Guardian Energy Management Solutions™

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Berlin Public Safety Complex
23 Linden St.
Berlin, MA 01503

Prepared By: Erik Larson
Report Date: May 7, 2018

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INTRODUCTION

This report presents the recommendations resulting from the retrocommissioning study performed at the Berlin Public Safety Complex, in Berlin, MA. This study was completed by Guardian Energy Management Solutions (Guardian).

Retrocommissioning is commonly used as a way of identifying strategies for reducing energy consumption and costs associated with the operation of a facility. While this is always a goal of the process, this study is primarily focused on improving the ability of the HVAC systems to properly serve the spaces. The target building is the Berlin Municipal Building.

STUDY DESCRIPTION

The Guardian team conducted visits to the building in November, 2017 and April, 2018. Information gathered on these visits included documentation review, site observation, equipment testing, and energy management system (EMS) investigation. Documentation obtained included construction and control documents, equipment lists and utility billing information.

The study included a point-to-point test of all EMS control points, functionality testing of all HVAC equipment, airflow testing of all diffusers and a survey of the flowrates of all plumbing fixtures.

FACILITY DESCRIPTION

The Berlin Town Offices/Public Safety Complex is a two-story, 68,028 square foot facility originally built in 1953. The building underwent a significant renovation/addition in 1999, and the major equipment was all installed during this renovation. The building is heated with hot water boilers and cooled by rooftop units that have DX cooling coils. Primary areas in the building include a 24/7 police station, fire station, office area and meeting rooms.

UTILITY ANALYSIS

Utility data for FY 2017 was gathered for both electrical and fuel oil consumption. For Fiscal Year 2017, the utility use and costs for the building are shown in the table below

Utility End Use Analysis		
Electricity Use (kWh):		**Notes/Comments:**
218,658	Total	Based on utility analysis
82,654	Lighting	Based on utility analysis
21,866	Motors	Estimated
48,105	Cooling	Estimated
66,033	Plug Load	Estimated
Fuel Oil Use (Gallons):		**Notes/Comments:**
12,436	Total	Based on utility analysis
11,158	Boilers	Based on utility analysis
1,278	DHW	Based on utility analysis

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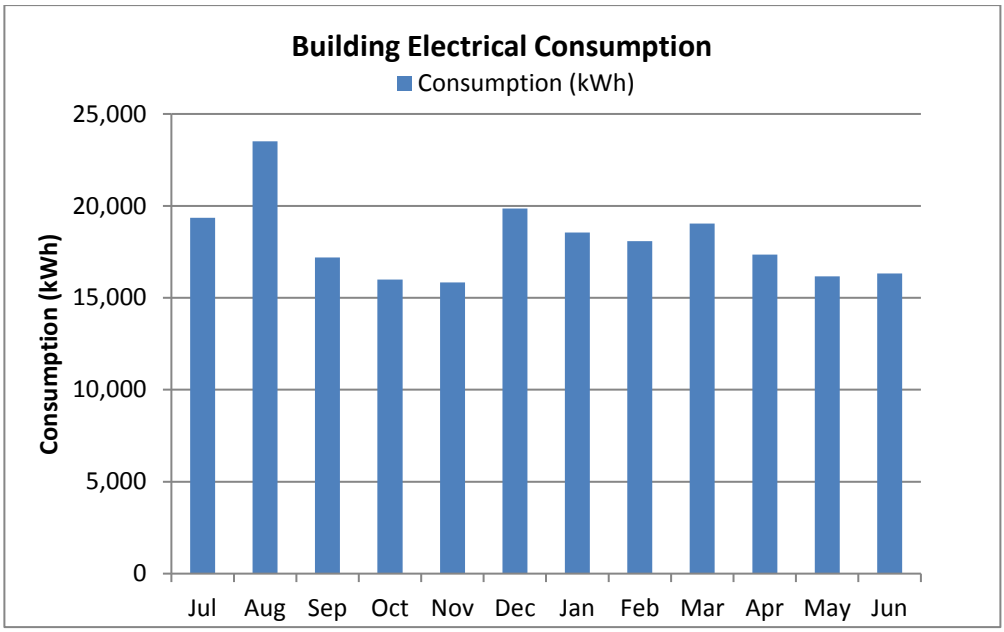
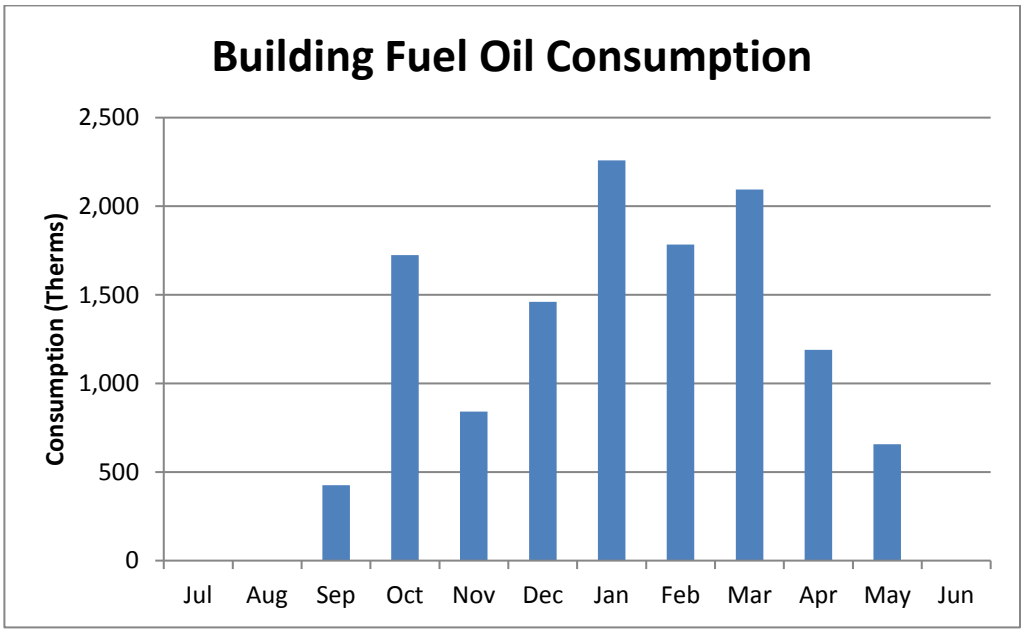
The electricity usage for the building is fairly typical of this building type. The usage peaks in the summer, indicating increased cooling, with a smaller increase in the winter months, indicating greater lighting usage and portable electrical heater use during the darker, colder months. The analytical monitoring that is being conducted on the building has also indicated that elevated levels of winter DX cooling has occurred. This also contributed to this peak.



The fuel oil usage is typical of a building of this type and age. The chart marks oil purchases, and not direct consumption, which explains some of the variability, but it shows an expected peak during the colder months. While there were no oil purchases during the summer months, the domestic hot water usage is assumed to be fairly constant throughout the year.



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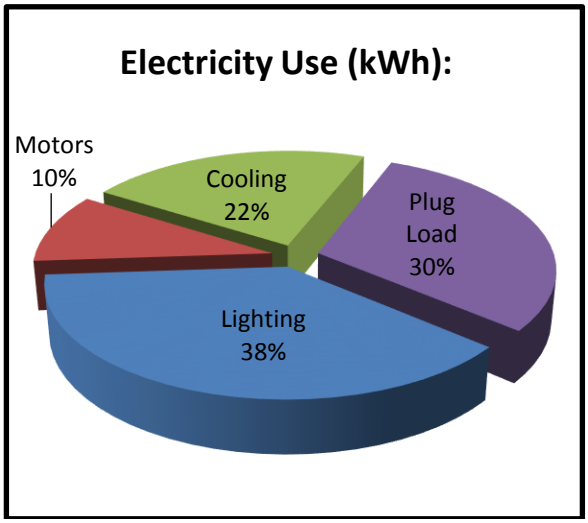

