
New Air Rotation Unit	$4,089	11.5%	(1,541)	(6)	3,141
Heat Pump system for Office	$155	0.4%	705	12	(0)
Lighting Retrofit	$1,367	3.8%	8,494	-	
Building Envelope Improvements	$1,071	3.0%	-	-	776
Total Savings	**$9,378**	26.4%	12,848	35	5,243

Building ECM	Guaranteed Savings	% Total Util. Cost	Guaranteed kWh Saved	kW Saved	Therms Saved
Harbor Master					
New Heat Pump	$821	31.0%	4,751	18	-
Lighting retrofit	$128	0.4%	798	-	
Total Savings	**$950**	35.8%	5,549	18	-

Building ECM	Guaranteed Savings	% Total Util. Cost	Guaranteed kWh Saved	kW Saved	Therms Saved
Massasoit Fire Station					
Overhead Door Replacement	$689	9.7%	82	0	489
Boiler Plant Replacement	$814	11.5%	816	1	487
Lighting Retrofit	$208	0.6%	1,293	-	
Total Savings	**$1,710**	24.1%	2,191	1	976

Building ECM	Guaranteed Savings	% Total Util. Cost	Guaranteed kWh Saved	kW Saved	Therms Saved
Transfer Station					
Heat Pump for Offices at Maint Bldg	$1,441	13.7%	9,889	15	(124)
Over Head Doors at Maint Bldg	$868		(7)	(0)	630
Lighting Retrofit for all buildings	$1,280	12.1%	7,958	-	
Total Savings	**$3,589**	34.0%	17,840	15	505

Building ECM	Guaranteed Savings	% Total Util. Cost	Guaranteed kWh Saved	kW Saved	Therms Saved
Main Street Fire Station					
Boiler Replacement	$711				515
Lighting Retrofit	$157	0.4%	978	-	
Building Envelope Improvements	$169		0	0	123
Total Savings	**$1,038**	25.2%	978	-	638

Building	Guaranteed	% Total	Guaranteed kWh	kW	Therms

ECM	Savings	Util. Cost	Saved	Saved	Saved
WWTP					
Lighting Retrofit	$1,280		7,958	-	-
Building Envelope Improvements	$508		0	0	368.2
Total Savings	**$1,789**		7,958	-	368
Building ECM	**Guaranteed Savings**	**% Total Util. Cost**	**Guaranteed kWh Saved**	**kW Saved**	**Therms Saved**
Police Station					
Building Envelope Improvements	$407		0	0	295
Total Savings	**$407**	3.9%	-	-	295
Building ECM	**Guaranteed Savings**	**% Total Util. Cost**	**Guaranteed kWh Saved**	**kW Saved**	**Therms Saved**
Animal Shelter					
Lighting Retrofit	$125	0.4%	778	-	
Total Savings	**$125**	1.2%	778	-	-
Building ECM	**Guaranteed Savings**	**% Total Util. Cost**	**Guaranteed kWh Saved**	**kW Saved**	**Therms Saved**
Recreation Center					
Lighting Retrofit	$349	1.0%	2,167	-	-
Building Envelope Improvements	$169		0	0	123
Total Savings	**$518**	4.9%	2,167	-	123
Building ECM	**Guaranteed Savings**	**% Total Util. Cost**	**Guaranteed kWh Saved**	**kW Saved**	**Therms Saved**
Child Care Center					
Lighting Retrofit	$373	1.0%	2,318	-	
Total Savings	**$373**	3.5%	2,318	-	-
Grand Total / Avg.	**$ 74,053**	**28%**	**239,691**	**148**	**26,686**

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ECM: New Air Handling Units and Unit Ventilators

Trane proposes to replace the existing old, inefficient Heating, Ventilating, and Air Conditioning (HVAC) equipment and controls with new units at the following Town of Marshfield Public School Buildings: Marshfield High School, South River Elementary School, Daniel Webster Elementary School, and Eames Way Elementary School

The majority of the HVAC equipment in the above-mentioned facilities is more than 40 years old and past its useful life. Additionally, all of the above-mentioned buildings, except for the High School, use their original, inefficient, pneumatic controls. The High School uses a combination of pneumatic and electronic controls for the HVAC equipment.

The HVAC systems at the High School served by RTU 1, RTU 2, and Administrative AHU will be converted from the older multi-zone technology to the new Variable Air Volume (VAV) technology, which will produce significant savings from decreased fan operation and the inherent simultaneous heating and cooling of multi-zone technology. Presently, Trane is not recommending the replacement of the air-handling units that serve the shop areas in the high school, since facility personnel do not use them. For Senior Center, Trane is proposing to replace existing air handling units and associated condensing units with variable speed air handling units with 20 SEER condensing units.

Trane proposes to replace the following list of equipment:

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School	Unit	Qty	Area Served
High school	69 Gym Unit above Clinic	1	Gym
High school	73 Gym Unit Electrical Rm	1	Gym
High school	Library Unit 1 RM 224 Pent House	1	Library
High school	Library Unit 2 RM 224 Pent House	1	Administration
High school	69 Locker Room unit Pump Room	1	Boys Locker Room
High school	73 Locker Room unit Pump Room	1	Girls Locker Room
High school	Floor 2 Unit 1	1	RM 232
High school	Floor 2 Unit 2	1	RM 226
High school	H & V Unit	1	Athletic Director Office
High school	H & V Unit	1	Half of the Girl's Locker room
High school	Auto Shop Unit	1	Metal Shop Unit
High school	Metal Shop Unit	1	Metal Shop
High school	Café Unit 1	1	Kitchen
High school	Café Unit 2	1	Café
High school	RTU 1	1	Class Rooms
High school	RTU 2	1	Class Rooms
High School	Unit Ventilators	55	Class rooms
High School	Class room Exhaust Ventilators	30	Class rooms

South River	Gym AHU	1	Gym
South River	Café AHU	1	Café
South River	Arts Room AHU	1	Art Room
South River	Computer Room AHU	1	Computer Room
South River	Unit Ventilators	27	Class rooms
Eames Way	Café AHU	1	Café
Eames Way	Kitchen AHU	1	Kitchen
Eames Way	Unit Ventilators	22	Class rooms and Gym
Daniel Webster	Café AHU	1	Café
Daniel Webster	Primary Activity Room AHU	1	Primary Activity Room
Daniel Webster	Gym AHU	1	Gym
Daniel Webster	Unit Ventilators	28	Class rooms and Gym
Senior Center	Air Handling Units	9	

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ECM: VAV Conversion at Town Hall

The existing Heating, Ventilating, and Air Conditioning (HVAC) system at the Town Hall is more than 30 years old and comprised of individual Packaged Terminal Air Conditioning (PTAC) units, central air handling units, and makeup air units. In its more than 30 years of occupancy, the building interior has gone through several modifications, but no modifications have been made to the HVAC systems. This has resulted in temperature zoning issues and, according to facility personnel, areas have become uncomfortable hot and cold, which leads to a loss of worker productivity.

Trane proposes to convert the existing HVAC system into a Variable Air Volume (VAV) system. The new system will include one central air handling unit, three new condensing boilers, and approximately forty five (45) VAV boxes. The new air-handling unit will be equipped with a variable frequency drive, so that the supply air fan motor will consume energy proportional to the heating requirements of the building. In addition, the new VAV system will provide temperature control in individual spaces, which will resolve the existing temperature zoning issues.

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ECM: Hot Water Boiler Replacement

Trane proposes to install new Viessmann gas-fired, high-efficiency, condensing, hot water boilers in the following Town of Marshfield facilities: Town Hall, South River Fire Station, Main Street Fire Station, Massasoit Fire Station, Senior Center, Daniel Webster Elementary, and Furnace Brook Middle School. The proposed boilers have a thermal efficiency of approximately 95%, but vary slightly depending on the model. For all of the buildings mentioned above, except the Furnace Brook Middle School, Trane is proposing to install wall-mounted, modular boiler systems, similar to that pictured on the right. A modular boiler system takes up a smaller footprint than a traditional boiler system (since the boilers are mounted on the wall) and saves considerable energy over a traditional fire-tube boiler. The combustion efficiencies with modular boilers are generally higher than their fire-tube counterparts, but due to the modular system design and advanced microprocessor controls, the skin (or jacket) losses of the modular boilers are also less than their fire-tube counter parts. For fire-tube boilers, the skin losses are constant, regardless of the required heating load. But with a modular system design, the wall-mounted boilers only produce skin losses when the boilers are firing – making the skin losses proportional to the building heating load, and thus a better system design for low-load conditions.

