THERMAL ENERGY STORAGE TANK “DOWN UNDER”

OWNER

ENGINEER

TANK BUILDER

SHARING SOLUTIONS, SUSTAINING OUR FUTURE

CampusEnergy2018

Mt. San Antonio College

Walnut, CA – Los Angeles area

Community College serving over 50,000 students

Host to the 2020 U.S. Olympic Track & Field Competition

Why Mt. SAC Considered TES

- Campus expansion plan through 2025
- Increased district cooling requirement
- Limited space for central plant
- Reliability
- Redundancy of the chilled water system
- Reduce daytime noise
- Economic benefits

Economic Benefits of TES

- Lowest first cost and operation & maintenance costs when compared to adding more central chiller plant equipment
- Energy cost savings by shifting the electric load to off-peak periods
- Permanent Load Shift incentives and State energy efficiency funds

What led to a Fully Buried TES Tank?

- Limited space in central plant area
- Eliminates aesthetic concerns
- Less maintenance with a concrete tank

Engineering Perspective

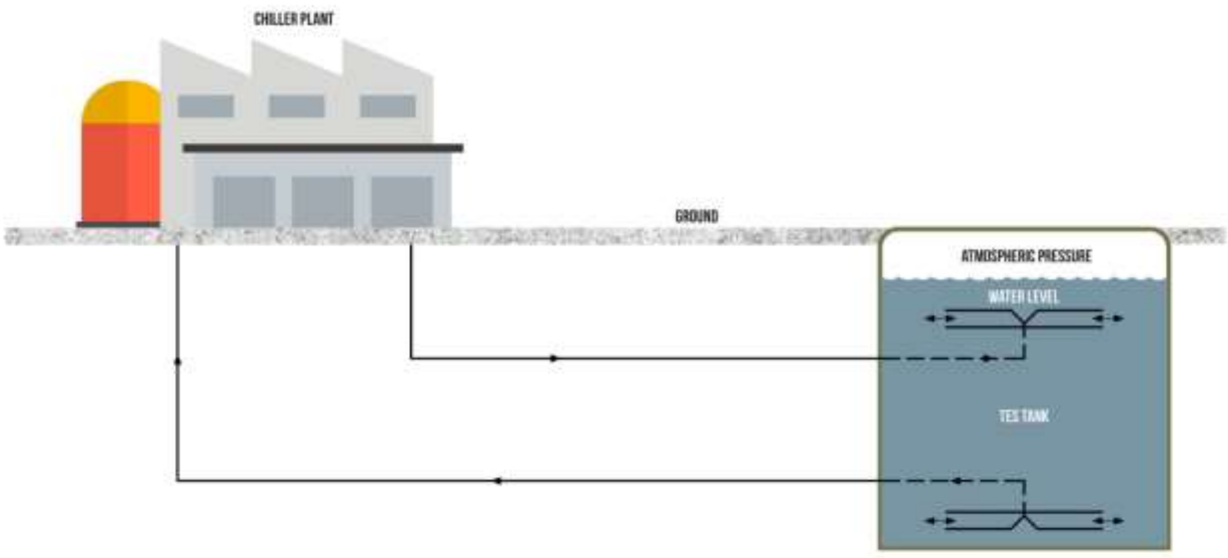
Engineering Perspective

Underground TES tanks have challenges that are not faced by above ground applications. A few significant ones are:

- The water elevation of the tank may be lower than some or all of the buildings and plant.
- The tank's venting and access location will be at grade.
- Draining the tank may require pumping.

Tank Water Level in Relation to Building Equipment

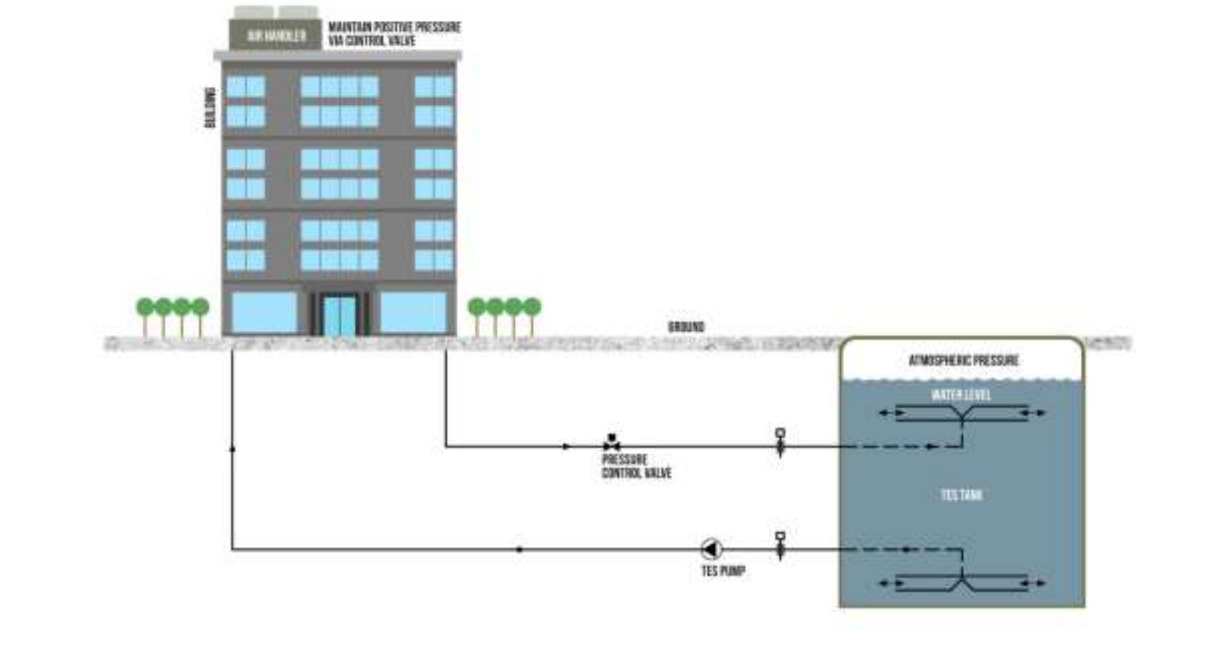
- TES tanks operate as “open” systems – the top of the tank is at atmospheric pressure.
- If the tank water is at a lower elevation than other parts of the system there is a possibility of chilled water lines going in to a vacuum and/or the tank may overflow.



