Best Management Practice and Guidance Manual for Cooling Towers

Prepared by JEA for the control of pollutants discharged to the sanitary collection system.

August 2005

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Introduction

Best management practices (BMP) are designed to help facilities comply with environmental regulations and prevent pollution. This best management practice contains a set of recommended operating procedures and guidelines designed to reduce the amount of pollutants discharged to the JEA Publicly Owned Treatment Works (POTW). The development of this BMP is intended to protect the POTW and environment without unduly burdening facilities that utilize cooling towers.

As part of the Clean Water Act, the National Pretreatment Regulation (40CFR 403) was established to protect POTWs and the waterways in which they discharge. The Environmental Protection Agency (EPA) delegates this responsibility to the State of Florida Department of Environmental Protection (DEP). In Jacksonville, Fl, the State has delegated local authority to JEA (an electric, water, and sewer utility). It is the responsibility of the JEA Industrial Pretreatment (IP) program to regulate discharges to the POTW.

Background

Many industries, hospitals, institutions, and office buildings utilize some type of cooling tower. Open recirculating cooling water systems utilize cooling towers to reject heat through the process of evaporation. Cooling tower evaporation transfers heat from HVAC systems and other processes into the atmosphere

As evaporation occurs, the concentration of mineral salts increases in open recirculating cooling water systems (cooling towers). When the concentration of mineral salts exceed their solubility, fouling and scale formation on heat exchange surfaces may occur. Cooling systems control the level of dissolved solids (mineral salts) by discharging part of the recirculating water in the system and replenishing this volume with fresh make up water. Cooling towers can cycle water numerous times before the water becomes saturated and must be discharged out of the system. Blow down is a term for water that is removed from the recirculated cooling water to reduce contaminant buildup in the tower water. Management of cooling tower blow down is necessary to prevent fouling and efficiently use the makeup water resource. This water is often discharged to the sanitary sewer system.

In addition to blow down, most recirculating cooling water system maintenance plans include controlled additions of conditioning chemicals. Chemical additions are made for the purposes of microbiological control, corrosion protection, and to increase the solubility of mineral salts. (See table 1). Scale and bacterial growth may reduce the operating efficiency of heat exchange devices like cooling towers, condensers and heat exchangers.

One common constituent of cooling tower chemicals is molybdenum (Mo). It is used in cooling tower treatment chemicals for corrosion inhibition or as a tracer to determine the concentration of treatment chemical present. Molybdenum has been used for corrosion inhibition in cooling water systems for many years because of its ability to passivate cathodic surfaces. Frequently, molybdenum is used in combination with other corrosion inhibitors like organic phosphates and aromatic azoles.

In an effort to beneficially re-use a waste product, JEA uses sludge from its POTWs to produce pellets at its Biosolids Re-use facility. These pellets are class AA Biosolids marketed as a soil amendment. As such, the pellets must meet the ceiling limits criteria set forth in 40 CFR 503.13, table 1.

In April of 2004, the concentration of molybdenum in the pellets began to increase. Molybdenum levels exceeded the limit of 75 mg/kg established for land application by 40 CFR 503.13, Table 1. High levels of molybdenum in the sludge prohibited the pellets from being reused as fertilizer. Instead, at great expense, the solids had to be hauled to a landfill for disposal. A major source of the Mo was from cooling tower blow down. As the local Control authority, JEA is required to meet the objectives of the General Pretreatment Regulation to "improve opportunities to recycle … municipal …sludges" (40 CFR 403.2 C). In lieu of developing a local limit for Mo, JEA established a BMP as a source control of Mo and other pollutants discharged from cooling towers. Reuse of wastewater sludge as a land applicable soil amendment is a critical part of JEA's environmental stewardship strategy.

