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RE: RI SEMP –Department of Labor & Training, Pastore Campus - Scoping Study Report

Dear Andrea:

As requested, DMI visited the Department of Labor and Training (DLT) on the Pastore Campus on January 20th, 2017 and met with John Couture (DOA Project Manager) and the building operator to discuss energy savings opportunities and walk through the facility. Included in this report is a list of potential energy efficiency measures as well as savings estimates where possible. Any savings value listed in this scoping report is an estimate meant to provide a rough approximation of potential energy savings.

Energy Efficiency Measures

Table 1 provides a summary of the measures identified during this scoping study. The savings values presented are interactive (i.e. savings for ECM 2 assume ECM 1 has been implemented).

Table 1
Identified Measure Summary

ECM No		Measure Description	Savings kWh	Savings lb steam	Savings $	Cost $	Payback years	Incentive Program
1	*	Interior LED Lighting	656,482	0	$78,778	$393,889	5.0	Prescriptive Retrofit
2		Lighting Controls - Occupancy Sensors	94,533	0	$11,344	$62,435	5.5	Prescriptive Retrofit
3		Lighting Controls - Daylight Sensors	23,948	0	$2,874	$24,074	8.4	Prescriptive Retrofit
4		Façade LED Lighting	2,970	0	$356	$1,713	4.8	Prescriptive Retrofit
5		Condenser Water Pump VSDs	22,902	0	$2,748	$18,204	6.6	Prescriptive Retrofit
6		Electric Reheat Programmable Tstats - Heating Only	6,770	0	$812	$1,500	1.8	Custom Retrofit
7		Kitchen Hood Controls	3,453	32,400	$900	$20,000	22.2	Custom Retrofit
8		Exhaust Fan Scheduling Controls	47,296	50,122	$6,427	$16,500	2.6	Custom Retrofit
9	*	Investigate Unoccupied Airflow Controls	353,382	3,288,469	$91,733	$458,664	5.0	Custom Retrofit
10	*	Energy Recovery - Runaround Loops	-53,958	523,493	$1,377	$6,887	5.0	Custom Retrofit
11	*	Demand Controlled Ventilation	0	336,355	$5,045	$25,227	5.0	Custom Retrofit
12		Window Replacements	0	228,389	$3,426	$238,884	69.7	Custom Retrofit
13	†	Steam Trap Survey	0	26,138	$392	$281	0.7	Custom Retrofit
14	*	Investigate Data Center Heat Recovery	5,518	350,365	$5,918	$29,588	5.0	Custom Retrofit
15	†	FCU EC Motors when Replacing (NC)	143	0	$17	$271	15.8	Prescriptive NC
16	†	FCU Programmable Thermostats (NC)	39	8,148	$127	$500	3.9	Prescriptive NC
17	*	Building 73: On-Demand Hot Water Heater (NC)	0	9,947	$149	$746	5.0	Custom NC
18	†	High Performance Ductless Split Systems (NC)	599	0	$72	$582	8.1	Upstream NC
Total		-	1,164,077	4,853,826	$212,497	$1,299,944	6.1	-

*Cost estimate unknown; cost provided is cost to achieve a 5-year payback

**Utility Rates: $0.12 per kWh (DMI assumption) and $15 per 1,000 lbs steam (site estimate)

† Savings and cost estimated on a per unit basis.

These values are based on limited information collected during the short site-visit. Additional information may need to be collected to confirm the accuracy of these estimates. Cost data is unknown for a number of the measures above and the cost provided in the table is the maximum cost that could be spent to achieve a 5-year payback. These are not actual cost estimates, but are rather included for budgetary purposes.

