SUBJECT **KSC COOLING TOWER WATER TREATMENT PROCEDURE**

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PURPOSE

This procedure defines the monitoring, operations and maintenance activities for the Base Operations and Spaceport Service (BOSS) contract operated cooling tower water systems located at J7-0337 (Pad B), J8-1708 (Pad A), K6-0947 (Utility Annex (UA)), L6-0147 (Booster Fabrication Facility (BFF)) and M7-0407 (Industrial Area Chiller Plant (IACP)) to maintain adequate water quality in compliance with industry standards.

SCOPE AND APPLICABILITY

This procedure is applicable to the BOSS operated/maintained cooling tower water systems. All monitoring, maintenance and operations shall be performed by BOSS HVAC shop personnel and System Engineering (SE) as specified in this procedure.

PROCESS

The following details the monitoring, operation and maintenance associated with the water treatment equipment and systems of the cooling towers located on KSC.

1. General Treatment Requirements for Cooling Tower Water Systems

Cooling tower water is treated to minimize scale, corrosion and biological growth. Conventional treatment for cooling tower water involved using corrosion and scale inhibitors (chemicals) along with biocide to control all three issues. In the early 1990's, Kennedy Space Center began the use of ozone treatment to combat all three issues at its largest cooling towers (IACP, UA and BFF). Ozone is a powerful disinfectant of water. Additionally, it is thought that due to its ability to destroy biofilm, scale formation is greatly impacted as the biofilm serves as a binding agent allowing scale to adhere to heat exchanger surfaces. The control of the conductivity of a tower also allows for control of mineral build-up (scale). With increased conductivity within the cooling tower water system, alkalinity increases which provides a buffer against corrosion.

Biological growth is always present in a cooling tower but must be carefully controlled so as not to allow buildup of dangerous bacteria and algae which could adversely affect human health. The buildup of bacteria, algae and viruses presents hazards to the tower system and the health of humans encountering the water. Of greatest importance is the potential for Legionella buildup within the tower water which can cause Legionnaire's Disease for those personnel working in or around the tower or for those personnel working in facilities serviced by that cooling tower. High levels of bacteria within the tower water can also result in an increased risk of Microbiologically Induced Corrosion (MIC) and/or formation of a biofilm coating on heat exchanger surfaces reducing heat transfer efficiency. Biological growth must be controlled in a cooling tower water system to kill bacteria that may result in risk to human health and prevent biofilm growth which in turns leads to increased operating cost and potential failure of equipment due to MIC.

2. Ozone Treated Cooling Towers

Cooling towers located at K6-0947, L6-0147 and M7-0407 are treated with ozone (O_3) as the sole treatment for control of biological growth, scale and corrosion. Ozone is produced by the passage of oxygen through an electric arc. The ozone is then mixed with a flowing side stream from the cooling tower circulating water and returned to the cooling tower basin. Ozone is a strong oxidizing agent and is very effective as a biocide in destroying bacterial and fungal growth. By maintaining cycles of concentration through blowdown and monthly analysis for Langelier Saturation Index (LSI), cooling tower water is maintained to a slight scale forming tendency.

2.1. Ozone Treated Cooling Tower Water Monitoring

Cooling tower water shall be checked weekly for general water clarity and biological/algae growth at all ozone treated cooling towers (UA, IACP and BFF). The Operator shall perform weekly testing of the IACP and UA cooling towers using the hand-held Ultrameter II for pH, Oxidation/Reduction Potential (ORP), and conductivity. The Ultrameter II shall be calibrated by the Operator at these plants using standard solutions (pH of 7 and 10) monthly using procedure on the back of the meter. Record this action in the plant log book. In addition to these calibrations, a semi-annual calibration of these meters are performed and scheduled through the KSC Physical Calibration Laboratory. Compare the conductivity measured on the hand-held unit against the in-plant conductivity controller weekly. Calibrate the in-plant unit to the hand-held unit conductivity using Manufacturer's instructions if the value is less than or greater than 2% or anything more than 100 micromhos different than the value of the hand held unit. Record the pH, conductivity and ORP values weekly on the Water Treatment Logsheets (UTI-F-2003 (for IACP) and UTI-F-2004 (for UA)), kept in the control rooms at each plant. In addition, record all makeup and blowdown meter readings on the logsheets daily (M-F). BFF tower monitoring shall be recorded daily (M-F) on form UTI-F-2009 and shall include makeup and blowdown meter readings, side stream filter differential pressure, ozone unit ORP values and conductivity. In addition to the above monitoring, monthly sampling is performed on all towers and results are reviewed by the SE for any anomalies in treatment.

2.2. Ozone Water Treatment Equipment/Systems Operation

2.2.1. Utility Annex (UA), K6-0947

2.2.1.1. Cooling Tower Water Parameter Range Matrix

Appendix A lists the ranges of various parameters monitored and/or analyzed.

2.2.1.2. Ozone Generation Equipment

There are five ozone generators (each rated at 26 lbs/day) and associated equipment located in the Condenser Water Treatment building, K6-0947E. The Operator/Mechanic shall perform the following daily (Monday – Friday (M-F)) checks:

- Check ozone generator gages and overall operation
- Check oxygen and ozone monitors – oxygen should show between 19.5 – 25%; notify Supervisor of any alarm conditions
- Oxygen generators – check gages (60 – 90 psig) and solenoid switching operation (pressure –swing cycling)
- Flow rate (rotameter on each unit) – maintain a level of 3 - 5
- Water flow (cooling water) – verify range 2 – 3 and temperature of 40 - 60°F
- Main pumps (cooling tower water circulating pump) – operational check
- Operational check of machines to make sure fans are working and machines are not overheating
- Air dryer – pressure (90+ psig) and temperature (40°F)

Record daily (M-F) the following data in the Ozone Equipment Logbook located in the Condenser Water Treatment building:

- Name, date
- Any problems/issues found (Note: WON's and event reporting shall be submitted in accordance with ENG-P-0027 and SMA-P-0016, respectively)
- Any maintenance performed

The generators are typically operated at 30 – 80% total capacity. During summer months or high load periods, this rate is adjusted to closer to 80% for the increased water treatment demands of the cooling tower water. Oxygen flow rates are typically kept to 30% on the sight glass. The ozone generators will trip out on high temperature if the cooling fans or flow-through cooling water fails to provide adequate cooling.

During daily checks, if the Operator observes any problems with the equipment, the Operator should refer to Manufacturer's information for troubleshooting techniques. If further help is necessary in resolving the problem, System Engineering should be contacted.

