Hydraulic Modeling of NRG Energy Center Downtown Minneapolis Chilled Water System

Carl Jauch, NRG Energy Center Minneapolis
Thomas Lund-Hansen, Reliability Efficiency & Optimization

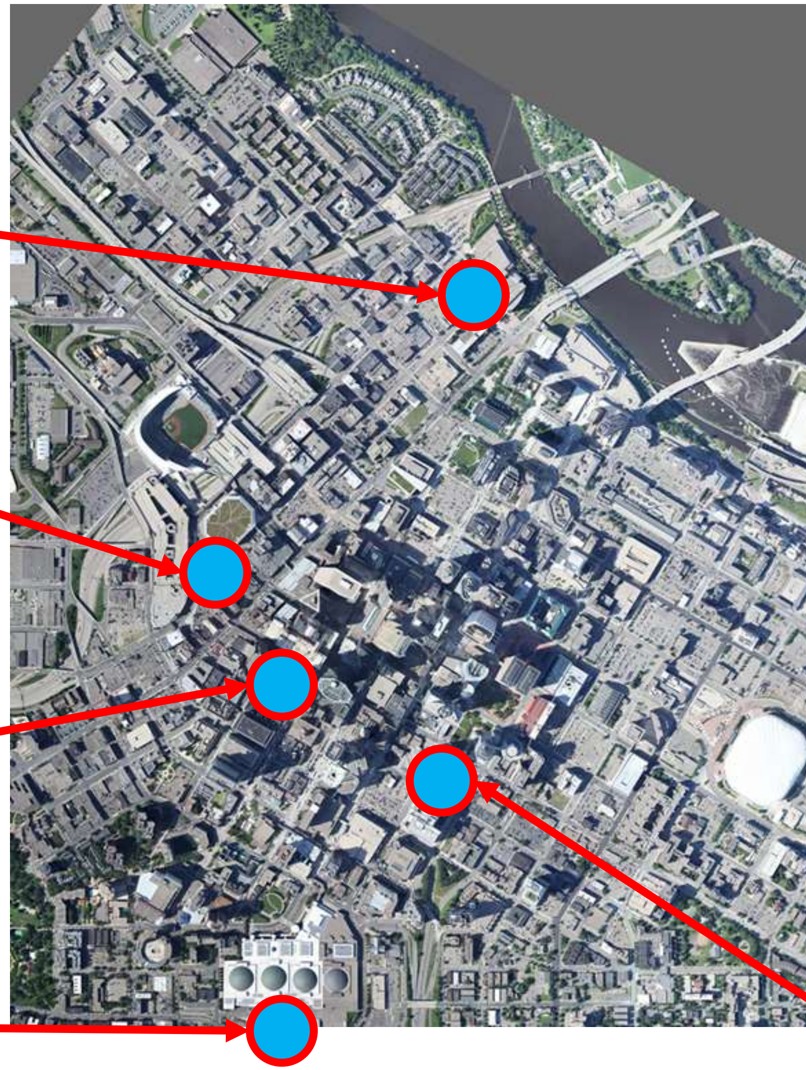
Minneapolis System

Foster House:
2,000 tons, electric

First Avenue:
9,000 tons, steam

Macy's:
2,700 tons, electric

Convention Center:
5,150 tons,
electric/gas

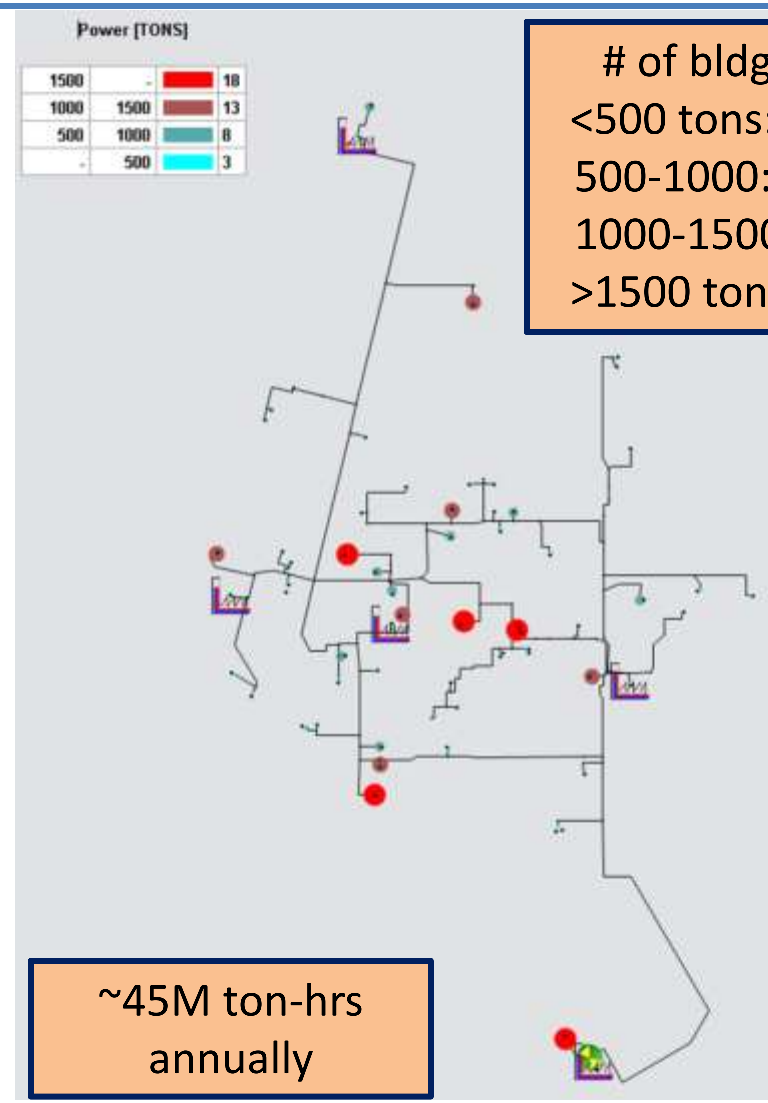


- ***One system in the NRG portfolio***
- ***Operating since 1972, portions date to 1920's***
- ***Capacity: 36,650 tons***
- ***Demand: 27,500 tons***
- ***More than 22 M sq. ft. cooled space***
- ***5 miles direct buried pipe***

Main Plant:
4,000 tons, electric
17,800 tons, steam

Challenges & Need for Modeling

- Competitive market
  - Customer driven
    - Cost/Value
  - NRG initiatives
    - Efficiency & Sustainability
- Complex system
  - Multi-plant, chiller types
  - Broad customer mix
- Tools have to add value
  - Prefer in-house ability
  - Partnership with REO Termis Solution Providers



