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American Recovery and Reinvestment Act (ARRA)

Federal Energy Management Program

Technical Assistance Project 279

IMCOM-Southeast Region: Redstone Arsenal

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September 2010

Pacific Northwest
NATIONAL LABORATORY

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U.S. Department of Energy
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and the U.S. Army Installation Management Command Southeast
under Contract DE-AC05-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99352

Executive Summary

PNNL staff held the Building Retuning workshop at Redstone Arsenal, Huntsville, Alabama May 17-19, 2010. The workshop consisted of 1 day of classroom training and 2 days of hands-on training. Six staff members from the Directorate of Public Works' (DPW) energy management office and the base maintenance contractor attended the workshop. The primary goal of the class is to examine current heating, ventilation, and air conditioning (HVAC) operations and to present no- and low-cost energy-saving ideas that can be incorporated on a daily basis to improve both energy efficiency and operations. The hands-on retuning sessions focused on the Sparkman Center, the Von Braun Complex, and Building 4488.

Going forward, the general recommendation for Redstone Arsenal is to systematically select large facilities and, if possible, implement the no- and low-cost measures presented in the class. It is recommended that a small team, consisting of an engineer, an energy manager and a technician, works as a group to implement measures and observe the results.

The first issue that should be addressed pertains to the occupied and unoccupied settings. A control scheme that checks night temperatures and perhaps humidity would allow the air handlers to be off for a significant amount of time. The control scheme should also close all outside air makeup systems, leave exhaust fans off during morning warm-up, and institute high and low limits during night and weekend operations. The last issue that should be addressed is to fix the hot water reheat systems. This would allow them to run at much lower temperatures and to lock out the pumps during nights, weekends, and holidays. It would also allow them to lock out the pumps if the water exceeds an upper temperature set-point, when reheat may not be required.

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Description of ARRA Program

On February 13, 2009, Congress passed the American Recovery and Reinvestment Act (ARRA) of 2009 at the urging of President Obama, who signed it into law 4 days later. A direct response to the economic crisis, the Recovery Act has three immediate goals:

- Create new jobs and save existing ones
- Spur economic activity and invest in long-term growth
- Foster unprecedented levels of accountability and transparency in government spending.[1]

The Installation Management Command, Southeast Region (IMCOM-Southeast) submitted three proposed projects for ARRA funding, offering 50% co-funding on each task. The Region was awarded the following projects:

- Building Retuning Training
    - Fort Gordon Retuning Training (IMCOM-funded)
    - Redstone Arsenal Retuning Training (ARRA-funded)
- Renewable Energy Assessment
    - Fort Gordon (ARRA-funded)
    - Installation TBD (IMCOM-funded)
- Solar Hot Water
    - Installation of metering equipment on nine buildings at Fort Campbell to study hot water usage patterns (IMCOM-funded)
    - Solar hot water system analysis and forecasting (ARRA-funded).

The report documents the findings during the Building Retuning Training workshop at Redstone Arsenal, Huntsville, Alabama.

[1] Source: http://www.recovery.gov/

Background

The IMCOM mission is to provide the Army with the installation capabilities and services to support expeditionary operations in a time of persistent conflict, and to provide a quality of life for soldiers and families commensurate with their service. [2]

The Region is responsible for delivering all facets of installation support including care of soldiers and families; morale welfare and recreation; education services, food and laundry; religious support; force protection; fire and emergency services; public works; environmental compliance; residential housing; and execution of DoD Base realignment.

IMCOM-Southeast, which was activated Oct. 1, 2002, uses a host of innovative business practices, such as common levels of support, competitive sourcing, and a business improvement methodology that maximizes shareholder value by achieving the fastest rate of improvement in customer satisfaction, cost, quality, process speed, and invested capital to effectively manage Army installations.

The IMCOM-Southeast team includes Anniston Army Depot, Blue Grass Army Depot, Fort Benning, Fort Bragg, Fort Buchanan, Fort Campbell, Fort Gordon, Fort Jackson, Fort Knox, Fort McPherson, Fort Polk, Fort Rucker, Fort Stewart, Holston Army Ammunition Plant, Milan Army Ammunition Plant, Mississippi Army Ammunition Plant, MOT Sunny Point, Pine Bluff Arsenal, Redstone Arsenal, and US Army Garrison, Miami (see Figure 1).