UA Ozone operation and shutdown procedures are shown in Appendix B of this procedure. A matrix of required maintenance, monitoring and operations are shown in Appendix E.

2.2.1.3. **K6-0947E Fixed Monitoring & Alarm Systems**

- Ozone Permissible Exposure Limit (PEL) – The OSHA 8-hour time weighted average PEL for ozone is 0.100 ppm. KSC has adopted the 8-hour time weighted average PEL of 0.1 ppm as the action level for employee exposure.

- Ozone Monitoring & Alarm System - The Condenser Water Treatment building, K6-0947E, is supported by an ozone monitoring and alarm system. Signs are posted on the entrance door. An amber beacon will be activated if the ozone concentration within the building is 0.100 ppm or greater. In this event, the ozone generators will be shut down and an exhaust fan will be activated.

Personnel are not allowed to enter the building until Environmental Health checks the building and gives clearance to enter. Contact BOSS Quality, Safety & Environmental (QSE) anytime the system goes into alarm and they will set up with Environmental Health for atmospheric monitoring during normal working hours. If the system goes into alarm after hours, the duty office should be contacted for Environmental Health support. The ozone monitor is calibrated annually and is on the KSC Calibration Laboratory schedule for this frequency. HVAC personnel shall look at the display of the ozone monitor each time they enter the building to check for alarms or malfunctions.

- Oxygen Monitoring & Alarm System – An oxygen monitoring system is located within this facility. Signs are posted on the entrance door. A red beacon will be activated if the oxygen concentration within the building goes below 19.5% or above 25%. In this event, personnel are not allowed to enter the facility until Environmental Health checks the building and gives clearance to enter. Contact BOSS QSE anytime the system goes into alarm and they will set up with Environmental Health for atmospheric monitoring during normal working hours. If the system goes into alarm after hours, the duty office should be contacted for Environmental Health support. The oxygen monitor is calibrated semi-annually and is on the KSC Calibration Laboratory schedule for this frequency.

- Alarm Activation While Occupied: If personnel are within the facility and either the ozone and/or oxygen monitors go into alarm, personnel shall immediately exit the facility by way of the entrance door located on the south side of the facility and notify the Plant Supervisor who shall contact BOSS QSE during normal working hours to set up Environmental Health for an atmospheric check of the facility and to give clearance to re-enter the facility. If this occurs after hours, the duty office should be contacted to get Environmental Health support.

- Actions Required While Unit(s) Out of Service/Not in Use: If either ozone or oxygen monitors are out of service or removed for maintenance/calibration, Environmental Health shall conduct a facility atmospheric check prior to any personnel entering the facility, each time it is entered. During this period, temporary signs shall be placed on the doors indicating the monitoring system(s) that is down and that personnel shall not enter until approval is given by Environmental Health. When units are returned to normal service, verify warning light, exhaust fan, and audible alarms are functioning.

- If power is shut down to ozone or oxygen monitors (planned or unplanned outages), the SE shall verify the alarm set-points are correct when power is restored.

2.2.1.4. **Side Stream Filtration System**

There is a side stream filtration system located adjacent to the UA Cooling Tower. The system is set up to filter the cooling tower basin water to further polish the

water. The units will go into backwash using cooling tower water and this waste stream will go to the sanitary sewer at a rate of 900 gallons/backwash. This unit shall be checked daily for proper operation including the following:

- Check both inlet and outlet pressure gages and check differential pressure gage to verify the unit is operating within the proper pressure range. The units differential pressure should not be greater than 20 psig.
- Approximately weekly or as needed, clean the strainer on the line feeding the filter.
- Record backwash cycles (part of the cooling tower blowdown) on the water treatment log sheet, UTI-F-2004.

If there are any problems with the operation of the unit, refer to Manufacturer's instructions for troubleshooting techniques.

2.2.1.5. **Water Softener System**

A Twin Marlo SRS-300-2-MX-TA-ASME Water Softener system is located in K6-0947D, just west of the UA. These units shall be operated to provide approximately 50% of the cooling tower makeup as softened water. Daily checks of the unit include the following:

- Check general operation
- Check level of salt in the brine tank; add salt as needed.
- Record meter reading of gallons processed per day in the Logbook located in K6-0947D and on the water treatment logsheet kept in the UA control room.
- Record the flow rate through the unit and which unit (1 or 2) is in service in the Logbook.
- Record any problems or any maintenance performed in the Logbook.
- If there are any problems with the operation of the unit, refer to Manufacturer's instructions for troubleshooting techniques.

The water softener will process up to 90 gpm (flowrate is displayed on the softener unit) providing a total of 129,600 gallons of softened water to the cooling tower each day. The minimum flow rate that the unit can process is 20 gpm. Flow through the unit can be reduced, as needed, by throttling down an outlet valve on the water line to the tower. The following table shows the expected gallons fed per day as makeup given various flow rates going through the water softener:

Flow rate, gpm	Total gallons per day
20	28,800
45	64,800
70	100,800
80	115,200
90	129,600

Modification of the flow rate through the unit is necessary to provide the 50% softened water makeup rate. For example, during summer months when the cooling tower makeup rates are 150,000 – 200,000 gallons per day, flow through the water softener unit should be approximately 70 gpm.

The water softener discharge shall be checked on an as needed basis for total hardness and recorded in the Logbook. Discharge levels from the softener shall not be more than 5 mg/L total hardness. Higher discharge levels indicate the unit needs regeneration or troubleshooting. Refer to Manufacturer's instructions for troubleshooting techniques.

The softener brine tank shall be filled with salt as needed to maintain a minimum depth of six inches. The recommended salt for use is solar-grade salt (<0.5% insolubles). Rock salt is not recommended.

2.2.2. Industrial Area Chiller Plant (IACP), M7-0407

2.2.2.1. Cooling Tower Water Parameter Range Matrix

Appendix A lists the ranges of various parameters monitored and/or analyzed.