Table 1. Conditioning Chemicals

Conditioning Chemicals	Use	Application	Recommended Maximum Concentration
Organophosphates (phosphonates)	Control scaling	Continuous	20 mg/L as PO_4
Orthophosphates, polyphosphates	Inhibit corrosion and control scaling	Continuous	20 mg/L as PO_4
Sodium Silicate	Inhibit corrosion	Continuous	150 mg/L as SiO_2
Aromatic azoles	Inhibit corrosion	Continuous	1-4 mg/L
Molybdates[1]	Inhibit corrosion Tracer	Continuous	5-10 mg/L as molybdate
Non-oxidizing biocides such as • Isothiazolin • Dinitriopropionamide • Quaternary amines	Inhibit biological growth	Slug	N/A
Chlorine Bromine	Inhibit biological growth	Continuous or slug	0.5 mg/L 0.2 mg/L

[1] Molybdates are prohibited if the cooling water is discharged to the sanitary sewer in the JEA service area.

[2] Isothiazolin contains copper at ppm levels. If your facility is in District II, the use of this biocide requires an industrial user discharge permit. Please contact the JEA Industrial Pretreatment department at (904) 665-8300 or visit their website: http://www.jea.com/business/services/industrialpre/index.asp

Statement of Problem

Because of the wide variation of chemicals used in water treatment systems and the operational characteristics of various towers, it is not possible to quantify the exact amount of pollutants discharged. Based on information supplied by water treatment chemical suppliers, an estimate of the molybdenum from cooling towers in the region was calculated. It was determined that the mass of Mo being discharged from cooling tower blow down to the POTW was 13-18 lbs per day in 2004.

The JEA POTWs have a total Maximum Allowable Headworks Loading (MAHL) of 12.3 lbs/day for molybdenum. The MAHL measures the maximum mass of a pollutant that a treatment plant can receive and stay in compliance with its discharge or land application limits. The estimated mass of Mo from cooling towers alone (13-18 lbs/day) exceeded the MAHL.

These calculations reinforced the concept that molybdenum from cooling tower discharges are a significant source of the Mo in the pellets. Removal of molybdenum from cooling tower discharges would result in pellet Mo levels returning to below ceiling limit levels. Molybdenum free chemical alternatives are available and commonly used for corrosion inhibition in open recirculating cooling water systems.

Policy

Cooling tower discharges present a potential problem to the treatment of sanitary sewer and sludge quality especially for the Biosolids reuse facility. JEA, as the Control authority, is required to regulate cooling tower discharges to the POTW. It is the policy of the JEA Industrial Pretreatment program to require all users discharging cooling tower blow down to the sewer system to abide by this policy and implement the best management practices in this document to minimize the amount of pollutants entering the POTW.

Statement of Discharge Policy

1. All cooling tower discharges must be in accordance with applicable state, local or federal rules and regulations.
2. Water treatment chemicals utilized for cooling tower systems which contain molybdenum are prohibited in the JEA sanitary sewer.
3. Operation and maintenance of cooling towers must be in accordance with applicable regulations and BMPs outlined in this document.
4. If the pollutant characteristics of cooling tower effluent meet the Prohibited Discharge Standards (section 2.1) and Local Limits (appendix A) in JEA's Industrial Pretreatment Regulation, the effluent may be discharged to the sanitary sewer system.
5. Cooling tower effluent should be discharged to surface waters only in accordance with applicable state and local regulations. Cooling tower effluent is prohibited to the municipal storm sewer system according to Jacksonville City Ordinance Chapter 754.
6. Systems should minimize the amount of water used in keeping with good operational practices consistent with system design. In this regard, systems that involve recycling and reuse of water should be considered whenever possible. A good example is land application of blow down as irrigation.

Required Maintenance Practices

- Control the concentration of dissolved mineral salts and chemicals in the cooling water by automating blow down and fixing leaks. Minimize leaks in the recirculating cooling water piping and basin. Leaks waste water and chemicals, and lower the number of cycles that can be achieved. Leaks also disturb the balance of the chemical treatment by diluting the system with excess makeup water. Maintaining the proper chemical composition is important for two reasons; the protection of the equipment and the efficient operation of the system.

- Have a cooling water treatment company analyze the chemical composition of the makeup water and prescribe a specific water treatment program for your makeup water and usage. The program should include routine analysis of the recirculating cooling water and subsequent adjustments to blow down and chemical addition rates.