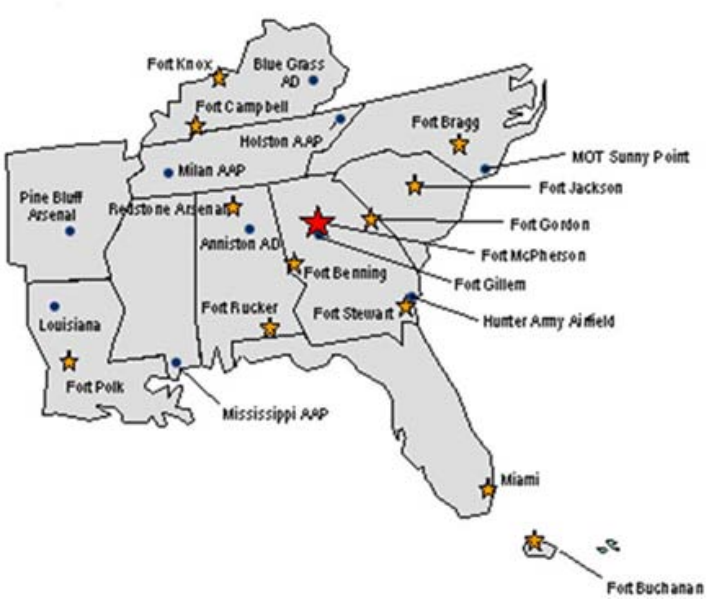

Figure 1. IMCOM-Southeast Installations

The Region supports the senior commander on each installation by relieving him/her of the requirement to oversee day-to-day garrison operations. The

[2] Source: IMCOM HQ Website. http://www.imcom.army.mil/hq/about/mission/

Region exercises installation management, provides for public safety, provides for sound stewardship of resources, executes community and family support services and programs, and maintains and improves installation infrastructure.

IMCOM-Southeast is one of six regions under the Installation Management Command, which is headquartered at Arlington, Virginia. IMCOM was first organized as the Installation Management Agency in 2002. In 2006, IMCOM was activated as a three-star command that includes the former Installation Management Agency, the former Community and Family Support Center and the Former Army Environmental Center under a single command as a direct reporting unit.[3]

[3] Source: IMCOM-Southeast website. http://www.imcom.army.mil/regions/southeast/about/history/.

Task Description: Building Retuning Training

Periodic retuning of building controls and heating, ventilation and air conditioning (HVAC) systems can help eliminate operation faults and improves building efficiency. *Retuning is a systematic, semi-automated process of detecting, diagnosing, and correcting operational problems with building systems and their controls*. The retuning process can significantly increase energy efficiency at low or no cost – and the impact is immediate. Unlike the traditional retro-commissioning approach, which has a broader scope, retuning primarily targets HVAC systems and their controls. In addition, retuning uses monitored data, when available, to assess building operations even before conducting a building walk through.

Pacific Northwest National Laboratory's (PNNL) developed a building retuning and retro-commissioning course for the State of Washington (http://buildingefficiency.labworks.org/lg_bldg_training.stm). Since its development, it has been expanded and customized for other government organizations and private corporations. The course is targeted at operations and maintenance (O&M) staff, HVAC technicians, controls specialists, and energy management staff. After completing the course, the participants are asked to continue the process on their own, retuning additional buildings and reporting the results back to the instructors. The idea is to train the people who can affect real change at an installation rather than always bringing in outside "experts" to retune buildings.

Site Description

Redstone Arsenal was built in 1941 to produce conventional chemical ammunition for use in World War II. For more than 40 years, Redstone has been the heart of the Army's rocket and missile programs. Dr. Werner von Braun and his German rocket experts developed the first ballistic missile; this led to the establishment of National Aeronautic and Space Administration's (NASA's) Marshall Space Flight Center in 1960. Today, Redstone is home to the U.S. Army Aviation and Missile Command (AMCOM), the Space and Missile Defense Command, numerous Program Executive Offices (PEO), and major components of the Defense Intelligence Agency and the Missile Defense Agency. Also located here are numerous tenant and satellite organizations. Redstone is approximately 37,910 acres and contains 11.7 million square feet of building space. Population includes 157,223 soldiers (active, retired, and dependents) and 27,620 civilian employees.[4]

PNNL staff held the Building Retuning workshop at Redstone Arsenal, Huntsville, Alabama May 17-19, 2010. The workshop consisted of 1 day of classroom training and 2 days of hands-on training. Six staff members from the Directorate of Public Works' (DPW) energy management office and the base maintenance contractor attended the workshop. The central goal of the class is to examine current HVAC operations and to present no- and low-cost energy-saving ideas that can be incorporated on a daily basis to improve both energy efficiency and operations.

