

COMMERCIAL BUILDING CHILLER RETROFIT TO TES AND VARIABLE FLOW CONSTRUCTION MANAGEMENT PROJECT

This month's B2B will focus on an existing two-story commercial office building receiving an energy grant to retrofit the existing air-cooled, 160-ton chillers to an 80-ton, thermal energy storage (TES) system with new variable flow chilled water. The existing constant flow HVAC chilled water system includes three-way automatic temperature control (ATC) valves at two rooftop air handling units (RTU). The RTUs, heating system, and terminal units are not part of this month's test.

The antiquated chillers each have two reciprocation compressors rated for 1.45 kW per ton and four stages of operation when originally installed 18 years ago. The energy consumption is considered excessive when compared to today's air-cooled chiller unit (ACCU) technology and TES off-peak ice capabilities. With TES 1,100 ton-hours, the new chiller will be half the size of the existing chillers (one 80-ton chiller versus two 80-ton chillers).

To select the optimum ACCU replacements, building owner approved the building program with the basis of design:

1. Replace the existing ACCU unit sizes but improve on kW per ton and limit peak kW during daytime electric utility rates;
2. Improve on the existing design parameters e.g., increase the delta T between chilled water supply and chilled water return temperatures;
3. Reuse the existing two-pipe, reverse return piping configuration but replace the three-way ATC valves with straight-through ATC valves at the two existing RTUs.
4. Re-engineer the chilled water system to variable flow with a variable-speed drive on pump and ACCU compressors using hydraulic modeling software simulating daytime and off-peak nighttime operation during the air conditioning season.

The design engineer is directed to *2015 ASHRAE Handbook — HVAC Applications*, chapter 3 (Commercial and Public Buildings) and chapters 36-43 (Building Operation and Management). The engineer shall refer to *ASHRAE 2016*, chapter 43 (Liquid-Chilling System), for additional design information. Also, read chapter 51 (Thermal Storage) to complete the design of this TES energy retrofit project.

The project delivery method shall be construction management (CM) beginning in the conceptual phase of the building program. The building owner has contracted the services of an owner representative along with a third-party commissioning (Cx) and testing, adjusting, and balancing (TAB) consulting firm. The HVAC consulting engineer, along with electrical, plumbing, and structural engineering sub-consultants, will lead the design team. The local utility company shall also have a project representative to assist in the processing of the energy initiative application.

The HVAC design engineer shall also complete a hydraulic model of the entire primary chilled water system based on existing system data (gpm and pressure drops) collected by the third-party TAB consultant. The building's O&M technician and her assistant shall review the documents throughout the design phase and receive introduction

training of the new equipment during the DD phase of the contract documents. The O&M personnel shall observe equipment startup, TAB, CM subcontractors' punchlist, and the commissioning system demonstration in the construction phase.

The new ACCUs will be installed on the existing office building roof reusing existing structural steel as well as additional steel to support the new equipment footprint. A new primary pump and standby pump shall be resized to deliver the design gpm but at a reduced pump head based on TAB actual pump head readings and the hydraulic model results.

The new TES ice tank will be installed adjacent to the ACCU, extending the steel platform supporting both units. The chilled water shall have 30 percent propylene glycol.

The system shall operate in the air conditioning season with the ACCU producing 80 tons of cooling and drawing ice water from the TES tank, as needed, to deliver sufficient chilled water to the two RTUs. During the off-peak electrical period the RTUs will be off, and the ACCU will produce 20°F chilled water delivered to the TES tank to rebuild the ice tank.

480/3/60 electrical power shall be provided to the outdoor disconnect mounted on the ACCU, the factory-furnished starter for this unit, and the in-door disconnects to the primary and standby pump starters. ACCU controls shall include pre-wired and pre-programmed BACnet variable speed compressor drives. The ACCU manufacturer shall also provide pre-wired, automatic controls, including chilled water supply temperature, flow switch, pump control, safeties, and remote alarms. The pump variable frequency drive shall be furnished, installed, and programmed to vary chilled water flow to the two RTUs down to 20 percent flow thru each ACCU.

The CM shall include the following during the shop drawing submittal phase:

- TES equipment submittal - Chiller and pump submittals with performance curves - Startup sheet - Troubleshooting sheets - O&M manuals, parts, and lubricants - ATC and energy management submittal - field coordinated piping drawings.

Third-party commissioning and TAB consultants shall complete the following:

- TAB system flow diagram of entire (new and existing) primary chilled water system with gpm and pumps heads indicated at each piece of equipment.
- TAB system flow diagram of entire supply and return water system drawing upon data from the hydraulic model with gpm and pressure drops at each RTU cooling equipment.
- Commissioning functional performance test of the entire HVAC system (new and existing).

Refer to The Facility File for additional information pertaining to completing the B2B test. **ES**



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The design engineer shall check off the boxes from the list of the company’s standardized field observation checklists below that he will need to upload on to his tablet computer prior to heading out to the construction site to complete his final HVAC inspection and punchlist. These checklists will be touchscreen-type. When the engineer returns to the office, or he sends the completed

checklists via the internet to the office, the completed checklists shall be automatically downloaded to the company’s computer server and placed in the job folder’s “Project Closeout” section of the folder. The completed checklists, along with associated digital photographs taken at the time of the field visit, will automatically be sent to the following individuals and departments.

TEAM CORRESPONDENCE DIRECTORY CHECKLIST

(Check the appropriate boxes)

- Owner Representative IPD Manager Construction Manager
- General Contractor Design-Build Contractor Design Team Consultants HVAC Subcontractor Architect ATC Subcontractor Utility Co. Energy Representative ASHRAE
- Piping Subcontractor Sheet Metal Subcontractor
- Third-Party Cx Consultant Third-Party TAB Consultant
- Equipment Manufacturers Building Inspector
- Others: *(insert list)* _____

HVAC CONTRACT SPECIFICATION CHECKLIST

- Division 1 Project Closeout Office Equipment Structural
- Electrical Plumbing Fire Protection HVAC Infection Control ATC Chiller TES Tank Pumps Fans Air Handlers Piping System Sheet Metal System TAB
- Commissioning Others: _____

HVAC CONTRACT DRAWING INSTALLATION CHECKLIST

- Division 1 Notes RE: Project Closeout Office Equipment
- Structural Electrical Plumbing Fire Protection HVAC
- Infection Control ATC Chiller TES Tank Pumps Fans
- Air Handlers Piping System Sheet Metal System TAB
- Commissioning Others: _____

HVAC STARTUP CHECKLIST

- Owner Furnished Equipment Structural Electrical
- Plumbing Fire Protection HVAC Infection Control
- ATC Chiller TES Tank Pumps Fans Air Piping System Sheet Metal System Equipment Room TAB
- Commissioning Others: _____

COMMISSIONING FPT (Functional Performance Test)

- Division 1 Project Closeout Telecommunication Equipment
- Owner Furnished Equipment Structural Electrical
- Plumbing Fire Protection HVAC System Infection Control System ATC System Central HVAC Air Systems Heating System Chilled Water System TES System Cycle Condenser Water System Chiller TES Tank Variable Speed Pumping
- Fans Air Handlers Piping System Sheet Metal System
- Equipment Room Others: _____