Controlling Pressure in Buildings

A pump and control valve arrangement works well for maintaining positive system pressure during tank discharge.

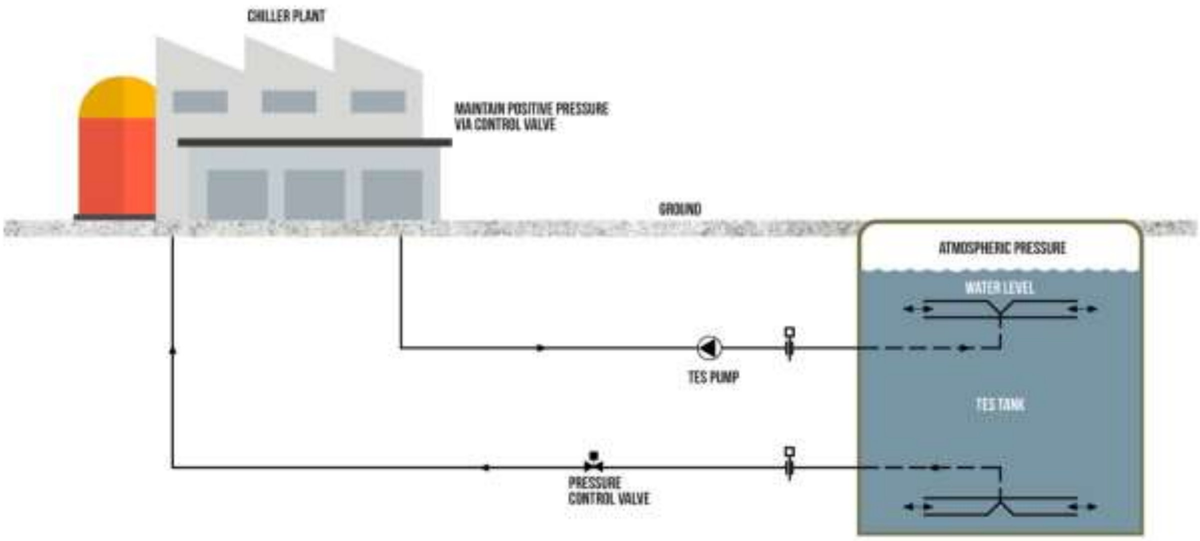
- Pump the water from the bottom of the tank when discharging TES tank.
- Maintain positive pressure at all air handlers and fan coils.
- Pump the water from the top of the tank when charging and control the chilled water return line pressure.



Controlling Pressure During Regeneration

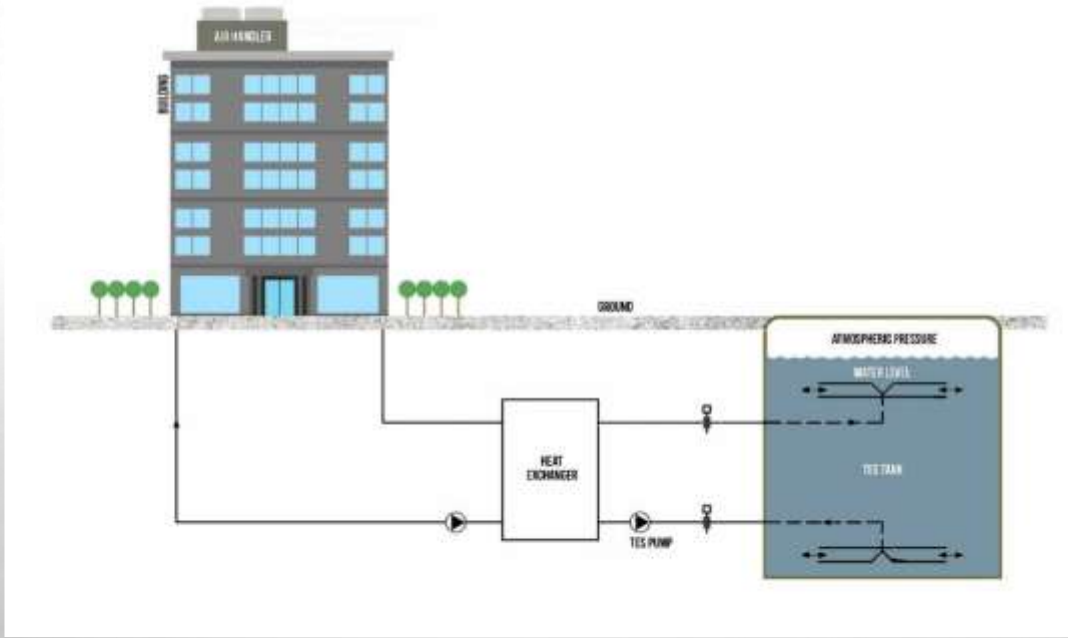
A pump and control valve arrangement works well for maintaining positive system pressure during tank regeneration.