2.2.2.2. Ozone Generation Equipment

There are two ozone generators (each rated at 26 lbs/day) and associated equipment located in the Equipment building, M7-0355B. Perform daily checks (M-F) of the following equipment:

- Check ozone generator gages and overall operation
- Check oxygen and ozone monitors – oxygen should show between 19.5 – 25%; notify Supervisor of any alarm conditions
- Oxygen generators – check gages (60 – 90 psig) and solenoid switching operation (pressure –swing cycling)
- Flow rate (rotameter on each unit) – maintain a level of 3 - 5
- Water flow (cooling water) – verify minimum 3 gpm
- Main pump (cooling tower water circulating pump) – operational check
- Operational check of machines to make sure fans are working and machines are not overheating
- Air dryer – pressure (90+ psig) and temperature (40°F)

Record the following data in the Ozone Equipment Logbook located in the Ozone Treatment building:

- Name, date
- Any problems/issues found (Note: WON's and event reporting shall be submitted in accordance with ENG-P-0027 and SMA-P-0016, respectively)
- Any maintenance performed

The generators are typically operated at 30 – 50% total capacity. During summer months or high load periods, this rate is adjusted closer to 50% for the increased water treatment demands of the cooling tower water. Oxygen generators will trip

out on high temperature if the cooling fans or flow-through cooling water fails to provide adequate cooling.

During daily checks, if the Operator observes any problems with the equipment, the Operator should refer to Manufacturer's instructions for troubleshooting techniques. If further help is necessary in resolving the problem, system maintenance engineering should be contacted.

IACP Ozone operation and shutdown procedures are shown in Appendix C of this report. A matrix of required maintenance, monitoring and operations are shown in Appendix E.

2.2.2.3. **M7-0355B Fixed Monitoring & Alarm Systems**

- Ozone Permissible Exposure Limit (PEL) – The OSHA 8-hour time weighted average PEL for ozone is 0.100 ppm. KSC has adopted the 8-hour time weighted average PEL of 0.1 ppm as the action level for employee exposure.

- Ozone Monitoring & Alarm System - The Ozone treatment building, M7-0355B, is supported by an ozone monitoring and alarm system. Signs are posted on the entrance door. An amber beacon will be activated if the ozone concentration within the building is 0.100 ppm or greater. In this event, the ozone generators will be shut down and an exhaust fan will be activated. Personnel are not allowed to enter the building until Environmental Health checks the building and gives clearance to enter. Contact BOSS QSE anytime the system goes into alarm and they will set up with Environmental Health for atmospheric monitoring during normal working hours. If the system goes into alarm after hours, the duty office should be contacted for Environmental Health support. The ozone monitor is calibrated annually and is on the KSC Calibration Laboratory schedule for this frequency. HVAC personnel shall look at the display of the ozone monitor each time they enter the building to check for alarms or malfunctions.

- Oxygen Monitoring & Alarm System – An oxygen monitoring system is located within this facility. Signs are posted on the entrance door. A red beacon will be activated if the oxygen concentration within the building goes below 19.5% or above 25%. In this event, personnel are not allowed to enter the facility until Environmental Health checks the building and gives clearance to enter. Contact BOSS QSE anytime the system goes into alarm and they will set up with Environmental Health for atmospheric monitoring during normal working hours. If the system goes into alarm after hours, the duty office should be contacted for Environmental Health support. The oxygen monitor is calibrated semi-annually and is on the KSC Calibration Laboratory schedule for this frequency.

- Alarm Activation While Occupied: If personnel are within the facility and either the ozone and/or oxygen monitors go into alarm, personnel shall immediately exit the facility by way of the entrance door located on the south side of the facility and notify the Plant Supervisor who shall contact BOSS QSE during normal working hours to set up Environmental Health for an atmospheric check of the facility and to give clearance to re-enter the facility. If this occurs after hours, the duty office should be contacted to get Environmental Health support.

- Actions Required While Unit(s) Out of Service/Not in Use: If either ozone or oxygen monitors are out of service or removed for maintenance/calibration, Environmental Health shall conduct a facility atmospheric check prior to any personnel entering the facility, each time it is entered. During this period, temporary signs shall be placed on the doors indicating the monitoring system(s) that is down and that personnel shall not enter until approval is given by Environmental Health. When units are returned to normal service, verify warning light, exhaust fan, and audible alarms are functioning.

- If power is shut down to ozone or oxygen monitors (planned or unplanned outages), the SE shall verify the alarm set-points are correct when power is restored.

2.2.2.4. **Side Stream Filtration Equipment**

There is a side stream filtration system located adjacent to the IACP Cooling Tower. The system is set up to filter the cooling tower basin water to further polish the water. The units will go into backwash using cooling tower water and this waste stream will go to the sanitary sewer at a rate of 1200 gallons/backwash. This unit is checked daily for proper operation including the following:

- Check both inlet and outlet pressure gages and check differential pressure gage to verify the unit is operating within the proper pressure range. The units differential pressure should not be greater than 20 psig.
- Approximately daily or as needed, clean the strainer on the line feeding the filter.
- Record backwash cycles (part of the cooling tower blowdown) on the water treatment log sheet, UTI-F-2003.
- If there are any problems with the operation of the unit, refer to Manufacturer's instructions for troubleshooting techniques.

2.2.2.5. **Water Softener System**

A Twin Marlo MRG-210-2 Water Softener system is located on the southwest corner of the IACP cooling tower. These units shall be operated to provide approximately 50% of the cooling tower makeup as softened water. Daily checks of the unit include the following:

- Check general operation
- Check level of salt in the brine tank; add salt as needed.

- Record any problems or any maintenance performed in the Logbook.
- If there are any problems with the operation of the unit, refer to Manufacturer's instructions for troubleshooting techniques.

The water softener will process up to 80 gpm (flowrate is displayed on the softener unit) providing a total of 115,200 gallons of softened water to the cooling tower each day. The minimum flow rate that the unit can process is 20 gpm. Flow through the unit can be reduced, as needed, by throttling down an outlet valve on the water line to the tower. The following table shows the expected gallons fed per day as makeup given various flow rates going through the water softener:

Flow rate, gpm	Total gallons per day
20	28,800
40	57,600
60	86,400
80	115,200

Modification of the flow rate through the unit is necessary to provide the 50% softened water makeup rate. For example, during summer months when the cooling tower makeup rates are 120,000 – 130,000 gallons per day, flow through the water softener unit should be approximately 50 gpm.

The water softener discharge shall be checked on an as needed basis for total hardness and recorded in the Logbook. Discharge levels from the softener shall not be more than 5 mg/L total hardness. Higher discharge levels indicate the unit needs regeneration or troubleshooting. Refer to Manufacturer's instructions for troubleshooting techniques.

The softener brine tank shall be filled with salt as needed to maintain a minimum depth of six inches. The recommended salt for use is solar-grade salt (<0.5% insolubles). Rock salt is not recommended.

2.2.3. Booster Fabrication Facility (BFF), L6-0147

2.2.3.1. Cooling Tower Water Parameter Matrix

Appendix A lists the ranges of various parameters monitored and/or analyzed.

