Final Commissioning Report

to

XXX

for

Fire Station #XXX

submitted by

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Introduction

Portland Energy Conservation Inc. (PECI) had contracted with the Client to perform design-phase and construction-phase commissioning on the new Fire Station #XXX project to meet the requirements of the Utility's *XXX* program. The following report will outline the project, document the commissioning issues and their resolution, and summarize current operating parameters of the systems commissioned.

Project Description

Fire Station #XXX is a new facility constructed in the XXX area of City, State. The building is single story, approximately 5,600 square feet, and is occupied 24 hours per day, 365 days per year. The original design estimated a 20% reduction in energy consumption over a building constructed to meet State Energy Code, based on incorporating the following design features:

- daylighting control;
- occupancy sensors;
- efficient HVAC systems; and
- efficient construction.

The facility received a "Green" certification rating through Utility's *XXX* program.

Design Intent

The primary design intent for the facility was to achieve a "Green" certification rating through Utility's *XXX* program. In order to achieve that goal, several individual measures under each of the general categories outlined below had to be met.

- Energy Efficiency
- Quality Indoor Environment
- Environmental Responsibility
- Resource Efficiency

Two primary criteria necessary to achieve a "Green" certification were an estimated 20% reduction in energy usage over a building designed to meet the State Energy Code and participating in a full building commissioning process. A detailed description of the overall building design intent and a copy of the energy conservation measures implemented to achieve the 20% energy reduction can be found in the appendix.

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The building commissioning process entailed:

- a comprehensive design review to ensure the design intent was met, including the addition of commissioning language in the contract documents;
- submittal review of all equipment to be commissioned, as well as other items that could impact any *XXX* measures;
- site visits during construction to identify and resolve issues that could impact system performance; and
- functional performance testing of each system to ensure proper operation and compliance with the design intent.

Copies of submittal review comments, field/commissioning reports, and system performance testing documentation can be found in the appendix.

As-Operating System Descriptions

HVAC Units

Building heating and cooling loads are met by three roof-top HVAC systems and radiant heating units. Each system is individually controlled and discussed in greater detail below.

AC-1

The sleeping quarters, fitness room, and various utility rooms are served by roof-top HVAC unit AC-1 with rated cooling and heating capacities of 3.5 tons and 60,000 Btuh, respectively. The unit is controlled by a programmable thermostat that is located in the main hallway. Since this space is basically occupied 24 hours per day, the scheduling features of the programmable thermostat are not enabled. Current heating and cooling setpoints are approximately 70°F and 73°F, respectively, but are adjusted as needed by building occupants to meet desired space temperatures.

The supply fan is presently set in the “auto” position, which means the supply fan only cycles on and off with a call for either heating or cooling. This minimizes energy usage by the supply fan motor, but also means that ventilation air is not continually circulated through the space. However, the lack of continuous ventilation air is not as critical here since the building is equipped with many operable window and exterior doors.

The HVAC unit is also equipped with an economizer which will allow space cooling loads to be satisfied by outside air, rather than using the compressor, when atmospheric conditions are acceptable. Economizer control is achieved using a snap disc which will enable the economizer when outside air temperature is typically less than 60°F65°F, and disable the economizer when

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the outside air temperature is typically greater than 70°F65°F. A snap disc operates based on the thermal expansion and contraction of a bi-metallic element at corresponding temperatures, which either closes or opens the economizer circuit. Since the operating temperature range for a snap disc cannot be adjusted manually, economizer operation cannot be optimized.

AC-2

The day room, kitchen area, and dispatch room are served by roof-top HVAC unit AC-2 with rated cooling and heating capacities of 3.5 tons and 60,000 Btuh, respectively. The unit is controlled by a programmable thermostat that is located in the main day room area. Since this space is basically occupied 24 hours per day, the scheduling features of the programmable thermostat are not enabled. Current heating and cooling setpoints are approximately 70°F and 73°F, respectively, but are adjusted as needed by building occupants to meet desired space temperatures.

The supply fan is presently set in the "auto" position, which means the supply fan only cycles on and off with a call for either heating or cooling. This minimizes energy usage by the supply fan motor, but also means that ventilation air is not continually circulated through the space. However, the lack of continuous ventilation air is not as critical here since the building is equipped with many operable window and exterior doors.