For larger buildings, with larger heating requirements, such as the Furnace Brook Middle School, a modular system design is not cost effective due to the number of modules required. In this instance an ultra high efficiency, condensing, fire-tube boiler with a fully modulating burner assembly is the best application. In fact, the thermal efficiency on this proposed boiler is slightly better than the wall-mounted modular boilers mentioned above. The table below provides a summary of the new, proposed boiler systems at the above-mentioned buildings.

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Building Name	Proposed Boiler				
	Make	Model	Qty	Approx. MBH Capacity Each	Thermal Efficiency / AFUE
Town Hall	Viessmann	Vitoden WB2B	2	350	95%
South River Fire	Viessmann	Vitoden WB2B	3	350	95%
Massasoit Fire	Viessmann	Vitoden WB2	1	150	95%
Main Street Fire	Viessmann	Vitoden WB2	1	150	95%
Senior Center	Viessmann	Vitoden WB2B	2	275	95%
Daniel Webster Elementary	Viessmann	Vitoden WB2B	3	350	95%
Furnace Brook Middle School	Viessmann	Vitocrossal CT3	1	3,300	96%

All of the boilers specified above are "condensing." Condensing boilers work on the principle of recovering as much as possible of the waste heat, which is normally rejected to the atmosphere from the flue of a conventional (non-condensing) boiler. This is accomplished by using an extra-large heat exchanger, which maximizes heat transfer from the burner, as well as recovering useful heat, which would normally be lost with the flue gases.

When in condensing mode (for condensing boilers do not condense all the time), the flue gases give up their latent heat which is then recovered by the heat exchanger within the boiler. As a result, the temperature of the gases exiting the flue of a condensing boiler is typically 120-140°F compared with 250-350°F in a current non-condensing boiler. At the same time, an amount of water or "condensate" is produced.

A condensing boiler will always have a better operating efficiency than a conventional non-condensing one, due to its larger and more efficient heat exchanger.

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ECM: Steam Boiler Replacement

Trane proposes to install new H.B. Smith Series 28HE high efficiency, gas-fired, steam boilers in the following Town of Marshfield facilities: South River Elementary School, Eames Way Elementary School, and Martinson Elementary School. The proposed boilers have a thermal efficiency of approximately 83%, but vary slightly depending upon the model. With this level of thermal efficiency in a steam boiler, the steam systems at the above-mentioned facilities can heat the buildings in a cost-competitive manner, compared to newer, hot-water systems.

The H.B. Smith Series 28HE boilers have:

- Larger heat transfer surfaces with cast-in heat transfer pins for maximum thermal efficiency
- Orotund steam chest design provides improved internal circulation and drier steam for enhanced performance
- Exact alignment of boiler sections allows for a continuous ceramic rope seal and cast-in smoke hood for reduced operational noise

The table below provides a summary of the new, proposed boiler systems at the above-mentioned buildings.

Building Name	Proposed Boiler				
	Make	Model	Qty	Approx. BHP Capacity Each	Thermal Efficiency
South River Elementary School	H.B. Smith	28HE-S-7	2	50	82.5%
Eames Way Elementary School	H.B. Smith	28HE-S-7	2	50	82.5%
Martinson Elementary School	H.B. Smith	28HE-S-13	2	100	83.0%

ECM: Existing Energy Management System (EMS) Upgrades

Existing Systems Description

The existing automatic temperature control systems serving the Town of Marshfield facilities range considerably in type and age. The following table summarizes these systems by building:

Daniel Webster Elementary	Pneumatic/Electric
South River Elementary	Pneumatic/Electric
Eames Way Elementary	Pneumatic/Electric
Governor Winslow Elementary	Pneumatic/Electric
Martinson Elementary	Direct Digital Control (DDC, Invensys)
Furnace Brook MS	Direct Digital Control (DDC, ALC)
High School	Pneumatic & DDC (partial - American Automatrix)
Town Hall	Electric
Library	Electric
Senior Center	Electric
Police Station	Electric (undergoing updating)
Fire Station (South River)	Direct Digital Control (partial – JCI)
Fire Station (Old Main)	Electric
Fire Station (Massasoit)	Electric
DPW Garage	Electric

The smaller facilities (Animal Shelter, Harbormasters Office, etc.) are largely controlled through electric-type controls such as programmable thermostats, line-voltage thermostats, and a small number of electro-mechanical time clocks.

The pneumatic control systems in the elementary schools were installed when the buildings were constructed. These systems typically consists of an air compressor, an air dryer, a compressed air distribution system including a combination of copper and poly-tubing as well as the pneumatically operated controllers, thermostats, valve and damper actuators, etc., required to control the associated HVAC equipment. This type of system is dated and is no longer used in new school construction.

The most up-to-date control system may be found at the Furnace Brook Middle School. This system is a "direct digital control" system, or "DDC" system and consists of a network of small microprocessor-based controllers that operate the HVAC equipment serving the building. In turn, these individual controllers are networked to an "operators' workstation" (OWS) that serves as a graphics-based user interface to the control system. The building operator may view the status of equipment, change set points, and schedule the operation of equipment and the like by using this workstation.

A similar system, though different manufacturer, has been installed at the High School, however, only selected areas and equipment have been converted to operate using DDC technology. At Martinson

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Elementary, a DDC system was installed during the renovation of the facility in 1999 (manufactured by Invensys). The user interface is now dated.

Recommended Replacement/Upgrade Options

Ideally, DDC technology would be implemented in all facilities. This approach may be justified either through energy cost savings or by virtue of the fact that existing control systems may simply be at the end of their useful service life and require replacement.

As the age, use, size, and condition of the HVAC equipment and associated control systems serving these facilities differs, the specific approach to each building will necessarily vary. These options may be divided into four general categories, which are described in more detail below:

- Full Replacement (schools with existing pneumatic controls or facilities with dated HVAC equipment);
- Modification of Existing: (existing Middle School DDC system);
- Upgrade/Expansion of Existing (High School and Martinson);
- "Scope Limited" Replacement (Library, Senior Center, DPW Garage).

The option to replace an existing control system is largely associated with replacement of selected HVAC equipment as well. For example, in an ECM described elsewhere in this report, we recommend that the existing unit ventilators at Eames Way Elementary (among others) be replaced. The new unit ventilators may be ordered with a "factory-installed" direct digital controller and all associated control valves, sensors, damper actuators, etc., would be included in this "factory-packaged" option. These DDC controllers would then be networked together with any required field-installed controllers (for pump or boiler control, as an example) into a full building automation system with an operators' workstation serving as the interface to the new system.

The option to "modify" an existing DDC system applies to the Furnace Brook Middle School. This system is relatively new and no replacement is warranted. However, for selected ECMs, such as the installation of variable speed drives and CO_2 sensors, the control system must be modified to accommodate both the new hardware required as well as the new control strategies that are to be implemented to ensure energy costs are reduced.

The "upgrade/expand" option may apply to both the High School and Martinson Elementary. Regarding the High School, a significant portion of the HVAC equipment serving the facility has been retrofitted with DDC technology under a program designed largely to address indoor air quality issues. If the existing HVAC equipment is to remain in service for the foreseeable future, then this automation system could be expanded to incorporate remaining equipment currently being operated through the existing pneumatic control system or to accommodate recommended ECMs. If, however, the option to replace HVAC equipment serving this building were selected, the existing automation system would be replaced by new controllers that would be "factory-installed" in each new unit ventilator or air-handling unit. A new operators' workstation would be installed as well.

