

**Project Description**  
**Town of Acton**  
**Public Safety Building**  
**EMS Modifications and Retro-Commissioning**  
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## **Table of Contents:**

Building Description .....	Page 3
Existing Energy Usage .....	Page 6
Scope of Work EMS Upgrade.....	Page 7
Graphic Upgrades.....	Page 9
Detail Sequence of Operation.....	Page 10
Summary of Savings.....	Page 14

## Building Description

The facility is a 26,108 square foot, two floor, four (4) year old modern, mix use facility. The main building is approximately 22,433 square feet and provides conditioned space for the Police and Fire Chiefs, Dispatch, 911 room, administrative offices, conference rooms, Emergency Operations Center (EOC), data center, interview rooms, detention center, locker rooms, and showers. Also, there is an outbuilding that is a half open carport and half enclosed space (for munitions, bulk evidence, and maintenance shop) that is approximately 3675 square feet. The facility is open and operational 24 hours per day, 7 days per week (168 hours per week). The Dispatch Room has a dedicated HVAC system to accommodate its 24/7 operation while the rest of the building maybe in the un-occupied mode. The building envelope consists of red brick over masonry, some wood siding, double glazed windows, and an asphalt shingled roof. The building is well insulated and very air tight.

### Lighting & Controls

The primary fluorescent lighting systems consist of electronically ballasted fixtures outfitted with T8 lamp(s) with reflectors. The hallways and offices have motion sensors, which were observed to be doing an excellent job of turning off lights when not in use. There are (10) 250 watt metal halide (MH) outdoor fixtures that operate on a dusk to dawn photo eye.

### Boiler Plant

The boiler plant consists of a gas-fired HydroTherm Multitemp® hot water modular-boiler, model MF-1200BPV. The modular boilers total input rating is 1,200,000 BTU per hour, and output rating is 960,000 BTU per hour. The nominal efficiency rating is 80%. Each of the four modules is rated at 300,000 BTUs per hour. Two (2) modules are available for indirect (tankless) domestic hot water generation. There are two (2) variable speed primary hot water pumps (P-1, and P-2) rated at 80 gpm at 40' of head, operated in a lead / lag fashion. Each pump has a 2 hp Baldor Super-E motor, wired for 200 volts. This system is not monitored or controlled by the Tridium Honeywell Building Automation System (BAS). The boiler plant is enabled whenever the outdoor air temperature (OAT) is below 65 °F. Heating hot water is provided to cabinet unit heaters (CUHs), unit heaters (UHs), reheat coils associated with air handler unit (AHU) -1, and AHU-2 variable air volume (VAV) terminal boxes (TBs), and hot water coils associated with AHU-3 and AHU-4. A Tekmar controller 132 "Pump Sequencer" is supposed to alternate the lead and lag pump. There is another controller (S-1000) that is supposed to reset the boiler leaving water temperature as a function of OAT, and override the hot water reset whenever the shell and tube heat exchanger calls for heat for domestic hot water system.

### HVAC

The primary facility is served by four (4) York air-handlers that provide heating and air-conditioning. Hot water cabinet unit heaters and hot water unit heaters provide heat at stairwells and mechanical rooms. The building is normally occupied from 6AM to 6 PM Monday through Friday and one half hour before or after each police shift change 7AM, 3PM, and 11PM. Detention is seldom occupied. The conference room/Emergency Operations Center is occupied less than 10 hours per week.

**AHU-1** operates 24x7, and serves the first floor except for Dispatch and Computer Room. It is a variable air volume (VAV) system outfitted with variable speed drives (VSDs), and direct expansion (DX) R-22 refrigerant coil that feeds eleven (11) VAV boxes with hot water reheat coils. The reheat coils are outfitted with 2-way modulating valves. The supply fan is outfitted with a 5 hp VSD, and the return fan is outfitted with a 2 hp VSD. The average VAV Box minimum is 75 % or the maximum. Since the reheat

pumps are off all summer almost all spaces are sub-cooled. The conference room/Emergency Operations center has a manual over ride button for unscheduled occupants.

