

# COMMERCIAL BUILDING CHILLER RETROFIT TO VARIABLE FLOW

## CONSTRUCTION MANAGEMENT PROJECT

This month's B2B will focus an existing two-story commercial office building receiving an energy grant to retrofit the existing air-cooled 160-ton chillers as part of an overall building infrastructure renovation. The existing HVAC chilled water system is constant flow with 3-way automatic temperature control (ATC) valves and four rooftop air handling units (RTU). The RTU, 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 existing building central chilled water system is adequate to accommodate the existing building peak air conditioning loads, but system reliability is in question and energy consumption is considered excessive when compared to today's air-cooled chiller unit (ACCU) technology. Additional cooling capacity or equipment redundancy will not be part of the building program.

To select the optimum ACCU replacements, much of the selection criteria had already been determined when the building owner approved the building program with the basis of design: 1. Match the existing ACCU sizes but improve on kW per Ton. 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 2-pipe, reverse return piping configuration but replace the 3-way ATC valves at the four existing RTU. 4. Re-engineer chilled water system to variable flow with variable speed drive on pump and ACCU compressors using hydraulic modeling software.

The designer engineer is directed to *2015 ASHRAE Handbook — HVAC Applications*, chapter 3 (Commercial and Public Buildings) and chapters 36 through 43 (Building Operation and Management). The engineer shall also refer to *ASHRAE 2016*, chapter 43 (Liquid-Chilling System) for additional design information pertaining to replacing existing air-cooled chillers with new, more energy efficient air-cooled chillers.

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 3rd-party commissioning (Cx) and TAB consulting firm. The HVAC consulting engineer along with electrical, plumbing, and structural engineering sub-consultants will lead the design team.

The CM shall have a project manager, in-house estimating including mechanical and electrical estimators, a mechanical-electrical coordinator, and the company's own in-house registered professional engineer to assist in value engineering in the conceptual phase of the job.

The design team, along with the owner and the CM input, shall produce conceptual drawings, design development (DD) drawings and specifications, plus contract documents (CD) in sync with the CM providing budget estimates in the conceptual phase and guaranteed maximum project cost between the DD and CD phases. The HVAC design engineer shall also complete a hydraulic model of the entire

primary chilled water system (new and existing). The building's O&M technician and his assistant shall review the documents throughout the design phase and receive introduction training of the new equipment. The O&M personnel shall observe equipment startup, TAB, CM sub-contractors' punchlist, and the commissioning system demonstration.

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. 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 previous pump was oversized and the balancing valve on the pump discharge was 30% closed, introducing 40 excess ft of pump head.

System shall operate in the air conditioning season with the RTU providing airside economizer as needed during the heating season. ACCUs shall be piped in parallel with one primary, variable speed drive chilled water pump. The chilled water shall be 45°F CHWS and 58°F CHWR.

Electrical shall be 480/3/60 electrical power to outdoor disconnects mounted on each unit and to factory-furnished starters for the ACCUs and indoor disconnects to the primary and standby pump starters. ACCU controls shall include pre-wired and pre-programmed BACnet variable speed compressor drives. ACCU manufacturer shall also provide pre-wired automatic controls, including chilled water supply temperature, flow switch, pump control, safeties, and remote alarms. Chillers shall operate in series. The pump VFD shall be furnished, installed, and programmed to vary chilled water flow to the four RTU down to 20% flow through each ACCU.

Pumps shall be installed with all required temperature and pressure gages, water strainers, shut-off valves, and alarms per the engineer's design.

### CM shall include during the shop drawing submittal phase:

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

### A 3rd-party CxTAB firm 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 piece of cooling equipment.
- Commissioning functional performance test of the entire HVAC system (new and existing).

Refer to The Facility Files for additional information. **ES**



The design engineer shall check off the boxes from the list of the company's standardized field observation checklists below that she will need to upload on to her tablet computer prior to heading out to the construction site to complete her final HVAC inspection and punchlist. These checklists will be touchscreen type. When the engineer returns to the office or she 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 electronically 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  3rd-Party CxTAB Consultant  3rd-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  Chillers  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  Chillers  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  Chillers  Pumps  Fans  Air  Piping System  Sheet Metal System  Equipment Room  TAB  Commissioning
- Others: \_\_\_\_\_

**HVAC STARTUP CHECKLIST**

- Owner Furnished Equipment  Structural  Electrical  Plumbing  Fire Protection  HVAC System  Infection Control System  ATC System  Central HVAC Air Systems  Heating System  Chilled Water System  Condenser Water System
- Chillers  Variable Speed Pumping  Fans  Air Handlers  Piping System  Sheet Metal System  Equipment Room
- Others: \_\_\_\_\_