For Martinson, a DDC system was installed during the renovation in 1995? Although this system is currently functional, the operators' workstation is dated and should be upgraded to contemporary standards (Windows-7 based with graphical interface). If the boiler plant is replaced, the new plant would be incorporated into the existing DDC system as well. Ideally, if a single DDC system platform is to be implemented across all facilities, selected controllers at Martinson would be replaced with new controllers manufactured by the DDC vendor upon which the Town has standardized. End devices (valves, damper actuators, etc.) and wiring would be re-used to the extent possible.

The "scope limited" approach refers to a strategy of a measured implementation of direct digital control technology applied to selected systems or equipment serving a facility, particularly the smaller facilities in Town. This approach is recommended for the Library, Senior Center, DPW Garage, Town Hall, and one Fire Station (South River). The intent of the "scope limited" approach is to identify equipment that uses significant amounts of energy and ensure that this equipment is only operated when necessary and maintains comfort or ventilation conditions at acceptable levels. As an example, the operation of a packaged rooftop heating and cooling unit would be placed on a schedule through the DDC system but operate under the "local" controls that were provided with the unit.

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<u>"Town-Wide" Facilities Automation System</u>

The control systems described above are intended to be used to reduce energy costs and improve comfort conditions in individual buildings using direct digital control technology. These systems may continue to operate as individual systems or they may be further networked into a single town-wide building automation system. A key advantage of a town-wide system is that all facilities would be accessible from a single web-based access point, which, in turn, may be accessed from any authorized personal computer running Windows Explorer or other web browser software application.

Among the benefits of a web-accessible town-wide automation system are the following:

- Single-point access to multiple buildings without having to either physically travel to the site or log-in to numerous individual automation systems;
- Allow simultaneous access to building systems for up to thirty users;
- Improve speed of response to maintenance and service call issues;
- Organize alarm priorities and alarm message routing from multiple buildings to appropriate facilities staff;
- Leverage existing manpower levels and training investments with a single common user interface;
- Manage trended historical performance data and compare across buildings;
- Develop and share "best practices" to reduce energy costs or improve maintenance methods between and among facilities operators;
- Quickly implement changes to schedules for special events for specific or across all facilities;
- Allow authorized outside vendors (with appropriate user names/passwords) to remotely access the automation systems to assist in troubleshooting, training, or other suitable tasks.

For the Marshfield project, we would use Trane's "Tracer ES" platform to deploy the town-wide facilities automation system. The Tracer ES application would reside on a server, also provided by Trane. The specifics of integrating the Tracer ES system and individual building automation systems are to be identified in conjunction with Marshfield IT personnel prior to proceeding with this aspect of the project.

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ECM: Automatic Control Valves for High School Boilers

The heating plant for the High School is a hydronic system with major components consisting of four main pumps (two standby), three gas-fired boilers, and an associated three-way bypass valve utilized to reset the supply water temperature set point based on variations in outdoor temperature. The boilers are piped in parallel.

Whenever a pump is operational, there is continuous water flow through the boilers. By installing motorized isolation valves on each boiler, stack, jacket, and off-cycle boiler losses will be minimized.

The suggested motorized valve would be installed in place of an existing manually operated isolation valve located on the return line of each boiler. The actuator is to have a means to manually override the commanded valve position. The new valves would also have built-in end switches that may be used to interlock the burners based on valve position.

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ECM: Boiler Burner Controls for the High School

Trane proposes to install new boiler burner controllers on the three (3) Dietrich gas-fired, hot water boilers at the Marshfield High School.

The existing boilers cycle on and off based upon boiler water temperature set points. This retrofit incorporates a new boiler controller to optimize boiler operation by delaying the boiler start signal. As a result, the boilers will fire for a longer duration, but less frequently, resulting in reduced fuel consumption due to higher effective efficiency during the extended combustion cycle and fewer pre-purge and post-purge air cycles.

Typically, boilers are sized to accommodate the coldest days (5% of the year). During these periods of maximum demand, the burner is constantly on and the boiler is operating at its maximum capacity. At all other times, the burner cycles on and off maintaining a water temperature set point in the boiler. It is during these periods of lesser demand, that the controller will learn the boiler make-up rate and efficiently manage the firing of the boiler. Further, when configured in this manner the boilers often short cycle and therefore cause unnecessary wear and tear on the boiler systems and ancillary equipment that serve them.

The length of the burner's off-cycle is the best measure of total heating demand, or load. In other words, the load is directly related to the time it takes for water in the boiler to drop from its high-limit temperature to its low-limit or "call" setting. When demand is high, these off-cycles are short and the on-cycles are longer. When demand is lower, off-cycles are longer and on-cycles are reduced.

Trane proposes the installation of new Intellidyne boiler controllers for each of the boilers listed above. When installed on a new or existing gas burner, these controllers reduce fuel consumption; wear on parts, flue emissions, and electrical usage. The device, which is a microprocessor based computer, constantly monitors the demand on the boiler by assimilating all factors affecting a building's heating requirements, including occupancy, climate, wind chill, solar gain, type of building, and many others. Most other energy saving devices only consider outdoor temperature. With this information, the controller then calculates the optimum time between off and on cycles and controls burner ignitions accordingly.

A heating system must be able to provide acceptable comfort at the lowest anticipated outdoor temperature. In the U.S. and abroad, most commercial boilers have a heating capacity between 1.5 to 2 times larger than that needed to maintain the facility's temperature on those extreme days. Due to this over-sizing of the boiler, the burner will cycle on and off continuously. Even on boilers with proportional controls, once the heating load goes below the burner's low-fire point, the burner will cycle on and off to prevent overheating of the system water.

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The controller saves energy by adjusting the burner run pattern to match the system's "heat load." Its action is similar to the industry-accepted method of "outdoor-air temperature reset control," but does not require an outdoor air temperature sensor, or the need to profile the building in order to adjust the reset controller properly. The controller determines the "heat load" by using an easily installed strap-on temperature sensor that monitors the boilers out-flow water temperature and the rate that this temperature is changing. The controller increases "system efficiency" thus, the heating system uses less fuel to generate the same amount of heat. This is done by dynamically changing the aquastat's effective dead-band based upon the measured "heating load." This causes the average water temperature to be varied (depending upon the measured load), and is accomplished by extending the burner's "off-time." Extending the "off-time" also results in longer burns that are more efficient and a reduction in burner on/off cycling. This ECM improves the fuel utilization of heating systems by supplementing the antiquated on/off control action of the aquastat with the analysis and control capabilities of a computer.

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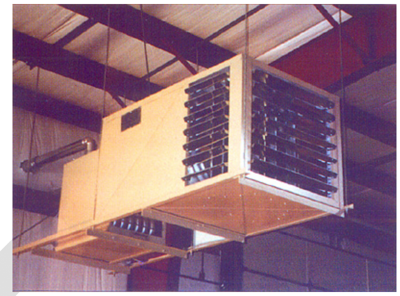
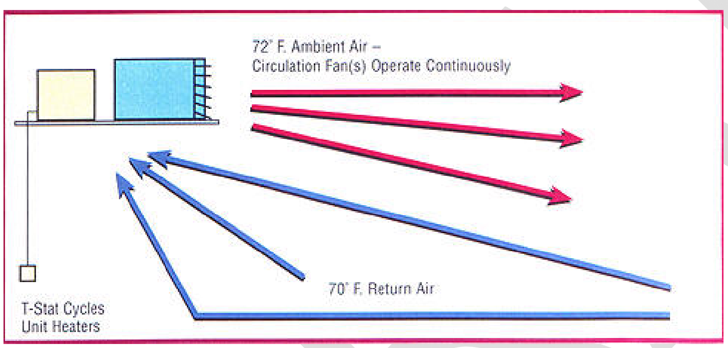
ECM: Air Rotation Units for the DPW Garage



Trane proposes to install two (2) new air rotation units in the DPW Garage (Air Energy Systems Model ER-142-310 with Modine PTC310 Heating Sections). These new air rotation units (similar pictured to the right) are comprised of two sections – a 93%, high-efficiency unit heater section and an air circulation fan section in front. The air circulation fan runs continuously to help maintain a constant internal building temperature from floor to ceiling. This system operates similar to de-stratification fans. It is not uncommon for the temperature to differ 20º F from floor to ceiling in taller spaces, since warm air is less dense and rises above the cold air. Since heating unit controlling thermostats are typically located at eye level, the thermostats will sense the colder air near the floor and not the hot air near the ceiling. This situation results in over-heating the air near the ceiling just to get the air near the thermostat to a comfortable level, thus wasting valuable energy. By using an air rotation unit, the warmer air near the ceiling is pushed down towards the floor, making the air at the thermostat level comfortable, all the while running the unit heater less. The diagram to the left depicts this scenario.



