GPG Outbrief 03

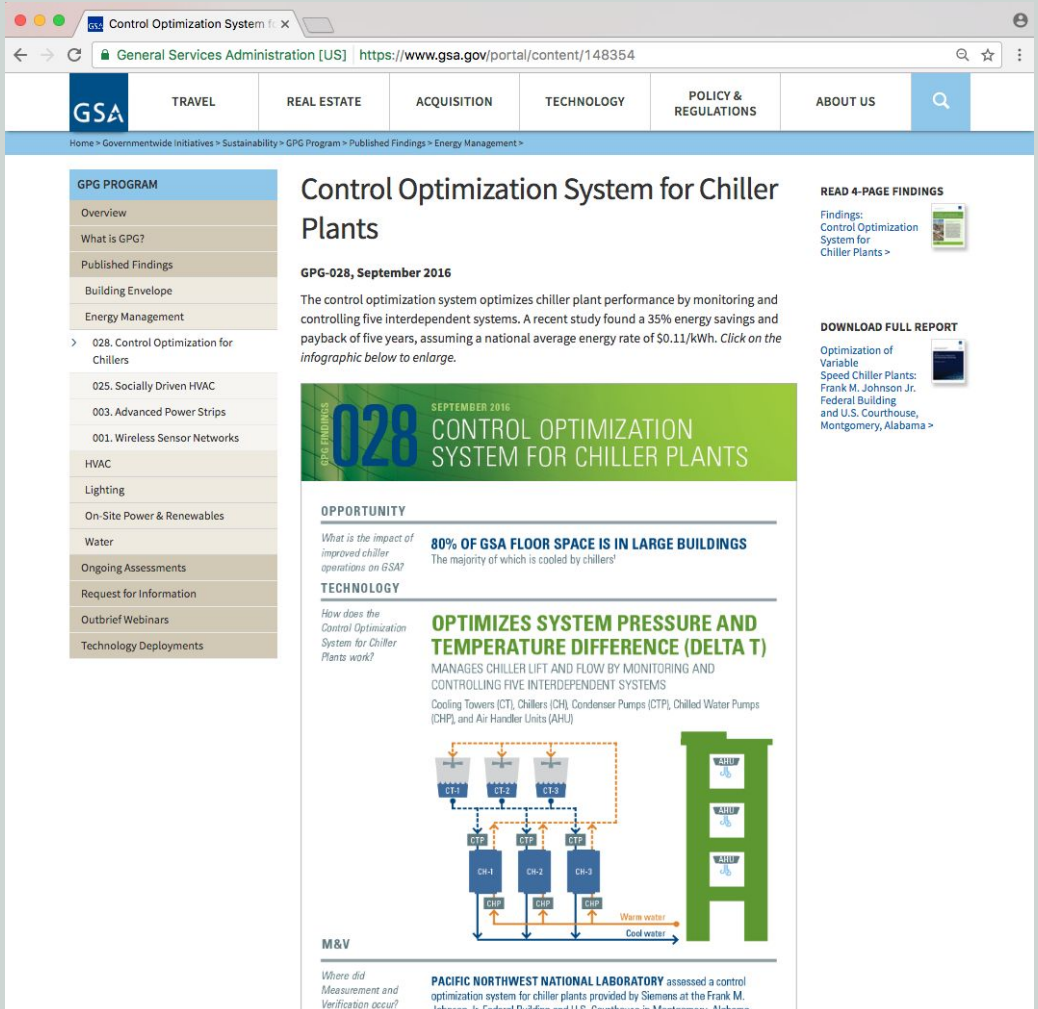
Chiller Plant Control Optimization System