# of bldgs.
<500 tons: 28
500-1000: 12
1000-1500: 5
>1500 tons: 5

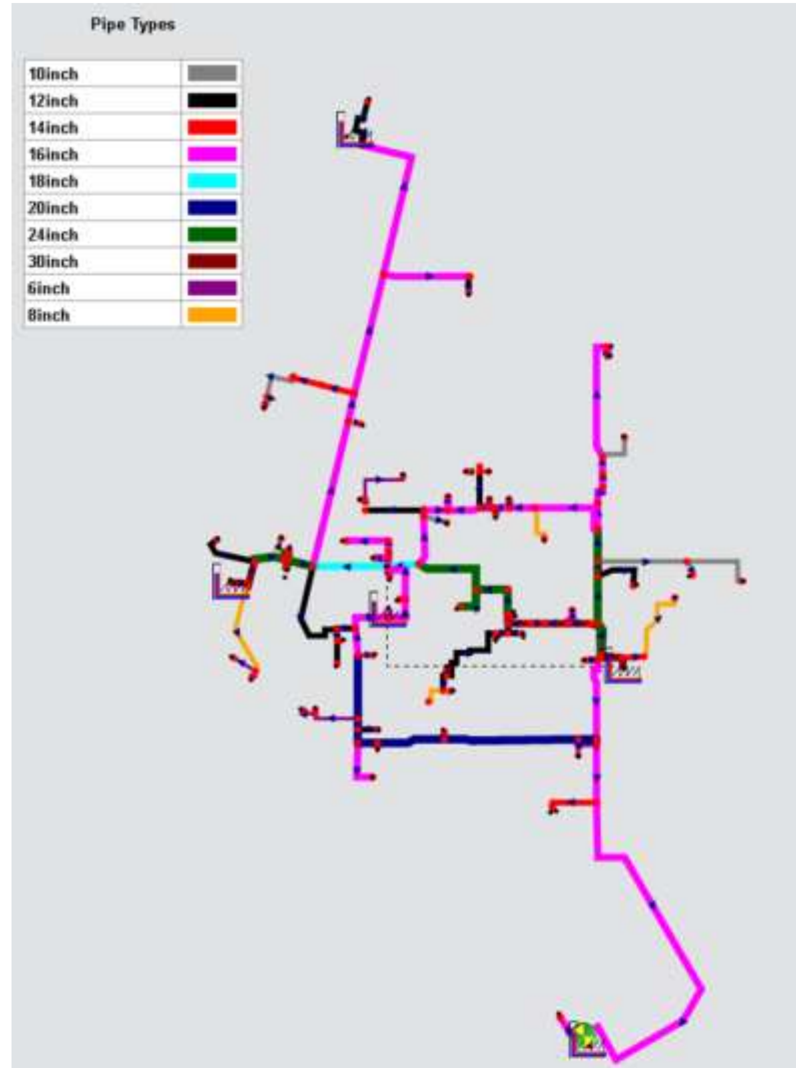
~45M ton-hrs annually

Modeling Objectives

- Flow modeling needed to accurately reflect system hydraulics
  - System expansion studies & customer addition studies
  - Evaluate operational flexibility & chiller dispatch
  - Model and quantify cost savings associated with system/operational changes
- Future real-time feedback
  - Chiller dispatch, outage planning, performance feedback, monitoring telemetry
  - Target customers needing assistance to reduce consumption

Termis Modeling

- Definitions/Input:
  - Bldg demand, ΔT
  - Supply temperature
  - Base Pressure
- Results/Output:
  - Plant production
  - System pressures
  - Flow rates
  - Pipe velocities
  - Pressure gradients
  - Temperatures