[4] Source: http://www.garrison.redstone.army.mil/sites/about/facts.asp

Building-Specific Findings

Sparkman Center

The Sparkman Center is a campus-style complex, consisting of 992,390 square feet in nine structures: one five-story, one four story, six three-story, and one one-story. The complex provides administrative facilities for over 3,000 staff, in addition to special purpose space for functions such as automated data processing, emergency operations, communications, special access programs, conferences and training. Also included are a cafeteria, physical fitness center, convenience store, snack bar, and service center (see Figure 2).[5]

Figure 2. Sparkman Center

During the hands-on portion of the retuning workshop, PNNL staff and class participants focused on Sparkman Center buildings 5307, 5308, and 5309.

The following observations were made while studying air-handling units in the buildings:

- Identified a 60-hp hot water system circulating pump that was running warmer than necessary and operating 24/7.
- No unoccupied modes were specified in the control system, even though most of the facility has long unoccupied periods.
- Discharge air temperature was set to 52°F, which is very low. The team tested the system at 60°F, and there was no immediate loss of zone control. The team left the system setting at 55°F, and they will continue to monitor the performance. Recommend a discharge air temperature reset program be added in all systems.
- Most variable air volume (VAV) boxes were running with high static pressure because the VAV dampers were nearly closed. The team

[5] http://www.redstone.army.mil/history/sparkman/welcome.html

changed the static pressure, lowering if from 1.5 down to 1.0 inches of water column with no apparent changes in room comfort. Reducing the static pressure on this one air handler is expected to save about $1,000 per year in electric cost. It appears that this change could be applied to most air handlers in the complex. The complex has 12 air handlers. Recommend running at a lower duct static, if possible, or programming in a reset schedule based on zone loading needs.

- The parking lot lights are on a normal clock, which requires maintenance staff to adjust the clock for time and seasonal changes. Recommend an astrological lighting time clock be installed with an off capability to turn off the lights at some late evening or early morning hours after all have gone home.
- This facility had steam supplied from the city on a year-around basis. Because the steam contract is a take-or-pay type of contract, the facility uses absorption chillers as their primary source of cooling, with electric chillers as the secondary source for producing chilled water. If the contract could be modified to better meet the needs of the arsenal's summer-time loads for steam, the coordination of the chillers at this facility could be modified to be more efficient.

Von Braun Complex

The Von Braun Complex houses the U.S. Army Space and Missile Defense Command (see Figure 3). Phase I of construction included completion of a four-story, 225,000 ft^2 administration building and a central plant, security room, and computer room. Phase II included a second four-story office building. Phase III included a six-story, 839,873 ft^2 administrative building and auditorium that will accommodate 2,649 occupants.

During the hands-on portion of the retuning workshop, PNNL staff and class participants focused on Buildings 5220, 5221, and 5222.

Figure 3. Von Braun Complex during Phase III Construction

Findings in these facilities were very similar to what was observed in the Sparkman Center. Recommendations focused around include hot water reheat settings and occupied mode issues.

The following observations were made when studying air-handling units in the buildings:

- Identified a hot water system circulating pumps that was running warmer than necessary and operating 24/7.
- No unoccupied modes were specified in the control system, even though most of the facility has long unoccupied periods.
- Most variable air volume (VAV) boxes were running with high static pressure because the VAV dampers were nearly closed. The team changed the static pressure, lowering if from 1.5 down to 1.0 inches of water column with no apparent changes in room comfort. Reducing the static pressure on this one air handler is expected to save about $1,000 per year in electric cost. It appears that this change could be applied to most air handlers in the complex. The complex has 12 air handlers. Recommend running at a lower duct static, if possible, or programming in a reset schedule based on zone loading needs.

Building 4488

Building 4488 is a 204,000 ft^2 three-story administrative building comprised of three parallel "wings" (see Figure 4). It should be noted that Building 5250 is nearly identical to Building 4488 and would be a good candidate for additional retuning activities.

Source: Microsoft Corporation Bing.com Maps

Figure 4. Building 4488 (front three "wings")

Building 4488 has a dual-duct system that could be analyzed through the direct digital control (DDC) control system.