- Pump the water from the top of the tank when charging and control the chilled water return line pressure.
- Maintain positive pressure in the central plant.



Alternative Pressure Control & Isolation Methods

- Pressure sustaining valves are often used, but represent a fixed pressure drop in the system and result in higher pumping energy.
- For very large elevation differences a pressure isolating heat exchanger may be required, but this poses other concerns:
  - Second pump system will be added.
  - Thermal losses in the heat exchanger.



Tank Venting and Access

The tank needs to have a point of entry and be vented to the atmosphere.

- With a buried tank, this may be at grade.
- Securing the access from the public is needed.

Draining and Overflow

- The tank requires an overflow pipe:
    - Route to sanitary drain? Check with local authorities.
    - May require a long underground pipe route to get to a suitable drain.
    - May require a separate sump with a pump.

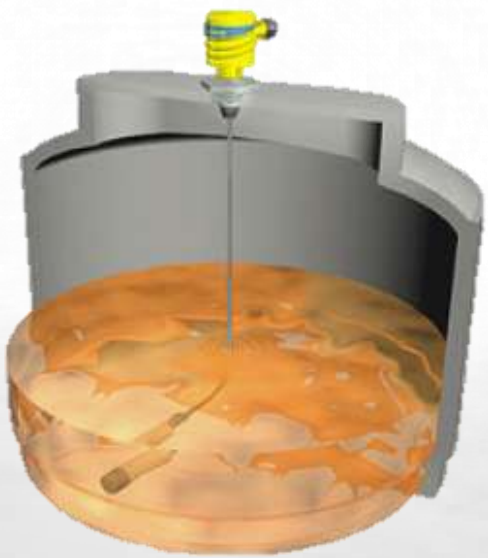
- Overflowing the tank is abnormal and designer should provide a means to detect and isolate.

- Tank may need to be pumped out if it is to be emptied if gravity flow is not feasible.

TES Tank Level Control

- The system chilled water make-up must be controlled by the tank water level.
  - The tank is the expansion control.
  - Other make-up water sources must be isolated.
- Example of level sensor types:
  - Ultrasonic sensors.
  - Pressure sensor at the bottom of the tank.

2270 Ultrasonic Level Sensor



LD31 Pressure Sensor

Engineering Summary

- Look at the issues associate with hydraulic elevations.
- Coordinate the location of the access hatch and vent.
- Coordinate the tank drain and overflow locations.
- Control tank water level and isolation any other sources of make-up water.