Target parameters should be established and maintained that will control fouling and corrosion in the system at acceptable levels.

- Maintain cooling water to the manufacturer's specifications by scheduling routine monitoring and maintenance activities.
- Include specific guidelines addressing chemical substitution options into any service contracts or agreements
- Optimize chemical treatment dosage by monitoring of cooling water and system conditions. See table 2.
- Test cooling tower water daily to control cycles of concentration
- Install influent and effluent totalizing flow meters to monitor performance of cooling tower.
- Maintain clean tower decks to prevent water loss because of overflow.
- Maintain tower fan maintenance to maximize the evaporation rate.
- With programs that utilize automatic bleed equipment**;** routinely clean the sensor probe and check the calibration of the meter**.**
- Check discharge water quality on a regular basis in accordance with applicable regulations.
- Maintain cooling tower fill to prevent water from dripping or sloshing from the fill and onto the ground. All the water passing through the fill should go into the basin.

Operation of a Cooling Tower

- Choose and design a system that meets your process requirements. Select the materials and system that will perform most efficiently based on the characteristics of the cooling water source.
- Consult a competent water treatment company for recommendations before completing the design or purchasing the system. Choosing the correct materials of construction may significantly lower the operational costs of a cooling water system.
- Maintain cycles of concentration as high as possible without concentrating chemicals and impurities to the point where they will cause problems elsewhere.
- Select feasible chemical treatment choosing less harmful chemicals or alternative chemicals which have a lower potential for impact on the environment.

- Identify operational requirements of the system and follow manufacturer's recommendations and operating manuals.
- Maintain proper water level control in tower basin. Establish a routine of regularly monitoring and adjusting the makeup valve float adjustment to optimize makeup water addition. Check the valve frequently for proper operation.
- Operate the tower systems at maximum cycles of concentration for efficient use of the makeup water resource.
- Lock out automatic blow down controllers so that they do not blow down while biocide slug dosages are occurring.

Table 2. Recommended Minimum Monitoring Schedule

Daily	• Visually inspect the equipment to verify that it is working properly. • Check to see if chemical supply is adequate. • Investigate anything which appears unusual or which may indicate changing conditions. • Record the daily volumes of makeup and blow down water. Significant variations in the daily flow may be indicative of system malfunctions or changed conditions.
Weekly	Check pH and conductivity. Significant variation from normal may indicate malfunctions or changed conditions requiring further investigation and/or chemical feed rate adjustment.
Monthly	Have a system expert: • Inspect the system, checking for proper equipment functions and physical evidence of corrosion or fouling. • Perform chemical testing on cooling system water to check water quality and report results and recommendations. • Check conditioning chemical dosages and adjust feed rates.
Semi-annually or annually	• Check and report corrosion rate.

Biocides

Biofouling is caused by the uncontrolled growth of microorganisms in aqueous environments. Biofouling consists of bacterial and algal colonies that thrive in the humid sunny environs afforded by cooling towers. Effects of biofouling include reduction of heat transfer capacity, increased corrosion rates, and reduced flow rates. Pathogenic organisms may colonize in cooling water that is not adequately conditioned on a regular basis.

Biocides are used in cooling tower systems to slow down the microbiological growth and reduce the number of cells in the recirculating cooling water. Biocides are generally defined as either oxidizing or non-oxidizing biocides. Oxidizing biocides like chlorine and bromine are usually applied continuously in a system and may be used in combination with non-oxidizing biocides. Non-oxidizing biocides are chemicals that kill microbes by means other than oxidation. Non-oxidizing biocides are slug fed to a system on a routine basis to establish a target concentration. Biological control programs may involve different combinations of oxidizing and non-oxidizing biocides. Every species of microbe has different resistance to each oxidizing and non-oxidizing biocide, so effective applications are largely dependent upon the native environment. Non-oxidizing biocide type should be switched when the effectiveness decreases, which is an indication that the microbes are developing a resistance.

Oxidizing biocides commonly used in cooling systems are halogens such as chlorine and bromine. Chlorine gas is used but has a safety risk when stored in bulk and is difficult to handle. Sodium hypochlorite, which contains chlorine, is most often used in large open recirculating and once-through systems.