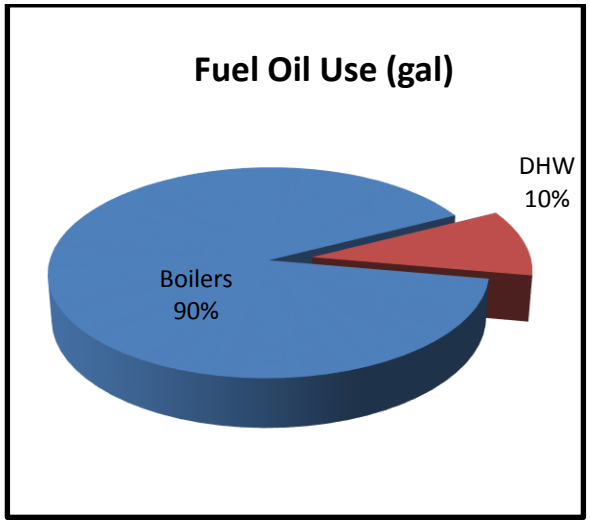

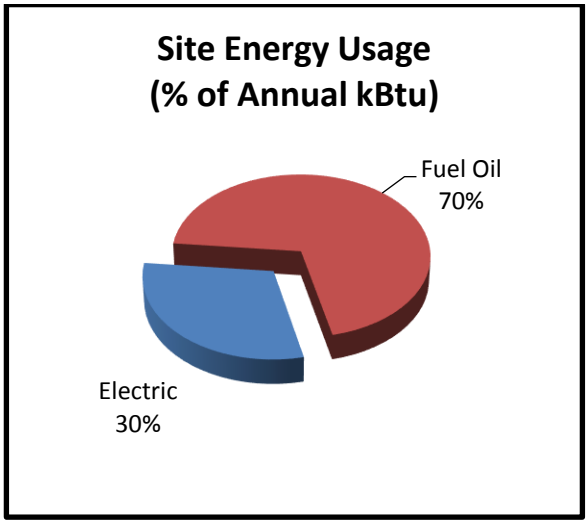

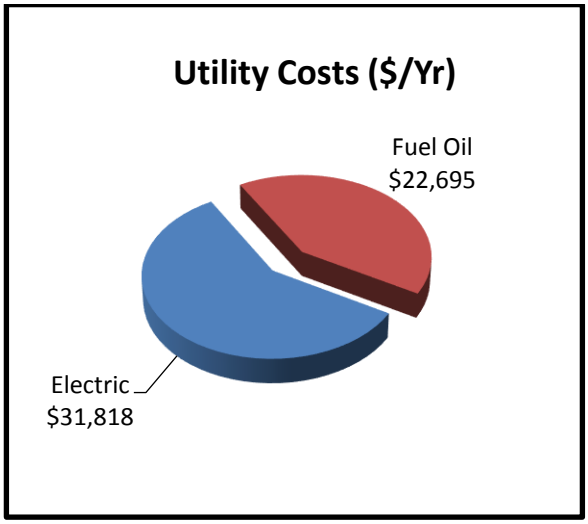

The EPA Portfolio Manager benchmarking tool provides a site Energy Use Intensity (EUI) for qualifying building types. The EUIs are provided in kBtu/ft^2/year. While public safety buildings are not a categorized building type, office buildings are, and this is the basis for the table 2 below.

Facility Benchmarking								
Building Name	Building Area	Total Cost	Electric	Fuel Oil	Total Energy	Site EUI	National Avg. EUI	ECI
	(SF)	($)	(kWh)	(Gallons)	(kBtu)	(kBtu/SF/Yr)	(kBtu/SF/Yr)	($/SF/Yr)
Berlin Municipal	68,028	$76,021	217,300	12,436	2,457,813	36.1	67.3	$0.80

The building EUI is significantly lower than the national average. This is an indication of energy efficiency, and also likely due to the building's lower than average worker density and usage pattern when compared to an average U.S. office building.

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HVAC EQUIPMENT DESCRIPTION

A survey of all HVAC equipment was conducted to assess general condition, deferred maintenance, and issues that affect equipment efficiency. A narrative describing the audit of the major equipment is below. Details of all assessed equipment are also included as well as a truncated version of this table detailing replacement costs and estimated energy cost savings. As all items on the audit are either very recently installed, or at or near the end of their ASHRAE rated service life, refurbishment is not recommended.

RTU-1

RTU-1 is the rooftop unit that serves the Town Hall offices. It is a constant volume system with a 35 Ton DX cooling coil. It was built in September 1999, and is original to the building. Rooftop units are rated by ASHRAE with a (15) year life expectancy. RTU-1 appears to be well maintained and is in good condition for its age. The fan belt appeared to be newer, and the cooling coil appeared to be in good condition. The air filters showed some build up, and we recommend that they get replaced. We also recommend that the cooling coil is cleaned as recommended by the manufacturer.

There are (3) components that degrade with time in a way that predominantly will affect the performance. The cooling coil can lose 3-6% efficiency every year if not maintained to the manufacturer's recommendations. Regular cleaning and maintenance can return the coil to its original efficiency. The fan belt can lose significant efficiency if not properly tensioned, and all belts should be replaced annually to ensure optimal performance. Dirty air filters in the unit can inhibit proper airflow leading to loss in performance and elevated fan motor brake horsepower. Replacing the filters every 3-6 months is recommended.

The 7.5 HP supply fan motor is rated at 90.2% efficiency. Current NEMA premium motors of this size are rated at a minimum of 91.70%. The 1 HP exhaust fan motor is rated at 83.0%. Current NEMA premium motors of this size are rated at a minimum of 85.5%

RTU-1 Filters

RTU-1 Dampers and general condition

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RTU-2

RTU-2 is the rooftop unit that serves the Connector zone between the Town Offices and the Police/Fire Departments. It is a constant volume system with a 3 Ton DX cooling coil. It was built in October 1999, and is original to the building. Rooftop units are rated by ASHRAE with a (15) year life expectancy. RTU-2 appears to be well maintained and is in good condition for its age. The coils appear to have some hail damage and the unit needs routine cleaning.

There are (2) components that degrade with time in a way that will predominantly affect the performance. The cooling coil can lose 3-6% efficiency every year if not maintained to the manufacturer's recommendations. Regular cleaning and maintenance can return the coil to its original efficiency. The air filters in the unit can inhibit proper airflow if not regularly changed. Replacing the filters every 3-6 months is recommended.

The 1 HP supply fan motor is rated at 83.0%. Current NEMA premium motors of this size are rated at a minimum of 85.5%. The cooling performance of the unit is rated at 9.00 EER. While the cooling coil is in fairly good shape, it does appear to have some buildup which could affect the efficency 3-6%. As stated, regular cleaning as recommended by the manufacturer will return the efficiency to near 9.00. Current code requires a minimum cooling performance of 10.5 EER.

RTU-2 hail damage

RTU-2 general condition

RTU-2 general condition

RTU-2 filter

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AHU-1

AHU-1 is the air handling unit that serves the Fire and Police stations. It is a constant volume system with an associated 15 Ton condensing unit (ACCU-1). It was built in June of 1998, and is original to the building. Air handling units are rated by ASHRAE with a (15) year life expectancy. AHU-1 appears to be in fair condition for its age. The coils appear to have some build-up and minor damage and the unit needs routine cleaning and new air filters.

There are (3) components that degrade with time in a way that predominantly will affect the performance. The cooling coil can lose 3-6% efficiency every year if not maintained to the manufacturer's recommendations. Regular cleaning and maintenance can return the coil to near its original efficiency. Fan belts can lose significant efficiency if not properly tensioned, and all belts should be replaced annually to ensure optimal performance. The air filters in the unit can inhibit proper airflow if not regularly changed. Replacing the filters every 3-6 months is recommended.

The 3 HP supply fan motor has been replaced since the original installation, and appears to be less than 5 years old. While the efficiency rating for the motor could not be identified, the NEMA premium efficiency minimum for this size motor is currently 89.5%.

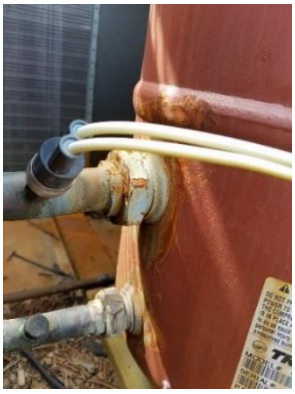
AHU-1 cooling coils

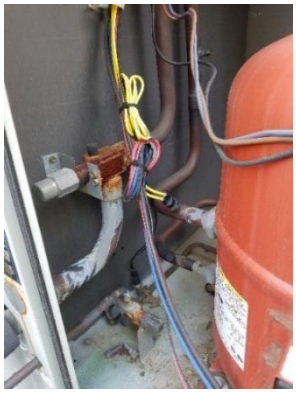
AHU-1 general condition

ACCU-1

ACCU-1 is the condensing unit for AHU-1. It is a 15 Ton unit, built in September 1999, and is original to the building. Air cooled condensing units are rated by ASHRAE with a (20) year life expectancy.
The cooling performance of the unit is rated at 9.3 EER. While the cooling coil is in fairly good shape, it does appear to have some buildup which could affect the efficiency 3-6%. As stated, regular cleaning as recommended by the manufacturer will return the efficiency to near 9.3. Current code requires a minimum cooling performance of 10.5 EER. The unit shows rusting, not uncommon for outdoor units, but maintenance and re-painting may be recommended.

ACCU-1 rust


ACCU-1 rust


ACCU-1 rust

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ACCU-2 and ACCU-3

ACCU-2 and ACCU-3 are the 1 Ton condensing units for FC-2 and FC-3. They serve Communications Room 134 and Data Room 011 respectively. They were built in 2009 and have replaced the original units serving those spaces. Air cooled condensing units are rated by ASHRAE with a (20) year life expectancy.

The 2009 efficiency rating for this model could not be determined. The IECC-2009 requirement was 10.3 EER. The current code requires 12.1 EER, and the current version of this unit has a rating of 11.2 EER.

ACCU-2

ACCU-3

B-1, B-2 and B-3

B-1, B-2, and B-3 are 663 MBh boilers that serve the entire building. They were installed in 2016. Cast iron boilers are rated by ASHRAE with a (30) year life expectancy. They have a rated efficiency of 86.5%. The current code requires 82.0% efficiency. A Bacharach Fyrite Intech Combustion Gas Analyzer was used to check the firing efficiency of the boilers:

B-1: Buderus GE315/8, 663-MBH, installed efficiency: 86.5% AFUE, current operating efficiency: 84.2% AFUE
B-2: Buderus GE315/8, 663-MBH, installed efficiency: 86.5% AFUE, current operating efficiency: 83.7% AFUE
B-3: Buderus GE315/8, 663-MBH, installed efficiency: 86.5% AFUE, current operating efficiency: 84.6% AFUE

The boilers are set on a lead/lag schedule that rotates the lead boiler every 10 days during the heating season. The boiler pumps are set on a 14 day rotating lead/lag schedule and are currently configured to maintain constant differential pressure in the hot water loop.