Tank Builder Perspective

Example TES Tank Applications


Los Angeles, CA - USC


Riverside, CA - UC


Orlando, FL - UCF

College Campuses

Lackland AFB, TX


San Antonio, TX - Airport


Raleigh, NC

Government and Municipalities


Brooks, CA – CCC Resort


Santa Clara, CA – DFP

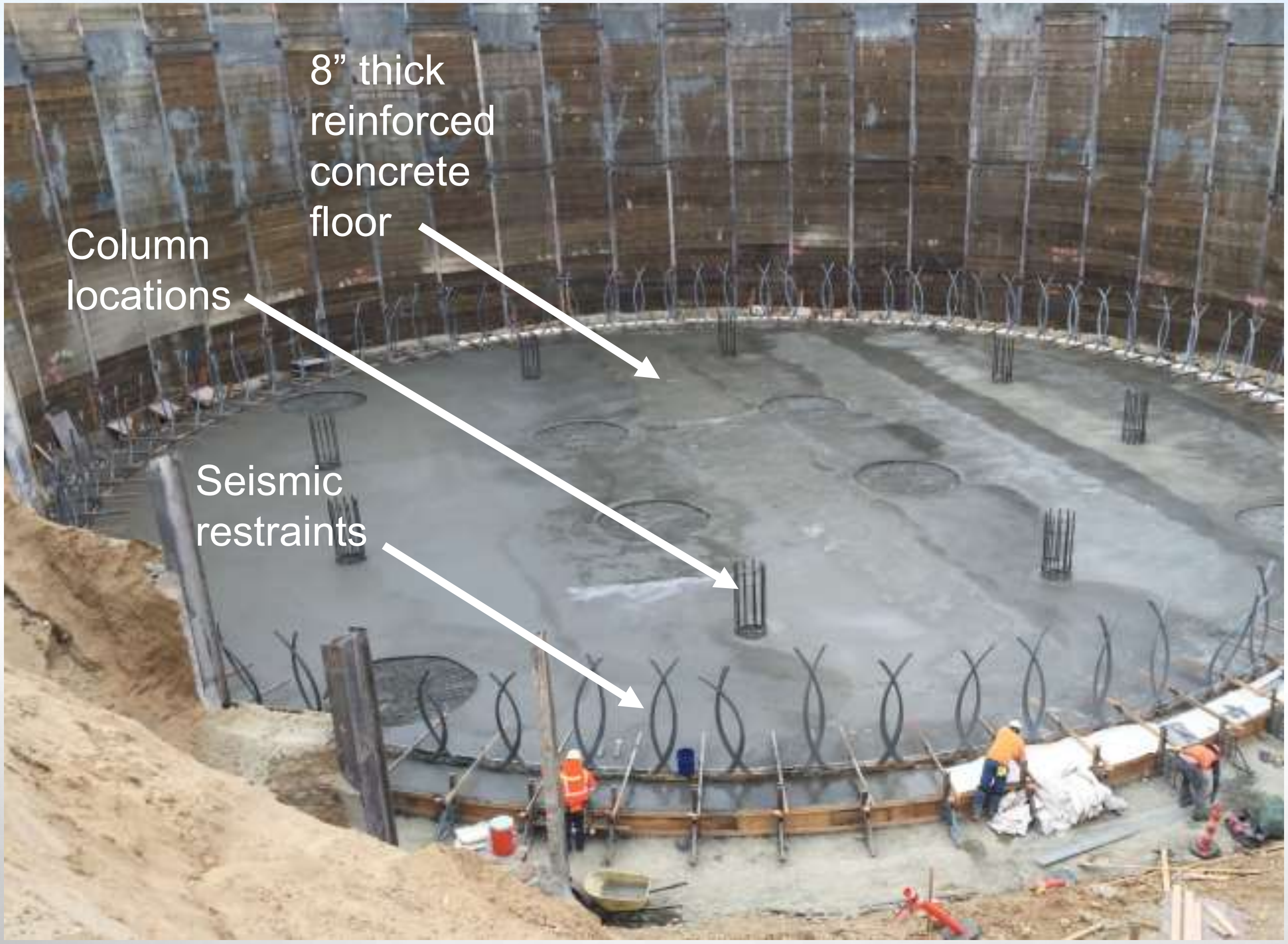

Front Royal, VA – Dominion

Private Industry, Power Plants, and Data Centers

2.0 MG TES Tank - Considerations for Fully Buried Under a Parking Lot

- Groundwater level
- Roof loading – HS20 (think firetrucks)
- Internal distribution piping and diffuser piping among columns
- Access into the excavation during construction
- Access through the roof after backfill

Floor Construction and Seismic Considerations



Temporary Shoring and Wall Form Placement

Form for cast-in-place reinforced concrete wall

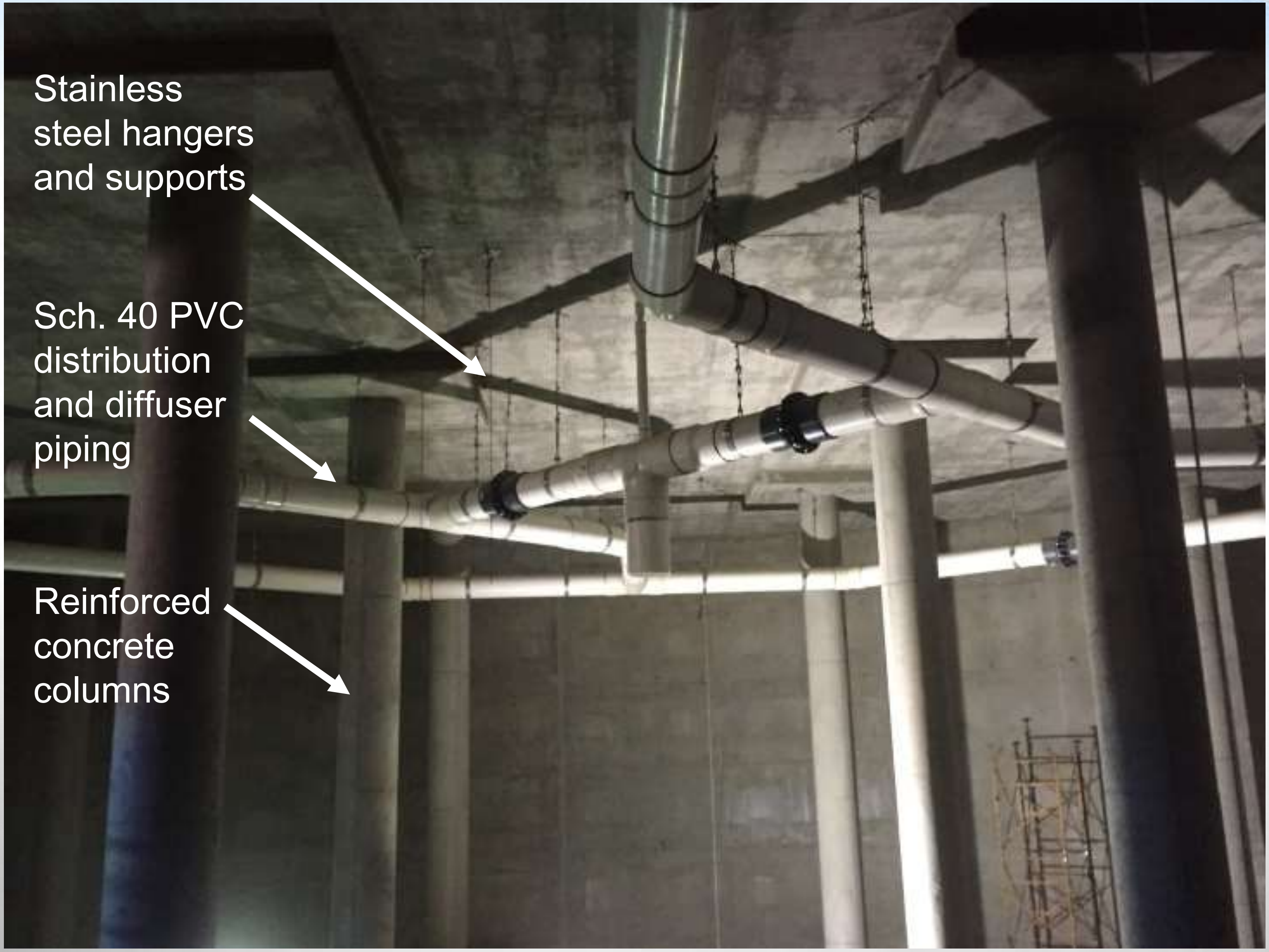
Temporary Shoring

Horizontal Prestressing and Cast-In-Place Roof

12.7 miles of steel cable under 140 ksi of tension – placing the wall sections into compression