In addition to the air rotation effects, the new Modine PTC310 unit heaters are up to 15% more thermally efficient than standard unit heaters, producing even more savings during the heating season (winter time).

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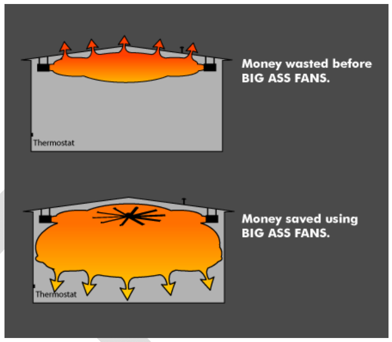
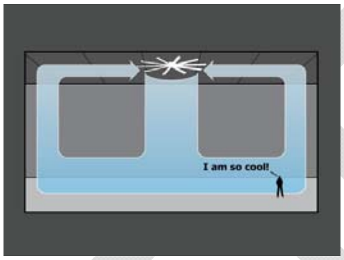
ECM: De-stratification Fans



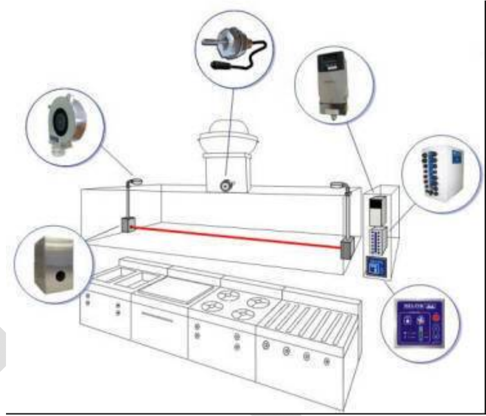
Trane proposes to install High Volume / Low Speed (HVLS) de-stratification fans in the High School Cafeteria (Big Ass Fan Model # EL161103). The HVLS de-stratification fans that Trane is proposing move a lot of air with their size (16 ft. diameter), not with the speed of the blades. Since the blades move slower, less energy will be consumed by the fan motor, when compared to smaller blade fans that need to move the same amount of air.

The cafeteria has a ceiling height in excess of 20 ft. It is not uncommon for the temperature to differ 20º F from floor to ceiling in taller spaces, since warm air is less dense and rises above the cold air. Since heating unit controlling thermostats are typically located at eye level, the thermostats will sense the colder air near the floor and not the hot air near the ceiling. This situation results in over-heating the air near the ceiling just to get the air near the thermostat to a comfortable level, thus wasting valuable energy. By using a HVLS de-stratification fan, the warmer air near the ceiling is pushed down towards the floor, making the air at the thermostat level comfortable, all the while running the heating equipment less. The diagram to the right depicts the pre- and post-retrofit scenarios.



In addition to the above mentioned heating season (winter time) savings, HVLS fans can provide summer time cooling. The steady, gentle breeze from the HVLS fans “cools” by increasing the rate at which perspiration is evaporated from the skin’s surface, making the surrounding area feel up to 8 - 16º F cooler.

ECM: Kitchen Hood Exhaust Controls



Trane proposes to install Kitchen Hood Controls at the following Town of Marshfield Municipal and School Buildings: Marshfield High School, Furnace Brook Middle School, Eames Way Elementary School, Martinson Elementary School, South River Elementary School, Daniel Webster Elementary School, and Senior Center

The kitchens for the cafeterias in the schools remain occupied from 6:00 AM to 2:00 PM. The kitchen hood exhaust fans at the schools operate at 100% capacity all day long even during idle, non-cooking periods. Trane proposes to install new kitchen hood exhaust controls. The controls are extremely simple to operate. In fact, the only noticeable difference in kitchens equipped with the controls is a blue keypad on the front of the hood. At the beginning of each day, the EMS will turn on the controls and that is it. The hood lights turn on and the fans reach a preset minimum speed of between 10 and 50 percent. The fan speed increases based on exhaust air temperature. During actual cooking, the speed increases to 100 percent until smoke and heat are removed. The control will also send a signal to the kitchen AHU to modulate the speed on the supply fan drive based on the exhaust air quantity.

Reduced Energy Costs
The new controls optimize energy efficiency by reducing the exhaust and make-up fan speeds.

Optimum Kitchen Comfort
These controls reduce the supply of hot and humid make-up air in the summer and frigid make-up air in the winter during idle cooking periods. They can also act as an economizer when indoor and outdoor conditions are right for free cooling. Finally, the controls reduce hood noise in the kitchen by up to 90 percent when the fans slow down.

Improved Fire Safety
Controls can improve fire safety by monitoring the exhaust air temperature. If the temperature approaches the fusible link rating of the fire suppression system, an alarm can sound and/or the cooking appliances can be shut down.

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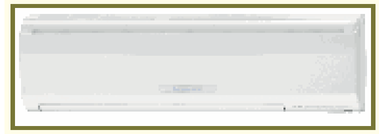
ECM: New Heat Pumps

Trane is proposing to replace the existing electric strip heat and window AC units that serve the two (2) office areas in the Maintenance Building of the Solid Waste Transfer Station, as well as the Harbor Master Office Building, with a new Mitsubishi air-to-air, ductless, heat pump system. The new air-to-air heat pump system will provide both the heating and cooling that the office area will require, by using the same piece of equipment. The new heat pump system will have a cooling efficiency of 17.0 EER, almost twice as efficient as the existing window AC units, and a heating system efficiency of 8.2 HSPF, which is almost two and a half times more efficient than the existing electric strip heat.



Sleek and compact indoor unit

Compact and powerful outdoor unit

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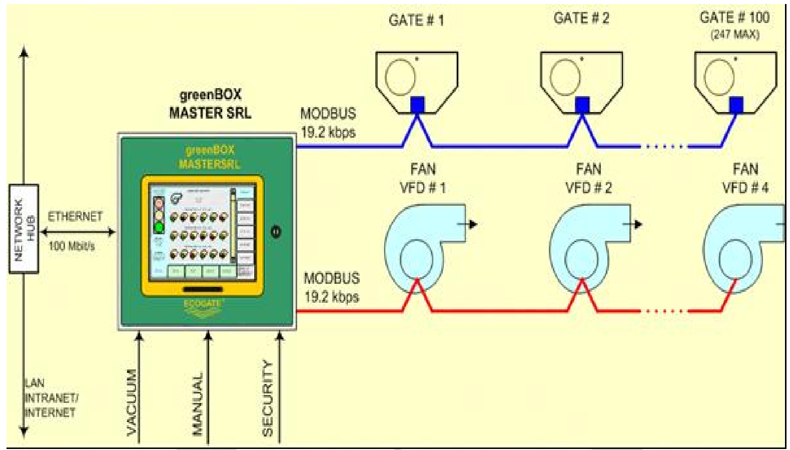
ECM: Dust Collector System Controls



The dust collector for the woodshop in the High School utilizes a 15-horsepower fan that runs approximately 1,000 hours per year at 100% load. There are seven (7) gates on the dust collector system that connect the dust collector system to the wood working equipment. None of these connections (drops) have a manual blast gate. Therefore, the volume of air that the dust collector must handle remains constant even though only a small percentage of the machines or sweeps are in use at any given time.

The actual load will vary continuously throughout the day. For most of the time, it will be significantly less than 100%. In addition, during the lunch break the dust collector can be shut down.

Trane recommends installing new automatic controls on the dust collection system. New automatic blast gates will be installed with controls to interlock them with the individual pieces of equipment (there will be a delay between the equipment turning off and the gate closing to ensure that the equipment stays clean). Once the automatic blast gates are installed, a Variable Frequency Drive (VFD) can be installed on the 15hp fan. As blast gates open and close throughout the day, the fan speed will increase and decrease to match the fan horsepower to the required CFM. Finally, time controls will be installed to ensure that the entire dust collection system shuts down during unoccupied periods.