2.2.3.2. Ozone Generation Equipment

There are three ozone generators (each rated at approximately 5 lbs/day) and associated equipment located in the Chiller building pump room, L6-0147. Perform daily checks of the following equipment:

- Check ozone generator gages and overall operation
- Check ozone monitor – notify Supervisor of any alarm conditions.

- Oxygen generators – check inlet pressure – adjust to 35-40 psi; oxygen concentration is monitored and fault will show if oxygen generators are not producing proper concentration (inside bottom cabinet of each generator). Notify Supervisor of any alarm conditions.
- Flow rate through ozone generator – maintain a level of 8-15 liters per minute (LPM) (inside bottom cabinet of each generator).
- Main pumps (cooling tower water circulating pump) – operational check; verify 20-30 psi drop across the injector (venturi).
- Operational check of machines to make sure fans are working and machines are not overheating

Record the following data in the Ozone Equipment Logbook located in the pump room:

- Name, date
- Any problems/issues found (Note: WON's and event reporting shall be submitted in accordance with ENG-P-0027 and SMA-P-0016, respectively)
- Any maintenance performed

During daily checks, if the Operator observes any problems with the equipment, the Operator should refer to Manufacturer's instructions for troubleshooting techniques. If further help is necessary in resolving the problem, the Supervisor should be contacted.

BFF Ozone operation and shutdown procedures are shown in Appendix D of this report. A matrix of required maintenance, monitoring and operations are shown in Appendix E.

2.2.3.3. **L6-0147 Fixed Monitoring & Alarm Systems**

- Ozone Permissible Exposure Limit (PEL) – The OSHA 8-hour time weighted average PEL for ozone is 0.100 ppm. KSC has adopted the 8-hour time weighted average PEL of 0.1 ppm as the action level for employee exposure.

- Ozone Monitoring & Alarm System – L6-0147 is supported by an ozone monitoring and alarm system. Signs are posted on the entrance doors. An amber beacon will be activated if the ozone concentration within the building is 0.100 ppm or greater. In this event, the ozone generators will be shut down. Personnel are not allowed to enter the pump room until Environmental Health checks the room and gives clearance to enter. Contact BOSS QSE ~~Safety~~ anytime the system goes into alarm and they will set up with Environmental Health for atmospheric monitoring during normal working hours. If the system goes into alarm after hours, the duty office should be contacted for Environmental Health support. The ozone monitor is calibrated annually and is on the KSC Calibration Laboratory schedule for this frequency. HVAC personnel shall look at the display of the ozone monitor each time they enter the building to check for alarms or malfunctions.

- Alarm Activation While Occupied: If personnel are within the pump room and the ozone monitor goes into alarm, personnel shall immediately exit the pump room and notify the Plant Supervisor who shall contact BOSS QSE during normal working hours to set up Environmental Health for an atmospheric check of the room and to give clearance to re-enter the room. If this occurs after hours, the duty office should be contacted to get Environmental Health support.

- Actions Required While Unit(s) Out of Service/Not in Use: If the ozone monitor is out of service or removed for maintenance/calibration, Environmental Health shall conduct a facility atmospheric check prior to any personnel entering the pump room, each time it is entered. During this period, temporary signs shall be placed on the doors entering the pump room indicating the ozone monitoring system is down and that personnel shall not enter until approval is given by Environmental Health. When the monitor is returned to normal service, warning light, exhaust fan, and audible alarms shall be checked to verify they are functioning.

- If power is shut down to the ozone monitor (planned or unplanned outages), the SE shall verify the alarm set-points are correct when power is restored.

2.2.3.4. **Side Stream Filtration Equipment**

There is a side stream filtration system located adjacent to the BFF Cooling Tower. The system is set up to filter the cooling tower basin water to further polish the water. This unit shall be checked daily for proper operation including the following:

- Check both inlet and outlet pressure gages (differential pressure) to verify the unit is operating within the proper pressure range. The unit's differential pressure should not be greater than 20 psig.
- Approximately weekly or as needed, clean the strainer on the line feeding the filter.
- For manual operation, see the instructions posted on the metal sign to the east of the unit.
- If there are any problems with the operation of the unit, refer to Manufacturer's instructions for troubleshooting techniques.

3. Chemically Treated Cooling Towers

Pad A and B cooling towers are both treated with biocide and a corrosion inhibitor (molybdenum) at feed rates established by the chemical sales vendor. Chemical injection pumps are programmed to supply the correct dosage of each chemical. Weekly checks shall be performed by the HVAC shop to include the following:

- Check operation of the chemical feed pump to ensure proper operation
- Clean out wye strainer
- Clean conductivity probe
- Check levels of chemicals in drums – notify Supervisor if low

- Check water quality within tower basin – notify SE if not clear

Monthly testing is performed of the tower water and is reviewed by the SE. Appendix A lists the ranges of the parameters analyzed. A matrix of required maintenance, monitoring and operations are shown in Appendix E.

4. Contingency Treatment Plan

The contingency plan outlined in this section provides interim guidelines and instructions for operating HVAC Cooling Tower water treatment systems in a contingency state when primary water treatment equipment is non-functional. Non-functioning conditions are defined below per tower.

4.1. UA Cooling Tower

The UA has five ozone generators as the primary water treatment. Non-functioning is defined as less than three (3) operating generators for 15 days or more.

- Contingency Treatment: Bromine at 1-3 ppm residual.

- Notifications: HVAC Supervisor shall notify the Water SE when non-functioning periods occur, either due to failure of the unit or required maintenance within the tower. The Supervisor shall provide an estimated downtime of the equipment to the SE. If this exceeds 15 days, the SE shall notify BOSS QSE. Any maintenance on the cooling tower during non-functioning periods of water treatment requires Safety review of each maintenance task to ensure adequate PPE is used.

- Event Reporting: If there is a total failure of all ozone generators or a part of the system that results in failure of the system to produce ozone, an event report shall be submitted in accordance with SMA-P-0016. A TAL 2 work order (WON) shall be initiated to repair the system and provide engineering problem-cause-remedy analysis regarding the event. BOSS Work Control shall prioritize this WON with a Safety Condition Assessment Codes (CAC) code per SHP-P-3200, *Condition Assessment Code Process,* to ensure timely repair.