18” thick reinforced concrete roof

Upper Diffuser Piping

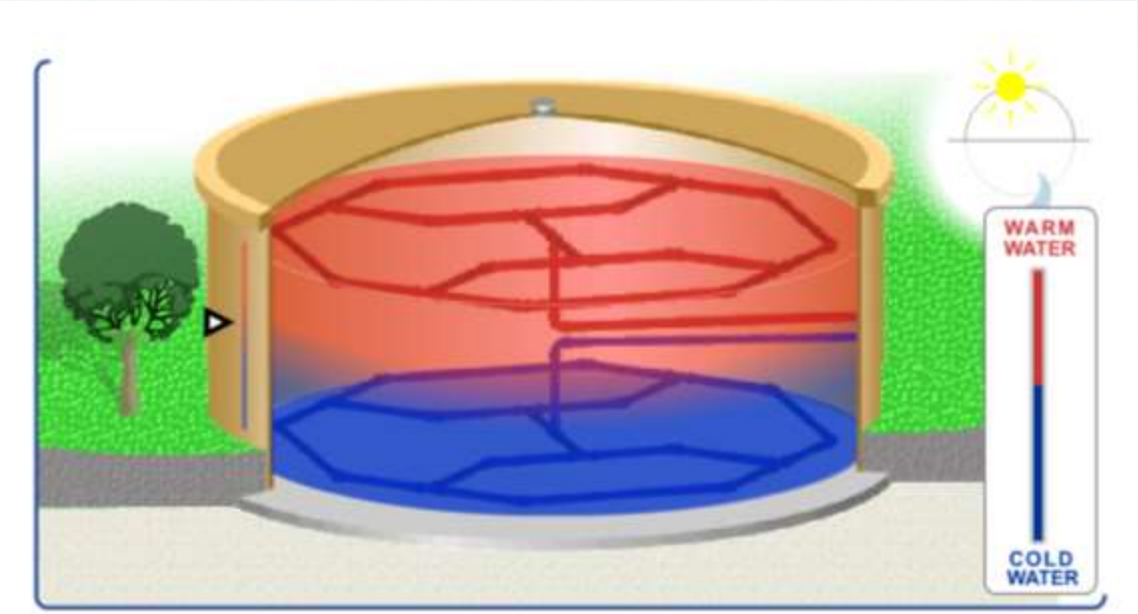


TES Tank – Ready to be Backfilled

Backfill and Parking Lot Restored

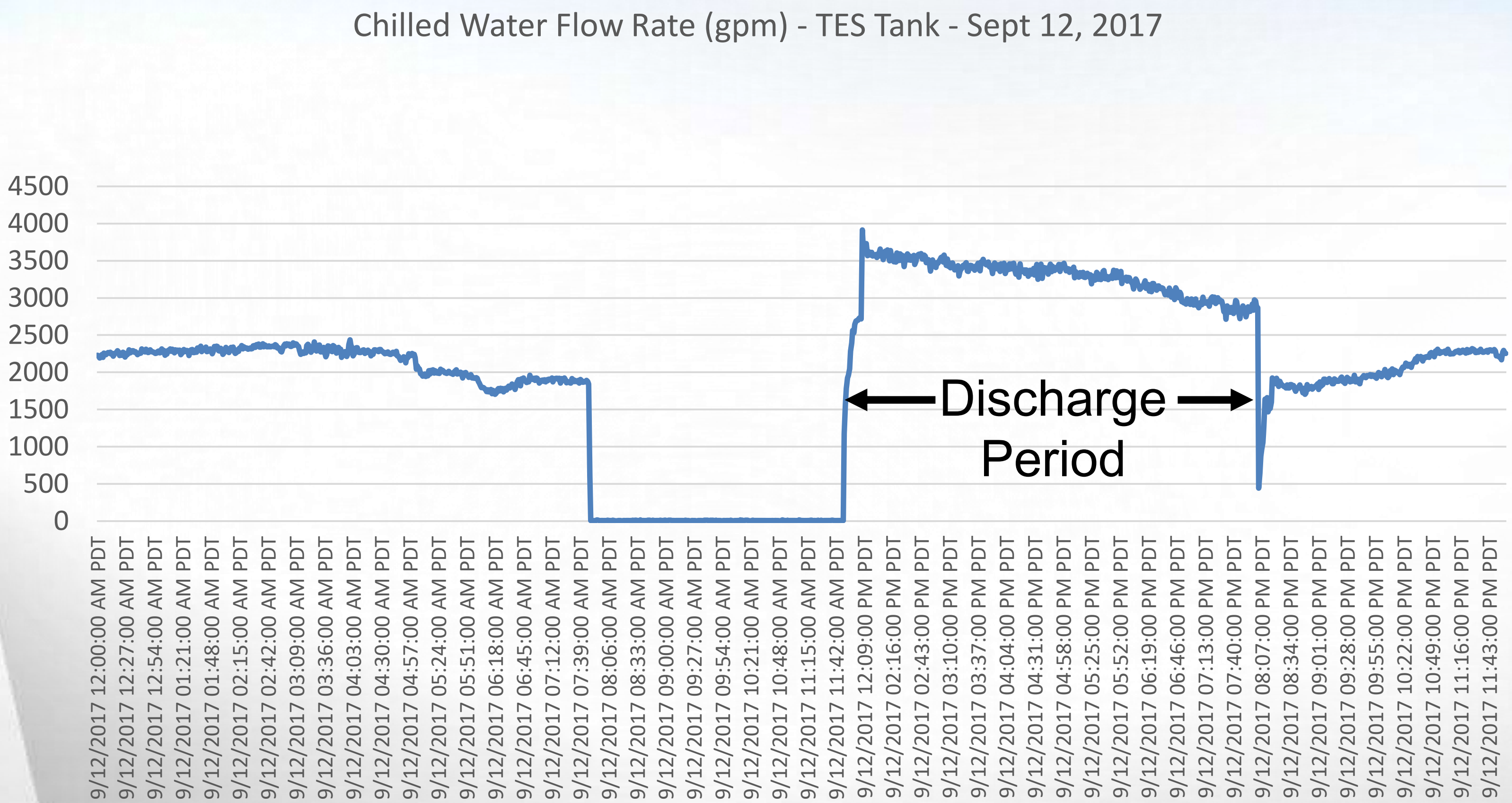
Performance of the TES Tank

