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

Silicon Valley Leadership Group April 15, 2015



#### Anna Maria Bailey, PE



#### LLNL-PRES-554151

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC

# **LLNL's Liquid Cooled Systems**

#### Sequoia

- IBM BGQ
- 98,304 nodes
- 1,572,864 cores
- 20 PF, 3<sup>rd</sup> 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
        - <u>Total project savings: \$2M</u>
        - 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

Anna Maria Bailey 925-423-1288 bailey31@IInl.gov

