2008

BEST PRACTICES

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ENGINEERING IV SATELLITE CHILLER PLANT

- Cal Poly San Luis Obispo
- Category: HVAC Design, New Construction
- Presented by Dennis K. Elliot, PE, CEM
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CAMPUS CENTRAL PLANT

- Central Chiller Plant built in 1997 as part of $26M Utilidor Project
- Original capacity 600 tons
- Designed for future TES
- Expanded to 1200 tons in 2003 by relocation of two 300 ton chillers from the Performing Arts Center
- CHW distribution only serves South half of campus
- Life cycle cost analysis showed cooling via central plant CHW cost approximately 50% less than local cooling equipment

TYPICAL AIR CONDITIONING APPROACH

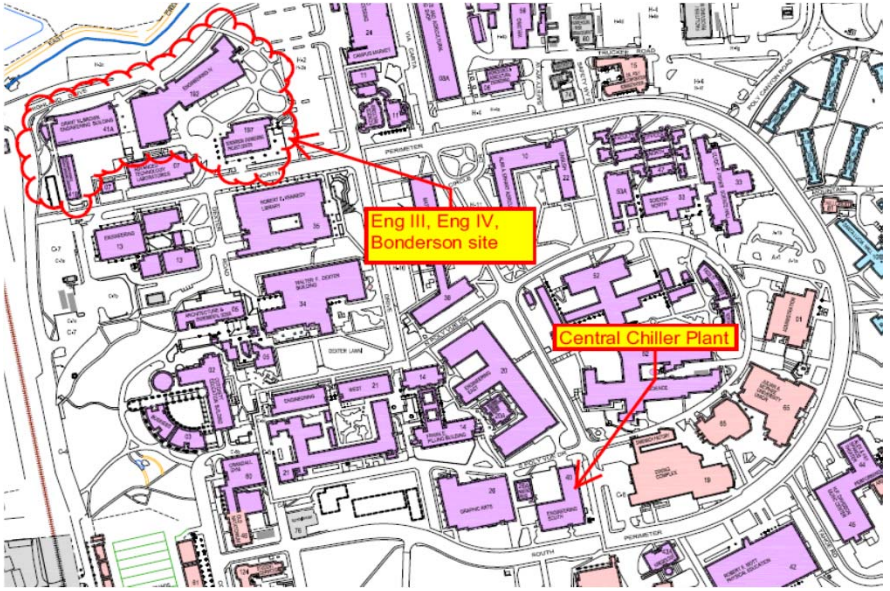
- Typical solution for buildings not served by central plant:
  - Cooling system sized for peak building load – little use of diversity
  - Air cooled chillers for large building wide loads
  - Package/split DX units for small/concentrated/critical loads
  - Efficiencies can range from 0.8 - 1.2 kW/ton
  - Compliant with Title 24, but much room for improvement

DESIRED AIR CONDITIONING APPROACH

- Use water cooled chillers for building wide loads – central plant is best
- Larger chillers = higher efficiency, lower maintenance - efficiencies can range from 0.4-0.6 kW/ton – 50% better than air cooled
- Central plant provides redundancy and allows for load diversity
- Use chilled water fan coils for concentrated/critical loads if campus has 24 hour CHW
- Use high efficiency DX cooling if 24 hour CHW is not available from central plant
- Title 24 allows DX equipment with SEER of 10-13. Units available with SEER of 19-23.
- Specify minimum efficiency in campus standards!

CAMPUS GROWTH AND MASTER PLANNING

- Most new construction requiring air conditioning
  - Increased equipment loads
  - Changing expectations
- Facilities trying to stem the proliferation of package AC units
- Campus committed to using central plant CHW whenever possible
- Next big wave of construction would be in the N/W quadrant of campus – Eng III, Eng IV, and Bonderson
- CHW distribution not available to site
- Project budgets could not afford Central Plant/Utilidor upgrades



NEW ENGINEERING QUAD

- Engineering III
  - Completed 2002
  - 40,000 gsf

- Bonderson Projects Building
  - Completed 2006
  - 19,000 gsf

- Engineering IV
  - Completed 2007
  - 105,000 gsf

DESIGN FOR ENG III, ENG IV, BONDERSON

- These capital projects could not afford a multimillion dollar upgrade to the central plant and distribution
- Local cooling would be necessary until the next major plant expansion could take place
- Campus was committed to future integration with the central plant
- Settled on a satellite chiller plant, using water cooled chillers, that would serve all three buildings
- CHW lines stubbed out in the street for future connection to Utilidor