Performance Requirements and Details of Mt. SAC's TES Tank



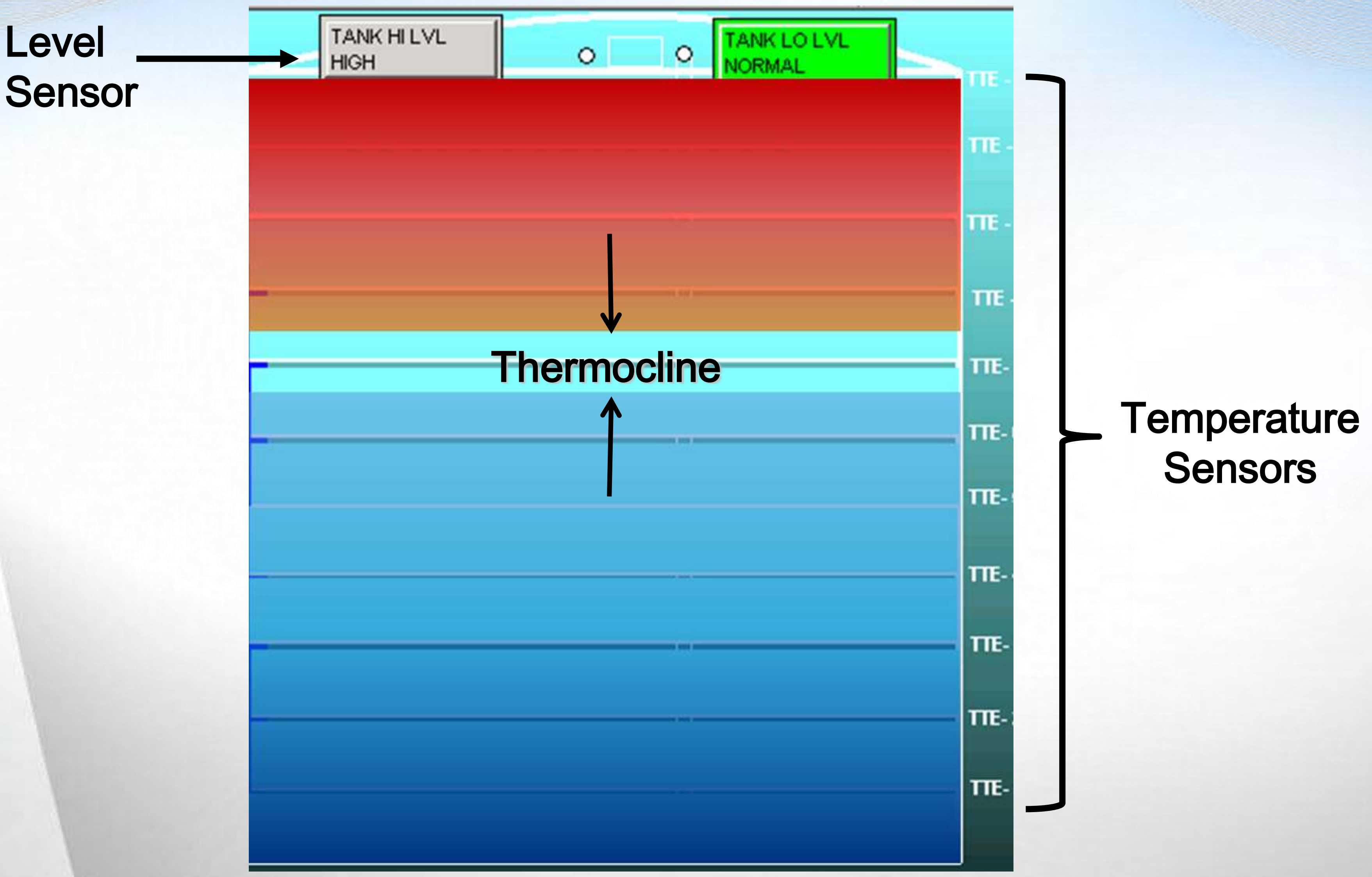
- 20,000 ton-hrs – useable TES capacity
- 16°F – chilled water ΔT
- 5,000 gpm – maximum chilled water flow rate
- 2,000,000 gallons – total volume
- 108'-3" inside diameter x 29'-9" water depth