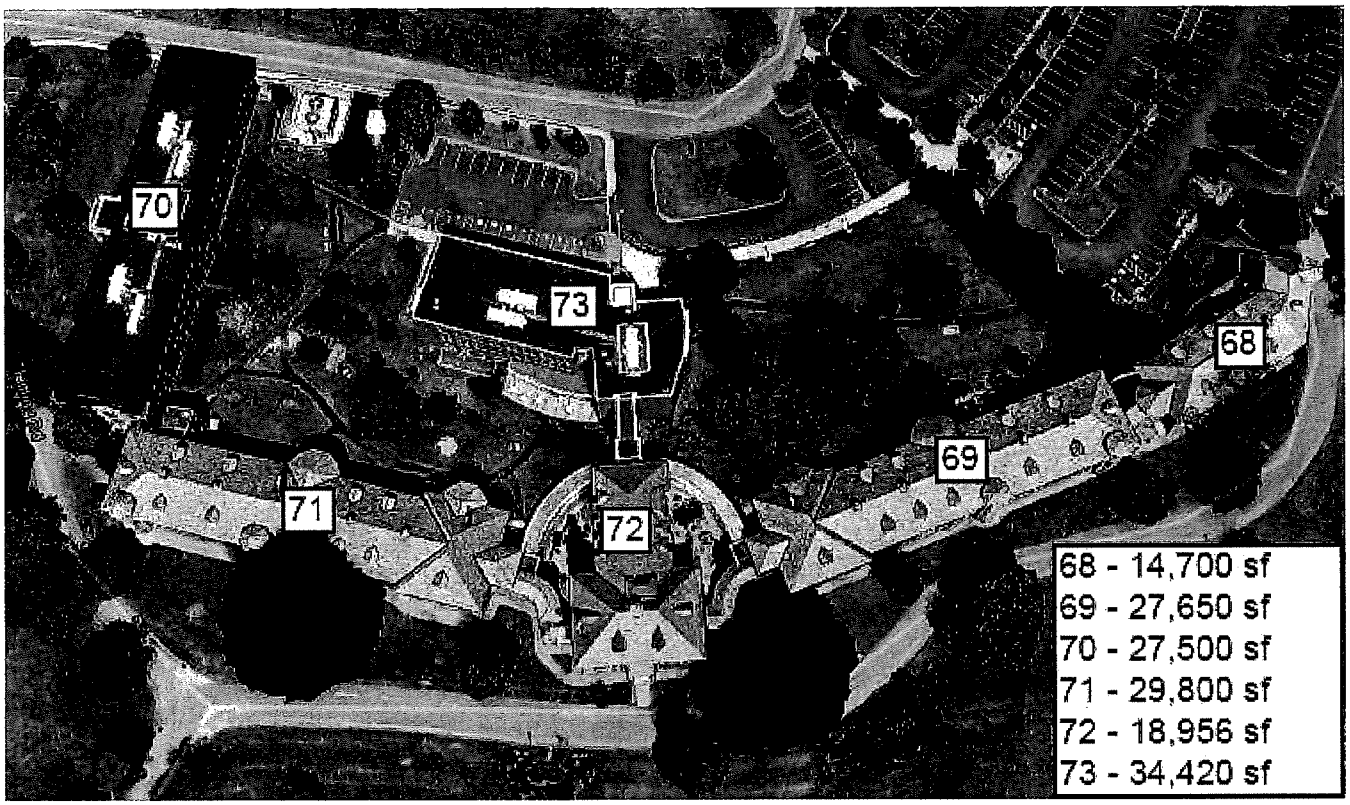
The buildings on the Pastore campus are powered by electricity and steam produced at the campus power plant. There is no submetering of the steam or electricity usage of individual buildings on the campus.

Therefore, no benchmarking can be completed for this building. Also, a utility data review typically helps to identify additional measures and reinforce savings estimates presented above; this type of review was not possible for this building.

Facility Description

The DLT is a complex of six interconnected buildings (#68-73) totaling 153,026 ft^2. Five of the six buildings were originally constructed in 1900; building 73 was added in 1998. All building spaces were renovated in 1998 and new mechanical systems were installed. These buildings are similar in design and operation; a majority of the spaces are offices. Building hours are ~7AM to 6PM on weekdays.

Google Earth – Birds Eye View of DLT, Building Information Added



The facility receives electricity and steam produced at the campus power plant. There is a central heating system and cooling system located in the basement of building 73 (the newest building). There is a steam-to-hot-water heat exchanger that activates at outdoor air temperatures below 60°F to supply 180°F hot water to the buildings. The hot water circulation system consists of two primary hot water pumps and three secondary hot water pumps, each secondary pump serves a subset of the buildings. There are two 255 ton absorption chillers that provide 45°F chilled water when turned on for the season. The chilled water circulation system consists of two primary chilled water pumps and three secondary chilled water pumps, each providing chilled water to a subset of the buildings. All secondary pumps are VFD controlled; the primary pumps are constant speed. There is a BAC cooling tower providing condenser water to the chiller. This tower was not observed, though the site indicated that it has variable speed fans.