The HVAC unit is also equipped with an economizer which will allow space cooling loads to be satisfied by outside air, rather than using the compressor, when atmospheric conditions are acceptable. Economizer control is achieved using a snap disc which will enable the economizer when outside air temperature is typically less than 60°F65°F, and disable the economizer when the outside air temperature is typically greater than 70°F65°F. A snap disc operates based on the thermal expansion and contraction of a bi-metallic element at corresponding temperatures, which either closes or opens the economizer circuit. Since the operating temperature range for a snap disc cannot be adjusted manually, economizer operation cannot be optimized.

AC-3

The meeting room is served by roof-top HVAC unit AC-3 with rated cooling and heating capacities of 4 tons and 90,000 Btuh, respectively. The unit is controlled by a programmable thermostat that is located on the back wall of the room. The meeting room is basically unoccupied most of the time and its use is very sporadic, therefore the programmable thermostat interfaces with the occupancy sensor used to control the lights. When the space is unoccupied, the thermostat maintains heating and cooling setpoints of 60°F and 85°F, respectively. However a signal from the occupancy sensor triggers the thermostat into the "occupied" mode and maintains heating and cooling setpoints of 70°F and 73°F, respectively. When the signal from the

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occupancy sensor is gone, the thermostat reverts back to the unoccupied mode temperature settings.

The supply fan is presently set in the “auto” position, which means the supply fan only cycles on and off with a call for either heating or cooling. This minimizes energy usage by the supply fan motor, but also means that ventilation air is not continually circulated through the space. However, the lack of continuous ventilation air is not as critical here since the building is equipped with many operable window and exterior doors.

The HVAC unit is also equipped with an economizer which will allow space cooling loads to be satisfied by outside air, rather than using the compressor, when atmospheric conditions are acceptable. Economizer control is achieved using a snap disc which will enable the economizer when outside air temperature is typically less than 60°F65°F, and disable the economizer when the outside air temperature is typically greater than 70°F65°F. A snap disc operates based on the thermal expansion and contraction of a bi-metallic element at corresponding temperatures, which either closes or opens the economizer circuit. Since the operating temperature range for a snap disc cannot be adjusted manually, economizer operation cannot be optimized.

Apparatus Bays

The apparatus bays are served by two natural gas-fired radiant heaters rated at 60,000 Btuh each and the units are controlled by manual thermostats. Since radiant heaters heat objects rather than the surrounding air, the heaters can be turned on and off as necessary and still provide adequate heating to the occupant within the work space. It is most likely that the building occupants will adopt this type of control strategy and turn the heaters on and off only when necessary.

There are no supply fans associated with the radiant heaters to circulate air or introduce ventilation air into the space. However, the lack of continuous ventilation air is not as critical here since adequate ventilation can be introduced through the exterior doors and main overhead garage doors if necessary. The space is also equipped with a vehicle exhaust fan system that will remove all engine exhaust should any vehicle need to operating while in the apparatus bay.

Interior Lighting

The lighting throughout the building primarily utilizes 4-foot T8 lamps and compact fluorescents. The average lighting density for the facility is approximately 1.0 watt/SF. Much of the lighting is controlled by manual wall switches; however, there are several automatic lighting control features in various area throughout the building, which are described below.

Day Room. The lighting in the day room includes both 4-foot T8 lamps and recessed compact fluorescent fixtures, and all are controlled by manual switches,

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occupancy sensors, and daylighting controls. The occupants can manually turn the lights on and off as desired, the occupancy sensor will turn the lights off if the space in unoccupied, and the daylighting sensor will dim the lights based on ambient light levels within the space. Note that the light sensor used to dim the lights is wired directly to the ballasts and sends out a continuous control signal. The electronic ballasts can dim down to approximately 5% total power, but they will not turn off regardless of the amount of ambient light entering the space.

Fitness Room. The lighting in the fitness room are 4-foot fixtures with T8 lamps, and are controlled by manual switches, occupancy sensors, and daylighting controls. The occupants can manually turn the lights on and off as desired, the occupancy sensor will turn the lights off if the space in unoccupied, and the daylighting sensor will dim the lights based on ambient light levels. Note that the light sensor used to dim the lights is wired directly to the ballasts and sends out a continuous control signal. The electronic ballasts can dim down to approximately 5% total power, but they will not turn off regardless of the amount of ambient light entering the space. It was noted during initial site visits that the occupancy sensor occasionally shut the lights off even when the space was occupied, however it appears that the problem has been solved since the occupants did not mention the issue during subsequent visits. Should the issue arise in the future, sensor sensitivity may need to be increased and a shield installed to prevent movement in the hallway from triggering the lights.