Performance Test
Chilled Water Flow Rate Thru Tank

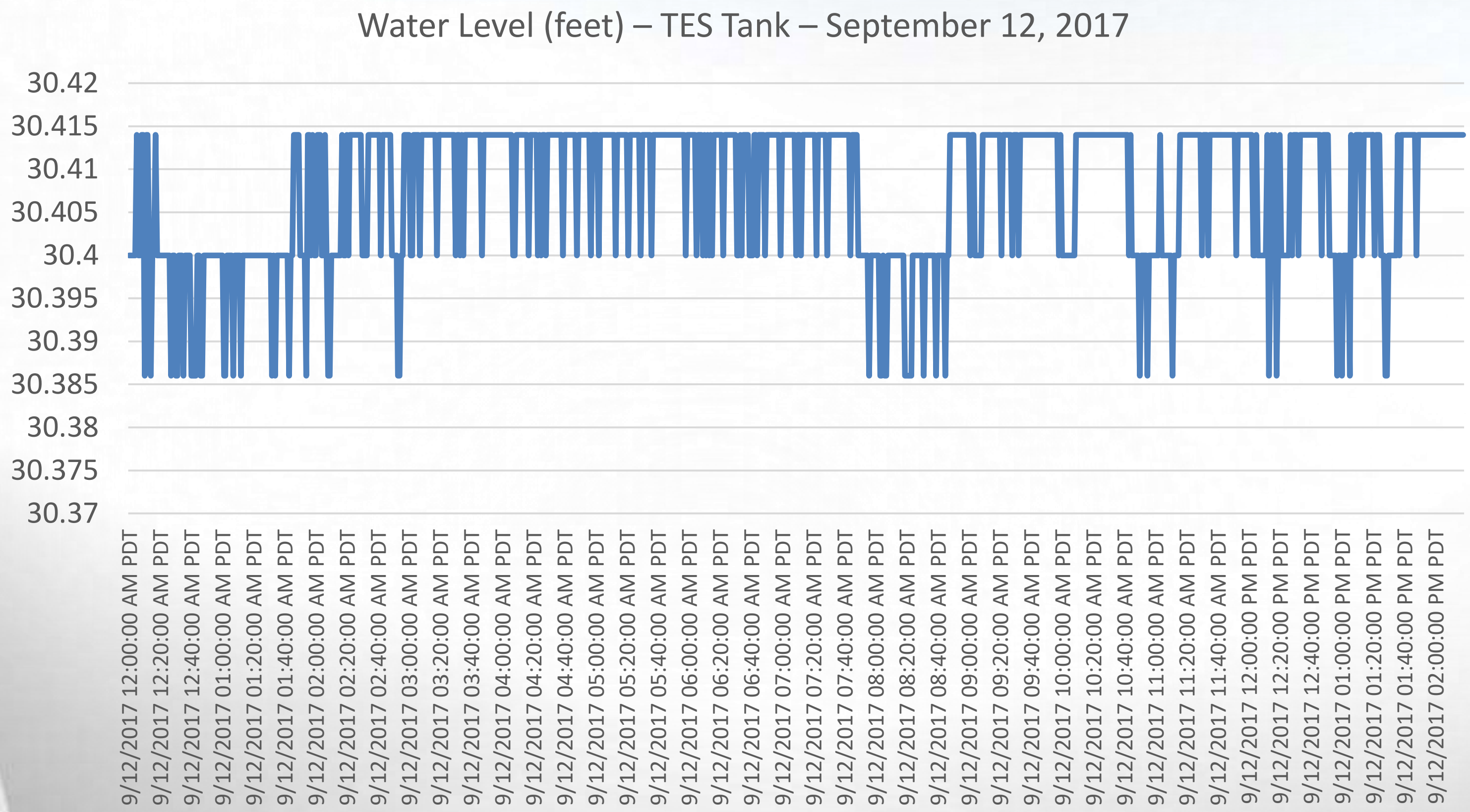


Discharge Period Coincides with On-Peak Electric Demand Charge

Instrumentation Inside of a TES Tank

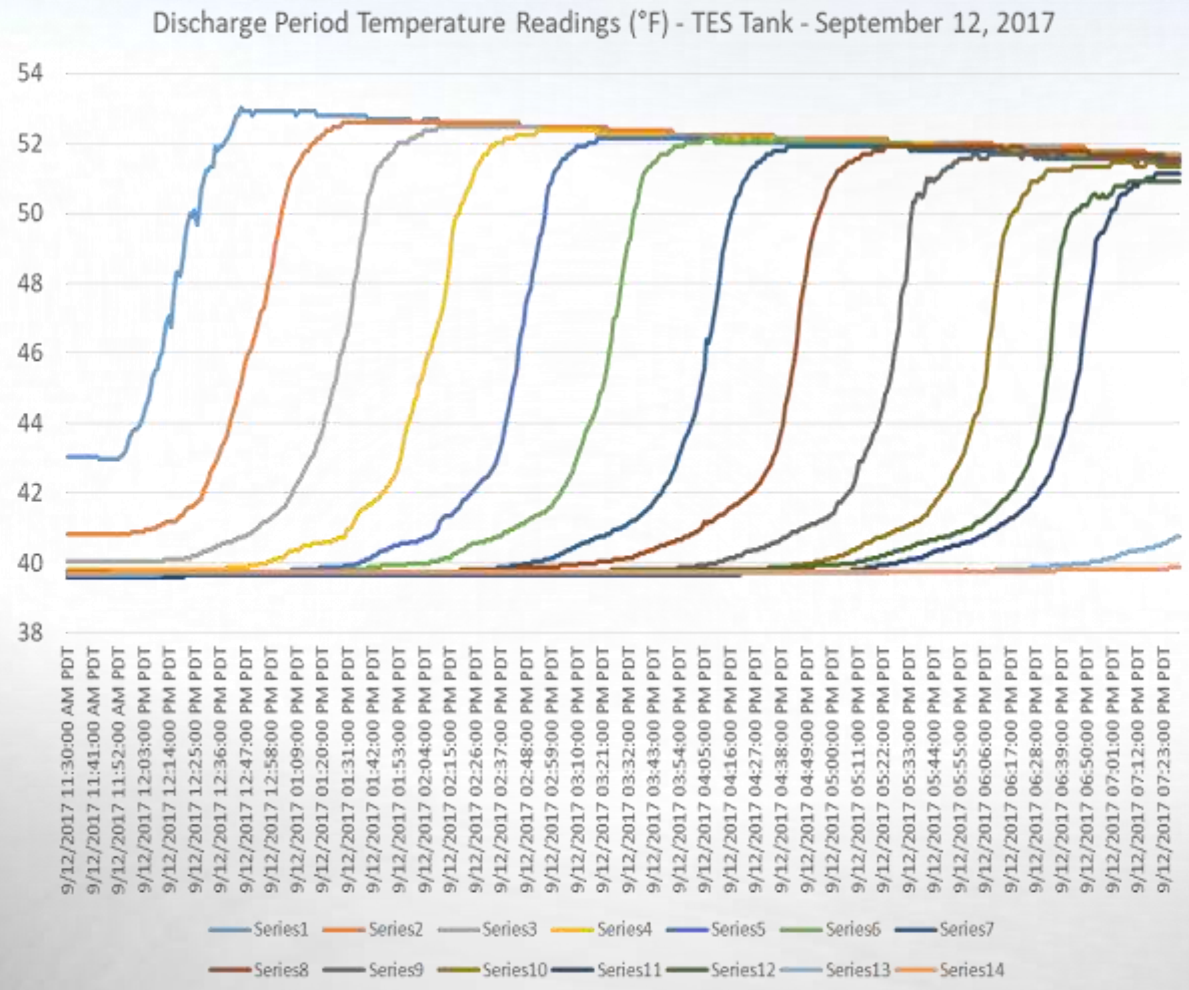


Performance Test