Biocides have the potential to impact the wastewater treatment plant and the body of water to which it discharges. All biocides are toxic to fish. Some biocides are less persistent and break down rapidly in water reducing the toxicity of the compound which in turn reduces their impact on the environment when discharged. The following factors are to be considered when using biocides:

- Persistence – a biocide with low persistence should be chosen.
- Dosage – apply the proper amount of biocide. Over dosing leads to excessive discharge of the biocide to the environment.
- Chemical alternatives – do not rely solely on biocides to control bacterial growth. Refer to the section on Alternative Treatment Methods on page 10.

Cycles of Concentration

Water quality in the tower is dependent on makeup water quality, water treatment, and blow down rate. Blow down can be controlled manually or automatically by valves actuated by timers or conductivity meters.

The amount of make-up water added directly affects the quality of water in the systems. Make-up water replaces water lost from evaporation, drift and blow down. The relationships between blow down and make-up water can be expressed as a concentration ratio or cycle of concentration. The most efficient use occurs when the concentration ratio increases and blow down decreases. See tables 3 and 4.

Water consumption can be reduced significantly by minimizing blow down. Typical cycle ratios are 2-3 and can be increased up to six or more in some instances. The concentration ratio equals blow down divided by make up water.

$$\text{Concentration ratio, CR} = \frac{\text{blow down volume}}{\text{make-up volume}}$$

The maximum concentration ratio at which a cooling tower can still properly operate will depend on the quality of the makeup water. See table 3. The total dissolved solids (TDS), alkalinity, calcium hardness, silica and sulfate concentrations affect the water quality and determine the number of cycles that can be achieved without forming mineral deposits. As the number of cycles increases, the blow down is minimized but the concentrations of mineral salts in the system increases.

The average number of cycles is two to three but more cycles can be achieved with additional makeup water treatment, side stream filtration, or chemical conditioning. Pretreatment or acidification may be used to increase cycles in a cooling water system: Conditioning the makeup water to remove problematic constituents will increase the number of cycles that can be run without fouling the system. Softening is the most common pretreatment method, but reverse osmosis is also common. Acidification is commonly used to depress the pH of the recirculating cooling water. Acidifying the recirculating water increases the solubility of most problematic mineral salts. However, pretreatment costs may outweigh the economic benefits of increasing the number of cycles in a system. Acidification requires the use of acid, a hazardous material with handling and use issues.

Table 3. Hypothetical Cooling Water Quality Estimate

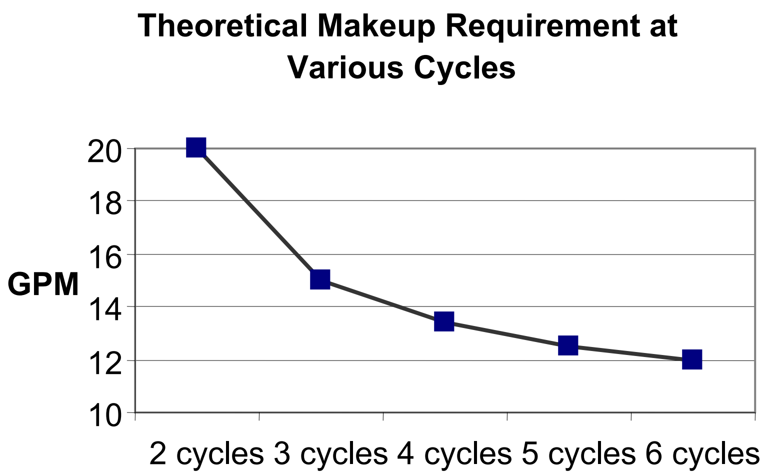
	JEA Makeup	2 cycles	3 cycles	4 cycles
Calcium	150 ppm	300 ppm	450 ppm	600 ppm
Sulfate	130 ppm	260 ppm	390 ppm	520 ppm
M Alkalinity	110 ppm	220 ppm	330 ppm	440 ppm
Silica	30 ppm	60 ppm	90 ppm	120 ppm
TDS	500 ppm	1000 ppm	1500 ppm	2000 ppm
pH	7.8	8.2	8.6	8.8
LSI	0.40	1.40	2.10	3.10
pHs	7.40	6.85	6.50	5.7

LSI = Langelier Saturation Index. An index of the relative corrosion and scale forming potential of water. Less than 0 is corrosive and greater than 0 is scale forming. The higher the number, the more extreme the tendency to form scale.

pHs = the pH at which the solution becomes saturated. Applicable if you acidify the cooling water.