Following the recommendations made in the 2017 RCx report, it is observed that the backdraft dampers on the units have been capped, and that the dampers on the boiler flues have been locked 100% open as recommended.

Boiler flue damper locked with sheet metal screw

Boiler backdraft dampers have been capped

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Exhaust Fans – The exhaust fan motors all appear to be original to the building, manufactured in the 1998-1999 time period, with the exception of EF-1, which was replaced in 2016. ASHRAE rates electric motors with an (18) year life expectancy. They are generally in good condition for their age, though replacing and re-tensioning the fan belts is recommended.

The majority of these motors are fractional HP in size, and the increase in efficiency to the new motor will be a minor consideration. For the Apparatus Room 10 HP motor, significant savings will result. The NEMA Premium classification for 10 HP motors in 1999 was 86.0%, whereas now it is 91.7%.

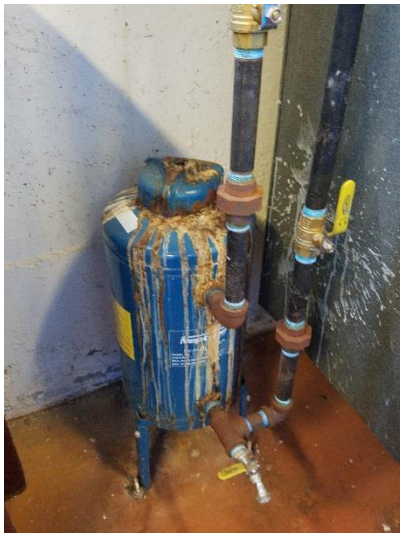
The fan belts on these units varied in condition. Some had been recently, but many showed signs of cracking and poor tensioning. Annual replacement and tensioning are recommended.

Unit Heaters – The (6) unit heaters in the building are all original to the 1999 building. ASHRAE rates hot water unit heaters with a (20) year life expectancy. While replacing these heaters will not result in a significant energy efficiency upgrade, they are nearing the end of their useful life.

UH-6 condition (typical)

EF-3 condition (typical)

Other Observations – In the mechanical room, the bypass feeder for the glycol is showing some wear. Cleaning and repainting are recommended, though some corrosion will likely remain.


By-pass feeder

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HVAC EQUIPMENT DETAILS AND REPLACEMENT COSTS

The table below details the equipment as detailed in the drawings, the details of the actual equipment found on site, and the costs (labor and materials) to replace each unit with a unit that meets the current Massachusetts building code. These costs are budgetary in nature, and we are not recommending the replacement of all equipment.

Tag	Equip Type	Drawing Model Number	Unit Model Number	Size	Replacement Cost	Est Energy Cost Savings
RTU-1	Rooftop	TCD420	TCD420	35 Ton, 13,500 CFM	$72,000	$150
RTU-2	Rooftop	TCD036C3	TCD036C30ABC	3 Ton, 1,200 CFM	$12,100	$75
AHU-1	Air Handing Unit	TWEI80B3	TWEI80B3	15 Ton	$32,600	$150
FC-2	Fan Coil	40QNB-012-3	Mitsubishi MS12NN	1 Ton Split System	$3,900	$25
FC-3	Fan Coil	40QNB-012-3	Mitsubishi MS12NN	1 Ton Split System	$3,900	$25
EF-1	Exhaust Fan	BSQ-140HP10	Dayton 3N603J	1 HP	$4,200	<$10
EF-2,3	Exhaust Fan	G-90-D	G-90-D	1/8 HP	$2,900	<$10
EF-4	Exhaust Fan	GB-260-T	GB-260-T	3/4 HP	$3,400	<$10
EF-5	Exhaust Fan	SQ-90-D	SQ-90-D	1/10 HP	$3,800	<$10
EF-6	Exhaust Fan	SQ-130-A	SQ-130-A	3/4 HP	$4,400	$25
UH-1	Unit Heater	HV-84	Dunham Bush UH A	61 MBH (Hot Water)	$2,500	<$10
UH-2-UH-5	Unit Heater	HV-144	Dunham Bush UH C	104 MBH (Hot Water)	$2,500	<$10
UH-3	Unit Heater	HV-144	Dunham Bush UH C	104 MBH (Hot Water)	$2,500	<$10
UH-4	Unit Heater	HV-144	Dunham Bush UH C	104 MBH (Hot Water)	$2,500	<$10
UH-5	Unit Heater	HV-144	Dunham Bush UH C	104 MBH (Hot Water)	$2,500	<$10
UH-6	Unit Heater	HV-118	Dunham Bush UH B	18 MBH (Hot Water)	$2,500	<$10
CONV-1	Baseboard	SF-A-26	AirTherm SF-A-26	1,125 BTU	$ 500.00/ft.	<$10
CONV-2	Baseboard	SF-A-26	AirTherm SF-A-26	1,125 BTU	$ 500.00/ft.	<$10
CONV-3	Baseboard	SF-A-26	AirTherm SF-A-26	1,125 BTU	$ 500.00/ft.	<$10
CONV-4	Baseboard	SF-A-26	AirTherm SF-A-26	1,125 BTU	$ 500.00/ft.	<$10
HWP-1	HW Pump	Series 80 2.5x2.5x9.5B	Baldor EJMM3218T	5 HP	$5,200	<$10
HWP-2	HW Pump	Not on Drawings	Baldor EJMM3218T	5 HP	$5,200	<$10
P-1-P-4	Circulator Pump	Not on Drawings	Grundfos UPS43-100F	1/3 HP	$3,800	<$10
DHW	Domestic HW	Not on Drawings	Bock 241E ASME	109 Gal, 277 MBh	$8,200	$25
ACCU-1	Cond. Unit	TTAA180B3	TTA180B300CC	35 Ton	$22,500	$100
ACCU-2	Cond. Unit	38AN012	Mitsubishi MU12NN	1 Ton Split System	$3,900	$25
ACCU-3	Cond. Unit	38AN012	Mitsubishi MU12NN	1 Ton Split System	$3,900	$25
CF-1,2	Ceiling Fan	5600-1	AirPear	Air Pear	$2,600	<$10
VFD-1,2	VFD	Not on Drawings	HVX00511B1	5 HP	$4,900	<$10
B-1-B-3	Boiler	Not on Drawings	Bosch GE315/8	663 MBh	$42,500	<$10

The major equipment was also compared against industry standard, both in terms of usable service life and current applicable energy efficiency requirements. This table is included below.

Tag	Equip Type	Age	Service Life	Rated Eff	2018 Code	Size
RTU-1	Rooftop	20 yr	15 yr	9.5 SEER	11.0 EER	35 Ton
RTU-2	Rooftop	20 yr	15 yr	10 SEER	10.8 EER	3 Ton
AHU-1	Air Handing Unit	21 yr	15 yr	9.3 EER	11.0 EER	15 Ton
ACCU-1	Condensing Unit	20 yr	20 yr	9.3 EER	11.0 EER	35 Ton
ACCU-2, 3	Condensing Unit	20 yr	20 yr	11.3 EER	10.8 EER	1 Ton
B-1 - B-3	Boiler	2 yr	30 yr	86.50%	82%	663 MBh

While we are not recommending the wholesale replacement of all equipment at or near the end of the usable service life, one pathway to do so would be to hire a design firm to create a Request for Proposal (RFP) package, detailing the requirements of the project, which can then be used to send the project out to bid. These packages include equipment narratives and detailed instructions for creating the bid package, and also can include as-built HVAC and electrical drawing sets when deemed necessary. A budgetary estimate for hiring a design team to create an RFP package such as this would be roughly $7,000 with a drawing set. The majority of this fee is for the as-built drawings, and a package that does not include drawings would be more economical.

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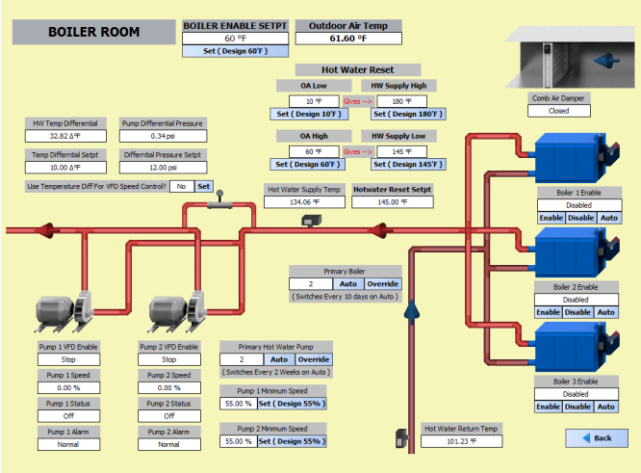
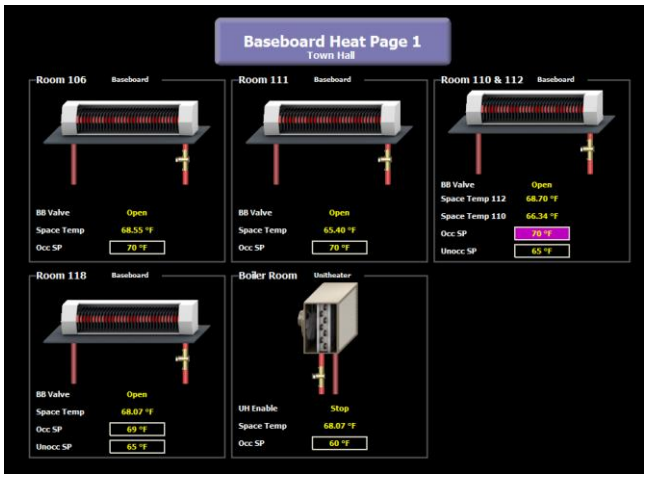
ENERGY MANAGEMENT SYSTEM

The Energy Management System (EMS) is a KMC-Controls BacNet compliant DDC system installed in 2013. ASHRAE rates electronic controls systems with a (15) year life expectancy. The system allows for the automated operation of all major HVAC systems in the building. This includes equipment operating schedules, environmental setpoints ranges, and operational sequences, which dictate the operational behavior of the equipment based on a series of inputs from sources such as environmental sensors, timers, and other HVAC equipment.