Modeling Information

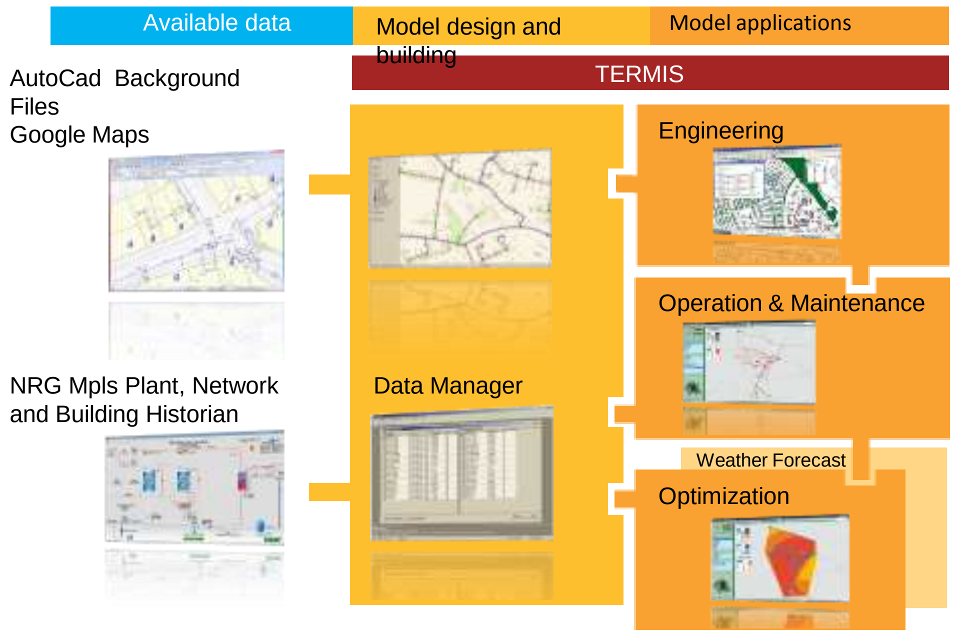
- Real-time vs static model

  "Seeing the world continuously with magnifying glasses vs one or few snapshot views"

- Real-time data import
  - Building usage/loads
  - Plant output and return

- Validation between measurements and predictions
  - Flow, Pressure, ΔP

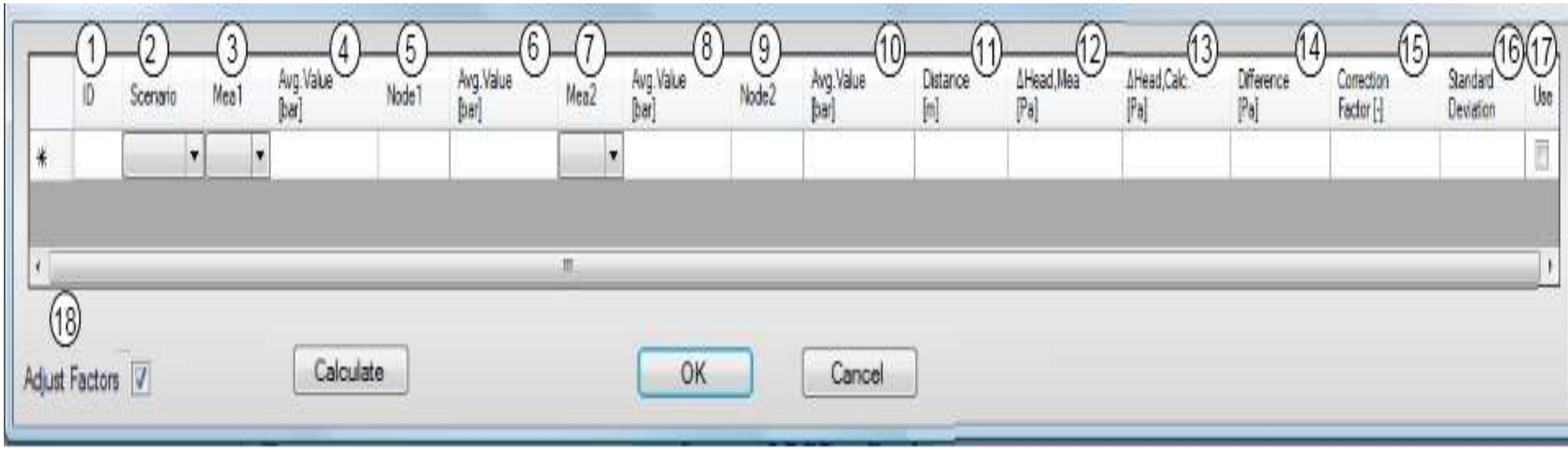
Real-Time Modeling



Real-Time measurements - about 380 building, network and plant meters/sensors (P,T, Tons and Q among others) - Every 5 minutes import of measurements and simulation