**AHU-2** operates 24x7, and serves the second floor. It is a variable air volume (VAV) system outfitted with variable speed drives (VSDs), and direct expansion (DX) R-22 refrigerant coil that feeds nine (9) VAV boxes with hot water reheat coils. The reheat coils are outfitted with 2-way modulating valves. The supply fan is outfitted with a 15 hp VFD, and the return fan is outfitted with a 5 hp VFD. The average VAV Box minimum is 77 % or the maximum. Since the reheat pumps are off all summer almost all spaces are sub-cooled. The two training rooms and conference room served by AHU # 2 have a manual over ride buttons for unscheduled occupants.

**AHU-3** operates 7 days a week, and serves the first floor conference room/Emergency Operations Center. It is a constant air volume (CAV) system, even though it has a variable speed drive (VSD) on its return fan. It has a hot water coil outfitted with a 2-way modulating valve, and a direct expansion (DX) R-22 refrigerant coil. The reheat coils are outfitted with 2- way modulating valves. Supply fan has a 5 hp motor (no VFD), and the return fan is outfitted with a 2 hp VFD (fixed speed 50%). AHU # 3 has a manual over ride buttons for unscheduled occupants.

**AHU-4** operates 24x7, and serves the first floor detention center. It is a constant air volume (CAV) system outfitted with a hot water coil outfitted with a 2-way modulating valve, and a direct expansion (DX) R-22 refrigerant coil. The supply fan has a 1 hp motor, and there is no return fan. The ¼ hp exhaust fans must run continuously. The detention cells do not have smoke alarms in them. The smoke alarms are located in the return air duct work. To operate correctly the exhaust fan and therefore the AHU must operate continuously. Currently the space temperatures are maintained at the occupied set point.

**Air-cooled condensers for specialized areas** - IT reports that server loads have not significantly increased during past four years.

- PFH067A-YL3 (serial) 0426N93539 = 5 tons (Dispatch 2hp)
- PFH014A-PL3 (serial) 0426N93532 = 1 ton (upstairs data closet 0.2hp)
- PFH037A-YL3 (serial) 0426N93519 = 3 tons (911 Room 0.5hp)
- Armory – 0.75 tons

## **HVAC Controls**

The AHUs and VAV boxes are controlled by a Honeywell Tridium JACE. The original Tridium JACE system graphics package and program parameters were lost/deleted in 2009. A new vendor installed a new expanded Honeywell Tridium JACE and attempted to re-create the graphics package. This activity corresponds with a 25% increase in gas usage and 15% in electric usage after taking into account differences in weather. These increases are easily seen when we compare the 07/08 and 08/09 utility data to the 09/10 and 10/11 utility data. Please see the utilities section for further details. The AHU graphic package was not fully restored. The Boiler graphics do not exist on the new Honeywell Tridium JACE. A Tekmar controller 132 "Pump Sequencer" determines the led pump. There is a HydroTherm model S-1000 Outdoor Air Reset Sequence Controller that reset the boiler leaving water temperature as a function of OAT. The pumps are manually turned on in early October and turned off in late May come online whenever the OAT is 65 °F, or below.

**Domestic Hot Water (DHW)**

Domestic hot water is produced by a Ruud electric domestic hot water heater with integral 85 gallon storage tank. The two stages of the heating boilers are only used as emergency back-up capacity.

# Existing Energy Use

## Natural Gas

The gas usage has increased 25% when we compare the most recent two (2) years to the previous two (2) years. This is most likely due to the new Tridium controls package not mirroring the old Tridium controls package, and possibly an increase in ventilation air. The following is a table is a summary of raw natural gas consumption and weather normalized natural gas consumption.