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ECM: New HW Pump Motors and VFDs

The High School, Furnace Brook Middle School, Daniel Webster Elementary School, and the South River Fire Station use constant volume pumps to distribute space heating hot water during the heating season. The terminal devices (unit ventilators, air handlers, fin-tube radiation, etc.) use two-way valves to control the flow of heating hot water and, hence, the heat provided to the space. When the heating hot water is no longer needed, the two-way valves close. To ensure that the pumps maintain their full flow rate and do not "dead head," there are bypass lines located in the boiler rooms of each of the buildings listed above, which will allow the heating hot water to bypass the terminal devices. So in this system configuration the pumps will always run at full power, even when the space heating hot water is not required by the terminal devices.

Trane proposes to replace the existing non-premium efficiency hot water pump motors, with new premium-efficiency units (existing premium efficiency units will remain). Additionally, Trane proposes to install Variable Frequency Drives (VFDs) to control the pump motors. The VFDs will allow the pump motors to modulate the hot water flow in proportion to the requirements of the terminal devices. The VFDs will operate based on a system differential pressure, so as the two-way valves at the terminal devices close, the system pressure will increase and the VFD will slow the speed of the motor. The VFDs can slow the speed of the motor to as low as 25% of its maximum. During times of low heating demand (fall and spring), the existing boiler room bypass lines will still be used to maintain the 25% minimum speed of the pump motors.

The proposed pump motor replacements and Variable Frequency Drive motor control will result in significant energy savings. The scope of work for the effected buildings is below:

Installation of Premium Efficiency Motors on the following pumps:

Building	System	Size (HP)	Quantity
High School	Space Heating	10	3
D. Webster	Space Heating	7.5	2

Installation of Variable Frequency Drives on the following pump motors:

Building	System	Size (HP)	Quantity
High School	Space Heating	10	4
Middle	Space	30	2

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School	Heating		
D. Webster	Space Heating	7.5	2
S. River Fire	Space Heating	2	2

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ECM: Walk-in Cooler and Freezer Controls

During the detailed audit, it was noted that the many of the walk-in refrigerators and freezers at the Marshfield Public School buildings do not utilize the latest control technologies. Retrofitting these units will result in significant energy savings.

The walk-in refrigerators and freezers in the Marshfield Public School buildings were analyzed for the following possible retrofits:

- Retrofit #1: Evaporator fans will be cycled off when the refrigerant supply line temperature rises above the set point.
- Retrofit #2: Replacing the existing, older temperature controls with new, fast-acting, direct digital controls.
- Retrofit #3: Replace the existing AC induction evaporator fan motors with new Electronically Commutated Motors (ECM).
- Retrofit #4: New controls for the electric defrost
- Retrofit #5: Automatic door closer
- Retrofit #6: Control of door and frame heaters based on the dew point temperature.
- Retrofit #7: Night set-back controls on novelty / vendor coolers

The table below summarizes the proposed scope of work:

Building	Affected Walk-in Unit Qty		Applicable Retrofit Codes
	Refrigerator	Freezer	
High School	1	1	1, 2, 3, 4, 6, 7
Middle School	1	1	1, 2, 3, 4, 6
Martinson Elementary	2	0	1, 2, 4
D. Webster Elementary	2	0	1, 2, 4
Eames Way Elementary	2	1	1, 2, 4, 6
South River Elementary	1	1	1, 2, 4, 6

ECM: Domestic Water Conservation

Most of the existing domestic water fixtures at the Town of Marshfield Municipal and School Buildings are older, less efficient units in need of replacement. Many of the toilet fixtures are the older 3.5 Gallons per Flush (GPF) type and many of the urinals use the older 1.5 GPF flushometer valves. Additionally it was noted that many of the sink aerators (flow restrictors) and showerheads were the less efficient, high volume units that come standard with the plumbing fixtures.

Trane proposes to replace the existing 3.5 GPF toilets with new 1.6 GPF toilet china and associated plumbing. On the urinals, Trane proposes to replace the existing 1.5 GPF flushometer valves with new 1.0 GPF flushometer valves. On the sink aerators, Trane proposes to replace the existing units with 0.5 – 1.5 Gallon per Minute (GPM), tamper resistant sink aerators (the GPM flow rate will be dependent upon the sink type, location, and usage). Additionally, four (4) sink faucets will need to be completely replaced with new metering units. And finally, on the showerheads, Trane proposes to replace the existing units with new 2.0 GPM showerheads. A summary table is provided below for the proposed retrofits at the individual buildings. Please note that some high-flow, inefficient, domestic fixtures may not be included in the retrofit due to a lack of use, based on interviews with facility personnel.

	QTY	QTY	QTY	QTY	QTY	QTY
BUILDING NAME	TOILET BOWL & VALVE	URINAL FLUSH VALVE	URINAL FLUSH VALVE REBUILD KIT	FAUCET RESTRICTOR (AERATOR)	NEW FAUCET	SHOWER HEAD
Fire Station Massapoit	2	0	0	6	0	2
Ocean Hill Recreation Center	0	0	0	5	0	1
Highway Department Garage	0	0	0	5	0	0
Town Hall	9	2	0	9	0	0
Daniel Webster E.S.	27	13	0	52	2	0
South River E.S.	41	6	12	69	2	1
Eames Way E.S.	22	7	0	43	0	0
Marshfield H.S.	60	27	0	133	0	3
TOTALS	**161**	**55**	**12**	**322**	**4**	**7**

All of these retrofits, above, conserve water and sewer utility consumption, but the retrofits to the sink aerators and showerheads help reduce domestic hot water consumption, so there are associated thermal savings.

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ECM: Building Envelope Improvements

Trane performed a detailed building envelope inspection using a smoke puffer to identify the location and severity of air leakage paths (infiltration) into the building. The air movement is caused by pressure differences between the outside and inside the building, due to wind, chimney (stack) effect, and mechanical systems.

In additional to the infiltration analysis, Trane also inspected the roof, wall, window, and door construction for possible retrofit / replacement with more energy efficient materials.

In summary, many of the exterior and interior (separating conditioned and non-conditioned spaces) doors were found to be in need of weather-striping retrofits. Additionally, various buildings required the roof / wall joint to be sealed. The findings of the detailed survey are below:

Daniel Webster Elementary School

Doors

- Weather-strip five (5) single exterior doors. (ground floor)
- Weather-strip two (2) double exterior doors. (ground floor)
- Weather-strip two (2) double exterior doors. (bottoms only)
- Weather-strip one (1) interior boiler room door.

Windows

Windows are original single pane steel framed units. The following retrofits will only be done if the window replacement ECM is not performed.

- Weather-strip two (2) – 4' x 3' awnings. (gym)
- Seal shut two (2) – 4' x 3' awnings. (gym)
- Seal window perimeters – 200' (gym)
- Weather-strip ninety six (96) – 4' x 1.5' awnings.
- Weather-strip one hundred eighty three (183) – 4' x 1.5' hoppers.
- Seal 7,340 ft. of window glazing.
- Seal shut five (5) – 4' x 3' steel awnings. (bathrooms)

Miscellaneous

- Seal perimeters of thirteen (13) pipe penetrations. (boiler room)
- Seal four (4) window AC unit penetrations

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<u>*Town Hall*</u>

Doors

- Weather-strip two (2) double exterior doors. (ground floor)
- Weather-strip one (1) double interior boiler room door. (2nd floor)

Windows

- Weather-strip eighty (80) – 3' x 1.5' steel hoppers

<u>*South River Elementary School*</u>

Doors

- Weather-strip five (5) double exterior doors. (ground floor)
- Weather-strip eight (8) single exterior doors. (basement)
- Weather-strip one (1) single interior boiler room door.

<u>*Furnace Brook Middle School*</u>

Doors

- Weather-strip seven (7) double exterior doors. (ground floor)
- Weather-strip five (5) single exterior doors. (ground floor)
- Weather-strip eighteen (18) exterior doors. (bottoms only)
- Weather-strip one (1) single interior boiler room door.