There are between two and four air handling units providing space conditioning in each building; there are 25 total air handling units between the six buildings. These constant volume AHUs have chilled water

cooling coils, hot water heating coils, and economizer controls. The AHUs are zoned by quadrant such that, within a building, generally all AHUs serve each floor. Each AHU is controlled by one thermostat located on the middle floor. Given that temperature is controlled to the middle floor space conditions, there are space comfort complaints on the top and bottom floors. Also, as AHUs serve adjacent spaces on the same floor, there is fighting of the AHUs (i.e. one in cooling and one in heating). Furthermore, many buildings have one return duct per floor which provides the return for multiple AHUs. This results in draft issues. These AHUs are controlled by the building operator via the EMS; space temperature is maintained between 72-75°F. There is minimal zone heating in the building, so the site does not operate the AHUs with nighttime setbacks as there are concerns with the bringing the buildings back to temperature.

A few of the buildings' spaces have retrofitted electric reheat onto the constant volume diffusers; the electric reheat elements are controlled by remote thermostats. There are 16 VAV boxes with hot water reheat serving conference rooms. It is unclear how these boxes operate in conjunction with the constant volume AHUs. There are also 77 four-pipe fan coil units scattered throughout the buildings (largely in building connecting areas) that are controlled by remote thermostats. Many of these fan coil units have valves that are stuck open; the site turns the steam off in the summer and the chiller off in the winter to avoid simultaneous heating and cooling.

Facility lighting consists of a mixture of CFL downlights, linear suspended CFL pendant fixtures, linear T8 strip light fixtures, and CFL sconces. All lighting controls are manual with the exception of the stairwells and bathrooms which have occupancy sensors.

Other equipment includes a steam-to-hot-water heat exchanger for domestic hot water in building 73, electric domestic hot water heaters in the other five buildings, a kitchen hood located in building 73, ~33 exhaust fans throughout the facility, five Liebert AC units with air-cooled condensing units serving the ~2,000 ft^2 data center in building 69, and a number of Mitsubishi split-systems serving the kitchen and IT spaces.

ECM 1: Interior LED Lighting (Prescriptive Retrofit)

The existing lighting fixtures are predominately linear CFL pendant fixtures, each of which has four 50-watt lamps. There are also CFL sconces, CFL downlights, and some linear T8 fixtures throughout the buildings. ECM 1 proposes replacing the existing fixtures with LEDs to achieve energy savings. Energy savings results from a reduction in connected lighting power.

ECM 2: Lighting Controls – Occupancy Sensors (Prescriptive Retrofit)

With the exception of stairwells and bathroom which have automatic occupancy sensors, lights throughout the facility are turned on and off manually. Typically these lights are shut off by building occupants when the spaces are vacated; however, it is likely that some building lights remain on overnight and during the day when the spaces are unoccupied. This measure proposes to install occupancy sensors to shut fixtures off if no occupancy is sensed. Energy savings result from a reduction in lighting hours.

ECM 3: Lighting Controls – Daylight Sensors (Prescriptive Retrofit)

No daylight dimming controls are currently used to control lighting fixtures in the facility. There are a number of perimeter office spaces and many large windows throughout the buildings, including the walkways connecting to building 72 (center of complex). ECM 3 proposes to install daylight controls to shut

fixtures off in appropriate spaces where outdoor lighting provides reasonable illumination during daylight hours. Energy savings result from a reduction in lighting hours

ECM 4: Façade LED Lighting (Prescriptive Retrofit)

Exterior pole lighting fixtures are outside of the scope of this report and will be addressed on a campus wide basis. In addition to pole fixtures, these buildings' have a few façade spotlight fixtures that are likely metal halide. These fixtures are controlled by a photocell. This measure suggests replacing these fixtures with LED equivalents to achieve energy savings from reduced connected lighting power.