GPG Program | U.S. General Services Administration | June 8, 2017

Reports Online

- Infographic
- 4-page Findings
- Full Report
- Additional Resources

www.gsa.gov/gpg



Upcoming GPG Outbriefs - Thursdays, 12 PM ET

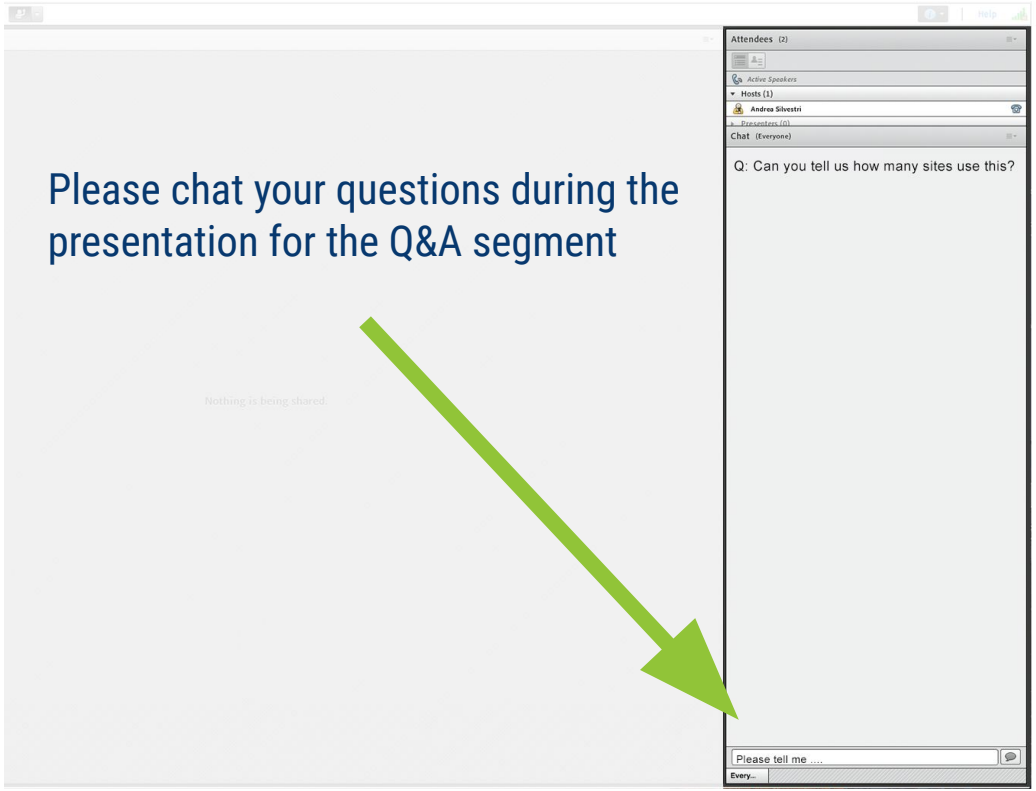
July 13	Condensing Boilers
August 10	Synchronous and Cogged Fan Belts
September 14	Next-Generation Chillers

Webinar Recordings

Access all webinars on GSA.gov

GSA.gov/GPG

How to Ask Questions



Webinar Agenda

- Overview of GPG (5 minutes)
  Michael Lowell, GPG Program Manager
- Control Optimization System for Chiller Plants Assessment (20 minutes)
  Ron Underhill, Pacific Northwest National Laboratory
- On-the-ground Feedback (10 minutes)
  Mark Moody, GSA Region 4
  John Tegan, GSA Region 3
- Q & A (15 minutes)

GPG Overview

Michael Lowell
Project Manager, GPG

The GPG program enables GSA to make sound investment decisions in next generation building technologies based on their real world performance.

GPG Process

Identify promising technologies at the edge of commercialization

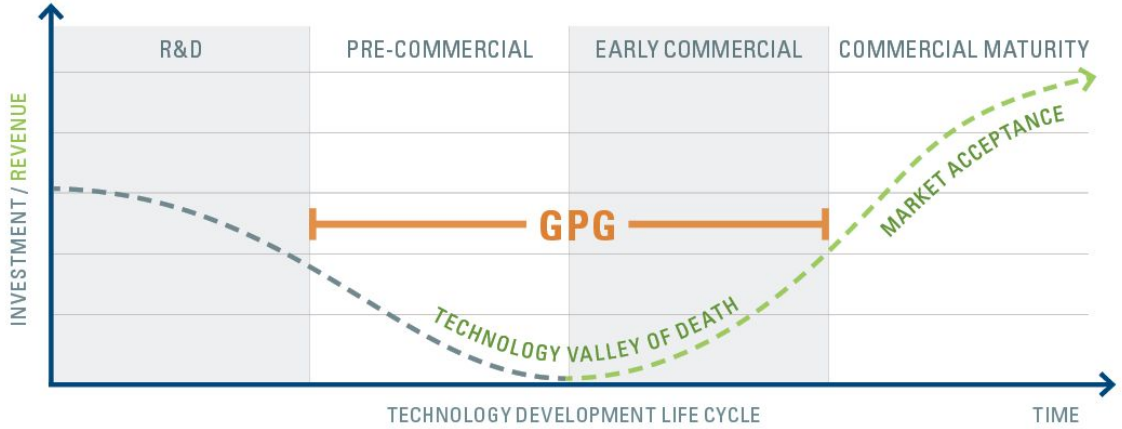
Pilot technology installations within GSA's real estate portfolio