The control sequences were analyzed for completeness and for energy efficiency additions, both in terms of additional points and advanced programming. With the exception of the small number of changes included in the Recommended Measures section, the sequences were found to be complete and appropriate for the building.

A point-to-point test was conducted of the building EMS system. This consisted of verifying that the output control points operated the intended equipment as expected when a range of commands were sent, and that input measurement points reported readings that were within acceptable ranges, and that the reported readings varied appropriately with changing conditions. The results of this testing are shown in the table below.

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Berlin Municipal Building Point-to-Point Checkout				Notes
AHU-1 and RTU-2		PASS	FAIL	
RCO2-L	CO2 level return air RTU-2	X		
MA-T	mixed air temp RTU-2	X		
RA-RH	return air RTU-2 relative humidity	X		
MA-T	mixed air temp AHU-1	X		
RA-T	return air temp RTU-2	X		
RCO2-L	CO2 level return air AHU-1	X		
RA-RH	return air AHU-1 relative humidity	X		
MAD-O	RTU-2 mixed air damper output	X		
MAD-O	AHU-1 mixed air damper output	X		
AHU-1				
SF-S	supply fan status	X		
SMK-A	duct smoke alarm			Did not test due to building occupancy
FZ-A	freeze stat alarm			Did not test due to building occupancy
SF-C	supply fan command	X		
DX1-C	cooling stage 1			Did not test due to outdoor temperature
S-P	static pressure	X		
DA-T	discharge air temperature	X		
RCO2-L	return CO2 level	X		
RA-RH	return air relative humidity	X		
MA-T	mixed air temperature	X		
HTG-O	heating valve output	X		
BYP-O	bypass dampers output	X		
Basement Radiation 1				
106BB-C	106 baseboard rad valve command	X		
106RM-T	106 room temperature	X		
110BB-C	110 baseboard rad valve command	X		
110RM-T	110 room temperature	X		
111BB-C	111 baseboard rad valve command	X		
111RM-T	111 room temperature	X		
112BB-C	112 baseboard rad valve command	X		
112RM-T	112 room temperature	X		
118BB-C	118 baseboard rad valve command	X		
118RM-T	118 room temperature	X		
BRM-C	boiler room UH command	X		
BRM-T	boiler room temperature	X		
Basement Radiation 2				
113RM-T	113 room temperature	X		
MRM-T	mens room temperature		X	HW valve stuck open, not accepting commands
STR-T	stairwell temperature	X		
COR1-T	corridor 1 room temperature	X		
COR2-T	corridor 2 room temperature	X		
SE-T	side entry temperature	X		
113BB-C	113 baseboard command	X		
MRM-C	mens room baseboard command	X		
STR-C	stairwell baseboard command	X		
COR1-C	corridor 1 baseboard command	X		
COR2-C	corridor 2 baseboard command	X		
SE-C	side entry baseboard command	X		
113-SP	room 113 dial setpoint	X		
Boiler Pump 1				
P1-S	pump 1 status	X		
P2-S	pump 2 status	X		
P1-C	pump 1 command	X		
P2-C	pump 2 command	X		
B1-EN	boiler 1 enable	X		
CAD-C	combustion air damper command	X		
B2-EN	boiler 2 enable	X		
B3-EN	boiler 3 enable	X		
HWS-T	hot water supply temperature	X		
OA-T	outdoor air temperature	X		

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Boiler Pump 1 (cont.)		PASS	FAIL	
HWR-T	hot water return temperature	X		
OA-RH	outdoor air relative humidity	X		
D-P	differential pressure	X		
OACO2-L	outdoor air CO2 level	X		
P1-O	pump 1 speed output	X		
P2-O	pump 2 speed output	X		
P1-FB	pump 1 speed feedback	X		
P2-FB	pump 2 speed feedback	X		
Police/Fire Unit Heaters				
G1-T	garage UH 1 temp	X		
G2-T	garage UH 2 temp	X		
G3-T	garage UH 3 temp	X		
G4-T	garage UH 4 temp	X		
G1-C	garage UH 1 command	X		
G2-C	garage UH 2 command	X		
G3-C	garage UH 3 command	X		
G4-C	garage UH 4 command	X		
Zone Damper 1				
RTUSMK-A	rtu-1 duct smoke alarm			Did not test due to building occupancy
RTU1FZ-A	rtu-1 freeze stat alarm			Did not test due to building occupancy
ZN1-T	zone 1 temperature	X		
BZND-C	basement zone damper command	X		
ZN1D-O	zone 1 damper output	X		
Zone Damper 2-23				
ZN2-T	zone 2 temperature	X		
ZN2-O	zone 2 damper output	X		
ZN3-T	zone 3 temperature	X		
ZN3-O	zone 3 damper output	X		
ZN4-T	zone 4 temperature	X		
ZN4-O	zone 4 damper output	X		
ZN5-T	zone 5 temperature	X		
ZN5-O	zone 5 damper output	X		
ZN6-T	zone 6 temperature	X		
ZN6-O	zone 6 damper output	X		
ZN7-T	zone 7 temperature	X		
ZN7-O	zone 7 damper output	X		
ZN8-T	zone 8 temperature	X		
ZN8-O	zone 8 damper output	X		
ZN9-T	zone 9 temperature	X		
ZN9-O	zone 9 damper output	X		

AIRFLOW TESTING

A survey was conducted, measuring the supply airflow from each of the diffusers connected to AHU-1, RTU-1, and RTU-2, when the zone damper was locked at 100% open. The total CFM of each unit was within expected ranges. Due to the addition of VFDs on the Supply Fan motors, comparing the absolute CFM of each diffuser to the output specified on the drawings is no longer an appropriate measure. We did, however, compare the diffuser airflow distribution for each zone (% of total zone CFM for each diffuser) to the distribution specified on the drawings. Comparing these figures showed a wide disparity between the two figures. Generally speaking, the zone CFM % indicated on the drawings showed little to no relation to the % of the actual diffusers. This indicates the need to conduct an air system Test and Balance (TAB) procedure.

EQUIPMENT MAINTENANCE

All HVAC equipment requires some level of regular maintenance. A 1-page review of the manufacturer's recommended maintenance has been included in Appendix B for reference. These checklists are meant only to supplement the manufacturer's official documentation, which will accompany this report in pdf form.

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Frequently, regular servicing is done through a service contract with a 3rd party. While many levels of contracts are available, a base contract, involving quarterly equipment checks and filter monitoring/replacement, along with annual belt replacement and tensioning would cost approximately $5,800 annually for this building.

WATER FIXTURE EFFICENCY

The fixtures in the facility generally do not meet low-flow standards. The EPA has published guidelines under the WaterSense program that guide facility owners through the selection of water efficient equipment. See the Appendix C for details regarding the EPA WaterSense program.