- Contingency Bromine Treatment and Testing: Bromine shall be used as the contingency treatment when ozone generation is down. Bromine shall be fed directly into the cooling tower basin using flow through bromine-filled buckets. The Water SE shall perform bromine checks twice per week (or provide a bromine feed schedule when not available) of the cooling tower water when in the contingency status (one sample per tower using standard HACH colorimetric method). The SE shall direct the plant operators to adjust bromine feed rates based on the sampling results to ensure adequate bromine residual (1-3 ppm) is maintained during the contingency period.

- PM Deferrals: Ozone equipment has annual Preventative Maintenance (PM) issued and shall be performed as required. If equipment is unavailable because

the system is off-line, a reschedule of the maintenance shall be requested through the PM Deferral Process. PM Deferrals shall be avoided whenever possible.

- Microbiological testing during non-functional periods: The Water SE shall coordinate all required sampling through BOSS QSE. Heterotrophic Plate Count (HPC) shall be conducted during non-functioning periods monthly until systems are returned to normal operation. (See “Microbiological Sampling Plan” section for action levels of HPC sampling analysis).

- Daily Operational Checks (M-F): HVAC personnel shall continue to perform daily checks of all water treatment systems and log applicable maintenance activities during contingency treatment periods.

4.2. BFF Cooling Tower

The BFF has three ozone generators as the primary water treatment for three cooling towers. Non-functioning is defined as less than one ozone generator online per operational tower for 15 days or more.

- Contingency Treatment: Bromine at 1-3 ppm residual.

- Notifications: HVAC Supervisor shall notify the Water SE when non-functioning periods occur, either due to failure of the unit or required maintenance within the tower. The Supervisor shall provide an estimated downtime of the equipment to the SE. If this exceeds 15 days, the SE shall notify BOSS QSE. Any maintenance on the cooling tower during non-functioning periods of water treatment requires Safety review of each maintenance task to ensure adequate PPE is used.

- Event Reporting: If there is a total failure of all ozone generators or a part of the system that results in failure of the system to produce ozone, an event report shall be submitted in accordance with SMA-P-0016. A TAL 2 work order (WON) shall be initiated to repair the system and provide engineering problem-cause-remedy analysis regarding the event. BOSS Work Control shall prioritize this WON with a Safety CAC code to ensure timely repair.

- Contingency Bromine Treatment and Testing: Bromine shall be used as the contingency treatment when ozone generation is down. Bromine shall be fed directly into the cooling tower basin using flow through bromine-filled buckets. The Water SE shall perform bromine checks twice per week (or provide a bromine feed schedule when not available) of the cooling tower water when in the contingency status (one sample per tower using standard HACH colorimetric method). The SE shall direct the plant operators to adjust bromine feed rates based on the sampling results to ensure adequate bromine residual (1-3 ppm) is maintained during the contingency period.

- PM Deferrals: Ozone equipment has annual and tri-annual Preventative Maintenance (PM) issued and shall be performed as required. If equipment is unavailable because the system is off-line, a reschedule of the annual

maintenance shall be requested through the PM Deferral Process. Deferral of annual PM's on this equipment shall be avoided whenever possible. Tri-annual PM's can be deferred if equipment is off-line and not scheduled to be brought back on-line within the month.

- Microbiological testing during non-functional periods: The Water SE shall coordinate all required sampling through BOSS QSE. Heterotrophic Plate Count (HPC) shall be conducted during non-functioning periods monthly until systems are returned to normal operation. (See "Microbiological Sampling Plan" section for action levels of HPC sampling analysis).

- Daily Operational Checks (M-F): HVAC personnel shall continue to perform daily checks of all water treatment systems and log applicable maintenance activities during contingency treatment periods.

4.3. IACP Cooling Tower

The IACP/O&C towers have 2 ozone generators as the primary water treatment. Non-functioning is defined as less than two (2) operating generators for 15 days or more.

- Contingency Treatment: Bromine at 1-3 ppm residual.

- Notifications: HVAC Supervisor shall notify the Water SE when non-functioning periods occur, either due to failure of the unit or required maintenance within either the O&C or IACP cooling towers. The Supervisor shall provide an estimated downtime of the equipment to the SE. If this exceeds 15 days, the SE shall notify BOSS QSE. Any maintenance on the cooling tower during non-functioning periods of water treatment requires Safety review of each maintenance task to ensure adequate PPE is used.

- Event Reporting: If there is a total failure of both ozone generators or a part of the system that results in failure of the system to produce ozone, an event report shall be submitted in accordance with SMA-P-0016. A TAL 2 work order (WON) shall be initiated to repair the system and provide engineering problem-cause-remedy analysis regarding the event. BOSS Work Control shall prioritize this WON with a Safety CAC code to ensure timely repair.

- Contingency Bromine Treatment and Testing: Bromine shall be used as the contingency treatment when ozone generation is down. Bromine shall be fed directly into the cooling tower basin using flow through bromine-filled buckets. The Water SE shall perform bromine checks twice per week (or provide a bromine feed schedule when not available) of the cooling tower water when in the contingency status (one sample per tower using standard HACH colorimetric method). The SE shall direct the plant operators to adjust bromine feed rates based on the sampling results to ensure adequate bromine residual (1-3 ppm) is maintained during the contingency period.

- PM Deferrals: Ozone equipment has annual Preventative Maintenance (PM) issued and shall be performed as required. If equipment is unavailable because the system is off-line, a reschedule of the maintenance shall be requested through the PM Deferral Process. PM Deferrals shall be avoided whenever possible.

- Microbiological testing during non-functional periods: The Water SE shall coordinate all required sampling through BOSS QSE. Heterotrophic Plate Count (HPC) shall be conducted during non-functioning periods monthly until systems are returned to normal operation. (See “Microbiological Sampling Plan” section for action levels of HPC sampling analysis).

- Daily Operational Checks (M-F): HVAC personnel shall continue to perform daily checks of all water treatment systems and log applicable maintenance activities during contingency treatment periods.

4.4. PAD A & B Cooling Towers

Both Pads use conventional water treatment chemicals including corrosion inhibitor and biocide. Non-functioning is defined as no automatic pre-programmed chemical feed system for 15 days or more.

- Contingency Treatment: Manual feed of chemicals if chemical feed equipment is non-functional. See contingency feed rates below.

- Notifications: HVAC Supervisor shall notify the Water SE when chemical feed systems are taken off-line for repair or maintenance for greater than one day. The Supervisor shall provide an estimated downtime of the equipment to the SE. If this exceeds 15 days, the SE shall notify BOSS QSE. Any maintenance on the cooling tower during non-functioning periods of water treatment requires Safety review of each maintenance task to ensure adequate PPE is used.