- The team found hot decks and cold decks heating and cooling at the same time. This causes an excess of mixing at the boxes and is generally not required in a facility like this. During the visit, the building was in cooling mode, so the team locked out the heating decks on two air handlers. Zones became more comfortable with no cold zones reported. The team found one air handler whose cold deck motor operator had been replaced with the wrong style and was not operating. This cold deck was down to 45°F.
- No unoccupied modes were being used by the control system. Because some small zones require 24/7 cooling, a small chiller was installed so that the entire building would not have to be conditioned 24/7. However, the smaller chiller was no longer being used. Site staff members were going to check out the unoccupied switchover events and reactivate the unoccupied modes for the facilities. These six air handlers had about 60-hp supply fans and 30-hp returns, so a significant amount of energy could be saved by turning these systems off based on an occupied/unoccupied schedule including scheduled government holidays. In Table 1, we calculate the cost of a 60-hp motor running at full load and the 60-hp motor running at a reduced load (45-hp), which is where most fans run on normal day-to-day operation. Then, savings are calculated for various schedules at the reduced horsepower on one air handler.

  Table 1 shows the potential savings of using occupied/unoccupied schedule to turn off the 60-hp motor. The size of other motors may vary, but this is a good indicator of how much money could be saved by just adding an occupancy schedule for the hot water pump and only running it when it is needed.

Table 1. Potential Savings of Unoccupied Schedule on a 60-hp Motor

Horsepower	Kilowatts	Cost Electricity / kWh	Run Time, or Speed	Total Annual Cost (per fan)	% Savings	Annual Savings (per fan)
60 hp	44.76KW	.09 cents	24 hr / day; 365 days/ year	$35,289	0%	0.0
45 hp	33.57KW	.09 cents	24 hr / day; 365 days/ year	$26,465	0%	0.0
45 hp	33.57KW	.09 cents	24 hrs / day; 250 days/ year	$18,128	32%	$8,337
45 hp	33.57KW	.09 cents	12 hrs / day; 250 days/ year	$9,064	66%	$17,401
45 hp	33.57KW	.09 cents	10 hrs / day; 250 days/ year	$7,553	71%	$18,912

Conclusions

The 24/7 operating mode is the most common mode of operation that was observed while conducting field training. There appear to be several reasons for constant operation, but the most common is equipment cooling needs and some nighttime operations. In many facilities, the discharge air temperature appeared to be lower than normally required. In addition, most discharge static air pressures, although in a normal range, appeared to be higher than required for the operations, and the time and weather conditions observed during the site visit.

Zone temperature set points were found to be consistently set around 72°F. Temperature set points for cooling should be 76°F, and set points for heating should be 68°F, according to Army regulations. It is likely that set points were lowered to control humidity. Site staff should consider other measures like reducing outdoor air intake, when possible, to address humidity concerns.

In two of the complexes that the team visited, the hot water reheat systems were running above 160°F and operating 24/7. This combination negatively impacts both pumping cost and hot water heating cost. There appears to be an issue with the dielectric unions used in the system. The unions leak if the water in the system is allowed to cool to a certain temperature. This is a design issue and may be caused from an incorrect gasket or union during original construction. This is a major concern because it not only causes high energy use, but also appears to be a trend at this installation that PNNL has not seen at other locations. The specification for the Watts type of dielectric union states: “Rated to 180°F (82°C) at 250 psi (17.2 bar) with standard gasket A and 300ºF (149ºC) at 50 psi (3.4 bar) with optional gasket B”. It appears that the lower temperature gaskets may have been used and are deteriorating with time because the system is running at the upper limit of the design specifications for these gaskets.

Future Approach

Going forward, the general recommendations for Redstone Arsenal are to systematically select large facilities and, if possible, implement the no- and low-cost measures presented in the class. It is recommended that a small team, consisting of an engineer, an energy manager, and a technician, works as a group to implement measures and observe the results. After the first few facilities have been successfully retuned, this template can be used in many facilities throughout the installation.

The first issue that should be addressed pertains to occupied and unoccupied settings. The installation has started addressing this issue, and it appears that most of the systems could be configured to use setbacks. A control scheme that checks night temperatures and perhaps humidity would allow the air handlers to be off for a significant amount of time. The control scheme should also close all outside air makeup systems and leave exhaust fans off during morning warm-up and institute high and low limits during night and weekend operations. The last recommendation is to fix the hot water reheat systems. This would allow them to run at a much lower temperatures and to turn off the pumps during nights, weekends, and holidays. It would also allow them to turn off the pumps if the water exceeds an upper temperature set point, when reheat may not be required.

The installation runs on a modified 5-day work week; only half the staff members are there on Fridays. If control systems can be setup to match occupancy in a facility, an unoccupied 3-day weekend schedule could be applied to save significant energy in certain facilities.

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APPENDIX A
ATTENDEES LIST

Appendix A: Attendees List

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