<u>*Martinson Elementary School*</u>

Doors

- Weather-strip eleven (11) double exterior doors. (ground floor)
- Weather-strip ten (10) single exterior doors. (ground floor)
- Weather-strip three (3) double exterior doors. (courtyards)
- Weather-strip seven (7) single exterior doors. (courtyards)
- Weather-strip two (2) single interior boiler room doors.
- Weather-strip one (1) single interior electric room door.

Roof / Wall

- Seal the wall to the wood roof deck. Total 1,883 ft.
- Seal the wall to the roof with caulking. Total 210 ft.

Miscellaneous

- Seal perimeters of six (6) pipe penetrations. (boiler room)

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High School

Doors

- Weather-strip nineteen (19) double exterior doors. (1st floor)
- Weather-strip one (1) single exterior door. (ground floor)
- Weather-strip four (4) single exterior doors. (1st floor)
- Weather-strip four (4) double exterior doors. (courtyards)
- Weather-strip one (1) single exterior door. (courtyards)
- Weather-strip one (1) single interior boiler room door.

Windows

Windows are original single pane steel framed units

- Weather-strip two hundred nineteen (219) – 3.5' x 1.5' hoppers.
- Weather-strip twenty seven (27) – 4' x 2' hoppers.
- Weather-strip nine (9) – 4' x 1.5' hoppers.

Roof / Wall

- Seal the wall to the steel roof deck. Total 375 ft. (2nd floor math wing)
- Seal the wall to the steel roof deck. Total 630 ft. (2nd floor language wing)

Fire Station – South River Street

Doors

- Weather-strip two (2) single exterior doors. (ground floor)
- Weather-strip one (1) single exterior door. (roof)
- Weather-strip four (4) single interior doors. (2 stairwells, alarm room, and EMS)

Miscellaneous

- Seal wood to the concrete block wall near the overhead doors. Total 336 ft. (interior)

Highway Department Garage

Doors

- Weather-strip five (5) single exterior doors. (ground floor)
- Weather-strip one (1) single interior fan room door.

Miscellaneous

- Repair various areas of insulation on the walls and ceiling.
- Repair 3' x 4.5' hole beside the front overhead door.
- Repair concrete and install threshold at one of the single exterior doors.

Ventress Memorial Library

Doors

- Weather-strip four (4) single exterior doors. (ground floor)
- Weather-strip one (1) double exterior door. (ground floor)
- Seal shut one (1) – 8' x 8' overhead door.

Windows

- Seal shut four (4) – 2’ x 3’ steel hoppers. (2nd floor)
- Seal perimeter of the window in the history room. Total 70 ft.

Roof / Wall

- Seal the wall to the steel roof deck. Total 105 ft. (2nd floor storage)

Miscellaneous

- Seal two (2) - 5’ x 16’ louvers in the wall. (interior 2nd floor)

Eames Way Elementary School

Doors

- Weather-strip eight (8) double exterior doors. (ground floor)
- Weather-strip twenty (20) single exterior doors. (ground floor)
- Weather-strip one (1) single interior boiler room door.

Windows

Windows are original single pane steel framed units. The retrofits listed below will only be performed if the window replacement ECM is not done.

- Weather-strip sixty seven (67) – 4’ x 1.5’ hoppers.
- Weather-strip one (1) – 5’ x 1.5’ hopper.
- Weather-strip four (4) – 5’ x 1.5’ hoppers. (gym)
- Seal 4,726 ft. of window glazing.
- Seal perimeters of twenty five (25) – 4’ x 8’ window systems. Total 600 ft.

Roof / Wall

- Seal the wall to the wood roof deck at soffit area. Total 120 ft.
- Seal the wall to the wood roof deck. Total 220 ft.

Recreation Center

Doors

- Weather-strip three (3) single exterior doors. (ground floor)
- Weather-strip one (1) single exterior door. (2nd floor)

Attic

- Install an attic hatch
- Insulate, weather-strip, and latch the hatch
- Add R-20 blown in cellulose to approx. 800 sq. ft.
- Seal perimeter of the furnace vent.

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Senior Center

Doors

- Weather-strip one (1) double front exterior door. (center only)

Fire Station – Old Main Street

Doors

- Weather-strip one (1) single interior attic door.
- Weather-strip two (2) single exterior doors.

Attic

- Add R-40 blown in cellulose to approx. 800 sq. ft.
- Add R-20 to walls of locker room in the attic approx. 300 sq. ft.

Fire Station – Massasoit Avenue

Doors

- Weather-strip three (3) single exterior doors.
- Weather-strip two (2) single interior doors.

Attic

- Add R-32 blown in cellulose to approx. 1,080 sq. ft.
- Seal attic access with a prefabricated cover.

Miscellaneous

- Seal cracks in block. Approx. 150 ft.
- Seal block at the old door opening east side. Approx. 50 ft.
- Panel Room – Discard existing insulation, replace with new, and seal walls.

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Police Station

Doors

- Weather-strip six (6) single exterior doors.
- Weather-strip one (1) single interior boiler room door.
- Weather-strip three (3) – 10' x 10' overhead doors. (bottoms only)
- Seal existing weather-stripping of three (3) – 10' x 10' overhead doors.

Attic

- Seal perimeter of the chimney.
- Seal perimeters of the ducting.
- Insulate existing ductwork.
- Add R-20 blown in cellulose to approx. 10,575 sq. ft.
- Insulate, weather-strip, and latch the hatch. Total two (2).

School Admin. Building

Doors

- Weather-strip four (4) single exterior doors.
- Weather-strip one (1) double exterior door.
- Weather-strip one (1) single interior boiler room door.

Windows

- New on the second floor
- Weather-strip fourteen (14) - 3.5' x 7' double hung wood framed units.
- Weather-strip two (2) - 3' x 7' double hung wood framed units.
- Seal shut two (2) - 3.5' x 7' double hung wood framed units. (receiving area)

Attic

- Install new hatch cover
- Insulate, weather-strip, and latch the hatch.
- Add R-32 blown in cellulose to approx. 2,000 sq. ft.

Solid Waste Transfer Station

Doors

- Weather-strip one (1) single exterior door. (scale house)
- Weather-strip two (2) single exterior doors. (office and maintenance)
- Weather-strip two (2) – 12' x 14' overhead doors. (office and maintenance)

Miscellaneous

- Seal perimeter of the AC unit in the office. Total 12 ft.

Waste Water Treatment Plant

Doors

- Weather-strip five (5) single exterior doors. (main floor)
- Weather-strip one (1) double exterior door. (main floor)
- Weather-strip one (1) single exterior door. (roof)
- Weather-strip one (1) double interior door. (boiler room)
- Weather-strip one (1) single interior door.

Miscellaneous

- Seal perimeter of the skylight in the maintenance room. Total 70 ft.

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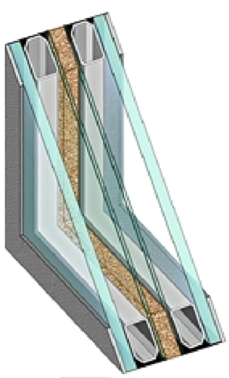
ECM: Window Replacements

During the detailed audit, it was noted that the steel-framed window systems in the Eames Way Elementary School, Governor Winslow Elementary School, and the Daniel Webster Elementary School are past their useful life and in need of replacement. The existing window systems are comprised of single pane glazing with steel frames and some have operable sashes or hoppers. Due to the continuous use over time, the frames have developed gaps, which allows outside air to infiltrate into the building.

The existing glazing is inefficient, with a U-Value of approximately 1.04 Btu/hr•ft²•ºF. This allows a substantial amount of heat to transfer out through the glass during the winter months, and into the space during the summer months. Moreover, this glazing system allows much of the sun's radiant heat to penetrate, making building occupants uncomfortable in perimeter areas.

Trane proposes to replace the existing single-pane window systems with new energy efficient systems. The new window systems will be comprised of new 3mm, annealed, double-pane, low emissivity ("low-e"), argon-filled, high-performance glass with aluminum trim, which will have a U-Value of 0.30 Btu/hr•ft²•ºF.