HDD/d	Days in Period		Therm Equiv. Weather Adjusted 2010-2011	Therm Equiv. Weather Adjusted 2009-2010	Therm Equiv. Weather Adjusted 2008-2009	Therm Equiv. Weather Adjusted 2007-2008	Therm Equiv. Raw 2010-2011	Therm Equiv. Raw 2009-2010	Therm Equiv. Raw 2008-2009	Therm Equiv. Raw 2007-2008
0.02	30	Jul	-147	34	-184	-46	0	0	0	0
0.16	32	Aug	-143	48	-184	-39	0	0	0	0
3.06	34	Sep	163	333	69	195	149	707	12	32
14.46	28	Oct	1,153	1,185	912	924	710	1,350	853	753
22.83	29	Nov	1,967	1,918	1,595	1,537	1,754	1,804	1,691	1,946
34.90	31	Dec	3,296	3,118	2,708	2,538	2,915	3,387	2,967	2,669
40.84	31	Jan	3,883	3,642	3,201	2,978	3,784	2,831	3,031	2,389
37.38	30	Feb	3,427	3,229	2,820	2,634	3,830	2,758	2,669	2,652
27.67	29	Mar	2,415	2,319	1,971	1,873	2,725	2,095	1,996	2,017
15.28	32	Apr	1,401	1,428	1,113	1,118	1,864	1,149	1,087	1,211
8.00	25	May	514	597	382	439	329	459	138	302
2.02	33	Jun	49	225	-25	107	0	0	0	0
	364	Total	<b>17,978</b>	<b>18,076</b>	<b>14,378</b>	<b>14,256</b>	<b>18,060</b>	<b>16,540</b>	<b>14,444</b>	<b>13,971</b>

The electric usage has increased 15% when we compare the most recent two (2) years to the previous two (2) years. This is most likely due to the new Tridium controls package not mirroring the old Tridium controls package, potential issues with the economizer controls, DAT reset programs, and perhaps an increase in minimum ventilation air (fresh air).

CDD/d	day		kWh Weather Adjusted 2010-2011	kWh Weather Adjusted 2009-2010	kWh Weather Adjusted 2008-2009	kWh Weather Adjusted 2007-2008	kWh Raw 2010-2011	kWh Raw 2009-2010	kWh Raw 2008-2009	kWh Raw 2007-2008
11.30	30	Jul	66,820	72,588	55,400	49,919	64,680	52,320	49,800	41,520
7.48	31	Aug	58,936	62,840	50,812	45,979	60,360	67,200	45,240	44,400
4.26	31	Sep	50,389	52,554	45,373	41,242	51,360	48,000	40,200	40,200
0.52	30	Oct	39,169	39,314	37,805	34,594	40,680	38,520	34,800	35,160
0.11	31	Nov	39,405	39,337	38,384	35,155	38,880	36,840	32,280	32,280
0.00	30	Dec	37,844	37,720	36,962	33,860	36,600	35,640	35,400	33,120
0.00	31	Jan	39,106	38,977	38,194	34,989	37,680	36,600	36,360	33,960
0.00	31	Feb	39,106	38,977	38,194	34,989	38,160	37,560	38,520	35,160
0.00	28	Mar	35,321	35,205	34,498	31,603	34,320	33,720	36,120	33,360
0.00	31	Apr	39,106	38,977	38,194	34,989	39,000	39,000	39,000	36,360
0.47	30	May	39,041	39,160	37,723	34,523	40,320	41,520	45,840	34,080
3.79	31	Jun	49,149	51,063	44,585	40,555	51,480	52,920	44,760	46,200
	365		<b>533,393</b>	<b>546,714</b>	<b>496,122</b>	<b>452,396</b>	<b>533,520</b>	<b>519,840</b>	<b>478,320</b>	<b>445,800</b>

## Scope of Work EMS Upgrade

The existing EMS system serving the Acton Public Safety Building is a Honeywell Tridium JACE. The current graphics are incomplete with equipment missing. The boilers and heating hot water pumps are controlled by stand-alone controls that are coordinated with the EMS system. In addition to upgrading and completing the graphic package we are:

- adding CO2 based demand controlled ventilation
- eliminate the stand alone heating controls and program the EMS to perform these functions
- change the turn down ratio of the VAV boxes
- modify the scheduling
- add un-occupied cooling set point
- change the sequence of operation

Install CO2 sensors in the return air plenum of AHU # 1, #2, and # 3. Install wall mounted CO2 sensors in Training Room #1 and # 2 (VAV boxes 2-1 and 2-2) and second floor Conference Room (VAV box 2-3). The sensors shall be self-calibrating with an accuracy of plus or minus 50 PPM or 2 % of scale.

The existing four (4) Hydrotherm modular boilers are currently divided into two (2) stages of control with RIB relays from the existing Hydrotherm S-1000 Sequence controller. Using the existing relays control the heating supply water temperature based on outdoor temperature by sequencing the number of stages on line. The default schedule is 130 °F at 70 °F and 180 °F at 0 °F (adjustable). Install a return water sensor in an existing well on the return header. The heating hot water pumps flows are controlled by VSD's, the led pump runs all the time, and the led pump is rotated by a Tekmar controller. Since the building does not use reheat during the summer the pumps shall be programmed to run when outdoor air temperature is below 55 °F (adjustable). In addition the heating hot water pumps will be scheduled to operate from Oct 15<sup>th</sup> through May 31<sup>st</sup>. The VSD drives shall be controlled to maintain the current pressure setting (adjustable). On the graphics include which pump is on line, supply and return water temperature, number of stages firing, VSD speed, and pressure set point.

The VAV Box turn down ratios shall be adjusted to the following schedule:

VAV Box #	Area Served	Max. CFM	Min. CFM
1-1	Fire Chief Office	425	100
1-2	Deputy Fire Chief Office	560	110
1-3	Administration Asst. Fire	720	150
1-4	1st Floor Lobby	675	135
1-5	Corridor 132	375	75
1-6	Evidence	325	100
1-7	Records	550	110
1-8	Corridor 136	300	60
1-9	Patrol LT	330	100
1-10	Shift SGT	955	200

1-11	Lunch Room	275	55
2-1	Training # 1	1,050	210
2-2	Training # 2	600	120
2-3	Conference	1,000	200
2-4	Administration LT	680	140
2-5	2nd Floor Lobby	300	60
2-6	Police Chief	405	100
2-7	Interview	675	135
2-8	Female Locker	225	45
2-9	Physical Training	530	110
2-10	Youth Office	450	100
2-11	Detectives	500	100
2-12	Prosecutor	500	100
2-13	Male Locker	1,075	215

AHUs # 2 serve Police and Fire administrative spaces and shift change spaces. Currently it operates 24/7. Re-program occupied operation from 5AM to 6PM Monday through Friday and morning warm-up operation one half hour before and after shift changes 7AM, 3PM, and 11PM (see detail sequence of operation).

AHU # 3 runs all the time. It serves the conference room/ emergency management center. Most activities are scheduled in advance. The room temperature sensor has an override button for unscheduled activities. The unit shall be shutdown unless there is a scheduled or override event (see detail sequence of operation).

AHU # 4 and EF # 3 runs all the time. The AHU serves detention spaces. The smoke alarm is located in the exhaust fan intake instead of cells. If EF #3 does not run the smoke alarms go off therefore the HVAC equipment must run 24/7. Currently the space does not have set back set points. We will institute set back with dispatch over ride.

None of the spaces have an un-occupied cooling set point. Without an un-occupied set point when spaces are in the un-occupied mode the system cools to the un-occupied heating set point resulting in over cooling of the space.

Remove the old un-used Tridium JACE.

## Graphic's Changes

The fan static set point shall be converted from metric to SI units. The set point shall be added to the AHU # 1 & 2 graphics.