Water Level in the Tank



Water Level Varies Very Little Throughout the Day

Performance Test
Temperature Readings in the Tank



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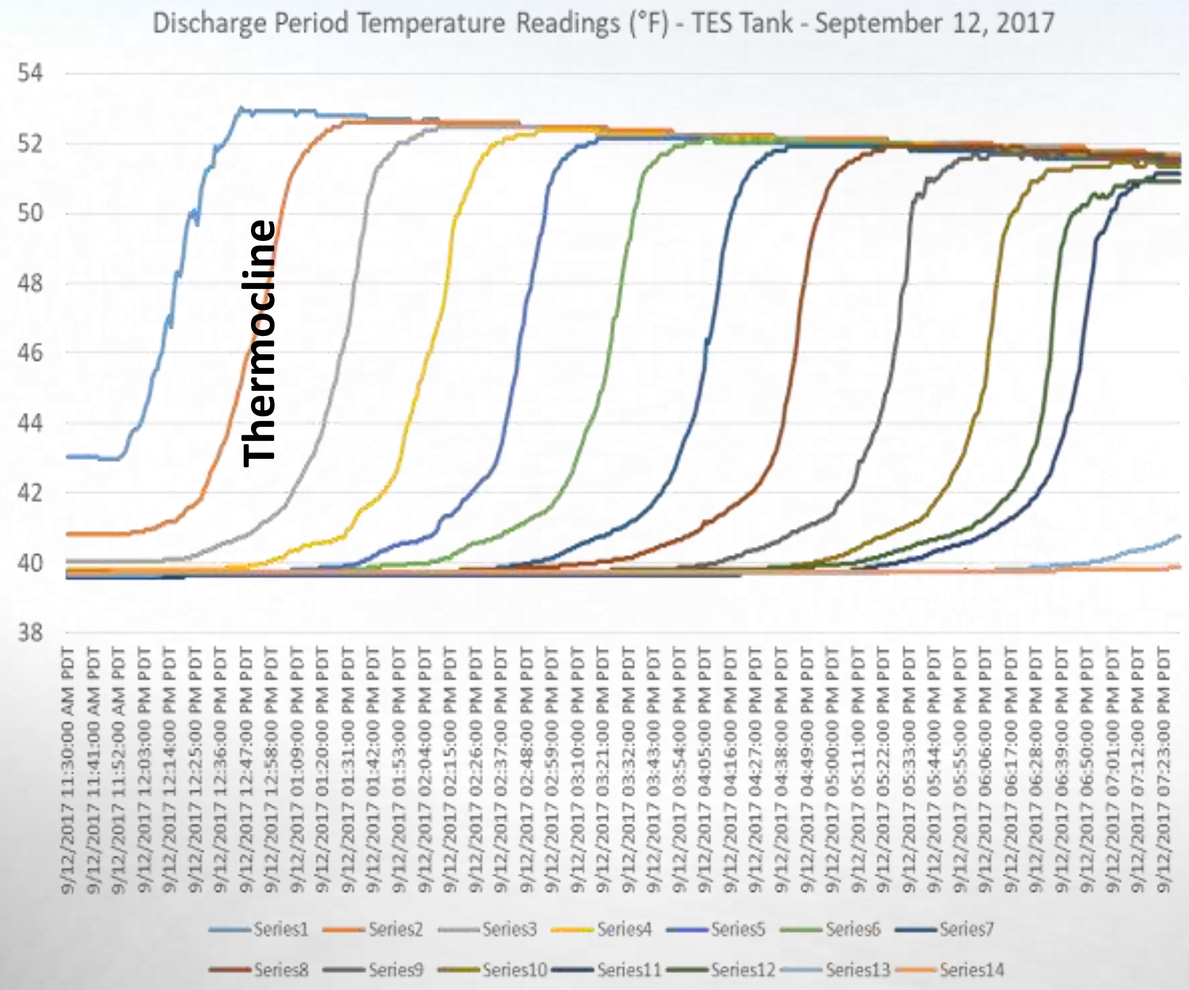

Q&A

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