ECM 5: Condenser Water Pump VSD (Prescriptive Retrofit)

There is one cooling tower with variable speed fan control providing heat rejection for the chiller. There are two condenser water pumps serving the condenser water loop; one operates at a time and the other provides backup. This measure proposes installing variable speed drives on the condenser water pumps and controlling the VSDs based on the temperature differential across the tower. Savings result from a reduced average pumping power.

ECM 6: Programmable Thermostats for Supplemental Electric Heat (Custom Retrofit)

All AHUs in these buildings are constant volume. After the systems were installed, supplemental electric heating elements were retrofitted into some of the constant volume diffusers. The building operator estimates there to be at least five of these electric heating elements throughout the buildings. These heating elements are controlled by local thermostats and space temperature is not typically set back overnight. This measure suggests installing programmable thermostats to control the supplemental electric heating elements and implementing setbacks to reduce space temperature during unoccupied periods. Savings result from reduced electric heating.

ECM 7: VAV Kitchen Hood Controls (Custom Retrofit)

Building 73 has a commercial kitchen that operates during building hours. There is a kitchen hood (1,500 CFM and 1.5 hp exhaust fan) that is turned on by staff in the morning and turned off overnight. There is a makeup air unit (1 hp supply fan) with both heating and cooling serving the kitchen, along with a supplemental Mitsubishi split system for added cooling capacity. This measure proposes the installation of a variable speed kitchen exhaust control system. This type of system monitors the temperature and smoke levels in the kitchen hood and adjusts the exhaust fan speed accordingly through variable speed drive controls. These controls can be interlocked with the kitchen makeup air unit to modulate supply and exhaust airflow together. Savings result from reduced fan energy along with reduced heating and cooling ventilation loads. Given the small size of the kitchen exhaust fan and make-up air unit, this measure may not be cost effective.

ECM 8: Exhaust Fan Scheduling Controls (Custom Retrofit)

Per a set of mechanical drawings provided for the buildings, there are ~33 exhaust fans serving bathrooms, breakrooms, janitor closets, and MEP spaces. These exhaust fans run 24/7. This measure suggest implementing exhaust fan scheduling controls to shut the fans off during unoccupied periods. Savings result from reduced fan power and reduce fan ventilation conditioning loads.

ECM 9: Investigate Unoccupied Airflow Controls (Custom Retrofit)

The 25 AHUs are controlled to maintain a space temperature of 72-74°F set by the building operator on the EMS. There are currently no unoccupied mode setbacks, as there are a limited number of zone heating elements and the system has difficulty bringing spaces back to temperature. Furthermore, the outdoor air dampers remain open, at least at minimum position, during overnight hours. This measure suggests investigating the unoccupied mode controls and implementing controls to both close the OA dampers completely during unoccupied periods and to cycle the AHU supply and return fans to maintain space setpoints. Savings results from reduced heating and cooling ventilation loads along with reduced fan power.

Additionally, space temperature setbacks could be implemented to save heating energy in the winter and cooling energy in the summer. If setbacks are not possible as some spaces have difficulty being brought back to temperature, the systems may need to be rebalanced. Additional investigation is required.

ECM 10: Energy Recovery Runaround Loops (Custom Retrofit)

The AHUs are largely located in attic spaces where there is ample room for additional equipment. The current setup has a common return duct for two air handling units; the minimum outdoor airflow ranges from 10% to 100%, depending on the unit. This measure suggests installing glycol runaround loops on the energy recovery units to recover heat from the exhaust to preheat the outdoor air. Savings results from reduced heating loads. There is a pumping penalty associated with transferring heated fluid from the exhaust to the supply, and a fan penalty associated with the added pressure drop. The runaround loops are best suited for units with high outdoor air ratios.

ECM 11: Demand Controlled Ventilation (Custom Retrofit)

There AHUs are equipped with economizer controls; however, there is no demand controlled ventilation in the building. This measure suggests installing carbon dioxide sensors in the return ductwork for the AHUs and implementing controls to vary outdoor airflow rates based on CO_2 readings. Reducing outdoor airflow rates during low-occupancy periods will save on outdoor air conditioning loads.

Additionally, the mechanical drawings indicate that there are a total of 17 variable volume boxes split between the buildings' conference rooms. It is unclear how the systems are controlled given DMI's understanding that all AHUs are constant volume. If there are variable speed AHU controls, there is an opportunity to implement occupancy based demand controlled ventilation sequences in these spaces to completely shut VAV boxes when there is no occupancy. This would save fan energy and ventilation conditioning energy. More investigation is required into the air-side systems to make this suggestion.