Implementation of this measure will reduce heat losses in the winter and heat gains in the summer, as well as reduce infiltration rates, thereby producing energy savings all year long. The occupants will benefit from improved comfort, especially when seated near windows. In addition, the new window system will greatly improve the aesthetic appearance of the building. The new windows will also close more completely, adding to the safety and security of the building.

The existing window system will be entirely replaced. The new window systems will be configured with in-fill panels, glazing sections and operable window sashes to fit properly and closely match the existing conditions.

The approximate window area to be replaced is given below for each building:

Building	Masonry Opening Area (ft²)
Governor Winslow Elementary School	4,237
Eames Way Elementary	4,391
Daniel Webster Elementary	6,815

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ECM: Overhead Door Replacements

During the detailed audit, it was noted that many of the overhead doors at the DPW Garage, Massasoit Fire Station, and the South River Fire Station are past their useful life and in need of replacement.

- The construction material layers in many of these doors are separating, leaving the insulation exposed and susceptible to damage.
- The weather-striping on many of these doors is missing.
- Some of the doors show signs of impact, which have warped the doors so that they do not have a weather-tight seal with the ground and/or walls.

Trane proposes to replace these existing overhead doors with new Thermacore Series 592 units. The new Thermacore units have an insulating R-Value of 17.5 and one of the best overall air infiltration ratings in the industry. The overhead door quantity and sizes for each building are below:

DPW Garage

- Size: 14'-2" Wide by 12'-3" High
  - Qty: Two (2)
- Size: 14'-2" Wide by 12'-1" High
  - Qty: Five (5)
- Size: 8'-2" Wide by 8'-1" High
  - Qty: One (1)

Massasoit Fire Station

- Size: 12'-2" Wide by 10'-1" High
  - Qty: Three (3)

South River Fire Station

- Size: 12'-0" Wide by 10'-1" High
  - Qty: Six (6)

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ECM: Computer Network Controls

Currently, a computer energy management system is not installed on the computers located in the facilities owned by the Town of Marshfield. The majority of the computers run year round, wasting energy during unoccupied hours. Trane proposes to install Faronics Power Save Computer Energy Management Software on all one thousand five hundred sixty five (1,565) computers – 1,315 in the school buildings and 250 in the town buildings. Faronics Power Save delivers desktop computer energy management that does not interfere with user or IT needs. Power Save keeps computers running when users need them, accurately determines when computers are inactive to be powered down, and proves its rapid return-on-investment through network-wide power consumption and savings reports. The software has an Audit Tool feature, which can analyze the existing operating characteristics of the computers, as if the software was not present. In addition, compare that to the computer system with the Faronics software fully operational.

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ECM: Interior Lighting System Retrofits

Trane performed a detailed, room-by-room lighting survey of the Town of Marshfield Municipal and School buildings to determine the energy efficiency and lighting improvement opportunities that exist throughout.

An over-view of the scope of work at each building can be found at the end of this section. Below is a summary of the proposed retrofits by building to give an overview of the project.

Type	Total Qty	Town Buildings	High School	Daniel Webster	Eames Elem. School	Winslow Elem. School	Martinson Elem. School	Furnace Middle School	South River Elem. School
Re-Lamp / Re-Ballast (RLRB)	3,821	1,023	823	289	3	3	0	1,073	507
No Retrofit	3,329	519	405	125	399	728	867	360	29
New Fixture	1,218	56	1,009	29	11	0	0	0	113
Occ. Sensor	769	107	147	80	62	43	57	182	91
Reflector	348	117	92	52	0	0	0	80	4
Disconnect	146	12	134	0	0	0	0	0	0
CFL	88	22	0	11	2	0	0	47	6
Exit Sign	26	3	0	10	0	0	0	0	13
	9,745	**1,859**	**2,610**	**596**	**477**	**774**	**924**	**1,742**	**763**

New T8/electronic ballast systems offer the following advantages over conventional fluorescent systems:

- Enhanced lighting performance (color rendering up to 85 CRI, on a scale of 0-100)
- Energy savings
- Silent, flicker-free operation
- Improved lumen maintenance (lamps maintain their brightness better over the life of the lamp)
- Cooler operation
- Five-year warranty
- Excellent reliability

Occupancy Sensors: Motion sensors will be installed to reduce any wasteful energy for lighting when the areas are unoccupied.

Summary Scope of Work

Town Buildings

- Re-Lamp / Re-Ballast existing fixtures with low wattage T8 lamps and high efficient electronic ballasts (ballast factor “low”).
- Replacement of Interior High Bay fixtures with new fluorescent T8 high bay fluorescent fixtures with clear acrylic lens and motion sensors
- Library Indirect HID fixtures will be replaced with new 8’ fluorescent direct / indirect fixtures and utilizing a daylight harvesting control scheme.

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- T8 lamps proposed include F25T8 (25W Lamp) and F28T8 (28W Lamp). F28T8 will be used in fixtures over 4' in length.
- Office areas, restrooms, and storage areas will be controlled with motion sensors.

Daniel Webster Elementary School

- Re-Lamp / Re-Ballast existing fixtures with low wattage T8 lamps and high efficient electronic ballasts (ballast factor "low").
- F28T8 (28W Lamps) will be used in the fixtures.
- Classrooms, offices and storage rooms will be controlled with motion sensors.
- Existing exit signs are a mix of incandescent and LED, the incandescent units will be replaced with LED units.

Eames Elementary School

- A lighting upgrade was conducted 3 years ago.
- The existing fixtures use 30-watt T8 lamps.
- Incandescent / CFL RLM fixtures will be replaced with fluorescent fixtures.
- T8 lamps proposed include F25T8 (25W Lamp) and F28T8 (28W Lamp). F28T8 will be used in fixtures over 4' in length.
- Classrooms, cafeteria, restrooms, storage rooms, and gym will be controlled with motion sensors.

Furnace Brook Middle School

- All existing exit signs are LED.
- The existing fixtures are F32T8 (32W Lamp).
- Re-Lamp / Re-Ballast existing fixtures with low wattage T8 lamps and high efficient electronic ballasts (ballast factor "low").
- Inboard / Outboard switching in the classrooms will remain.
- Convert existing 2x2 2-lamp 6"/U lamps to 2' T8 utilizing a white reflector and high efficient electronic ballasts (ballast factor "normal").
- Classrooms, office areas rest rooms, and storage areas will be controlled with motion sensors.

High School

- School was retrofitted 2 and 4 years ago.
- Wide range of existing designs, T12 (older lamp technology) with sensors in the Math wing to 30W T8 with dual tech sensors in the Science and Art wing classrooms.
- Re-Lamp / Re-Ballast existing fixtures with low wattage T8 lamps and high efficient electronic ballasts (ballast factor "low").
- T8 lamps proposed include F32T8 (32W Lamp) and F28T8 (28W Lamp).
- In some areas, fixtures will be dropped from 11' 6" to 8' to bring the fixtures out of the ceiling coffer.
- Classrooms, office areas, restrooms, and a few hallways will be controlled with motion sensors.

Martinson Elementary School

- Office areas, classrooms, restrooms, and storage areas will be controlled with motion sensors.

Winslow Elementary School

- Office areas, classrooms, restrooms, and storage areas will be controlled with motion sensors.

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South River Elementary School

- Re-Lamp / Re-Ballast existing fixtures with low wattage T8 lamps and high efficient electronic ballasts (ballast factor “low”).
- F28T8 (28W Lamp) will be used in the fixtures.
- Classrooms, offices, and storage rooms will be controlled with motion sensors.
- Existing exit signs are a mix of incandescent and LED, the incandescent units will be replaced with LED units.