Table 4. Makeup Requirement estimate at various cycles
(Assume 1000 gpm recirculation rate and 10 degree temperature change)

	2 cycles	3 cycles	4 cycles	5 cycles	6 cycles
Blowdown	10 gpm	5 gpm	3.4 gpm	2.5 gpm	2.0 gpm
Makeup	20 gpm	15 gpm	13.4 gpm	12.5 gpm	12 gpm
Evaporation	10 gpm	10 gpm	10 gpm	10 gpm	10 gpm



Alternative Treatment Methods

Many alternative methods to using chemicals have been developed for maximizing cooling tower efficiency. Most of these methods are friendlier to the environment and may have additional benefits.

- Side stream filtration can also be used to reduce solids build-up in the system.
- Ozone is an extremely effective microbiocide chemical that is generated on site.
- Reverse Osmosis: uses membrane filtration to remove bacteria, solids and salts. Constant monitoring of the pH and membrane filters is required and can be labor intensive.
- Cover exposed areas of cooling towers to prevent exposure to direct sunlight. This step greatly reduces the growth rate of algal colonies.

Eliminate Once-Through Cooling Systems

Equipment such as vacuum pumps, air compressors, condensers, hydraulics, welders, etc. are often cooled by one pass through of water which wastes water and increases utility bills. Consider connecting the equipment to a recirculating cooling system.

- A cooling tower loop may be an economical alternative. Another area of the plant may have excess cooling capacity that can be utilized.
- Consider replacing water-cooled equipment with air cooled equipment.
- Re-use the once-through cooling water for other facility water requirements such as cooling tower make-up, rinsing, washing or landscaping.

Guidance for Working with Service Contractors

- Work closely with your water treatment vendor or contracted service provider to reduce blow down. Because reducing blow down reduces the amount of chemicals used, consider performance based contracts.

- Require vendors to commit to a predetermined minimum level of water efficiency.

- Communicate to your vendor that water efficiency is a priority and ask about alternative treatments to reduce blow down.

- Understand the process and have the vendor explain the purpose of the chemicals they are recommending.

- Ask your vendor to provide a written report of each service call and have them explain the test results.

Water Conservation Practices

- Improve the bleed-off release method by combining a preset level indicating a total dissolved solids (TDS) reading at the high end of the manufacturer specified range, with a shorter bleed-off duration.

- Consider installing side stream filtration if water supply is turbid or where the cooling water passages are small and susceptible to clogging.

- Consider adjusting pH by feeding sulfuric acid to the recirculating water to control scale build up.

- Consider using recycled or reclaimed water as a source for makeup water.

- Include specific guidelines addressing water conservation options in any of your service contracts.

- Re-use water from another area of the plant for make-up water. Reject water from reverse osmosis, water from a once through cooling process or other clean wastewater streams can be utilized. Treated effluent from industrial processes may also be used as make-up water as long as the amount of contaminants is acceptable. Using treated effluent may reduce the cycles of concentration for cooling tower operation.

Conclusion

Thermal efficiency, proper operation, and life of the cooling tower are related directly to the quality of the recirculating water in the tower. Maintaining water balance, maximizing the cycles of concentration, and optimization of blow down presents the greatest opportunity for water efficiency and minimizes environmental impacts.

By following the suggestions in this document and utilizing treatment chemicals which do not lead to violations of JEA Industrial Pretreatment discharge standards, you will assist the local POTW to meet its discharge and land application limits contributing to a healthier environment.

