Agenda

• Background of Chilled Water System
• Review of Early Optimization Efforts
• Current Status of System
• Targeted Approaches Used
UT's Chilled Water System

- 60,000 tons of capacity
- 5 chilled water plants
- 18 electrical centrifugal chillers (2,500 to 5,000 tons)
- 18 miles of loop piping
- 3.6 MG, 36,000 ton hour & 5.5 MG, 55,000 ton hour thermal storage tanks
- Nearly 200 connected loads
- Over 200 loop valves
- 35 primary chilled water pumps
- Variable primary pumps in plants
- Variable secondary pumps in buildings
Operations at a Glance

- Peak Cooling Load – 36,000 Tons
- Peak Chilled Water Flow – 45,000 gpm
- Average Supply Temperature - 39°F
- Average Return Temperature - 49°F
- Average Supply Pressure at Plants – 100 psig
- Peak Supply Pressure at Plants – 125 psig
- Total Annual Production 137,000,000 Ton-Hours
- Total Annual Power to Plants – 80,000,000 kWh
Chilled Water System Roadmap

• Started with Power Plant Optimization
• Linked Chilled Water System to Optimization
• First all VFD cooling plant in 2007
• Learned the value of primary pumps in 2009
• Used Termis (real time model) to investigate DP reduction
• Used OE to link plants to loop optimization
Model Options
• Building Pump Status
• Bottlenecks
• Differential Pressure
• Load
• Supply/Return Temps
• Flow levels
• Friction loss
• Isolation Valve Status
Bottlenecks

Pressure Gradients [TONS]

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<th>Gradient Value</th>
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DP Reduction History

Added VFDs On CS 5 CW Pumps
 Cooling Plant Performance

Campus Added 2.4 Million GSF
Saved 12.4 million Ton-Hours
Saved 20.9 million kWh
Cooling Plant Performance

Campus Added 2.4 Million GSF
Saved 93,000 lbs/hr Reheat Steam

<table>
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<tr>
<th>Year</th>
<th>Annual Average KW/Ton (Chillers Only)</th>
<th>Annual Average KW/Ton (Aux Only)</th>
<th>Annual Average KW/Ton (Total)</th>
<th>Summer Avg Steam to Campus</th>
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The Foundation of UT’s Optimization

Campus Optimization

1. You cannot optimize what you cannot measure

2. Optimize systems not just components

3. Optimization must be fully automatic, dynamic, and supported by experts

3 LAWS OF OPTIMIZATION
Step 1: CS6 – Master DP Control
Step 2: CS7 – Sweet Spot Optimization
Step 2: CS7 – Sweet Spot Optimization
Step 3: CS7 – Maximize Output
Step 4: TES Discharge

### TES Discharge Information
- **Capacity**: 0.0 gal/min
- **Pressure**: 6.0 PSI
- **Temperature**: 0.0 °F

### Discharge Details
- **OL CLT E/L**: 0.0 ft
- **OL CLT Elec**: 0.0 Tons
- **OL CLT Avg**: 0.0 Tons
- **Discharge Period Allowed**: 0.0
- **Charge Period Allowed**: 0.0
- **OL CLT Flow SP**: 3,000.0 gal/min
- **OL CLT Charge Flow SP**: 3,000.0 gal/min

### SOE Calculations
- **SOE Calcd Thermo**: 0.0 ft
- **SOE Calcd MTP**: 0.0 ft
- **SOE Calcd Chill Tons**: 0.0 Tons
- **SOE Calcd Chg Tons**: 0.0 Tons
- **SOE Calcd Chg Time**: 0.0
- **SOE Calcd Chg Time Remaining**: 0.0

### SOE Mode
- **SOE Mode**: OFF
- **Loop Freq**: OFF
- **ComLoss**: Normal
- **BOP Watchdog**: 0.0
- **SOE Watchdog**: 0.0
- **AlertWatchdog**: 0.0
- **Chiller Needed**: 0.0

### P102
- **Speed**: 0.0 %
- **kW**: 0.0 kW

### P101
- **Speed**: 0.0 %
- **kW**: 0.0 kW

### Storage Information
- **Stored Ton Hours**: 0 TonHrs
- **琬吨吨吨吨吨吨吨timeout**: 0 TonHrs
Step 5: CS5 – Flow Control (imitate CS6)
Step 6: CS3 – Flow Control (maximize CS Chiller output while keeping CS6 at 12,500 tons)
## Step 7: Campus Chiller Shed (excess tons)

### UT Austin Campus Chillers

<table>
<thead>
<tr>
<th></th>
<th>Tons</th>
<th>Desired Max Tons</th>
<th>Excess Tons</th>
<th>CHW Flow</th>
<th>Availability</th>
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### Calculation

- **Sum Excess Tons** = 4549.0 Tons
- **Max Tons (Non CS6)** = 0.0 Tons
- **Max Excess Tons (Non CS6)** = 0.0 Tons

**= Shed Event Tons** = 0.0 Tons

**= Greater than 500**
Buildings – reducing DP and temperatures
High delta T Syndrome?

- Prior to 2010 – Campus delta T used to average between 7.5 and 11.5 deg F with maximum flow requirement of 70,000 gpm (12 deg F delta T)

- CS5 and CS6 were installed with no low flow chilled water bypass

- 2017 maximum flow requirement is 45,000 gpm (19.2 deg F delta T)

- Chillers are going into minimum flow control (campus pressures increase)

- Possible Solutions we are debating
  - Increase chilled water set point from 39 deg F to 42 deg F
  - Decrease minimum flow to 2 ft/sec in evaporators
JUAN M. ONTIVEROS, P.E.
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