- Contingency Feed Rates: Manual feed of the chemicals should be started as early as possible when the chemical feed system is offline and repairs cannot be accomplished in a two or three day period from discovery of the failed system. Contact the SE for feed rates of each chemical.

- PM Deferrals: The cooling towers have annual PM’s issued that allow for cleaning of the towers. Deferrals of Annual PM’s shall be avoided whenever possible.

- Microbiological testing during non-functional periods: The Water SE shall coordinate all required sampling through BOSS QSE. Heterotrophic Plate Count (HPC) shall be conducted during non-functioning periods monthly until systems are returned to normal operation. (See “Microbiological Sampling Plan” section for action levels of HPC sampling analysis).

- Weekly Operational Checks: HVAC personnel shall continue to perform weekly checks of all water treatment systems and log applicable maintenance activities during contingency treatment periods.

5. Microbiological Sampling Plan

The following table details the microbiological sampling plan that will be used for analysis of the tower water biological control at all BOSS maintained cooling towers. This plan uses the cooling tower industry standard of Heterotrophic Plate Count (HPC) of less than 10,000 colony forming units (CFU) per milliliter (mL) as a measure of good water quality (reference Cooling Technology Institute (CTI): Legionellosis, Guideline: Best Practices for Control of Legionella; CTI Guidelines WTB-148 (08)). The table also includes an action plan respective to the HPC sampling results based on CTI guidelines. Technical Anomaly Levels (TAL) assigned for each HPC level shown in the table are in accordance with Procedure ENG-P-0027, Technical Anomaly Event Disposition Process.

Microbiological Sampling Plan			Sample Result Action Plan		
	Target Limit, CFU/mL	Frequency	<10,000 (CFU/mL)	>10,000 but <100,000 (CFU/mL)	>100,000 (CFU/mL)
HPC – Routine sampling	<10,000	Semiannual	No Action	**TAL 2 Anomaly:** Evaluate treatment system; increase biocide dosage	**TAL 3 Anomaly:** Hyperhalogenate & resample within 24 hours in accordance with CTI; Perform Emergency Disinfection if still > 100,000
HPC – Contingency Treatment sampling	<10,000	Monthly until system returned to normal operation	No Action	**TAL 2 Anomaly:** Evaluate treatment system; increase biocide dosage	**TAL 3 Anomaly:** Hyperhalogenate & resample within 24 hours in accordance with CTI; Perform Emergency Disinfection if still > 100,000
Legionella	<20 or none detected	Event of an outbreak or at the request of the customer	No Action	No Action	Any additional sampling and actions as determined by ERB

All active cooling towers shall be sampled semiannually for HPC. Requests for the sampling will be initiated by the SE through BOSS QSE. A total of one sample per

cell will be requested per cooling tower and shall be analyzed separately. The above table details actions needed per HPC sample result received. Legionella testing is only performed in the event of an outbreak or at the request of the customer.

If routine or contingency HPC readings exceed 10,000 CFU/mL, a TAL 2 Anomaly is assigned and increased biocide dosage and evaluation of the treatment system is required. If HPC readings exceed 100,000 CFU/mL, a TAL 3 Anomaly is assigned. A hyperhalogenation shall be conducted on the tower. A hyperhalogenation is a disinfection process where a halogen (bromine in this case) is added to the cooling tower water to achieve 5 parts per million (ppm) for a 6-hour period. Once completed, a resample for HPC shall be conducted within 24 hours to determine if emergency disinfection is required in accordance with CTI. Further actions or sampling shall be determined through the Engineering Review Board (ERB) in accordance with ENG-P-0027. HPC sampling shall cease when results are <10,000 CFU/mL for any tower for any given event.

6. Maintenance

Maintenance and inspection items required by this procedure are itemized within a table in Appendix E.

APPENDIX A: COOLING TOWER WATER TREATMENT LIMITS

Summary of Cooling Tower Water Treatment Limits					
Chemistry Parameter	IACP / O&C	UA	BFF	LC-39 PAD A	LC-39 PAD B
Conductivity (micromhos/cm)	3500 - 4000	4800 - 5300	3500 - 4000	3000 - 3500	3000 - 3500
pH	8.0 – 8.5	8.0 – 8.5	8.0 – 8.5	8.0 – 8.5	8.0 – 8.5
ORP, millivolts	>250	>250	>250		
LSI	+2.0 – 2.5	+2.0 – 2.5			
Total Hardness, mg/L	<500	<800	<500	<500	<500
Calcium Hardness, mg/L	<260	<450	<260		
Alkalinity	>240	>250	>240		
Chlorides, mg/L	600 - 800	900 - 1200	600 - 800	500 - 700	500 - 700
Cycles of Concentration	6 - 8	9 - 11	6 - 8	3 - 5	3 - 5
Corrosion Rates, mils per year	<1 Carbon Steel <0.2 Copper	<1 Carbon Steel <0.2 Copper	<1 Carbon Steel <0.2 Copper		
Iron, Fe	<1 ppm	<1 ppm	<1 ppm	<1 ppm	<1 ppm
Copper, Cu	<1 ppm	<1 ppm	<1 ppm	<1 ppm	<1 ppm
Molybdenum, ppm				0.5 – 1.0	0.5 – 1.0

APPENDIX B: UA OZONE OPERATION AND SHUTDOWN PROCEDURE

Operation Procedure

1. Remove necessary lockout/tagout.
2. Open 6” PVC ball valves (supply and return) to corresponding cell.
3. Verify swithes for venturi pumps located on ozone system control panel are on. Inside West venturi pump room select 2 pumps to run and start them by pulling respective stop switch out. Ensure that two pumps are running and primed.
4. Turn Oxygen Generators on at electrical control panel. Also at Oxygen Generator, verify switch in normal position.
5. Plug in Ozone machine electrical cord at back of machine.
6. Open stainless steel ball valve Oz-1 located on NW wall.
7. Turn on ozone solenoid valve at electrical panel.
8. Turn power switch on at ozone machine. Ensure that PSU switch on machine is OFF, and purge is ON.
9. Turn power on at ozone system control panel for Ozone Generator selected.
10. Machine will go through system test and start purging.
11. Purge for at least 24 hours.
12. Set machine feed gas flow rate at minimum of 3 on machine flow meters.
13. Before proceeding, check ozone monitoring and alarm system. Notify Supervisor if unit is not operational.
14. After purging, turn chilled water pump on (switch located by chilled water pump on north wall). Turn PSU ON and purge OFF. Set power to necessary percentage. Utility Annex set for 50%. Adjust as necessary.