Model Calibration

- Use of Real-Time model

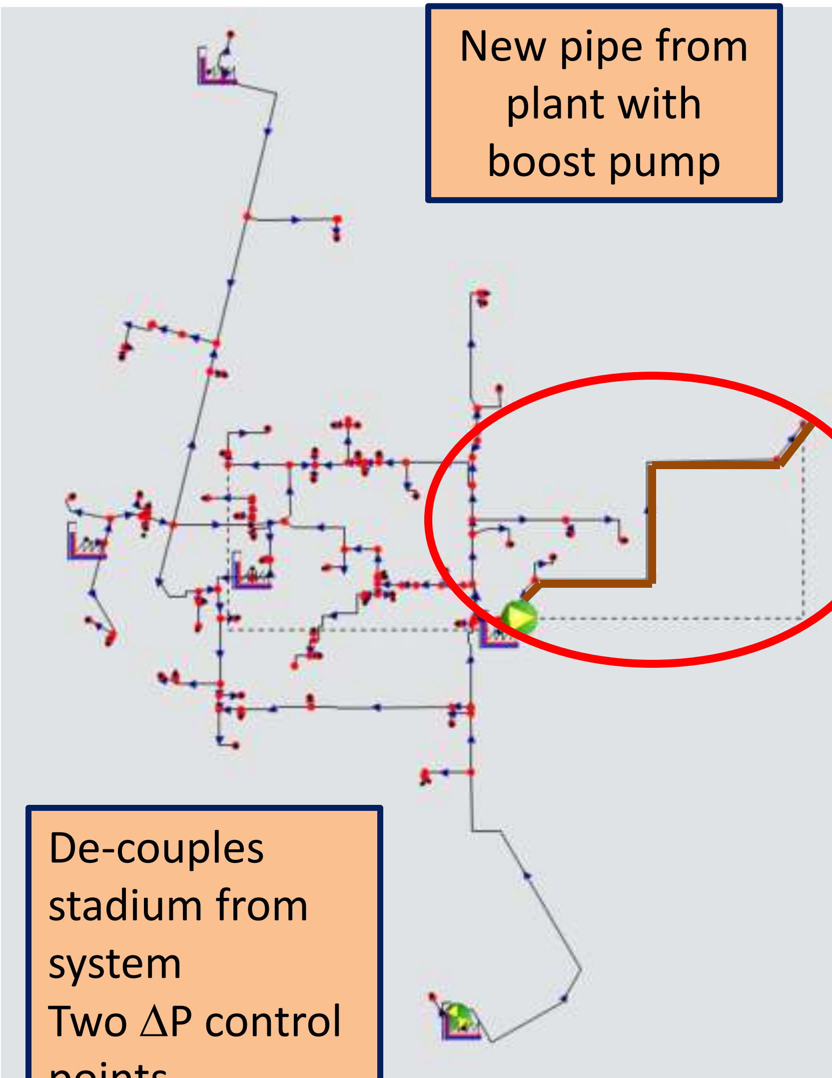


- System Tests
  - Plymouth bldg pressure differential doesn't match predictions
  - Pipe routing such that valves could be used to flow water via different routes
    - Locate possible source of calibration error