Meeting Room. The lighting in the meeting room includes both 4-foot T8 lamps and recessed compact fluorescent fixtures, and all are controlled by manual switches, occupancy sensors, and daylighting controls. The occupants can manually turn the lights on and off as desired, the occupancy sensor will turn the lights off if the space in unoccupied, and the daylighting sensor will dim the lights based on ambient light levels within the space. Note that the light sensor used to dim the lights is wired directly to the ballasts and sends out a continuous control signal. The electronic ballasts can dim down to approximately 5% total power, but they will not turn off regardless of the amount of ambient light entering the space.

The original design included a dimmer switch to manually override the control signal from the light sensor and adjust the light output from the 4-foot T8 fixtures and two of the recessed compact fluorescent fixtures as desired. A subsequent design revision included a twist timer wired in series with the dimming rheostat so that the signal from the light sensor could not be overridden continually. Due to a misinterpretation of the revised design by the electrical contractor, the lighting for this area is controlled as follows:

- The two compact fluorescent fixtures that were to be connected to the dimming circuit are now connected directly to a twist timer and will only operate at full light output whenever the twist timer is enabled.
- A manual rheostat was never installed so there is no manual control over light output of the 4-foot T8 fixtures in the space. On/off control for these fixtures is controlled by the wall switches and occupancy sensors, while light output is controlled only by the light sensor.

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- The remaining recessed compact fluorescent fixtures in the space are controlled by the wall switches and occupancy sensor (per the original design).

Even though the as-constructed lighting control strategy does not meet the original design intent, the lights operate very efficiently and the less-that-optimal manual control over light output from the dimmable lights is a minor inconvenience.

Apparatus Bays. The lighting in the apparatus bays are 4-foot fixtures with T8 lamps, and are controlled by manual switches, occupancy sensors, and daylighting controls. The occupants can manually turn the lights on and off as desired, the occupancy sensor will turn the lights off if the space in unoccupied, and the daylighting sensor will dim the lights based on ambient light levels within the space. Note that the light sensor used to dim the lights is wired directly to the ballasts and sends out a continuous control signal. The electronic ballasts can dim down to approximately 5% total power, but they will not turn off regardless of the amount of ambient light entering the space.

Exterior Lighting

All of the exterior light fixtures mounted around the perimeter of the building contain compact fluorescent lamps and are controlled by a single photocell that will turn the lights on and off based on ambient light levels. The parking lot is served by two self-contained solar powered fixtures, each with a single high intensity discharge lamp. The solar panel should charge the respective battery during the day and the integral control module will power the light with the energy stored in the battery based on ambient conditions. Neither of the fixtures have any electrical back-up should the solar panel/control module experience a failure or be taken off-line for service.

During the first few months of occupancy, it was noted that one of the fixtures did not operate correctly. Both the manufacturer and electrical contractor have worked to resolve the problem and as of this writing, it appears that both fixtures are operating as intended.

Special Features

The meeting room is equipped with mechanical shades that can be lowered to reduce the amount light and solar energy entering the space. The original design intent was to have these shades operate automatically based on reducing the solar heat gain to the space; however the as-constructed control strategy is manual operation. Even though this deviates from the original design intent, the impact on energy usage will be minimal since the HVAC unit serving this area only operates when the space is occupied. In addition, manual control of the blinds not only provides the occupants with increased flexibility in controlling ambient light levels, but will also reduce solar heat gains when they are lowered.

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Conclusions

Building occupancy began in November 2002 and all systems were tested for proper operation and safety under all operating conditions. All of the goals for the project were met and the project was a success. The final commissioning report documents the overall process as well as "as-operated" parameters for the primary HVAC and lighting equipment.

The appendix contains documentation pertaining to the building design intent, building efficiency measures, commissioning recommendations/findings/issues, and system functional performance verification. This report should be kept with the O&M manuals, which were provided by the general contractor, for future reference. The information in these documents will help the building owner maintain proper system operation and can provide guidance during future remodels, renovations, or additions to ensure the original design intent continues to be met (or refined as necessary).

Appendix

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