ECM 12: Window Replacements (Custom Retrofit)

There is a project that has been in the works for a few years now to replace the nearly 1,200 windows in these buildings. DMI's understanding is that no work has been done to date. The existing windows are drafty and likely single-pane constructions. This measure recommends replacing the existing windows with more modern windows equipped with double pane insulated glass and air sealing between the window frame and wall opening. This measure will save on space conditioning energy by reducing infiltration air and reducing conductive losses with higher performing window units.

ECM 13: Steam Trap Survey (Custom Retrofit)

There are a number of steam traps in the facility and the building operator believes some of them to be oversized and some of them to be leaky; the exact quantity and condition of these steam traps in unknown. Broken steam straps release low-pressure steam from the system, adding the steam load. Modern steam-system design incorporates steam traps throughout the piping to allow condensate to be trapped and discharged from the system as soon as it is formed with minimal steam losses. This measure proposes that the facility participate in a steam trap survey and replace or repair broken steam traps to reduce steam losses.

ECM 14: Investigate Data Center Heat Recovery (Custom Retrofit)

There is a data center on the ground floor of building 69 that is currently served by five Liebert CRAC (computer room air conditioning) units. These units are ~17 years old and will likely require replacement soon. The data center is located close to two AHUs that have hot water heating coils. This measures suggests investigating recovering heat from the Liebert units to offset the steam plant heating for the building. Savings will result due to reduced steam demand at the central plant and also lower heat rejection energy usage.

ECM 15: FCU Electronically Commutated (EC) Motors when Replacing (Prescriptive New Construction)

There are 77 four-pipe fan coil units throughout the building. A few of the fan coil motors are in need of replacement, and many of these fan coil units have valves that are stuck open. The site turns the steam off in the summer and the chiller off in the winter to avoid simultaneous heating and cooling. The building operator is aware of the maintenance issues associated with the fan coil units and noted that it is less expensive to replace the fan coil units than to fix the broken valves. This measure suggests installing fan coil units with EC motors, which are significantly more efficient the older, permanent-split capacitor (PSC) motor technology, when replacing the existing units.

ECM 16: FCU Programmable Thermostats when Replacing (Prescriptive New Construction)

The existing fan coil units also have remote thermostats that are non-programmable. This measure suggests installing programmable thermostats when replacing the FCUs and implementing unoccupied setbacks to reduce space temperature when the building is not in use. Savings result from reduced heating and cooling loads. There may be interaction between this measure and the FCU valve operation discussed in ECM 15.

ECM 17: On-Demand Domestic Hot Water Heaters (Custom New Construction)

Domestic hot water is provided to the building 73 by a steam-to-hot-water heat exchanger; the remaining six buildings use electric domestic hot water heaters. The site mentioned that this steam unit is failing and they would like to replace it with an electric heater. This measure proposes investigating installing an on-demand steam fired hot water heater instead of an electric fired unit, when replacing this unit. Steam DHW heaters are less expensive to operate on a $ per MMBTU basis than electric heaters, and on-demand heaters save on storage losses.

ECM 18: Ductless High-Performance Split Systems (Upstream New Construction)

There are a number of Mitsubishi split systems serving building spaces including the commercial kitchen, data rooms, computer labs, and phone rooms. The site mentioned that all of these split systems are ~17

years old and nearing the end of their useful life. This measure suggests installing ductless high-performance split systems when replacing the current units. Additional investigation is needed to determine the exact quantity and size of the split systems. High performance split systems are incentivized under National Grid's Upstream program.

Additional Considerations and Conclusion

A few condensate piping leaks were observed in the mechanical room. While these leaks are maintenance related issues and not covered under the incentive programs, DMI recommends addressing leaks to improve overall system efficiency and minimize losses.

Please contact DMI if you have any questions or concerns regarding the details of this report. If you and the customer are interested in studying any of the aforementioned measures in greater detail, please contact us and we will provide a proposal to complete the identified scope. It is a pleasure to be of service to National Grid and its customers.

Sincerely,

Maddy Messer
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