Berlin Municipal Building Water Fixture Survey					
Room Description	**Fixture Description**	**GPM GPF**	**Source of Flow Data**	**Notes**	**Low Flow Standard**
210 Men's	H/C Toilet	1.6	Toilet rating	Unable to disassemble.	Dual Flush 1.28/1.0 gpf
210 Men's	Toilet	1.5	Flushometer	Sloan A-163	Dual Flush 1.28/1.0 gpf
210 Men's	Basin	1.5	Aerator rating	Excessive sediment	WaterSense Compliant
210 Women's	H/C Toilet	1.5	Flushometer	Sloan A-15-A	Dual Flush 1.28/1.0 gpf
210 Women's	Toilet	1.6	Toilet rating	Unable to disassemble.	Dual Flush 1.28/1.0 gpf
210 Women's	Basin	2.2	Aerator rating	Excessive sediment	WaterSense Compliant
225 Break Room	Sink	1.5	Aerator rating		WaterSense Compliant
LL Women's	H/C Toilet	1.6	Toilet rating	Unable to disassemble.	Dual Flush 1.28/1.0 gpf
LL Women's	Toilet	1.5	Flushometer	Sloan A-15-A	Dual Flush 1.28/1.0 gpf
LL Women's	Basin	0.5	Aerator rating	Drain insulation is falling off.	WaterSense Compliant
LL Men's	H/C Toilet	1.5	Flushometer		Dual Flush 1.28/1.0 gpf
LL Men's	Toilet	1.6	Toilet rating	Unable to disassemble.	Dual Flush 1.28/1.0 gpf
Dispatch	Sink	2.2	Aerator rating	Excessive sediment	WaterSense Compliant
Dispatch Restroom	Toilet	1.6	Toilet rating	Unable to disassemble.	Dual Flush 1.28/1.0 gpf
Dispatch Restroom	Basin	2.2	Aerator rating	Excessive sediment	WaterSense Compliant
Men's Lockers	Urinal	1	Flushometer	Sloan A-19-A	0.5 gpf
Men's Lockers	Basin	2.2	Aerator rating	Excessive sediment	WaterSense Compliant
Men's Lockers	Toilet	1.6	Toilet rating	Unable to disassemble.	Dual Flush 1.28/1.0 gpf
Men's Lockers	Shower 1	2.5	Shower rating		2.0 gpm showerhead
Men's Lockers	Shower 2	2.5	Shower rating		2.0 gpm showerhead
Women's Lockers	Toilet	1.6	Toilet rating	Unable to disassemble.	Dual Flush 1.28/1.0 gpf
Women's Lockers	Basin	2.5	Aerator rating		WaterSense Compliant
Women's Lockers	Shower	2.5	Shower rating		2.0 gpm showerhead
Breakroom	Sink	2	Aerator rating		WaterSense Compliant
Booking	Sink	???		No rating on aerator	1.5 gpm aerator
Cell 1	Sink/Toilet Combo	???		Acorn Industries unit.	No standard
Cell 2	Sink/Toilet Combo	???		Acorn Industries unit.	No standard
Cell 3	Sink/Toilet Combo	???		Acorn Industries unit.	No standard
Men's Lockers	Left Toilet	1.6	Toilet rating	Unable to disassemble.	Dual Flush 1.28/1.0 gpf
Men's Lockers	Right Toilet	1.6	Toilet rating	Unable to disassemble.	Dual Flush 1.28/1.0 gpf
Men's Lockers	Urinal	1	Urinal rating	Unable to disassemble.	0.5 gpf
Men's Lockers	Left Basin	???		No rating on aerator	WaterSense Compliant
Men's Lockers	Right Basin	???		No rating on aerator	WaterSense Compliant
Men's Lockers	Left Shower	2.5	Shower rating		2.0 gpm showerhead
Men's Lockers	Right Shower	???		No rating on showerhead	2.0 gpm showerhead
Women's Lockers	Toilet	1.6	Toilet rating	Unable to disassemble.	Dual Flush 1.28/1.0 gpf
Women's Lockers	Basin	???		No rating on aerator	1.5 gpm aerator
Women's Lockers	Left Shower	2.5	Shower rating		2.0 gpm showerhead
Women's Lockers	Right Shower	2.5	Shower rating		2.0 gpm showerhead
Day Room	Sink	2	Aerator rating		1.5 gpm aerator
Decon Room	Shower	???		No rating on showerhead	2.0 gpm showerhead

The estimated total costs to replace all of the fixtures in the building with WaterSense compliant fixtures would be $3,000. The Berlin Municipal Building sources water from a well, and does not pay a per gallon fee. Due to this, the paybacks are long enough that cost savings would not be a motivating factor, and savings information has not been calculated.

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RECOMMENDED MEASURES

Financial Analysis							
ECM	**ECM Description**	**Total Project Cost [$]**	**Total Estimated Incentive [$]**	**Final Cost [$]**	**Annual Cost Savings [$]**	**Simple Rate of Return**	**Payback [years]**
1	DHW Circulator Pump	$15,000	$79	**$14,921**	**$41**	0.3%	364.4
2	Boiler OA Reset/Combustion	$6,000	$0	**$6,000**	**$375**	6.3%	16.0
3	Boiler Flue	$17,500	$0	**$17,500**	**$0**	0.0%	N/A
4	DHW Thermometer	$500	$0	**$500**	**$0**	0.0%	N/A
5	HHW Thermometer	$500	$0	**$500**	**$0**	0.0%	N/A
6	AHU-1 Airflow	$65,000	$1,000	**$64,000**	**$8,121**	12.7%	7.9
7	AHU-1 Setbacks	$15,000	$0	**$15,000**	**$2,072**	13.8%	7.2
8	AHU-1 Scheduling	$1,000	$0	**$1,000**	**$654**	65.4%	1.5
9	AHU-1 Economizer	$35,000	$4,055	**$30,946**	**$2,108**	6.8%	14.7
10	AHU Condensate Drain	$500	$0	**$500**	**$0**	0.0%	N/A
11	Temperature Controls	$1,650	$124	**$1,526**	**$750**	49.2%	2.0
12	Basement Ventilation	$13,500	$1,000	**$12,500**	**$800**	6.4%	15.6
Totals		**$171,150**	**$6,258**	**$164,892**	**$14,921**	**9.0%**	**11.1**

Annual Savings Data								
		Electric Rate ($0.13/kWh)		**Fuel Oil Rate ($2.45/gal)**				
ECM	**ECM Description**	**Electric Savings [kWh]**	**Electric Savings [$]**	**Oil Savings [gal]**	**Oil Savings [$]**	**MMBtus Saved**	**% MMBTU Savings**	**Total Cost Savings [$]**
1	DHW Circulator Pump	315	$41	0	$0	1	0.0%	$41
2	Boiler OA Reset/Combustion	323	$42	136	$333	20	0.7%	$375
3	Boiler Flue	0	$0	0	$0	0	0.0%	$0
4	DHW Thermometer	0	$0	0	$0	0	0.0%	$0
5	HHW Thermometer	0	$0	0	$0	0	0.0%	$0
6	AHU-1 Airflow	19,841	$2,579	2,262	$5,542	380	13.2%	$8,121
7	AHU-1 Setbacks	2,707	$352	702	$1,720	106	3.7%	$2,072
8	AHU-1 Scheduling	0	$0	267	$654	37	1.3%	$654
9	AHU-1 Economizer	16,218	$2,108	0	$0	55	1.9%	$2,108
10	AHU Condensate Drain	0	$0	0	$0	0	0.0%	$0
11	Temperature Controls	495	$64	280	$686	40	1.4%	$750
12	Basement Ventilation	916	$119	278	$681	41	1.4%	$800
Totals		**40,815**	**$5,306**	**3,925**	**$9,616**	**680**	**23.6%**	**$14,921**

Measure 1 – DHW Circulator Pump

The 1/6 HP domestic hot water (DHW) circulator pump runs 24/7. We recommend replacing the circulator motor with an ecm motor that will operate off of a differential temperature control on the return water connection.

Measure 2 – Boiler OA Reset and Combustion Air

There is a 50 degree difference between supply and return temp sensors. Boilers are commanded on off of the return temp, causing them to be called to run continuously, yet they are cycling off of high temp at local control. There are no boiler statuses on the controls, so combustion air damper is always called to open. We recommend that boilers run off of outside air reset, rather than local controls. Further, we recommend the addition of boiler status points to allow for combustion air to modulate to match the firing rate and to close when the boiler is off.

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Measure 3 – Boiler Flue

The boiler flue system for the (3) boilers is improperly designed and sized. The combined flue piping is single-walled aluminum, and feeds into a brick chimney that has a 400 square inch inside area. The single walled piping allows for excessive flue gas cooling, and the chimney is too large to allow for a proper updraft to occur. We recommend that the existing flue pipe be demolished, and double walled aluminum flue pipes be installed for each of the (3) boilers. These will run in the same path as the existing flue pipe, and their length will be extended to the full length of the brick chimney. This will allow for up drafting to occur. While not an energy saving measure, this will improve operating processes.

Measure 4– Domestic Hot Water Thermometer

The domestic hot water thermometer in the mechanical room was observed with air gaps in the mercury line. We recommend the thermostat be replaced. While not an energy saving measure, this will improve operating processes.

Measure 5 – Heating Hot Water Thermometer

The heating hot water thermometer in the mechanical room was improperly secured in place, and can easily be removed. It is recommended that it properly be strapped into place to ensure accurate measurement. While not an energy saving measure, this will improve operating processes and ensure proper readings by the BAS.

Measure 6 – AHU-1 Airflow

AHU-1 currently runs in a constant volume mode, with zone level dampers to adjust the volume downstream. We propose to install a VFD on the supply fan and set the system up to run on an enhanced Demand Control Ventilation (DCV) scheme involving not just outside air level, but also modulating the total air volume. This VFD will have three stages: Off (0%), Cooling 1 (50%), and Cooling 2 (100%). Cooling 1 and 2 will activate the compressors independently, and the compressors will be set up to activate lead/lag based on lifetime runtime. This will also entail eliminating/blocking the two supply/return by-passes in the attic. We will utilize the existing VFD on RTU-1, controlled with a VFD based upon building differential pressure.

Measure 7 – AHU-1 Setbacks

Zone control damper (VVT) systems appear to allow any (1) zone of VVT to drive the condition of the RTU/AHU (heating or cooling). Reprogramming this system and establishing appropriate minimum positions on the zones will allow for the implementation of a true “majority rules” operation; cutting back greatly on overheating and overcooling at the zone level. What we're looking at is setback savings for the entire building. Not a full setback from 70 down to 60. More like a few degrees such as 72 down to 66F - due to removing the sloppy link in control sequencing. This will be done via a majority rules zone control methodology and a demand response based upon return air temperature.

Measure 8 – AHU-1 Scheduling

Every zone on AHU-1 currently is on a 24/7 occupied schedule, while large sections of the conditioned area are occupied for reduced hours. It is recommended that each area with a unique occupied schedule be designated as such in the BAS, and set for an unoccupied conditioning range during unoccupied times.