System Expansion Study

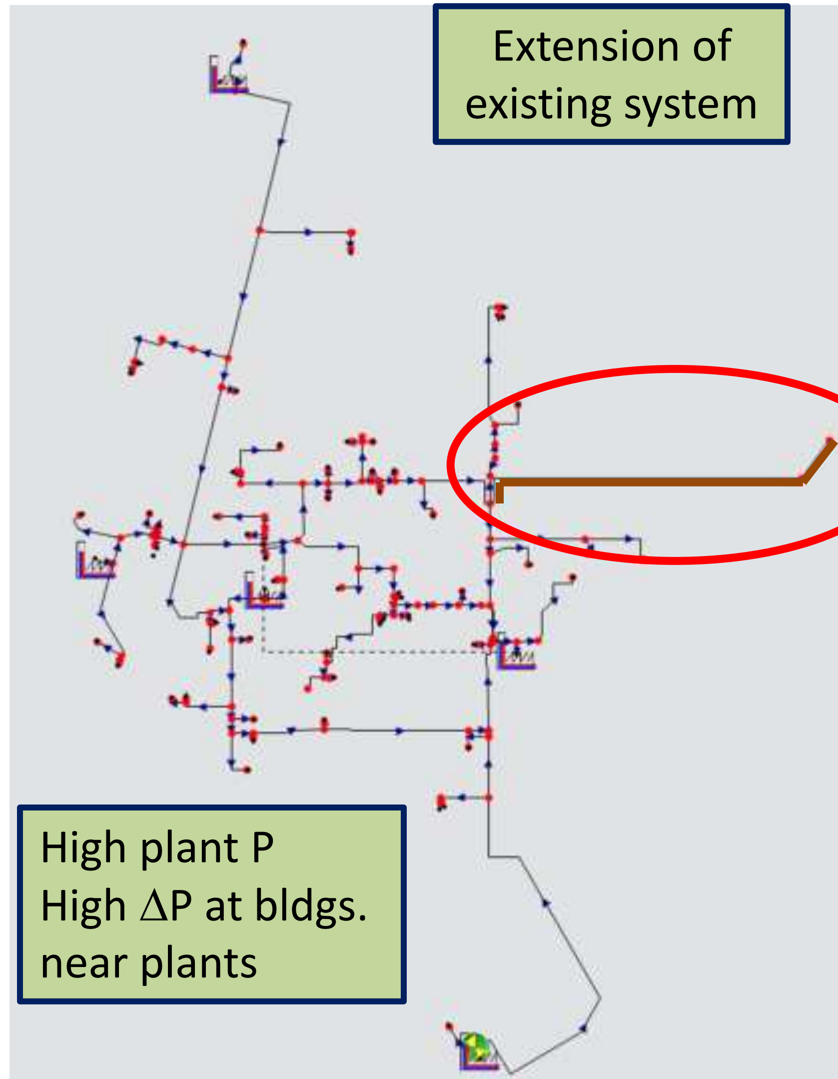
- New multi-purpose stadium
  - Have calibrated model to use for studies
    - Allowed system analysis prior to design specific tasks
- Chilled water system impacts
  - Evaluate two possible routes
    - Main plant connection
    - Extension of existing system
  - Assess overall impact on system
    - Plant P limits
    - Bldg P/ΔP limits
  - Assess operational changes to meet new load
    - Which plants to operate
    - Stadium load variability
  - Provide design input

Stadium Supply Routes



New pipe from plant with boost pump

De-couples stadium from system
Two ΔP control points



Extension of existing system

High plant P
High ΔP at bldgs. near plants

Stadium Supply Decisions

- Modeling analysis drove to need to run separate distribution line from main plant to stadium
- Existing piping distribution system has potential choke point which drives overall system pressure too high
- End result is new “east loop” that is somewhat independent of remainder of system
- Boost pump to overcome system losses to stadium
- Need to limit stadium load during normal weekday, can provide excess capacity at night and on weekends

Conclusions and Lessons Learned

- Calibrated model of system complete
  - Real-time and offline model provides understanding of system hydraulics, limitations and bottlenecks
- Model available as engineering design tool for system expansion studies
  - Evaluate operational flexibility and chiller dispatch too
- Moving toward use by Operations and in the Control Room
- Modeling/calibration partnership worked very well
  - In-house knowledge of software and overall system performance is invaluable
  - Allows tighter specifications for design tasks

Thank you!

Carl Jauch, PE, Director, MEC Engineering

NRG Energy Center Minneapolis

612-436-4112, Carl.Jauch@nrgenergy.com

www.nrg.com

and

Thomas Lund-Hansen, President

Termis Solution Group North America

Reliability Efficiency & Optimization LLC

845-270-3897, tlh@7T.dk or energyoptimizationefficiency@gmail.com

www.schneider-electric.com

Abstract

- The NRG Energy Center Minneapolis has developed a hydraulic model of their chilled water distribution system. It is be used for management, operation, engineering and maintenance of the 40,000 tons downtown system. Real-Time hydraulic modeling is a cornerstone of this new platform. This case study includes presentation and demo of the process, results of the work, how NRG has improved decision-making and savings.