# Industrial Water Treatment Operations and Maintenance

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# Module 1: Introduction to Industrial Water Treatment

## Learning Objectives

By the end of this section, you will be able to:

- **Identify** the primary differences between industrial and potable water systems within military facilities.
- **Evaluate** the impact of corrosion, scale, and biological fouling on system efficiency and safety.
- **Apply** environmental and safety regulations to the management of industrial water treatment programs and wastewater discharge.

*Executive Summary:* Effective industrial water treatment is essential for maintaining the operational efficiency and longevity of military heating, cooling, and power generation systems. By proactively managing corrosion, scale, and biological growth through chemical treatment and rigorous record-keeping, engineers can significantly reduce operating costs and ensure compliance with federal health, safety, and environmental regulations.

## Design Fundamentals and Scope

This section provides an overview of industrial water treatment operations and management. In this context, **industrial water** refers to water used in military power generation, heating, air conditioning, refrigeration, cooling, and processing.

## Distinction from Potable Water

Industrial water is **never consumed** or used in situations requiring high sanitation. It requires specific water preparation or chemical treatment to avoid operational failures.

## Core System Categories

- **Steam Boiler Systems:** Used for space heating, sterilization, humidification, and power generation.
- **Cooling Water Systems:** Includes cooling towers, evaporative condensers, and once-through systems.
- **Closed Water Systems:** Includes closed hot/chilled water loops and diesel jacket cooling.

## Fire Protection and Other Uses

Fire protection systems (sprinklers and waterfront firemains) are not technically classified as industrial water systems. While they require chemical treatment, established industrial standards are currently lacking. These systems often utilize salt or brackish water.

## Problems Encountered in Industrial Water Systems

Failure to treat water leads to restricted flow and operational changes. These issues result in **reduced efficiency**, **increased replacement costs**, and **safety hazards**.

## Primary Problem Categories

1. **Deposits:** A broad category including mineral scale, biological matter, and suspended materials (dirt/silt).
2. **Scale:** Specific deposits caused by mineral salts precipitating when solubility limits are exceeded. This adheres to surfaces, causing **loss of heat transfer**.
3. **Biological Growth:** Includes macrobiological (clams, mollusks) and microbiological (algae, fungi, bacteria) organisms.
4. **Suspended Solids (SS):** Non-dissolved materials such as silt, sand, or corrosion byproducts (iron oxide).
5. **Corrosion:** Metal deterioration via electrochemical reactions. Refined metals naturally tend to return to their original ore state.

## Objectives of Industrial Water Treatment

Treatment programs aim to:

- **Maintain efficiency** and prolong equipment "life."
- **Control** scale, corrosion, and fouling.
- **Produce** a continuous supply of properly conditioned makeup and system water.

💡 **Design Tip:** While potable water is the traditional source for industrial makeup, there is a growing trend toward using **recycled municipal wastewater** for cooling towers. Always ensure a backup water supply is available when using recycled sources.

## Water Conservation

Engineers must maximize water conservation by:

- Fixing leaks and reducing drift.
- Operating at the **highest permissible cycles of concentration (COC)**.
- Reducing blowdown to minimize chemical waste and costs.

## Responsibility for Treatment

- **Office Responsible:** The base or facility-level office manages resources and long-term strategy.
- **Organizational Assignments:** Specific personnel must be assigned to testing and treatment. If these are "additional duties," ensure they receive **adequate and continuous attention**.

## Unauthorized Non-Chemical Devices

⚠️ **Safety Constraint:** The military does not currently recognize the use of **non-chemical treatment devices** for comprehensive water treatment or trials.

## Health and Safety

Water treatment chemicals can be hazardous. Operators must follow **OSHA** directives, manufacturer recommendations, and **Material Safety Data Sheets (MSDS)**.

## Protection of Potable Water

To prevent contamination of potable supplies:

- **Eliminate cross-connections** (physical links between potable and non-potable systems).
- **Install backflow prevention:** Use Class III devices (air gap or reduced pressure principle) when connecting potable water to systems using non-potable sources or added chemicals.
- **Air Gaps:** Maintain a physical gap between the water inlet and the maximum overflow level in open tanks.

## Restrictions on Direct Steam Use

⚠️ **Safety Constraint:** Steam treated with **neutralizing amines** is unfit for consumption. Do not allow treated steam to contact food or be used for direct humidification. Use **steam-to-steam heat exchangers** for these applications.

## Record-Keeping Requirements

Accurate logs are the only way to verify program control. Computer-generated logs must have scheduled backups.

## Log Requirements by System

- **Large Boilers (>103 kPa / 15 psig):** Maintain on-site logs for boiler water, makeup, and condensate.
- **Cooling Towers:** Log all chemical tests, calculated COC, and chemical addition volumes.
- **Historical Records:** Maintain a permanent record of start-ups, outages, equipment inspections, and major maintenance.

**Calculation Note:** Control charts should be utilized to track chemical levels and testing parameters (e.g., pH and conductivity). Service companies usually provide these templates.

## Support Available

- **Quality Assurance (QA) Program:** Samples must be submitted to labs to verify in-plant test accuracy.
- **Technical Support:**
    - **U.S. Army Corps of Engineers:** HQ level policy and oversight.
    - **HQ AFCESA/CESM:** Air Force technical support.
    - **Naval Facilities Engineering Service Center:** Navy utilities systems branch.

# Industrial Wastewater

Industrial wastewater includes blowdown from boilers and cooling towers, as well as process discharge.

## Disposal Procedures

Management of discharge must be coordinated with the **Installation Environmental Engineer**.

## Discharge Controls

- **Pretreatment:** Required before discharging to storm or sanitary sewers.
- **Discharge Rate:** Limited by sewer hydraulic capacity and chemical concentration.
- **Discharge Time:** May be restricted to specific windows.

## Environmental Regulations

The following federal laws govern industrial water operations:

- **Toxic Substances Control Act (TSCA):** EPA control of hazardous chemicals.
- **Clean Water Act (CWA):** Limits pollutants in navigable waters.
- **Safe Drinking Water Act:** Protects underground water sources.
- **FIFRA:** Requires EPA registration of all microbiocides (pesticides).
- **RCRA:** Controls solid and hazardous waste via a manifest tracking system.
- **OSHA:** Establishes workplace safety and labeling requirements.
- **CERCLA (Superfund):** Governs hazardous waste site cleanup.
- **21 CFR 173.310:** Limits boiler water additives to maintain indoor air quality.

## Container Management Policy

The military generally does not own or dispose of chemical containers. Contractors must provide **reusable or returnable** containers and are responsible for **secondary containment**.

Purchase this course to see the remainder of the technical materials.