Measure 9 – AHU-1 Economizer

AHU-1 was observed with one compressor running with an outdoor temperature of 66F. This is an indication that the economizer may not be functioning properly. The programming should be set up to allow for free cooling (economizer mode) during all periods when the OAT is lower than the temperature setting of the zone calling for cooling.

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Measure 10 – RTU Condensate Drain

During the walkthrough, the RTU condensate drain pipe was observed to have broken off, and was lying next to the unit. This can cause moisture to backflow into the unit. It is recommended that the drain pipe be re-attached or replaced.

Measure 11 – Temperature Controls

The perimeter baseboard heat and the RTU cooling run independently. Due to this, competitive simultaneous heating and cooling can occur. To avoid this, two steps are recommended: Adjust the RTU cooling and baseboard heating to have an appropriately large deadband, and as a failsafe, each zone baseboard should be locked out if zone cooling is active.

Measure 12 – Basement Ventilation

The basement outside air system is currently constant volume, 100% outside air, with no conditioning. We recommend installing a VFD to the fan, with operations tied to a newly installed CO_2 detector installed in Meeting Room 112. We also recommend the installation of a HW coil on the primary duct. The HW coil will be supplied through a tertiary loop off the adjacent boilers. The intake for the duct is in an area near idling vehicles. We recommend that a high efficiency filter be installed near the intake, and that a CO sensor be installed in the duct, that will activate an automatic shutoff under adverse conditions.

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Retro-Commissioning Corrective Actions Log

Site: Berlin Public Safty Complex
Main Point of Contact: Greg Tremelling

Issue #	Equip Tag	Issue Description	Recommended Action	Action Taken	Issue Status	Resolution Date
VFDs-1	HHW VFDs	11/28/17 - The HHW pump VFDs were observed sending a 0% signal to the pumps, yet each VFD had its cooling fan running constantly during our visit	11/28/17 - Change control strategy for VFDs, such that the 2nd VFD remains off until the 1st is commanded to run at 1% or greater. Once VFD 1 is running, then power VFD 2 up for backup.		Open	
DHW Pump-1	DHW Pump	11/28/17 - The 1/6 HP domestic hot water (DHW) circulator pump runs 24/7.	11/28/17 - Replace the circulator motor with an ecm motor that will operate off a differential temperature control on the return water connection.		Open	
Boilers-1	B-1, B-2, B-3	11/28/17 - All three (3) boilers were observed activating simultaneously, and deactivating simultaneously, rather than operating independently.	11/28/17 - BAS programming change that allows the boilers to stage on as heating demand increases. The programming should also select the boiler with the lowest total runtime to be the next activated, ensuring that each receives equivalent runtime.	04/12/18 - Boilers tested fine during April analysis. Staging properly	Closed	4/12/2018
Boilers-2	B-1, B-2, B-3	11/28/17 - There is a 50 degree difference between supply and return temp sensors. Boilers are commanded on off of the return temp, causing them to be called to run continuously, yet they are cycling off of high temp at local control. There are no boiler statuses on the controls, so combustion air damper is always called to open.	11/28/17 - Boilers should run off of outside air reset, rather than local controls. Further, we recommend the addition of boiler status points to allow for combustion air to modulate to match the firing rate and to close when the boiler is off.		Open	
Boilers-3	B-1, B-2, B-3	11/28/17 - The boiler flue system for the (3) boilers is improperly designed and sized. The combined flue piping is single-walled aluminum, and feeds into a brick chimney that has a 400 square inch inside area. The single walled piping allows for excessive flue gas cooling, and the chimney is too large to allow for a proper updraft to occur.	11/28/17 - Existing flue pipe should be demolished, and double walled aluminum flue pipes be installed for each of the (3) boilers. These will run in the same path as the existing flue pipe, and their length will be extended to the full length of the brick chimney.		Open	
Boilers-4	B-1, B-2, B-3	11/28/17 - The (3) boiler flue stacks on each of the boilers has a manual damper installed. This is an unnecessary component.	11/28/17 - These manual dampers should be permanently locked in the fully open position.	04/11/18 - The dampers have been observed to be locked in a fully open position.	Closed	4/11/2018
Boilers-5	B-1, B-2, B-3	11/28/17 - The (3) boiler flue stacks have backdraft dampers. One has recently been replaced, and the other two, older dampers are not air tight, and leak flue gas into the mechanical room.	11/28/17 - Replacement of the two older backdraft dampers is recommended.	04/11/18 - The dampers have been observed to be capped off and are no longer an issue.	Closed	4/11/2018
DHW-1	DHW	11/28/17 - The domestic hot water thermometer in the mechanical room was observed with air gaps in the mercury line. This makes it unable to give an accurate reading.	11/28/17 - The thermostat should be replaced.		Open	
HHW-1	HHW	11/28/17 - The heating hot water thermometer in the mechanical room was improperly secured in place, and can easily be removed.	11/28/17 - The thermometer should be properly be strapped into place to ensure accurate measurement.		Open	
AHU-1-1	AHU-1	11/28/17 - AHU-1 currently runs in a constant volume mode, with zone level dampers to adjust the volume downstream.	11/28/17 - We recommend installing a VFD on the supply fan and setting the system up to run on an enhanced Demand Control Ventilation (DCV) scheme involving not just outside air level, but also modulating the total air volume. This VFD will have three stages: Off (0%), Cooling 1 (50%), and Cooling 2 (100%). Cooling 1 and 2 will activate the compressors independently, and the compressors will be set up to activate lead/lag based on lifetime runtime. This will also entail eliminating/blocking the two supply/return by-passes in the attic. We recommend utilizing the existing VFD on RTU-1, controlled with a VFD based upon building differential pressure.		Open	
AHU-1-2	AHU-1	11/28/17 - Zone control damper (VVT) systems appear to allow any (1) zone of VVT to drive the condition of the RTU/AHU (heating or cooling).	11/28/17 - Reprogram this system and establish appropriate minimum positions on the zones, allowing for the implementation of a true “majority rules” operation; cutting back greatly on overheating and overcooling at the zone level. This will result in setback savings for the entire building. This will be done via a majority rules zone control methodology and a demand response based upon return air temperature.		Open	
AHU-1-3	AHU-1	11/28/17 - Every zone on AHU-1 currently is on a 24/7 occupied schedule, while large sections of the conditioned area are occupied for reduced hours.	11/28/17 - Each area with a unique occupied schedule should be designated as such in the BAS, and set for an unoccupied conditioning range during unoccupied times.		Open	

Issue #	Equip Tag	Issue Description	Recommended Action	Action Taken	Issue Status	Resolution Date
AHU-1-4	AHU-1	11/28/17 - AHU-1 was observed with a one compressor running with an outdoor temperature of 66F. This is an indication that the economizer may not be functioning properly.	11/28/17 - The programming should be set up to allow for free cooling (economizer mode) during all periods when the OAT is lower than the temperature setting of the zone calling for cooling.		Open	
RTU-1-1	RTU-1	11/28/17 - The RTU condensate drain pipe was observed to have broken off, and was lying next to the unit. This can cause moisture to backflow into the unit.	11/28/17 - It is recommended that the drain pipe be re-attached or replaced.		Open	
RTU-1-2	RTU-1	11/28/17 - The perimeter baseboard heat and the RTU cooling run independently. Due to this, competitive simultaneous heating and cooling can occur.	11/28/17 - Adjust the RTU cooling and baseboard heating to have an appropriately large deadband, and as a failsafe, each zone baseboard should be locked out if zone cooling is active.		Open	
OA-1	OA System	11/28/17 - The basement outside air system is currently constant volume, 100% outside air, with no conditioning. Due to the lack of conditioning, the system is rarely used, resulting in both lack of outside air and high humidity levels.	11/28/17 - We recommend installing a VFD on the fan, with operations tied to a newly installed CO2 detector in Meeting Room 112. We also recommend the installation of a HW coil on the primary duct. The HW coil will be supplied through a tertiary loop off the adjacent boilers. The intake for the duct is in an area near idling vehicles. We recommend that a high efficiency filter be installed near the intake, and that a CO sensor be installed in the duct, that will activate an automatic shutoff under adverse conditions.		Open	
RTU-1-1	RTU-1	04/10/18 - EMS indicates that the Supply Air High and Low setpoints are 100F and 50F, yet the SAT setpoint is 121F.	04/10/18 - Troubleshoot on EMS	04/10/18 - Overridden the setpoint to 80F for testing. Could not identify issue. Contacted Automated Temperature Controls (ATC). They re-programmed to accept the High and Low limits.	Closed	4/11/2018
RTU-1-2	RTU-1	04/10/18 - The how water valve actuator is disconnected from the valve stem, and is not allowing the vavle to close completely	04/10/18 - Repair valve	04/10/18 - Re-connectred the actuator and valve stem. Tested fine.	Closed	4/10/2018
RTU-1-3	RTU-1	04/10/18 - Economizer Mode does not seem to be activating at appropriate times.	04/10/18 - Troubleshoot on EMS and at unit	04/10/18 - Verified that the damper and damper actuator are functioning as expected. Contacted ATC, who corrected the programming to optimize Economizer mode. Tested fine	Closed	4/11/2018
RTU-1-4	RTU-1	04/10/18 - Minimum damper setpoint on supply dampers appears to be 0%. This can not be changed via normal EMS navigation	04/10/18 - Troubleshoot on EMS	4/10/18 - Contacted ATC, who re-set the minimum damper position to 10%	Closed	4/11/2018
Bldg Inspector - 1	Bldg Inspect	4/10/18 - Zone is overheating. Upon inspection, a setting on the damper actuator was reversed, causing the damper to open when commanded closed, and vice cersa.	04/10/18 - Reverse setting on damper actuator	4/10/18 - Reversed setting on damper. Damper now operates as expected, and the room has returned to acceptable temperature range	Closed	4/10/2018
EMS-1	EMS	4/11/18 - Sub-sections of the control system are offline and have no connection. While the systems on this section are functioning under the last command given (so should be operating normally), no monitoring or operational tuning can occur.	04/10/18 - Troubleshoot on EMS	4/11/18 - Spot checked the systems by observin the zones, and appear to be operating normally. Contacted ATC to helpo resolve issue. 4/12/18 - ATC searched the systems one-by-one, and identified a supply air damper actuator in the Women's Locker Room that had broken. Once this was disconnected from the system, all other systems came back on-line and are functioning normally.	Closed	4/13/2018
BB-111-1	BB-111	4/11/18 - Baseboard in Men's Room on the lower level appears to have a valve stuck open. Not responding to commands from the EMS.	4/11/18 - Recommend valve testing/replacement		Open	