Partner with Department of Energy national laboratories to objectively evaluate real-world performance

Recommend technologies with broad deployment potential for GSA

Leading by Example

GSA's Proving Ground accelerates market acceptance by objectively assessing innovative building technologies in real-world environments, and deploying those that deliver. To date, GSA has installed 9 technologies across more than 200 buildings. In aggregate, these technologies are delivering $7.8 Million in annual O&M savings.



GSA Deployments of Chiller Plant Optimization

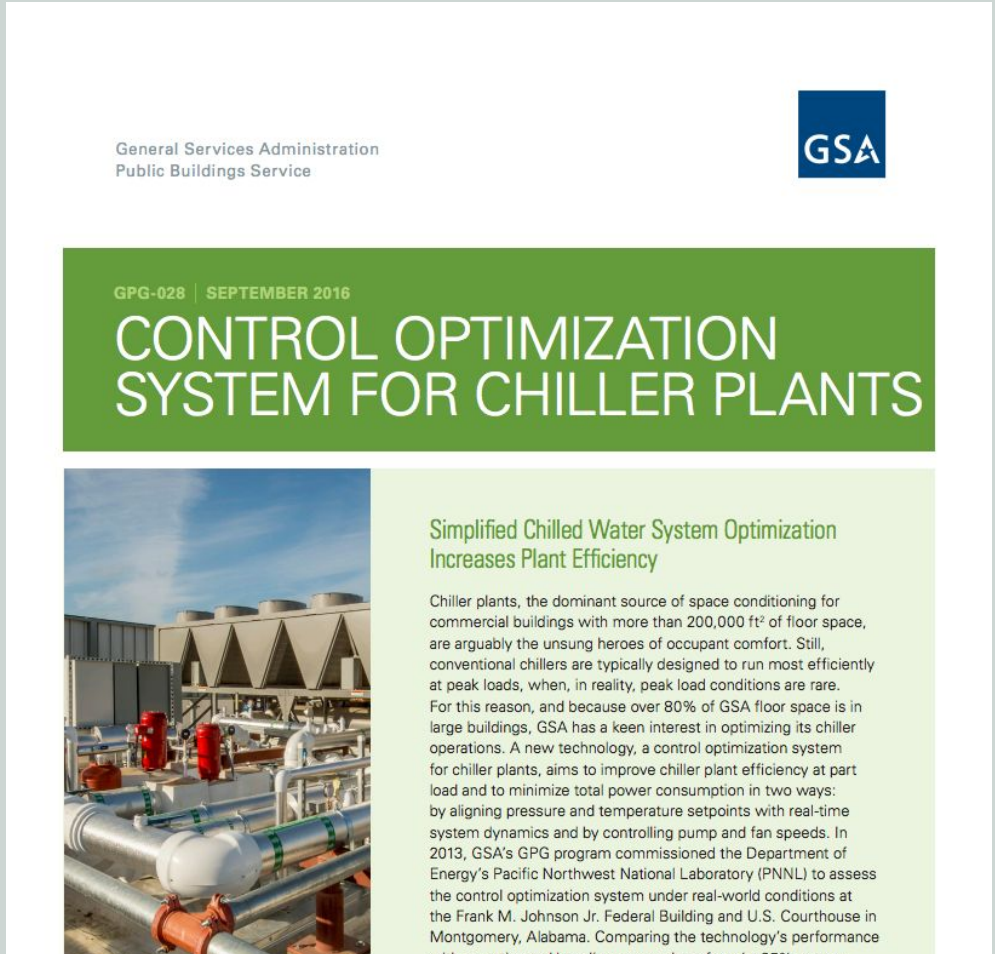
- R3, Veteran's Administration, Philadelphia, PA – 480,000 ft^2
- R4—Test-bed, Frank Johnson FB, Montgomery, AL – 65,660 ft^2 , 1,200 ton plant
- R7, Baton Rouge Federal Building, Baton Rouge, LA – 254,170 ft^2
- R7, H Boggs Federal Building, Baton Rouge, LA – 706,400 ft^2
- R7, Allen J Ellender Federal Building, Houma, LA – 63,648 ft^2
- R7, Wisdom Federal Courthouse, New Orleans, LA – 249,478 ft^2
- R5, Stokes US Courthouse, Cleveland, OH – 766,423 ft^2
- R5, Celebreeze Federal Building, Cleveland, OH – 1,471,286 ft^2
- NCR, LBJ Department of Education, Washington DC – 640,332 ft^2