Questions can be directed to:

JEA
Industrial Pretreatment, T-8
21 W. Church St
Jacksonville, FL 32202

(904) 665-8300

Or at our website: http://www.jea.com/business/services/industrialpre/index.asp

Resources

Integrated Pollution Prevention and control. Reference document on the application of best available techniques to industrial cooling systems, December 2001. EPA Waste Reduction Resource Center. http://wrrc.p2pays.org/

North Carolina Department of Environment and Natural Resources Fact Sheet http://www.scvurppp-w2k.com/cu_clearinghouse_web/cool_tower/03_cooling_towers_water_conservation.pdf

JEA Major Accounts. Jacksonville, FL. McKee,David. mckewd2@jea.com

Ameri Serve Water technology. Orange Park, FL.allen@ameriservwater.com

Bain & Associates Consulting LTD. Hoffman Estates Illinois. bain@bainconsulting.com.

American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc.

Hampton Roads Planning District Commission. November 1992. Virginia Beach, Virginia.

City of Palo Alto. Palo Alto, California.

Industrial Pretreatment

PROHIBITED DISCHARGES AND LOCAL LIMITS

1. Prohibited Discharges

In accordance with §2.1 of JEA's *Industrial Pretreatment Regulation*, no user shall introduce or cause to be introduced into JEA's Wastewater Treatment Facilities (JEAWWF) any pollutant or wastewater which causes pass-through or interference or shall introduce or cause to be introduced pollutants, substances, or wastewater that have not been processed or stored in such a manner that they could be discharged to JEAWWF. No significant industrial user shall discharge to JEAWWF without authorization from JEA. These general prohibitions apply to all users of JEAWWF whether or not they are subject to categorical pretreatment standards or any other Federal, State, or local pretreatment standards or requirements.

Additionally, no user shall introduce or cause to be introduced into JEAWWF the following pollutants, substances, or wastewater:

(1) Pollutants which create a fire or explosive hazard in JEAWWF, including, but not limited to, waste streams with a closed-cup flash point of less than 140°F (60°C) using the test methods specified in 40 CFR 261.21.

(2) Wastewater having a pH lower than 5.5 or higher than 10.5, or otherwise causing corrosive structural damage to JEAWWF or equipment.

(3) Any solids or viscous substances that may cause obstruction to flow or be detrimental to sewerage system operations. These objectionable substances include, but are not limited to, asphalt, dead animals, offal, ashes, sand, mud, straw, industrial process shavings, metals, glass, rags, feathers, tar, plastics, wood, whole blood, paunch manure, bones, hair and fleshings, entrails, paper dishes, paper cups, milk containers, or other similar paper products, either whole or ground.

(4) Any animal or vegetable based oils, fats, or greases whether or not emulsified, which would tend to coat or clog, cause interference, pass through, or adverse effects on JEAWWF. Grease removed from grease traps or interceptors shall not be discharged to JEAWWF.

(5) Pollutants, including oxygen-demanding pollutants (BOD, etc.), released in a discharge at a flow rate and/or pollutant concentration which, either singly or by interaction with other pollutants, will cause interference with JEAWWF.

(6) No user shall discharge into a sewer line or other appurtenance of the JEAWWF any wastewater having a temperature greater than 140°F (60°C) or which will inhibit biological activity in the treatment plant resulting in interference, but in no case wastewater which causes the temperature at the introduction into the treatment plant to exceed 104 °F (40°C). If a lower temperature limit is required than 140°F at the point of connection to JEAWWF, then the limit shall be depicted in the user's wastewater discharge permit.

(7) Petroleum oil, non-biodegradable cutting oil, or products of mineral oil origin at a total concentration exceeding 100 mg/l.

(8) Wastewater containing toxic pollutants in sufficient quantity, either singly or by interaction with other pollutants, to injure or interfere with a wastewater treatment process, constitute a hazard to humans or animals, create a toxic effect in the receiving waters of JEAWWF, causing the treatment plant to fail a toxicity test or exceed the limitation set forth in a categorical pretreatment standard.