RTU-1 Maintenance

	Monthly	Annually
Fan Belt adjustment	X	
Filter inspection/replacement	X	
Check Drain Pan	Cooling Season	
Inspect Coils for debris and damage	Cooling Season	
Inspect F/A-R/A Damper Hinges and Pins	X	
Manually rotate condenser to ensure free movement	Cooling Season	
Verify Fan mounting hardware is tight	X	
Check Supply Fan motor bearings. Repair/replace as necessary	X	
Check Fan shaft bearings. Replace bearings as necessary	X	
Check Supply Fan belt. Replace as necessary	X	
Check condition of gasket around control panel doors.	X	
Verify Fan mounting hardware is tight	X	
Verify Terminal connections are tight	X	
Remove corrosion present on external surfaces and repaint	X	
Generally inspect unit for unusual conditions	X	
Clean Coils		X

For details and additional considerations, please see maintenance manual

RTU-2 Maintenance

	Monthly	Annually
Fan Belt adjustment	X	
Filter inspection/replacement	X	
Check return air Smoke Detector	X	
Check Drain Pan	Cooling Season	
Inspect Coils for debris and damage	Cooling Season	
Inspect F/A-R/A Damper Hinges and Pins	X	
Manually rotate condenser to ensure free movement	Cooling Season	
Verify Fan mounting hardware is tight	X	
Check Supply Fan motor bearings. Repair/replace as necessary	X	
Check Fan shaft bearings. Replace bearings as necessary	X	
Check Supply Fan belt. Replace as necessary	X	
Verify Fan mounting hardware is tight	X	
Verify Terminal connections are tight	X	
Remove corrosion present on external surfaces and repaint	X	
Generally inspect unit for unusual conditions	X	
Clean Coils		X

For details and additional considerations, please see maintenance manual

AHU-1 Maintenance

	Monthly	Annually
Check the unit wiring connections insulation	X	
Inspect the cooling coils for dirt and debris, clean as needed	X	
In cooling mode, check suction and discharge pressure.	X	
Check unit superheat		Cooling Season
Remove accumulation of dust/dirt from unit casing		Cooling Season
Remove any corrosion and re-paint.		Cooling Season
Check condition of gasket around control panel doors.		Cooling Season
Inspect control panel wiring connections and insulation		Cooling Season
Check refrigerated piping and fittings for leaks		Cooling Season
Inspect condenser coils for dirt and debris, clean as needed		Cooling Season

For details and additional considerations, please see maintenance manual

B-1, 2, 3 Maintenance

	Monthly	Bi-Annually
Clean Boiler with cleaning brushes		Heating Season
Wet-clean the boiler		Heating Season
Check the operating pressure		Heating Season
Refill with boiler water and purge system		Heating Season
Check general condition of heating system	Heating Season	
Visual inspection and function check of heating system	Heating Season	
Check fuel and water-carrying components for leaks, corrosion or aging	Heating Season	
Check combustion chamber and heating surfaces for contamination	Heating Season	
Check the burner	Heating Season	
Check the flue gas and venting system	Heating Season	
Check operating pressure and inlet pressure of the diaphram expansion vessel for heating systems	Heating Season	
Check the functgion of indirect-fired heater and ionization rod	Heating Season	
Check the control panel setting	Heating Season	

For details and additional considerations, please see maintenance manual

DHW Heater Maintenance

	Bi- Annually	Annually
Drain Tank and inspect for Lime deposits	X	
Open T&P Valve and ensure that seat moves freely		X
Check Vent system for damage and/or blockage		X

DHW Burner Maintenance

	Bi-Annually	Annually
Clean Blower wheel and motor, replace is necessary	X	
Check the Ignitor	X	

For details and additional considerations, please see maintenance manualS

FC-2,3 and ACCU-2,3 Maintenance

	Monthly	**Annually**
Check outdoor unit for debris and damage	X	
Verify Terminal connections are tight	X	
Check Air Filter. Clean and replace as necessary	X	

For details and additional considerations, please see service manual

Unit Heater Maintenance

	Monthly	**Annually**
Clean Heating Coil	X	
Clean Casing	X	
Clean Motor/Fan Assembly	X	
Purge hot water coil to avoid air locked condition		X

For details and additional considerations, please see maintenance manual

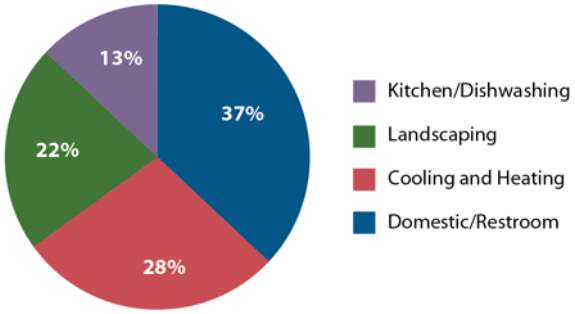
Saving Water in

Office Buildings

Commercial and institutional buildings use a large portion of municipally supplied water in the United States. With so many businesses making up the commercial and institutional sector, there are great opportunities to conserve water. *WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities* promotes water-efficient techniques that can be applied across a wide range of facilities with varying water needs.

Water used in office buildings accounts for approximately 9 percent of the total water use in commercial and institutional facilities in the United States.[1] The three largest uses of water in office buildings are restrooms, heating and cooling, and landscaping.

End Uses of Water in Office Buildings



Created by analyzing data from: New Mexico Office of the State Engineer, American Water Works Association (AWWA), AWWA Research Foundation, and East Bay Municipal Utility District.

THE BUSINESS CASE FOR WATER EFFICIENCY

Over the past 10 years, the costs of water and wastewater services have risen at a rate well above the consumer price index. Office building managers can expect these and other utility costs to continue to increase in order to offset the costs of replacing aging water supply systems.

The business benefits of implementing water-efficiency measures in and around office buildings can include

reducing operating costs, as well as meeting sustainability goals. In addition to water savings, facilities will see a decrease in energy costs because of the significant amount of energy associated with heating water.

Energy saved from reducing the amount of water supplied will not only save money, but reduce the building's carbon footprint as well. Many commercial building managers are subject to sustainability goals, which can be met by decreasing water and energy use.

Likewise, water-efficient practices can assist with achieving green certifications and demonstrating leadership in environmental management.

Because bathroom plumbing fixtures account for a significant portion of water use in office buildings, it is smart to assess the age and functionality of existing fixtures.

Putting Water Efficiency to Work

After upgrading its irrigation system, an office complex in Plano, Texas, reduced its outdoor water use by about 40 percent, saving nearly 12.5 million gallons of water in 2009. These retrofits helped the office complex earn water-efficiency credits toward LEED® Gold certification and saved more than $47,000 in 2009. With these savings, the project paid for itself in less than a year and a half!

High-performing, WaterSense labeled fixtures are now available that use at least 20 percent less water than standard models. Upgrades or retrofits can save money and often have short payback periods.

WaterSense at Work provides guidance that can help office buildings operate more water efficiently, which is good for sustainability and the bottom line.

USING WATERSENSE AT WORK

More information on operations, maintenance, and user education of equipment and processes within office buildings can be found in the following sections of *WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities*:

- Section 1: Getting Started
- Section 2: Water Use Monitoring and Education
- Section 3: Sanitary Fixtures and Equipment
- Section 4: Commercial Kitchen Equipment
- Section 5: Outdoor Water Use
- Section 6: Mechanical Systems
- Section 7: Laboratory and Medical Equipment
- Section 8: Onsite Alternative Water Sources

Look for the Label

- Install WaterSense labeled showerheads, toilets, and flushing urinals where appropriate.
- WaterSense labeled products have been independently certified to be at least 20 percent more water-efficient and perform as well or better than standard models.
- Check automatic sensors on faucets, toilets, and urinals to ensure they are operating properly and avoid unnecessary water use.

Water Landscapes Wisely

- Design water-smart landscapes that provide beautiful surroundings while reducing water needed for irrigation.
- Improve irrigation efficiency by hiring a professional certified through a WaterSense labeled program to audit an existing system or design and install a water-efficient system.
- Cut down on water loss from evaporation, wind, and runoff by replacing existing clock timers with WaterSense labeled irrigation controllers.

