THE UNIVERSITY OF TEXAS AT AUSTIN
Utilities and Energy Management

P. O. Box 7459 · H8000 · Austin, Texas 78713 · 512-471-6241 · FAX 512-471-1904
www.utilities.utexas.edu

June 24, 2020

Mr. Jim Walker, Director of Sustainability
University of Texas at Austin
1301 East Dean Keeton Street
Austin, TX 78712

Re: LEEDv4.1 WE Cooling Tower Water Use
Carl J. Eckhardt Combined Heating and Power Complex
Utilities and Energy Management Department
University of Texas at Austin

Dear Mr. Walker:

This document serves to provide information on the use of water and water treatment methods at the power plants and chilling stations that comprise the Carl J. Eckhardt Combined Heating and Power Complex. The Utilities and Energy Management (UEM) Department uses innovation and technology to provide reliable and cost-effective utilities to support the tradition of teaching and research excellence at The University of Texas at Austin. The power complex provides 100 percent of campus electricity and heating. Our five chilling stations and 9.5 million gallons of chilled water in two thermal energy storage tanks satisfy the cooling requirements for 22 million square feet in more than 160 campus buildings, serving 74,000 faculty, students and staff. The complex provides the university with an independent utility system, with electrical ties to the City of Austin electrical grid as an emergency backup source of power. UEM recently achieved PEER Platinum certification for this district energy system.

This narrative is provided to assist in individual LEED projects served by the university's PEER certified district energy system and in response to GBCI Meeting Notes dated June 16, 2020 with Lan Li, Gail Hampshire and Emma Hughes and GBCI Meeting Notes dated October 14, 2020 with Gail Hampshire, Ken Simpson and Lan Li.

System description –

The main campus of the University of Texas at Austin has a total of seven cooling towers in the district energy system - two for the power plant and five for the five chilling stations. The make-up water sources for these towers include:

- Recovered Water (condensate from building air handler units and water collected from process and perimeter drains)
- Reclaimed Water (purchased non-potable effluent from City of Austin water treatment services)
- Irrigation Water (purchased water from City of Austin without associated sewer charge)
- Domestic Water (purchased water from City of Austin including sewer charge)

The Irrigation and Domestic water sources are the same quality, just metered separately. Not all of the towers receive all of the make-up water sources. Also, not all of the towers are in operation at any particular time. Typically one power plant tower is running and the number of chilling station towers in operation are a function of the seasonal load and maintenance activities. Below is a table summarizing the cooling towers and water chemistry analyses averaged in 2019:

	Domestic City Makeup	CS#3 Tower (Offline)	CS#4 Tower (Offline)	CS#6 Tower	PP Tower #1	PP Tower #2 (offline)
Total Hardness as CaCO3, ppm	90.2	190.1	188.7	1047.8	656.0	210.0
Calcium as CaCO3, ppm	28.3	55.8	64.2	318.0	233.6	61.0
Magnesium as CaCO3, ppm	61.9	134.3	124.5	729.8	422.4	149.0
Conductivity, micromhos	302.0	897.0	788.0	2156.0	2483.0	843.0
Total Alkalinity as CaCO3, ppm	56.0	140.0	130.0	50.0	105.0	135.0
Chloride as Cl, ppm	31.7	127.7	115.2	297.1	322.7	117.0
Silica as Si, ppm	8.1	23.9	19.9	58.8	66.9	21.2
Cycles of Concentration				7.14	8.22	

	Reclaimed Water Makeup	CS#5 Tower	CS#7 Tower
Total Hardness as CaCO3, ppm	328.7	696.8	1003.8
Calcium as CaCO3, ppm	99.2	280.0	348.3
Magnesium as CaCO3, ppm	229.5	416.8	655.5
Conductivity, micromhos	1200.0	3719.0	3874.0
Total Alkalinity as CaCO3, ppm	80.0	180.0	55.0
Chloride as Cl, ppm	107.2	477.0	505.0
Silica as Si, ppm	10.1	41.7	44.3
Cycles of Concentration		3.10	3.23

Makeup water sources to the towers are introduced to the towers, in order of priority. That is to say, all available water from each source is used before the next source is utilized to maintain basin levels:

Recovered Water – All towers
Reclaimed Water – CS#5 and CS#7
Irrigation Water – All towers
Domestic Water – All towers (emergencies/maintenance only)

In this period of time shown, the operating towers were CS#6 Tower, PP-Tower #1, CS#5 Tower, and CS#7 Tower, with CS#3, CS#4 and PP-Tower #2 towers in a lay-up condition. As they are put into operation, CS#3, CS#4, and PP-Tower #2 Towers are operated similarly to CS#6 and PP-Tower 1, with similar chemistry program setpoints and cycles of concentration. The target cycles for concentration for these towers are 7.5-8.5 cycles. The towers for CS#5 and CS#7 have markedly different chemical analyses because they use reclaimed water as a primary make-up source and have different chemical treatment programs to deal with the higher conductivity present in the water. Reclaimed water is not currently used at any of the other towers.

A breakdown of makeup water source use is for the reference year is shown below:

	FY2019
All Cooling Towers (CS + PP)	Gallons
Domestic + Irrigation Water To Cooling Towers	199,787,964
Recovered Water, gal	47,018,608
Reclaimed Water, gal	108,657,467
Alternative Sources (Recovered + Reclaimed)	155,676,075
Blowdown	68,032,544
Total Water to Cooling Towers	355,464,039
Alternate Sources as percent of total makeup	**44%**

Utilities and Energy Management has worked closely with their contracted chemical services group, Apollo Water Services, to develop a chemical treatment program that provides protection against scaling and corrosion while utilizing the least amount of water to do so.