Measurement & Verification

Ron Underhill
R&D Staff, Pacific Northwest National Laboratory

GPG-028

Control Optimization System for Water-Cooled Chiller Plants



General Services Administration
Public Buildings Service

GSA

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CONTROL OPTIMIZATION SYSTEM FOR CHILLER PLANTS

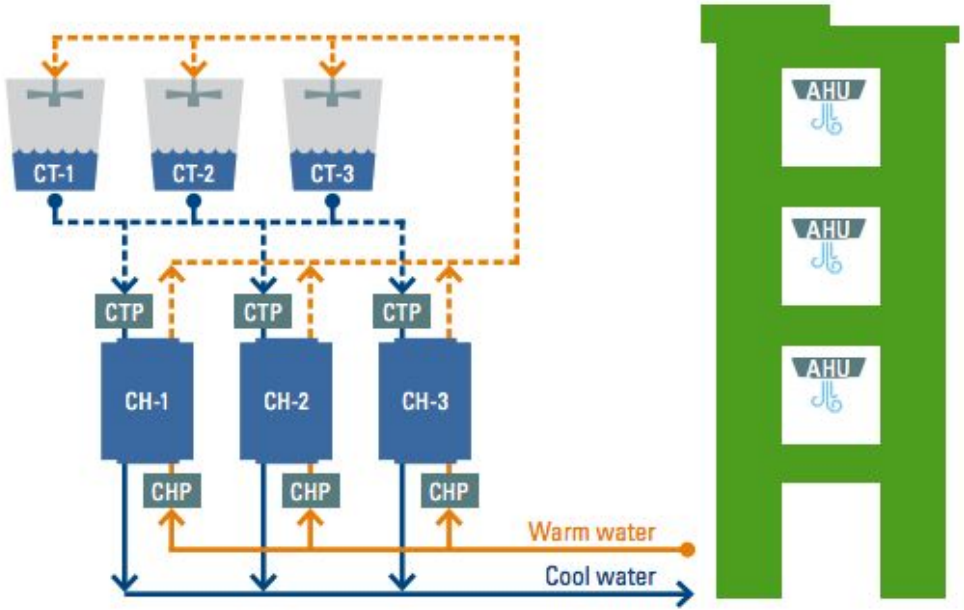
Simplified Chilled Water System Optimization Increases Plant Efficiency

Chiller plants, the dominant source of space conditioning for commercial buildings with more than 200,000 ft² of floor space, are arguably the unsung heroes of occupant comfort. Still, conventional chillers are typically designed to run most efficiently at peak loads, when, in reality, peak load conditions are rare. For this reason, and because over 80% of GSA floor space is in large buildings, GSA has a keen interest in optimizing its chiller operations. A new technology, a control optimization system for chiller plants, aims to improve chiller plant efficiency at part load and to minimize total power consumption in two ways: by aligning pressure and temperature setpoints with real-time system dynamics and by controlling pump and fan speeds. In 2013, GSA's GPG program commissioned the Department of Energy's Pacific Northwest National Laboratory (PNNL) to assess the control optimization system under real-world conditions at the Frank M. Johnson Jr. Federal Building and U.S. Courthouse in Montgomery, Alabama. Comparing the technology's performance

GPG-028. Control Optimization System for Chiller Plants

Optimizes system pressure & temperature difference (Delta-T)

Manages chiller lift and flow by monitoring and controlling five interdependent systems