Keep Cooling Towers Cool

- Implement energy-efficiency measures to reduce the need for building and equipment cooling and heating, which will reduce amount of water required by these systems.
- Keep indoor temperatures at a comfortable setting while increasing the efficiency of cooling towers, evaporative coolers, and boilers by using alternative sources of water, such as air handler condensate and captured rainwater.
- Monitor cooling tower and boiler water chemistry to minimize the mineral buildup in the system and maximize the number of times water can be recycled through the system.

For more information or to download a copy of *WaterSense at Work*, visit the WaterSense website at **www.epa.gov/watersense/commercial**.

[1]Dziegielewski, et al. 2000. *Commercial and Institutional End Uses of Water*. American Water Works Association Research Foundation.
[2]2009. *Water Use in Buildings SmartMarket Report.* McGraw-Hill Construction.

WaterSense® Labeled

Bathroom Sink Faucets & Accessories

Most of us know we can save water if we turn off the tap while brushing our teeth (as much as 3,000 gallons per year!), but did you know that there are products that will help save water when you turn on the tap too? WaterSense labeled faucets and faucet accessories (e.g., aerators) are high-performing, water-efficient fixtures that will help you reduce water use in your home and save money on water bills.

FAUCET FLOWS

WaterSense labeled bathroom sink faucets and accessories that use a maximum of 1.5 gallons per minute can reduce a sink's water flow by 30 percent or more from the standard flow of 2.2 gallons per minute without sacrificing performance. We could save billions of gallons nationwide each year by retrofitting bathroom sink faucets with WaterSense labeled models.

All products bearing the WaterSense label complete a third-party certification process to ensure they meet U.S. Environmental Protection Agency (EPA) criteria. Faucets and faucet accessories—products that can be attached easily to existing faucets to save water—that obtain the WaterSense label have demonstrated both water efficiency and the ability to provide ample flow.

WATERSENSE SAVINGS

Replacing old, inefficient faucets and aerators with WaterSense labeled models can save the average family 700 gallons of water per year, equal to the amount of water needed to take 40 showers. Since these water savings reduce demands on water heaters, households will also save enough energy to run a hairdryer 10 minutes a day for a year. Achieving these savings can be as easy as twisting on a WaterSense labeled aerator, which can cost as little as a few dollars. If every home in the United States replaced existing faucets and aerators with WaterSense labeled models, we could save nearly $1.2 billion in water and energy costs and 64 billion gallons of water across the country annually—equivalent to the annual household water needs of more than 680,000 American homes.

WaterSense labeled bathroom faucets and aerators can save the average family 700 gallons of water per year.

LOOK FOR THE WATERSENSE LABEL!

Whether replacing an older, inefficient faucet, or looking to reduce water in your bathroom, choose a WaterSense labeled sink faucet or faucet accessory. WaterSense labeled models are available at a wide variety of price points and styles. In many areas, utilities offer rebates and vouchers that can lower the price further. For more information or a list of WaterSense labeled products, visit www.epa.gov/watersense.

WaterSense® Labeled

Flushometer-Valve Toilets

Flushometer-valve toilets are usually found in commercial, institutional, or industrial facilities. Switching to a WaterSense labeled flushometer-valve toilet could save a typical business nearly $1,000 over the lifetime of the toilet.

Flushometer-valve toilets, also known as flushometer-valve water closets in plumbing standards, are typically found in such places as airports, theaters, stadiums, schools, and office buildings. The water closet has two main components—the toilet bowl and the flushometer valve.

The U.S. Environmental Protection Agency (EPA) estimates that about 26 percent, or 7 million, of the 27 million flushometer-valve toilets currently installed in commercial and institutional facilities nationwide flush at volumes higher than the 1.6 gallons per flush (gpf) federal standard—some as much as 3.0 to 7.0 gpf.

SMART FLUSHING

EPA's specification sets the maximum flush volume for WaterSense labeled flushometer-valve toilets at 1.28 gpf, or 20 percent less water than the federal standard. The maximum flush volume applies to both single- and dual-flush toilets.

WaterSense has also incorporated a minimum flush volume of 1.0 gpf to ensure plumbing systems have adequate flow to function effectively. Facility managers should consult a plumbing engineer if they have questions about using WaterSense labeled flushometer-valve toilets in their building.

Valves and bowls can be tested and labeled separately or as a complete system. To ensure that the individual components can be used in combination to meet WaterSense's requirements for efficiency and performance, consult the product information provided by the manufacturer and choose a flushometer valve and toilet fixture that have compatible flush volumes, as indicated on the WaterSense website.

WATERSENSE SAVINGS

By replacing old, inefficient flushometer-valve toilets with WaterSense labeled models, a 10-story office building with 1,000 occupants can save nearly 1.2 million gallons of water and more than $10,000 in water costs per year. Of those savings, nearly 870,000 gallons of water and $7,600 in water costs per year can be achieved by replacing the toilets in the women's restrooms alone.

If commercial facilities nationwide replaced all of their older, inefficient flushometer-valve toilets with WaterSense labeled models, we could save nearly 39 billion gallons of water per year. That's equivalent to nearly one full day's flow of water over Niagara Falls!

LOOK FOR THE WATERSENSE LABEL

Like all WaterSense labeled products, flushometer-valve toilets are independently certified for performance and efficiency. For more information, visit www.epa.gov/watersense.

EPA-832-F-13-003
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WaterSense® Labeled

Urinals

Urinals can account for a significant portion of indoor water use in commercial and institutional settings. A typical office building could reduce its water use from old, inefficient urinals by 26,000 gallons per year or more. While the current federal standard for commercial urinals is 1.0 gallon per flush (gpf), some older urinals use as much as five times that amount!

FLUSH WITH EFFICIENCY

Replacing these inefficient fixtures with WaterSense labeled flushing urinals can save between 0.5 and 4.5 gallons per flush, without sacrificing performance. The WaterSense label helps purchasers easily identify high-performing, water-efficient products. Installing WaterSense labeled flushing urinals will not only reduce water use in facilities, but also save money on water bills.

WaterSense labeled flushing urinals use no more than 0.5 gpf and comply with existing standards for flushing urinals. To ensure adequate performance, urinals must also be independently certified to ensure that they flush effectively and have properly functioning drain traps before they can earn the WaterSense label.

WATERSENSE SAVINGS

Replacing just one older, inefficient urinal that uses 1.5 gpf with a WaterSense labeled model could save a facility more than 4,600 gallons of water per year. Nationwide, if all older, inefficient urinals were replaced, we could save nearly 36 billion gallons annually. That's equal to the amount of water that flows over Niagara Falls in 21 hours!

Each WaterSense labeled flushing urinal can save a facility more than 4,600 gallons of water per year.

LOOK FOR THE WATERSENSE LABEL!

Whether looking to reduce water use in a new facility or to replace old, inefficient fixtures in men's restrooms, builders, designers, managers, and other specifiers can look for the WaterSense label to identify high-performing, water-efficient urinals. For more information or a list of WaterSense labeled products, visit www.epa.gov/watersense.

TO FLUSH OR NOT TO FLUSH?

While there are also urinals that don't use water available on the market today, the WaterSense specification is only for flushing urinals. WaterSense has posted clarification guidance for its partners on non-water-using urinals; for more information, please visit www.epa.gov/watersense/partners/urinals_final.html.

WaterSense® Labeled

Showerheads

Showering is one of the leading ways we use water in the home, accounting for 20 percent of residential indoor water use. For the average family, that adds up to nearly 40 gallons per day. That's nearly 1.3 trillion gallons of water used in the United States annually just for showering, or enough to supply the water needs of New York and New Jersey for more than 18 months! By retrofitting your showerheads with WaterSense labeled models, you can save a considerable amount of this water.

SHOWER WITH POWER

Did you know that standard showerheads use 2.5 gallons of water per minute (gpm)? Showerheads that earn the WaterSense label must demonstrate that they use no more than 2.0 gpm. The WaterSense label also ensures that these products provide a satisfactory shower that is equal to or better than conventional showerheads on the market. The U.S. Environmental Protection Agency (EPA) worked with a variety of stakeholders—including consumers who tested various showerheads—to develop criteria for water coverage and spray intensity. All products bearing the WaterSense label must be third-party certified to ensure they meet EPA water efficiency and performance criteria.

WATERSENSE SAVINGS

The average family could save 2,700 gallons of water per year by installing WaterSense labeled showerheads. Since these water savings will reduce demands on water heaters, they will also save energy. The average family could save more than 330 kilowatt hours of electricity annually, or the amount it takes to power a house for 11 days. On a national scale, if every home in the United States installed WaterSense labeled showerheads, we could save more than $2.9 billion in water utility bills and more than 260 billion gallons of water annually. In addition, we could avoid more than $2.5 billion in energy costs for heating water.

WaterSense labeled showerheads could save the average family 2,700 gallons of water per year.

LOOK FOR THE WATERSENSE LABEL!

Whether you are replacing an older, inefficient showerhead or simply looking for ways to reduce water use and utility bills in your home, look for the WaterSense label when purchasing showerheads to help you identify models that save water and perform well.

In many areas, utilities offer rebates and vouchers that can lower the price of a WaterSense labeled showerhead. For more information or a list of WaterSense labeled products, visit www.epa.gov/watersense.