Shutdown Procedure

1. Turn Ozone machine purge switch to purge.
2. Turn PSU switch to OFF.
3. Let machine purge for 5 minutes.
4. Turn power OFF at Ozone machine.
5. Turn Ozone solenoid valve to OFF at Ozone system control panel.
6. Close stainless steel ball valve Oz-1 located at NW wall.
7. Turn power switch for respective machine to OFF at Ozone system control panel.
8. Unplug machine electrical cord at back of machine.
9. Turn chilled water pump off. Switch located by chilled water pump on north wall.
10. Turn Oxygen generator off at Ozone system electrical control panel.
11. Turn venturi pumps off at electrical control panel.
12. Close 6” PVC ball valves to cell needing work performed.
13. Generators are locked out at panel on north wall center of room.

APPENDIX C: IACP OZONE OPERATION AND SHUTDOWN PROCEDURE

Operation Procedure

1. Remove necessary lockout/tagout.
2. Turn Oxygen Generator from OFF to normal position (not automatic). Wait 15 minutes to ensure oxygen pressure (approximately 40 psi) on oxygen storage tank located in south Ozone room.
3. Turn cooling water on to unit(s).
4. O&C ozone venturi
   a. Open 6” butterfly valve located between 1 & 2 condenser pumps
5. Startup IACP water pump venturi
   a. Open 4” discharge ball valve located at bottom east end of O&C tower overhang.
   b. Open (2 each) 6” suction ball valves located at NW corner of O&C cooling tower by south ozone building – check both valves.
   c. Turn on pump and ensure prime.
6. Plug in ozone machine electrical cord at back of machine.
7. Turn power on at electrical panel switch #1 or #2 located on east wall of ozone building.
8. Ensure PSU switch is OFF and purge switch is ON before turning power on to generator.
9. Turn ozone valve ON (stainless steel valve OZ-1 or OZ-2).
10. Turn power on to ozone machine.
11. After startup, check feed gas flow – should be “5” on flowmeter, front of generator.
12. Purge for 24 hours.
13. Before proceeding, check ozone monitoring and alarm system. Notify Supervisor if unit is not operational.
14. Open chill water supply gate valve located on floor by 3-way valve.
15. Start chill water pump (toggle switch on east wall).
16. Turn PSU switch ON.
17. Turn Purge switch OFF.
18. Set ozone percentage.
    IACP: 80%
    O&C: 30%

Shutdown Procedure

1. Turn Ozone machine purge switches located on front of ozone generators to purge.
2. Turn PSU switches to OFF.
3. Let machine purge for 5 minutes.
4. Turn power switches OFF on Ozone machines. Stop chilled water pump (toggle switch on east wall).
5. Turn ozone valves OFF (OZ-1, OZ-2).

6. Turn power OFF at control panel, switches #1 and #2, located on east wall of building
7. Unplug power cords at back of machines.
8. Shutdown of IACP water pump/venturi:
   a. Let pump run 5 minutes after shutting down ozone machine.
   b. Turn pump OFF.
   c. Close 6” suction butterfly valve located southeast corner of ozone building.
   d. Close 4” discharge valve located at bottom east end of O&C tower overhang.
9. O&C ozone venture:
   a. Close 6” butterfly valve located between #1 and #2 condenser pumps.
10. Turn cooling water off to unit(s).
11. Turn venturi pumps off at electrical control panel.
12. Close 6” PVC ball valve to cell needing work performed.
    Generators are locked out at panel on north wall center of room.

APPENDIX D: BFF OZONE OPERATION AND SHUTDOWN PROCEDURE

System Startup and Flow Adjustment

The process water flow/pressure valve is located on the skid between the booster pump and the Mazzei injector. The water flow and pressure are application dependent adjusted during installation. The injector inlet pressure should be between 40 to 50 psi for a flow of 93 to 104 gpm.

Warning: **Do not restrict water flow to the pump suction. This can cause pump cavitation which will lead to premature pump and/or seal failure and void warranty.**

The ozone flow metering valve is located inside of the ozone enclosure. The valves should be adjusted and concentrator pressure verified at 10-12 PSIG. The ideal ***total*** flow should range from 8 Liters Per Minute (LPM) to 14 LPM. Lower flow will result in higher ozone concentration. Higher flow rates will result in lower concentrations.

Warning: **Do not overflow the oxygen concentrator as this will DAMAGE the sieve beds. Refer to the line on the flow meter.**

System Startup Flow Adjustment:

1. Insure the electrical connections are correct and the supply voltage to CB1 is 208-240VAC.
2. Insure water is present at the pump. Verify valves to ozone generators/pumps and exiting ozone generators/pumps are open.
3. Check ozone monitoring and alarm system. Notify Supervisor is unit is not operational.
4. Turn on the main power disconnect on the ozone enclosure. Ozone will not operate since there is no vacuum present.
5. Keep the ozone generator off at the ON/OFF switch.
6. Fill the system by turning on the pump with the pump discharge valve partial open to prevent water hammer.
7. Slowly open the pump discharge valve once the system fills.
8. The Mazzei Injector will sound like cavitation. This is normal.
9. Turn the Ozone “On/Off” switch to “ON” and close the “On/Off” remote dry contact.
10. The system should start up and ozone should be introduced into the process.
11. The cavitation noise will subside once ozone flows into the Mazzei injector.
12. Set proper pressure drop across Mazzei Injector for 20 PSI or higher by throttling system back pressure valve to proper values.
13. The water pressure gauges should read 40 psi on the injector inlet and 20 psi on the Mazzei injector outlet for a 20 to 30 PSI pressure drop.
14. Ensure oxygen flow is 8 to 14 LPM. Please note that the total flow of ozone cannot exceed the capacity of the oxygen concentrator. Ozone flow gas

adjustments are inside the ozone enclosure.

System Shutdown

At each ozone generator on/off switch, turn the switch to “OFF”. Close valves on inlet side of each circulation pump and close each valve leaving the ozone generator (feeding the tower) to ensure no backflow of water into the ozone generators.