Opportunity

80% GSA floor space in large buildings

The majority of which is cooled by chillers

Measurement & Verification

Frank M. Johnson Jr. Federal Building and U.S. Courthouse, Montgomery, Alabama

1,200-Ton Plant

Three 400-ton constant-speed centrifugal chillers

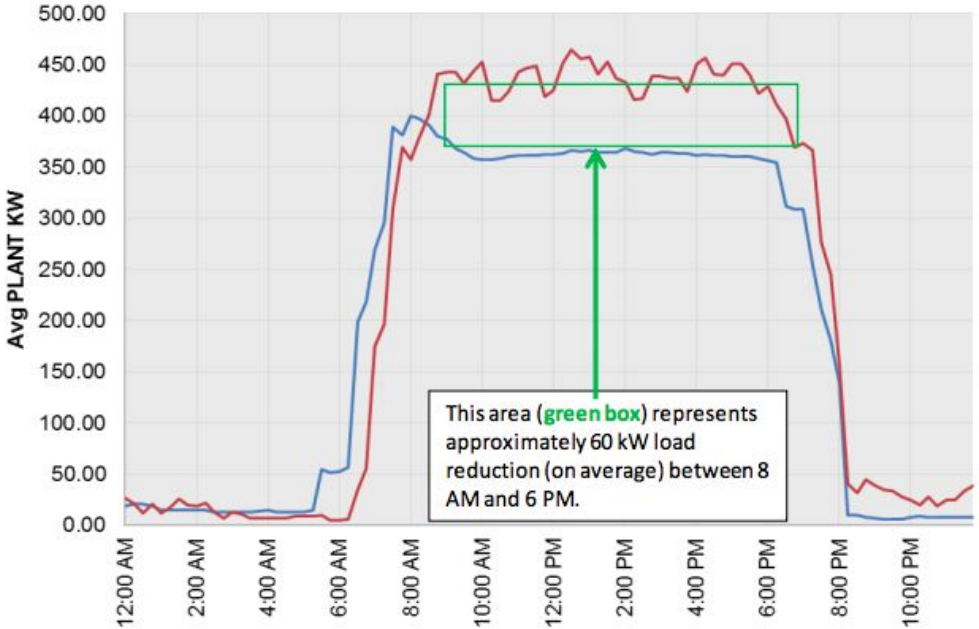
Technology for test-bed measurement and verification, provided by Siemens.

Frank M. Johnson Fed. Bldg. and Courthouse

Increased Efficiency

Pre- and post-installation power comparison

Averaged over the 8-month monitoring period (Jan. 2013 through Sept. 2013)