Develop a separate graphic page for VAV box summary table. Table will include name, space, Occ/unocc, damper position, box flow value, eff flow SP, center Si, Eff SP, Space Temp, Reheat valve position, supply air temp if available, Occ Heat SP, Occ Cool SP.

On Graphic's front page pick up AC# 1 (Communication Equipment) and AC # 3 (Dispatch) space temperature for monitoring only.

Add a graphic for the boiler room including number of stages calling, which pump led, supply and return water temperatures, pump speed, pump power, and control pressure.

## **Detail Sequence of Operations**

### **AHU # 1**

Morning warm-up and outdoor air flush – Shall be a one hour period when the AHU is started prior to occupancy and 6:30AM to 7:30AM, 2:30PM-3:30PM, and 10:30PM 11:30PM seven days a week. AHU # 1, RF # 1, and Exhaust fan # 4 & 5 (Forensic Cabinet & 1<sup>st</sup> floor exhaust) shall start. VAV boxes 1-1 through 1-11 shall open 100%. The outdoor air damper shall open to minimum position (20%). The two stages of cooling shall be sequenced based on the number of spaces calling for cooling. If outdoor air temperature is between 40 and 63 °F dry-bulb economizer shall override cooling and the exhaust damper shall open to correspond to the outdoor air damper position minus 20%. The supply and return fan speed shall be varied to maintain existing static pressure setting (adjustable).

Occupied (6AM to 6PM Monday through Friday) – During the occupied AHU # 1, RF # 1, and Exhaust fan # 4 (forensic Cabinet) shall run. The supply and return fan speed shall be varied to maintain existing static pressure setting (adjustable). The two-stages of cooling shall be sequenced based on the number of spaces calling for cooling. If outdoor air temperature is between 40 and 63 °F dry-bulb economizer shall override cooling and the exhaust damper shall open to correspond to the outdoor air damper position. The outdoor air damper shall open 30%. The return air CO2 shall be monitored and maintained at 800 PPM plus or minus 50 PPM (adjustable) by modulating open the outdoor air damper above minimum setting.

Un-Occupied (all other times)-

### **AHU # 2**

Morning warm-up and outdoor air flush – Shall be a one hour period when the AHU is started prior to occupancy and 6:30AM to 7:30AM, 2:30PM-3:30PM, and 10:30PM 11:30PM seven days a week. AHU # 2 supply fan, RF # 2, and Exhaust fan # 1 (2<sup>nd</sup> floor exhaust) shall start. VAV boxes 2-1 through 1-13 shall open 100%. The outdoor air damper shall open to minimum position (20%). The two stages of cooling shall be sequenced based on the number of spaces calling for cooling. If outdoor air temperature is between 40 and 63 °F dry-bulb economizer shall override cooling and the exhaust damper shall open to correspond to the outdoor air damper position minus 20%. The supply and return fan speed shall be varied to maintain existing static pressure setting (adjustable).

Occupied (6AM to 6PM Monday – Friday) – During the occupied AHU # 2, and RF # 2, shall run. The supply and return fan speed shall be varied to maintain existing static pressure setting (adjustable). The two stages of cooling shall be sequenced based on the number of spaces calling for cooling. If outdoor air temperature is between 40 and 63 °F dry-bulb economizer shall override cooling and the exhaust damper shall open to correspond to the outdoor air damper position. The outdoor air damper shall open 3% Minimum position. The return air, training room #1, Training Room # 2, and 2<sup>nd</sup> floor conference room CO2 shall be monitored and maintained at 800 PPM plus or Minus 50 PPM (adjustable) by modulating open the outdoor air damper above minimum setting to a maximum of 40%.

If the outdoor air temperature is below 50°F (adjustable) the stages of mechanical cooling shall be disabled.

**AHU # 4 set points**

Occupied Heating 70°F (adjustable)

Occupied Cooling 74°F (adjustable)

Un-Occupied Heating 55°F (adjustable)

Un-Occupied Cooling 80°F (adjustable)