(9) Storm water, surface water, ground water, artesian well water, roof runoff, subsurface drainage, condensate, deionized water, non-contact cooling water, and unpolluted wastewater, unless specifically authorized by JEA.

(10) Pollutants which result in the presence of toxic gases, vapors, or fumes within JEAWWF in a quantity that may cause acute worker health and safety problems. Acute worker health and safety problems may be defined using the most recent information on TWA-TLV, TWA-STEL, and IDLH from the American Conference of Governmental Industrial Hygienists (ACGIH), National Institute for Occupational Safety and Health (NIOSH), EPA, and the Occupational Health and Safety Administration (OSHA).

(11) Trucked or hauled pollutants, except at discharge points designated by JEA in accordance with §6.3 of JEA's *Industrial Pretreatment Regulation*.

(12) Noxious or malodorous liquids (City of Jacksonville, City Odor Ordinance, Chapter 376, Ordinance Code), gases, solids, or other wastewater which, either singly or by interaction with other wastes, are sufficient to create a public nuisance or a hazard to life, or to prevent entry into the sewers for maintenance, inspection or repair.

(13) Wastewater which imparts color that cannot be removed by the treatment process, and causes a violation of JEAWWF's NPDES permit such as, but not limited to, dye wastes and vegetable tanning solutions.

(14) Wastewater containing any radioactive wastes or isotopes except in compliance with applicable Federal and State regulations or permits issued by Federal and State Agencies and specifically authorized by JEA.

(15) Sludge, screenings, or other residues from the pretreatment of industrial wastes.

(16) Medical or infectious wastes, except as specifically authorized by JEA in a wastewater discharge permit

(17) Detergents, surface-active agents, or other substances which may cause excessive foaming and cause interference and pass-through JEA Wastewater Treatment Plants.

(18) Waters or wastes containing phenol or other taste- or odor-producing substances in such concentrations exceeding limits established by JEA, as necessary after treatment of the composite sewage to meet requirements of Federal, State or other public agencies having jurisdiction for the discharge to the receiving waters.

(19) Garbage that has not been properly shredded to such a degree that all particles will be carried freely in suspension under flow conditions normally prevailing in JEAWWF. At no time shall the concentration of properly ground garbage exceed a level that would prevent JEAWWF from maintaining the required efficiency or cause operational difficulties.

(20) Swimming pool drainage unless specifically authorized by JEA. No person who fills a swimming pool with non-metered water may discharge swimming pool drainage to a sanitary sewer without a JEA wastewater discharge authorization.

(21) It shall be unlawful for silver-rich solution from a photographic processing facility to be discharged or otherwise introduced into JEAWWF, unless such silver-rich solution is managed by the photographic processing facility in accordance with the most recent version of the Silver CMP prior to its introduction into JEAWWF.

2. Local Limits

The following pollutant limits are established to protect against pass-through and interference. No user shall discharge wastewater with pollutants in excess of the following:

Maximum Allowable Discharge Limits

POLLUTANT	District I (Buckman)	District II	District III (Southwest)	District IV (Arlington East)	District V (Mandarin)
Cadmium (mg/l)	1.20	1.20	1.20	1.20	1.20
Chromium (mg/l)	10.00	10.00	10.00	10.00	10.00
Copper (mg/l)	3.38	3.38	0.73	3.38	3.38
Cyanide (mg/l)	3.38	3.38	3.38	3.38	3.38
Lead (mg/l)	1.40	0.70	1.90	1.17	1.90
Mercury (mg/l)	0.006[1]	0.006[1]	0.006[1]	0.006[1]	0.006
Nickel (mg/l)	3.98[1]	3.98	3.98	3.98	3.98
Silver (mg/l)	0.43	0.43	0.43	0.43	0.43
Zinc (mg/l)	2.61	2.61	2.61	2.61	2.61
Chemical Oxygen Demand, COD (mg/l)	[2]	[2]	[2]	[2]	[2]
Total Suspended Solids, TSS (mg/l)	[3]	[3]	[3]	[3]	[3]
pH (SU)	5.5 to 10.5[4]	5.5 to 10.5[4]	5.5 to 10.5[4]	5.5 to 10.5[4]	5.5 to 10.5[4]
SGT-HEM[5] (mg/l)	100	100	100	100	100

The above limits apply at the point where the wastewater is discharged to JEAWWF. All concentrations for metallic substances are for "total" metal unless indicated otherwise. JEA may impose mass limitations in addition to, or in place of, the concentration-based limitations above.