*Chiller Plant average kW **Red** = Pre-Simulation, **Blue** = Post*

Maintained Delta-T above 8°

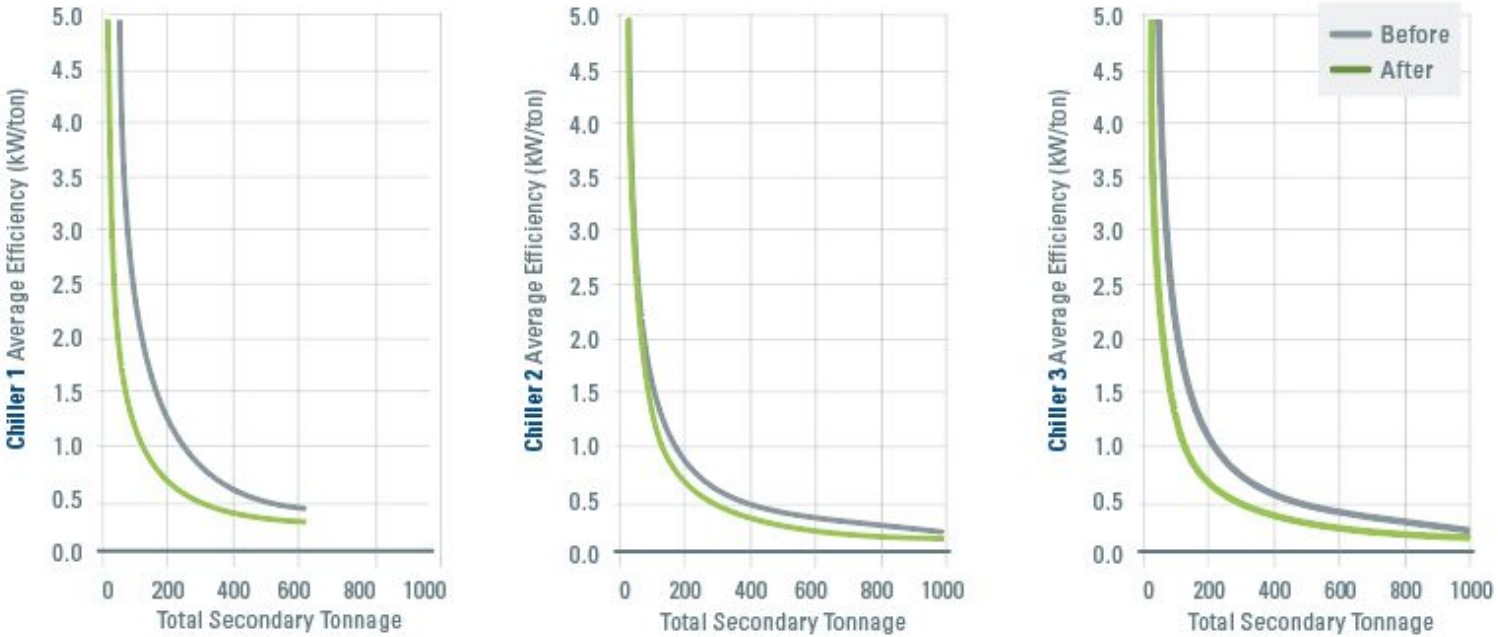
8–18°F

During part-load conditions >10°F consistently

Energy Savings, Especially at Part Loads

35% savings (+/- 10%)

Performance averaged 0.64 kW/ton after control optimization



Cost-Effectiveness

7 year payback at test bed with $0.08 kWh utility rate

Payback is 5 years at national average of $0.11/kWh

> 6 months of cooling season needed to be cost-effective

- @ > $0.11/kWh, load > 3 million ton-hours/yr
- @ < $0.11/kWh, load > 4 million ton-hours/yr

Further Improving Chiller Plant Performance

Cooling Tower Leaving Water Temperature (ECWT) Setpoint Reset

During cooler/dryer conditions, the ECWT can be lowered.

Chilled-Water Supply Temperature (ChWST) Setpoint Reset

Raising the chilled-water supply temperature will allow the evaporator refrigerant pressure to be increased, thereby reducing the load on the compressor and raising the COP.

Improved Optimal Equipment Runtime

This technology seeks to optimize pumping power based on dynamic loads. Validate planned staging operations to ensure that maximum efficiency is realized.

GSA Deployment Opportunity

Centrifugal chillers with loads > 3 million ton-hrs/yr

For energy rates below the national average, cooling loads > 4 million ton-hours per year are recommended.

Also consider for incorporation into new all-variable-speed chiller plants where installation costs as well as energy savings will be lower.

On-The-Ground Feedback

Mark Moody, P.E., C.E.M.
GSA Region 4 Mechanical Engineer
Energy Branch, Facilities Management Division

R4 Experience

Project Goals

1. Lower central cooling plant electrical energy usage (kW/ton)
2. Improve the chilled water plant's cooling turndown capability in order to provide year-round cooling.
3. Provide greater visibility into the central plant equipment via the Building Automation System (BAS)

Goal #1 - Lower Central Plant Energy Use Intensity (EUi)

How Does Demand Flow Work?

- Optimizes temperature setpoints based on current system dynamics
- Improves chiller sequencing so as to increase chiller runtime at higher efficiencies.
- Improves cooling tower fan sequencing so as to increase cooling tower efficiencies.
- Submeter the electrical usage of all chillers, chilled water pumps, and cooling tower fans

What Are the Hardware Requirements?

- Variable Frequency Drives (VFD's) on the primary & secondary CHW pumps
- VFD's on the condenser water pumps
- VFD's on the cooling tower fans
- Temperature sensors for EACH primary CHW loop, EACH secondary CHW loop, Condenser Water loop
- Current transducers for each chiller compressor motor and pump motor

Goal #2 - Provide Year-Round Cooling

Prior to Demand Flow installation, the mechanical system could not adequately meet space setpoints during the winter.

Goal #3 - Provide Greater Visibility Via the BAS into Central Plant Operations

New BAS Points

- Primary CHW pump speed, *status and control*
- Secondary CHW pump speed, *status and control*
- Cooling tower fan speed, *status and control*
- Primary CHW pump motor kW, *status*
- Secondary CHW pump motor kW, *status*
- Cooling tower fan kW, *status*

New BAS Capability

- New trends possible with the new I/O points
- Ability to compare one chiller's efficiency in real-time to the other chillers
- Ability to monitor real-time central plant kW/ton.
- Ability to monitor real-time equipment kW for pumps and cooling tower fans