APPENDIX E: COOLING TOWER WATER TREATMENT OPERATIONS AND MAINTENANCE MATRIX

Summary of Cooling Tower Water Treatment Operations and Maintenance Actions							
ACTION	FREQUENCY	IACP	UA	BFF	PAD A	PAD B	Responsibility
CHECK O3 SYSTEM • Is it working? • Any alarms showing? Notify Supervisor • Record which units online in log book	DAILY (M-F)	X	X	X			HVAC OPERATOR
CHECK O2 PRE-FILTER • Ensure water is not entrained	DAILY (M-F)	X	X				HVAC OPERATOR
CHECK O3 MONITOR • Is it working? • Is it in alarm?	DAILY (M-F)	X	X	X			HVAC OPERATOR
CHECK O2 MONITOR • Is it working? • Is it in alarm?	DAILY (M-F)	X	X				HVAC OPERATOR
RECORD MAKEUP AND BLOWDOWN METER READINGS	DAILY (M-F)	X	X	X			HVAC OPERATOR
CHECK COOLING TOWER FOR BIOLOGICAL/ALGAE, WATER CLARITY	WEEKLY	X	X	X	X	X	HVAC OPERATOR
ANALYZE/RECORD pH, CONDUCTIVITY & ORP	WEEKLY	X	X	X			HVAC OPERATOR
SIDE STREAM FILTER STRAINER	WEEKLY	X	X	X			HVAC OPERATOR
RECORD MAKEUP AND BLOWDOWN METER READINGS	WEEKLY				X	X	HVAC OPERATOR
CALIBRATE HAND HELD ULTRAMETER, RECORD IN LOGBOOK	MONTHLY	X	X				HVAC OPERATOR
CHECK CONDUCTIVITY OF HAND HELD TO PLANT METER	WEEKLY	X	X				HVAC OPERATOR
CHECK CHEMICAL FEED SYSTEM • Chemical feed pumps working? • Clean Wye strainer • Clean Conductivity Probe • Ample chemical supply in drums?	WEEKLY				X	X	HVAC OPERATOR

OZONE MONITOR INLET FILTER	SEMI-ANNUAL	X	X	X			HVAC OPERATOR
OXYGEN GENERATOR AIR FILTER ELEMENT	SEMI-ANNUAL	X	X	X			HVAC OPERATOR
CORROSION COUPONS • Set up with chemical vendor	SEMI-ANNUAL	X	X	X			SE
OZONE GENERATOR • Change filter mats • Tighten electrical connection screws/lugs	ANNUAL (PM)	X	X	X			HVAC OPERATOR
COOLING TOWER CLEANING	ANNUAL (PM)	X	X	X	X	X	HVAC OPERATOR

RECORDS

The following records are retained by the organizations listed below:

Record	Responsible Organization
Logbooks, various	FSEU OM&E Utilities
UTI-F-2003, IACP Cooling Tower Water Treatment Logsheet	FSEU OM&E Utilities
UTI-F-2004, Utility Annex Cooling Tower Water Treatment Logsheet	FSEU OM&E Utilities
UTI-F-2009, Booster Fabrication Facility Water Treatment Logsheet	FSEU OM&E Utilities

AFFECTED DIVISIONS

Engineering
FSEU and OM&E
Quality, Safety & Environment

ROLES AND RESPONSIBILITIES

FSEU OM&E Supervisor: Ensures compliance at the shop level to the requirements stated in this procedure.

FSEU OM&E HVAC Supervisor: Responsible for assigning personnel and support services as needed to assure compliance with this procedure.

FSEU OM&E HVAC Operators: Responsible for the day to day operation and maintenance of the cooling tower water treatment systems as defined in this procedure.

System Engineer (SE): Responsible for support as defined in this procedure.

REFERENCE DOCUMENTS

The following documents are referenced in this procedure:

Document Number	Title
N/A	Legionellosis Guideline: Best Practices for Control of Legionella; CTI Guidelines WTB-148 (08)
ENG-P-0027	Technical Anomaly Event Disposition Process
SHP-P-3200	Condition Assessment Code Process
SMA-P-0016	Event and Near Miss Reporting
UTI-F-2003	IACP Cooling Tower Water Treatment Log sheet
UTI-F-2004	Utility Annex Cooling Tower Water Treatment Log sheet
UTI-F-2009	Booster Fabrication Facility Water Treatment Log sheet

ACRONYMS

BFF	Booster Fabrication Facility
BOSS	Base Operations and Spaceport
CAC	Condition Assessment Codes
CTI	Cooling Technology Institute
ERB	Engineering Review Board
HVAC	Heating, Ventilation and Air Conditioning
IACP	Industrial Area Chiller Plant
KSC	Kennedy Space Center
LBS	Pounds
LSI	Langelier Saturation Index
mg/L	Milligrams per Liter
MIC	Microbiologically Induced Corrosion
N/A	Not Applicable
PEL	Permissible Exposure Limit
PM	Preventative Maintenance
PPM	Parts Per Million
SE	System Engineer
TDS	Total Dissolved Solids
UA	Utility Annex
WON	Work Order Number

DEFINITIONS

Alkalinity: The measure of how well the water can neutralize acids.

Blowdown: The displacement or wastage of water volumes from the circulating condenser water system used to control the water impurities being concentrated due to cooling tower evaporation. Blowdown includes both the automatic valve and the blowdown associated with the sidestream filter backwash.

Conductivity: A measure of the solution (cooling water) to carry an electric current. The higher the dissolved solids content, the higher the conductivity. Blowdown is activated by the measure of conductivity from a conductivity meter located on the north wall of the Annex.

Concentration: The measure of a substance (parameter) contained within water expressed as a ratio per water volume. For example, milligrams per liter (mg/L) is identical to parts per million (ppm).

Cycles of Concentration: Degree of concentration of the circulating water compared with the city water makeup, measured using chloride ion concentration.

Hardness: A measure of the calcium and magnesium ions in water.

Langelier Saturation Index (LSI): A calculated number that represents the scale forming or corrosive effect of the cooling water, positive being scale forming and negative being corrosive.

ORP (Oxidation/Reduction Potential): The measurement of “oxidizable” background substances contained in water that place a demand on ozone being added, and can be used to signify a lack of ozone or residual levels of ozone.

REVISION RECORD

The following revisions have been applied to this document:

Revision Number	Change Description	Date
4	Changes to ozone and oxygen monitors operation and maintenance	10/19/2010
5	Changes to incorporate Pad A&B cooling towers, BFF cooling tower and microbiological sampling plan	
6	Updated to BOSS procedure	03/27/2020

DOCUMENT APPROVALS

Expired certificate

X Melquiades Lopez

Mike Lopez
Technical Manager, FSEU OM&E
Signed by: Melquiades Lopez (affiliate)

Expired certificate

X Ellen S. Feeney

Ellen Feeney
Manager, Systems Engineering
Signed by: cards