Liquid Cooling Installation Lessons Learned at Lawrence Livermore National Laboratory (LLNL)

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LLNL’s Liquid Cooled Systems

Sequoia
- IBM BGQ
- 98,304 nodes
- 1,572,864 cores
- 20 PF, 3rd on Top 500 ranking – Nov. 2014
- 91% liquid cooled
- 30 gpm at 62 F
- 9% air cooled
- 1700 cfm at 70 F
- 100kw/rack
- 96 racks – 9.6MW

Vulcan
- IBM BGQ
- 24,576 nodes
- 393,216 cores
- 5 PF, 9th on Top 500 ranking – Nov. 2014
- 91% liquid cooled
- 30 gpm at 62 F
- 9% air cooled
- 1700 cfm at 70 F
- 100kw/rack
- 24 racks – 2.4MW
Liquid Cooling Specifics for Sequoia and Vulcan

- 91% liquid cooled, and 9% air cooled
  - Liquid cooling inlet requirements
    - Specified Range
      - 64F to 74F
      - Tolerance - (+/- 1 degree)
    - New tertiary loop required
      - GPM/rack = 25 to 35 gpm
      - Stainless steel or copper specified
        - Polypropylene piping selected
      - **Total project savings: $2M**
      - Maintain B453 LEED Gold status
      - Provides efficient flow
      - Reduced heat gain and loss
      - Minimized environmental impacts
        - Ensure ISO 14001 compliance
Lessons Learned - Case Study #1
Sequoia Water Quality Issues

- Water quality specified by vendor was inconsistent
  - Resistivity - ? or Conductivity - ?

- Demineralized water (DW) was initially used to flush/fill based on vendor’s interpretation
  - Facility only has a 1” DW line available
  - After initial fill, it was determined that DW was too resistive (5 to 7 M-ohms)

- City water (CW) was finally used to flush/fill
  - Just right amount of resistivity (2 M-ohms)

- These issues resulted in schedule delays and unforeseen additional rework
Lessons Learned - Case Study #2
Sequoia Erratic Water Temperatures

- Water temperatures specified by vendor to be within range of 64 F to 74F (+/- 1 degree)
- System was designed to modulate to 62F
- Vendor was unsure of correct requirement
- During commissioning, vendor experienced higher temperatures on various node cards
- Verified through extensive tests that facility water temperature was within tolerance
- Began to investigate packaging of the node cards and drawers
- Packaging was designed without a manifold and facility system was set to lowest possible setting
Lessons Learned - Case Study #3
Vulcan Water Utility Source Issues

- Hetch Hetchy – Primary Source
- Zone 7 – Secondary Source
  - Local ground water source
- Approval for construction delayed and computer delivery accelerated
- Hetch Hetchy annual maintenance coincided with flush/fill of system
- Plan included pre-filling portable tanks/pump skid with Hetch Hetchy
- Construction completed early
- System was filled directly with Hetch Hetchy, portable tanks were not needed and water was repurposed
Questions

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