ENGINEERING IV CHILLER PLANT

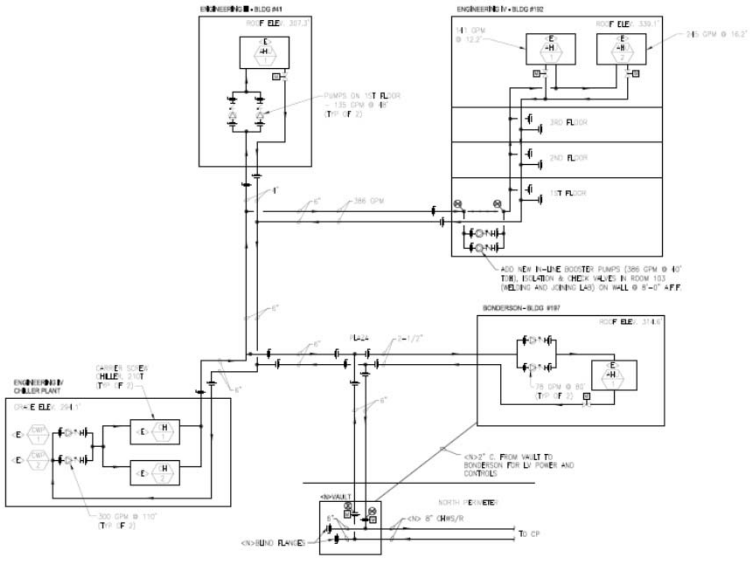
- Eng III built for future chilled water – DX used only for critical loads
- Satellite chiller plant built as part of Eng IV project to serve all 3 bldgs
- Equipment located centrally
- Selected two Carrier 210 ton 30HXC206 “Evergreen” water cooled screw chillers – provides redundancy and unloading capability
- Chillers rated at 0.53 kW/ton
- Good turn down ratio for part load conditions
- Uses R134A refrigerant – zero ozone depletion potential (ODP) and modest global warming potential (GWP)

ENGINEERING IV CHILLER PLANT

- Project Results:
  - Chiller Plant cost - $450K
  - Capital cost was $50K LESS than local air cooled chillers in each building
  - Load diversity allowed for smaller total equipment size
  - Two chillers provides redundancy not feasible for each of 3 bldgs
  - Some increased cost for extended piping and electrical service, offset by having fewer pieces of major equipment and smaller total size
  - Annual energy savings of 150,000 kWh and $15,000 per year

FUTURE PLANT / UTILIDOR / TES UPGRADE

- 1200 ton chiller plant approaching capacity, not adequate to serve new Center for Science building in 2011
- Performed utility master plan/feasibility study to determine utility growth needs and priorities (CHW was first!)
- Obtained $10M funding as part of Center for Science project for CHW plant and utilidor upgrade
- Will install new 1350 ton centrifugal variable speed chiller – phase I of an eventual 5,000 ton build-out
- Complete CHW piping in Utilidor
- Install 19,000 ton-hour TES tank
- Connect Satellite Plant to Utilidor – can run in 3 different modes – central plant/local chiller/hybrid



CHILLED WATER SCHEMATIC ENGINEERING COMPLEX 1

OTHER TES IDEAS…

OTHER TES IDEAS…

OTHER TES IDEAS…

LESSONS LEARNED

- Have a utility master plan and update it as your campus master plan/capital improvement plan changes
- Develop campus standards that include utility systems, energy management, metering, campus preferred equipment, design guidelines, and minimum energy efficiency criteria – set high goals and challenge your consultants to meet them
- Cooling from a water cooled central plant is approximately 50% cheaper than local air cooled equipment from a life cycle cost standpoint
- Be careful when evaluating variable speed chillers – if chillers will usually run fully loaded, there is no benefit. If you will usually run at part load or have TES, a significant efficiency increase is possible
- Address sound attenuation in chiller designs

SPECIAL THANKS TO:

- Goss Engineering – Utilidor Project and Utility Master Plans
- Salas & O'Brien Engineers – Chiller Plant/Utilidor Upgrade/TES
- AC Martin Partners – Architect for Engineering IV
- Innovative Engineering Group – Mech Engineer for Engineering IV
- Bob Kitamura and Joel Neel – Facilities Planning

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- Facilities Sustainability Page:
  www.facilities.calpoly.edu/sustainability/index.htm
- Biennial Sustainability Progress Report 2008
  www.facilities.calpoly.edu/sustainability/SusInd08.pdf
- Capital Project News:
  www.facilities.calpoly.edu/campusprojects/project_news.htm

QUESTIONS?

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