Using the New BAS Control Points and Data

Examples

- Monitor real-time equipment kW - pump motor coupling replacement
- Compare one chiller's efficiency in real time to others
- Monitor real-time central plant kW/ton

On-The-Ground Feedback

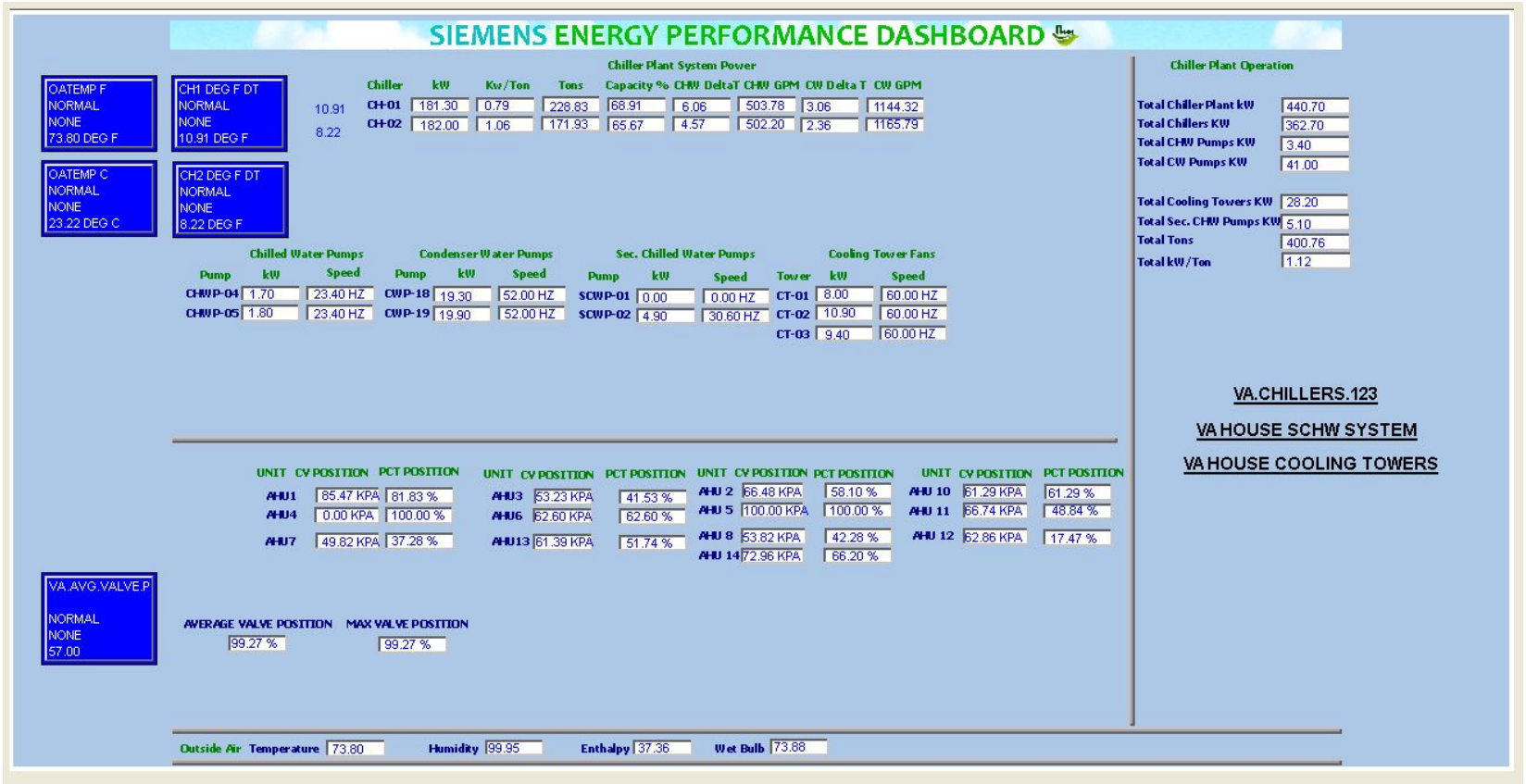
John Tegan, C.E.M.
GSA Region 3 Building Operations

R3 Experience

Engage O&M

- Have O&M buy the technology so they take ownership of it
- Get vendor to provide training and make operations transparent
- Make sure operators understand what is running the show

Veteran's Administration in Philadelphia



Q & A

Thank you!

For more information: gsa.gov/GPG

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