Determining the cycles for each tower to operate –

This is a fundamental concept when controlling cooling tower water systems. Running cycles too high can perpetuate system stresses that lead to scale and corrosion. Running cycles too low will lead to financial impacts with wasted water.

Determining optimum cycles of concentration to minimize scale/corrosion and enhance water conservation -

1. Maximum cycles of concentration are determined by the makeup water quality.
2. It is understood that makeup sources vary significantly from city to city and state to state. Typically, laboratory or field analysis is conducted of the makeup water source/s and ratios to total makeup determined. This includes calcium hardness, magnesium hardness, total alkalinity, sulfate, silica, pH and conductivity.
3. These parameters are then used to determine the limitations on cycles imposed by the solubility of calcium carbonate, calcium sulfate, calcium phosphate and silica, since these are the primary contributors to mineral scale, deposits, and corrosion.
4. Apollo Water Services uses industry standard software that models mineral scale potential over a narrow and broad operating range. The software does not necessarily rely on traditional indices (LSI, Larson Skold, RSI, etc.) but instead is powered by an ion association model that predicts scale saturation.
5. In addition, the modeling provides insight on a products saturation level limitations and dosage recommendations for a given cooling tower water system.

Control of microbiological activity in our cooling water systems -

1. We follow the guidance of the following agencies for microbicide treatment of cooling tower water systems:
    a. OSHA; Section III: Chapter 7.V.B2
    b. CDC/EPA; Technologies for Legionella Control
    c. CDC/EPA; Developing a Water Management Program to Reduce Legionella Growth
    d. Cooling Technology Institute (CT); Guideline: Best Practices for Control of Legionella
2. There are a multitude of other agencies that recommend similar if not verbatim guidelines to the sources listed above.
    a. Generally, these agencies recommend continuous chlorination and a non-oxidizing biocide treatment, coupled with monitoring.

Microbicide program and typical feed rates -

1. At minimum, a dual microbicide program is deployed in the cooling tower water systems consisting of a Oxidizing and Non-Oxidizing microbicide
    a. Cooling Tower Systems with 80+% domestic/irrigation water source makeup
        i. Oxidizing Biocide 12.5% Bleach – fed continuously to achieve a free chlorine of 0.08 – 0.20 ppm and a total chlorine of 0.8 – 1.2 ppm via Oxidation Reduction Potential (ORP) by real time automation control systems
        ii. Non Oxidizing Biocide (Isothiazolinone)– slug fed every other week in accordance with biocide label requirements, per system volume.
    b. Cooling Tower Systems with a 30+% recovery water source makeup
        i. Oxidizing Biocide 12.5% Bleach – fed continuously to achieve a free chlorine of 0.08 – 0.20 ppm and a total chlorine of 0.8 – 1.2 ppm via Oxidation Reduction Potential (ORP) by real time automation control systems
        ii. Non Oxidizing Biocide (Isothiazolinone) – slug fed every other week in accordance with biocide label requirements, per system volume.
        iii. Chlorine Dioxide – slug fed on a predetermined frequency, derived by testing of microbiological loading
    c. Cooling Tower Systems with a 80+% reclaim water source makeup
        i. Oxidizing Biocide 12.5% Bleach – fed continuously to achieve a free chlorine of 0.08 – 0.20 ppm and a total chlorine of 0.8 – 1.2 ppm via Oxidation Reduction Potential (ORP) by real time automation control systems
        ii. Non Oxidizing Biocide (Isothiazolinone) – slug fed every other week in accordance with biocide label requirements, per system volume.
        iii. Non Oxidizing Biocide (DBNPA) – slug fed M-F, at low dosages, per biocide label. Product works in synergistically with chlorine for a highly effective bacteria kill rate.
        iv. Chlorine Dioxide – slug fed on a predetermined frequency, derived by testing of microbiological loading

Monitoring microbiological activity in our cooling tower systems -

1. Legionella Testing is performed 4x per year on each cooling water system.
    a. Planned and documented remedial actions taken in accordance with OSHA/CDC guidelines.

2. ATP (adenosine triphosphate) testing is performed on each cooling water system at minimum two times per week. Results are logged and trended for evaluation of microbiological activity.
3. Sanicheck SRB & Bacteria Field Cultures
    a. Field cultures requiring incubation are performed at minimum 2 x month on each cooling water system. Results are logged and trended for evaluation of microbiological activity.
        i. If an increase (trend) is observed, biocide feed rates are evaluated and increased to suppress activity.
4. DATS Fouling Monitor
    a. Systems on 80+% reclaim water
        i. A side steam heat exchanger system designed to emulate the geometry and heat flux of the heat exchanger equipment.
        ii. Basically, a data acquisition system designed to control, monitor and record all parameters necessary to perform heat transfer analysis.
            1. In general, as deposits (scale, biofilm, debris) accumulate, the tube surface becomes thermally insulated and the change in heat transfer is electronically recorded, providing indication if fouling is occurring.

Maintenance –

The chillers are maintained by in-house UEM staff. The current program includes opening and inspecting the condenser water heat exchangers annually. The tubes are brushed clean and then inspected with a boroscope to check for any issues. The heat exchangers are also inspected with an eddy current process every five years to assess tube wall thickness and integrity.

Summary -

Through the chemical treatment and maintenance programs in place, we have had excellent performance and preservation of our cooling towers and heat exchangers. Annual inspections reveal good conditions in the heat exchangers and we have no recorded instance of needing to re-tube a condenser due to corrosion or fouling issues. With proper treatment and maintenance practices, we are successfully operating at higher conductivities and cycles while maximizing usage of recycled non-potable water sources for make-up.

Respectfully,

Ryan Thompson, PE, CEM
Associate Director of Power Plant and Chilling Station Operations
Utilities and Energy Management