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ECM: Exterior Lighting System Retrofits

Manufactured by Appalachian Lighting Systems, An Energy Star Partner

Trane proposes to replace the approximately twelve (12) existing 450 Watt metal halide parking lot light fixtures at the Eames Way Elementary School with new, high efficiency Light-Emitting-Diode (LED) units with occupancy controls. The new LED lights produce a whiter, brighter light (good for public safety), all the while consuming up to 80% less electricity. The LED lights have a life expectancy of 20 years (50,000 hr rated life), which is about 15 times longer than the existing metal halide fixtures. In addition, since LED technology is solid state, it can withstand physical shocks that would shatter conventional lamps. Additionally, LED lights can start instantaneously and flick-free in ambient temperatures ranging from -4º F to 158º F. This instant-start capability makes LED lighting a good candidate for occupancy sensor controls, even for parking lots in colder climates.

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ECM: Replace Water-cooled Condensing Unit for Walk-in Refrigerator with Air-Cooled Unit

Currently the condensing units for walk in refrigerator at Martinson Elementary, Daniel Webster Elementary, and Governor Winslow Elementary uses city water for condensing cycle cooling. The city water cools the refrigerant and drains to the sewer system. The current system of using city water for refrigeration system is wasteful and illegal. Trane proposes to retrofit existing system with an air-cooled condensing unit, which will utilize the ambient air for condensing cycle heat rejection of the refrigeration system.

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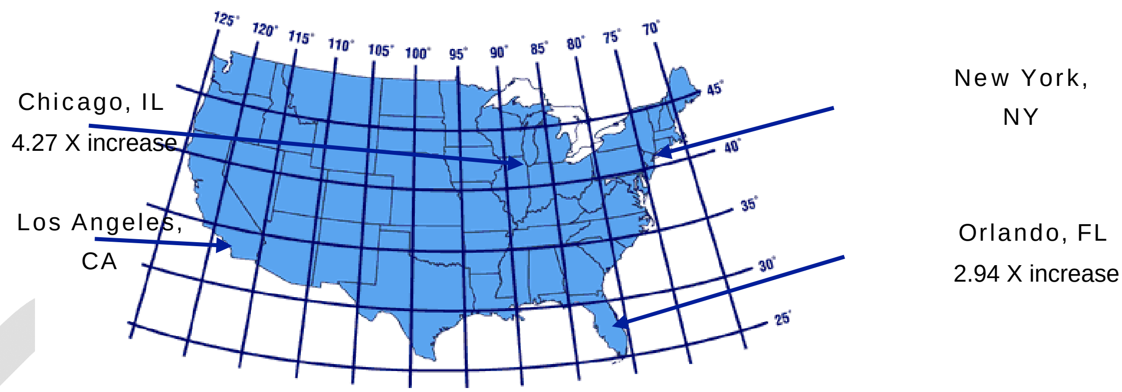
ECM: Solar Tracking Skylights

Trane proposes to replace the existing skylights at Martinson Elementary and Furnace Brook Middle School with new Solar Tracking Skylights. This new skylight technology uses a Global Positioning System (GPS) sensor and a set of angled mirrors on a motorized, rotating axis to follow the sun throughout the day. The system is completely self-contained within the dome structure, pictured to the right – the GPS sensor and the motor used to rotate the mirrors are powered by a small solar photovoltaic cell at the top of the dome. The skylight controls know by its exact location on earth, from the GPS sensor, which way the mirrors need to be positioned to capture the maximum amount of sunlight. For facilities located in the Massachusetts area, the Solar Tracking Skylight can produce in excess of four (4) times the amount of useful light as a standard skylight. The map below depicts the performance of the Solar Tracking Skylight, based on geographic location:



Since the skylights are mostly concentrated in the hallways and gymnasiums of the above-mentioned schools, the lights in these areas can remain off four times longer than with the existing skylights.

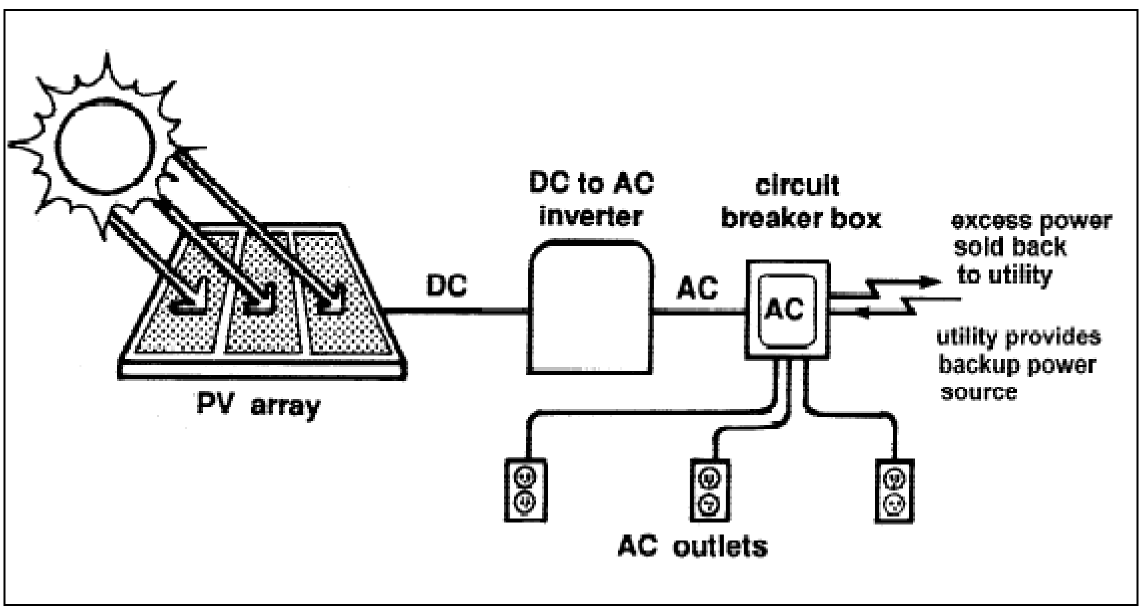
ECM: 25 kW Solar Photovoltaic System

Trane proposes to install a 25kW solar Photo Voltaic (PV) system on the southwest roof of the Town Hall. The PV panels will provide environmentally friendly power for the building, but will not cover the entire electrical load during times of peak demand.

Photovoltaic cells are solid-state electrical devices that convert sunlight into electricity. The photovoltaic cell is composed of thin layers of semiconductor materials, which produce an electric current when exposed to light. Single cells are connected in groups to form a module, and modules are grouped to form an array. The voltage and the current output from the array depend upon how the system is configured. Photovoltaic cells produce Direct Current (DC) electricity, which is the same type of electricity contained in batteries. Most commercial and residential appliances, however, are designed to use Alternating Current (AC) electricity, which is the same type of electricity that is available from a standard wall socket.

When AC current is required, an inverter is added to the photovoltaic system to change the current from DC to AC, but this will incur a 10 to 15 percent loss of power output.

A basic system diagram is below.



Several factors tend to limit the electrical output of the solar PV panels; these include the slope of the surface with respect to the horizontal, occasional snow cover, and bird excrement. These factors are not expected to decrease the system performance to any great extent, however.

The new panels will be installed directly on the existing southwest-facing roof, as depicted in the picture below.

The solar PV system will be "utility interactive" which means that it will operate seamlessly with the electric utility service. The PV system is designed to operate with little or no maintenance. When the sun comes out, the solar PV system turns on automatically and produces high-quality power to run the electrical equipment in the building using the existing wiring. When the solar PV system is producing more electricity than is required by the building, it will automatically send the electricity out to the utility and spin the electric meter backwards.

The solar PV system will also include a web-based monitoring system, so that the real-time energy output from the system can be viewed. Please see the example below:

The details of the proposed 25kW solar PV system are as follows:

Size of Solar PV System:	25.2 kW DC at STC
Number of Solar PV Panels:	90
Manufacturer and Model Number of Solar PV Panels:	Suntech STP280-24/Vb-1
Inverter Manufacturer:	Solectria Renewables
Direction of Solar PV Panels (Azimuth):	195 Degrees
Tilt of Solar PV Panels:	23 Degrees
Annual Solar Access:	98%

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5 MAINTENANCE AND OWNER TRAINING (TO FOLLOW)

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6 GUARENTEED ENERGY SAVING PROPOSAL AND MEASURMENT AND VERIFICATION METHODS (TO FOLLOW)

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