Case study of the chilled water energy distribution management system at the University of Texas at Austin, USA
Agenda

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- Solution chosen and why
- UT Austin SCADA Architecture
- How does it work
- How it was implemented
- Positive results
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UT's chilled water system

- Description of UT's chilled water system:
  - 45,000 tons of capacity
  - 4 chilled water plants
  - 11 electrical centrifugal chillers ranging from 3,000 tons to 5,000 tons
  - 12 miles of chilled water loop piping, 1,500,000 gallons.
  - 4 million gallon, 36,000 ton hour capacity thermal storage tank in construction
  - nearly 200 connected loads
  - over 200 loop valves
  - 20 chilled water pumps
  - variable primary system
Introduction to UT case study - 1

The University of Texas at Austin was faced with the several significant issues that had the potential to adversely impact the reliability and cost of their District Energy System:

- Building load growth and the corresponding chilled water growth was beginning to overtax the existing system

- Old chilled water plant control solutions were no longer applicable
  - One single system pressure was used for determining whether chillers were brought on line or taken off line
Introduction to UT case study - 2

- Solving "hot call" problems by starting a new chiller was no longer an acceptable option
- Long term plan was to control loop pressure to a minimum and let the building secondary pumps carry more of the load, "Pumping Optimization"
- Delivery problems were occurring more often at low load

- Needed a solution for extending and modifying the chilled water loop to meet the new loads other than the standard hydraulic analysis programs
Introduction to UT case study - 3

- In addition real time building energy use information was being captured and brought into the Plants’ SCADA system

- Chilled water flow
- CHW supply and return temperatures
- Steam, Electrical and Water use
Introduction to UT case study - 4

- Desired a solution that would
  - Provide an analysis tool that could be used to model the chilled water system under ALL load conditions.
  - Provide a tool to the operators to allow them the ability to determine if ”hot calls” were loop or building related.
  - Provide a SCADA tool that would alert Operators to loop and building problems before they became severe.
Solution Chosen and Why

- TERMIS Real Time Hydraulic and Thermal Modeling and Simulation System
  - Real time component for significantly improving operation, preparation for loop outages and identifying and solving problems
  - Engineering component for modeling additions and revisions to the loop under **ALL** conditions
  - Operator screens that have a “SCADA” look and feel so that Operators do not have to become Engineers.
UT Austin SCADA Architecture
UT Austin SCADA Architecture
How does it work
The implementation included the following four (4) phases:

- **Phase 1 – Build the Physical Model**
  - UT personnel spent 4 months mapping out the piping system for input into the TERMIS model
  - A by-product of this was that now for the first time the University had a "true" as-built model of the chilled water loop
How it was implemented

**Phase 2 – Calibrate the Model (Iterative Process)**

- Flow rates and supply and return temperatures for 50 of the largest building loads were brought into the TERMIS real time system from the SCADA system.
- System identified locations where differential pressure sensors and transmitters were required. Approximately 15 differential pressure measurements from "hydraulically critical" locations were brought into the TERMIS real time system.
- TERMIS technical support came on site for one week to calibrate the model - TERMIS on-line technical support continued with the calibration and trouble shooting until the model could accurately predict temperatures and pressures throughout the system under all load conditions.
- Measurements and model results typically within +/- 5%.
How it was implemented

- **Phase 3 – Put TER Mis to Work at the Plant**
  - Engineering using the Real Time Model (RTM) to discover anomalies throughout the system
  - Operations using RTM to determine when to bring chillers on and off line on a daily basis and what chiller combinations provide the best results throughout the loop
  - Maintenance using RTM to plan outages to buildings and loop piping. RTM allows them to develop best combination of chillers and loop valves to accomplish the outage with the minimum impact to the campus.
  - Utility Managers using RTM can now show Facilities Managers what buildings are negatively impacting the chilled water loop.
  - Can also show clear picture that 99% of “hot call” are building related and not loop related!!!
How it was implemented

- **Phase 4 – TERMIS into the Control Room and Loop Pump Optimization**
  - Install TERMIS Operation in the control room for daily use by Operators managing the chilled water plants
  - Develop database of loop valves and tie to TERMIS to help with maintenance and to help insure valves are not closed and forgotten
  - Develop and implement a Pump Optimization scheme that will minimize the chilled water pumping power of the main plant pumps and building primary pumps.
Positive Results - 1

- TERMIS Model located two (2) main loop valves that upon opening the valves, we were able to immediately shut down two (2) 250 HP pumps; saving in total 500 HP.

- Identified building pumps "over pumping" and artificially raising the return pressure in a section of the loop, reducing the differential pressure between supply and return for other buildings in the area forcing those building pumps to also "over pump. A simple control setting change solved the problem.
Positive Results - 2

- Identified a building that had been flowing 200 gpm at a 9 degree delta T and due to a building control issue the delta T dropped to 1 degree and the flow rate jumped to 1,800 gpm. The problem was quickly and easily solved significantly reducing the building pumps’ HP.

- Found that two new loop valves installed during the Chiller Station # 6 project had never been opened. Remedying this reduced pumping power at station 6 by approximately 100 HP.
Positive Results - 3

- Is used with great success to plan loop outages such that a minimum number of customers are affected.
  - Example: Modeling several different approaches to a recent loop shut down identified a chiller/valve combination that completely mitigated all of the issues that had arisen during a previous outage for the same section of line!

- As an aside, TERMIS technical support is very effective and their support is excellent. As I have identified needs, and "nice to haves" 7T has been very responsive in adding new features and solving problems as they arise
Positive Results - 4

- Total pumping energy savings thus far is estimated at approximately 1,100 HP.

- At current fuel prices this is equivalent to over $500,000 in annual savings giving TERMIS a simple payback of less than 6 months.
On the Horizon - 1

- Examples – Energy Distribution Optimization and continuation of cutting cost
  
  - Model the new thermal storage tank in order to help optimize its benefit to the campus.
  
  - Reduce system pumping pressures to the minimum needed to meet system needs. PUMPING OPTIMIZATION PLAN.
  
  - Install TERMIS Operation in the control rooms for daily Operator use.
On the Horizon - 2

- Optimize chiller and pump combinations to operate the chilled water system at the lowest possible kW per ton. PRODUCTION OPTIMIZATION PLAN.

- Provide continued alarming of adverse conditions, overpressure, low delta T, extremely high flow, changing differential pressures due to modifications of valving.

- Use as a design tool for extending and modifying the loop so as to meet the growing chilled water needs of the University.
On the Horizon - 3

- Connect the model to a Valve database to keep track of chilled water system valves, their size, type, age and open/shut status.

- Provide accurate design and operational data to consultants designing new facilities that will tie into the chilled water system.

- Use the UT TERMIS models as test-bed for consultants work.
Demo

- Engineering workstation
- Control room workstation
- Management workstation
Questions?

Thank you for your attention!

"If you cannot measure OR model it you cannot manage it efficiently"
"It’s much less costly to model it than measure it"

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