3. Sampling and Analytical Requirements

In accordance with §7.10 of JEA's *Industrial Pretreatment Regulation* and Rule 62-625.600(1)(e)6 FAC, all sampling and analyses conducted to support industrial pretreatment activities shall comply with Chapter 62-160 FAC, unless otherwise specified in an applicable categorical pretreatment standard (40 CFR, Chapter I, Subchapter N). If Rule 62-160 FAC, does not contain sampling or analytical techniques for the pollutant in

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1 Limits for contributory flow users only. Industrial user will be notified by JEA regarding status as a contributory user.

2 A sewer surcharge will be assessed if the COD exceeds 650 mg/l.

3 A sewer surcharge will be assessed if the TSS exceeds 300 mg/l.

4 Wastewater with a pH lower than 5.5 or higher than 10.5 shall not be discharged to JEAWWF.

5 Petroleum oil, non-biodegradable cutting oil, or products of mineral oil origin as determined by EPA method 1664, Revision A, Silica Gel Treated *n*-Hexane Extractable Material.

question, sampling and analyses shall be performed in accordance with procedures approved by FDEP.

Each laboratory conducting analyses to support industrial pretreatment activities shall be certified for the specific analyte being monitored in accordance with Rule 64E-1, FAC.

In accordance with §7.11 of JEA's *Industrial Pretreatment Regulation* and Rule 62-625.600(1)(e)3 FAC, except for oil and grease (SGT-HEM), temperature, pH, cyanide, phenols, sulfides and volatile organic compounds, all wastewater samples shall be collected using twenty-four (24) hour flow proportional composite collection techniques. Samples for oil and grease (SGT-HEM), temperature, pH, cyanide, phenols, sulfides, and volatile organic compounds shall be obtained using grab collection techniques. In the event that flow proportional sampling is unfeasible, JEA may authorize the use of time proportional sampling or a minimum of four (4) grab samples where user demonstrates that this will provide a representative sample of the effluent being discharged. In addition, grab samples may be required to show compliance with maximum allowable discharge limits.

Samples consist of two primary types: grab samples and composite samples. A grab sample is an individual sample collected over a period of time, not exceeding 15 minutes, usually all in one motion. Grab samples represent the conditions that exist at the moment the sample is taken.

A composite sample is a sample collected over an extended time period, formed either by continuous sampling or by mixing discrete grab samples (aliquots). A composite sample should be collected over the duration of discharge for a workday. If a facility operates and discharges 24 hours per day, then the composite sample should be taken as a 24-hour composite. If a facility operates 24 hours per day but only discharges wastewater for six hours, a six-hour composite sample should be collected. Composite samples can be collected in proportion to time or flow.

Time proportional composite samples are composed of constant volume aliquots collected in one container at constant time intervals (e.g. 250-ml aliquots collected every 15 minutes). This method provides representative samples when the flow of the sampled stream is relatively constant (i.e. within ±10% of average flow rate).

Flow proportional composite samples are collected by two techniques:

A. Constant volume aliquots are collected in one container at frequencies proportional to discharge flow (e.g. 250-ml aliquots collected for every 1,000 gallons discharged). This is the preferred method when using a flow-integrated, automatic sampler.

B. Aliquots with volumes proportional to discharge flow are collected in one container at equal time intervals (i.e. Aliquots collected every 30 minutes with the volume of the aliquot increasing as the discharge flow increases). This is the preferred method for manually composited samples. The time period between aliquots shall not exceed one (1) hour.

For any composite technique, the volume of each aliquot shall be at least 100 milliliters and total composite volume shall be at least two (2) liters. In no case may a composite sample consist of fewer than four (4) aliquots. For time proportional composite sampling, the time period between aliquots shall not exceed one (1) hour.