Industrial Water Treatment Operations and Maintenance

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CHAPTER 1

INTRODUCTION TO INDUSTRIAL WATER TREATMENT

1-1 **PURPOSE AND SCOPE**. This course provides an overview of industrial water treatment operations and management. As used in this course, the term "industrial water" refers to the water used in military power generation, heating, air conditioning, refrigeration, cooling, processing, and all other equipment and systems that require water for operation. Industrial water is not the same as potable water. Industrial water is never consumed or used under situations that require a high degree of sanitation.

Industrial water requires water preparation or chemical treatment, or both, to avoid the problems described in paragraph 1-1.2. Water preparation and chemical treatment requirements are described in Chapters 2 through 5 according to the type of system in question. Examples of industrial water systems and their uses are:

- Steam Boiler Systems. (See Chapter 3.) Steam uses include space and hot water heating, sterilization, humidification, indirect food processing, and power generation.

- Cooling Water Systems. (See Chapter 4.) Cooling water is used in cooling towers, evaporative coolers, evaporative condensers, and once-through systems. Applications are broad, ranging from simple refrigeration to temperature regulation of nuclear reactors.

- Closed Water Systems. (See Chapter 5.) These include closed hot water, closed chilled water, and diesel jacket systems.

1-1.1 **Fire Protection and Other Uses**. Fire protection water systems are not technically industrial water systems. These include building fire suppression sprinkler systems and fire-main systems at waterfronts. The need to chemically treat the water within such systems is recognized; however, there are currently no industrial standards in place. The fire-main systems at waterfronts often use salt water or brackish water. This type of water can also be used for once-through condenser cooling.

1-1.2 **Problems Encountered in Industrial Water Systems**. Problems found in industrial water systems are attributable to reduced or restricted water flow or other changes in operational parameters, and often caused by corrosion, deposits, and biological growth. These problems result in reduced system efficiency (higher operating costs), increased equipment replacement costs, and reduced safety. At times they can be serious enough to cause complete system shutdown. The problems in industrial water systems fall into three main categories:

- Steam boiler water problems (corrosion, deposits, and carryover).
- Cooling water problems (corrosion, deposits, and biological).
- Closed loop problems (corrosion, deposits, and biological).

1-1.2.1 **Deposits**. The term “deposits” refers to a broad categorization of residues. Deposits are composed of mineral scale, biological matter, and suspended or insoluble materials (e.g., sludge, dirt, or corrosion byproducts). Deposits can be created by the attachment of deposit-forming materials to pipe or equipment surfaces, or by settling and accumulation.

1-1.2.2 **Scale**. The term “scale” describes specific types of deposits caused when mineral salts, dissolved in water, are precipitated either because their solubility limits have been exceeded or as a result of reaction to water treatment chemicals. Scale adheres to pipe and equipment surfaces and its formation results in loss of heat transfer and restricted flow of water or steam. Many different types of scale reflect the quality and characteristics of the makeup water and the type of chemical treatment being applied.

1-1.2.3 **Biological**. The term “biological” describes both macro-biological organisms (mollusks, clams, fish) and microbiological organisms (algae, fungi, bacteria). Algae are microscopic plants that may grow in various industrial water systems but most commonly appear on the distribution decks of cooling towers. Fungi are living organisms that may cause damage to the wooden parts of cooling towers by causing decay. Slimes are accumulations of these biological contaminants that foul and corrode the cooling water equipment. Macro-biological organisms can cause fouling problems in once-through cooling water systems if untreated (“raw”) water is used.

1-1.2.4 **Suspended Solids (SS)**. The term “suspended solids” refers to any materials present in the water stream that are not actually dissolved in the water. SS can result from the presence of dirt, silt, and sand in the makeup water or can be introduced into the water from air in a cooling tower system. Biological matter, both dead and living, can be a form of SS if carried in the water stream. Corrosion products, such as iron oxide, are forms of SS that often originate in the system piping.

1-1.2.5 **Corrosion**. The term “corrosion” refers to metal deterioration resulting from a refined metal’s tendency to return to its original state (i.e., the ore from which the refined metal was produced). The process of corrosion involves a series of electrochemical reactions. Metals that contact water in any type of water system can corrode if there is no attempt to protect them.

1-1.3 **Objectives of Industrial Water Treatment**. Industrial water is treated to achieve the following objectives with respect to the equipment in which it is used: maintaining its efficiency, prolonging its usable “life,” and reducing the frequency of repair or replacement (or both). These objectives can be achieved by treating the water to prevent scale and to control corrosion, fouling, and microbiological growth. To meet

these objectives, an adequate and continuous supply of both properly conditioned makeup water and conditioned or chemically treated system water (i.e., water within the water-using system) is produced. The source for industrial water is often the installation's potable water distribution system; however, there is a growing trend to use recycled municipal wastewater for makeup to cooling tower systems. When this source of makeup water is used, additional steps can be taken to provide a backup water supply.

1-1.4 **Water Conservation**. Make every effort to conserve water used in boilers, cooling towers, and other water-using equipment. This includes identifying and fixing leaks throughout the systems, reducing uncontrolled water losses (drift) from cooling towers, and operating the systems at the highest permissible cycles of concentration (COC) by using proper procedures for blowdown and chemical treatment. Water conservation (i.e., using less water) also reduces the amount of treatment chemicals required for the water treatment program. This, in turn, eases operation of wastewater treatment facilities, reduces the requirements for chemical handling, reduces the volume of chemical wastes generated, and reduces the cost of water treatment.

1-1.5 **Responsibility for Treatment**

The development and implementation of efficient and economical procedures for industrial water treatment and water testing processes requires the assignment of specific and appropriate organizational responsibilities. If the person assigned to perform the treatment and testing of industrial water is assigned additional duties, assignment of additional personnel may be required to ensure that adequate and continuous attention is given to industrial water treatment and testing. A system for the regular reporting of trends in test results and for the regular assessment of system performance can be established to keep the assigned personnel appropriately informed.

Health and Safety. Many of the chemicals used to treat industrial water may be harmful to the health of the system operator and other installation personnel unless they are properly handled and controlled. Handle water treatment chemicals and test reagents with care, following the guidance of Occupational Safety and Health Administration (OSHA) directives, manufacturers' recommendations, and material safety data sheets (MSDS). To minimize chemical handling, you can use automated control and feed equipment. Chapter 7 describes chemical application processes.

Protection of Potable Water. Protecting potable water supplies, as it applies to an industrial water system, involves preventing contamination of the potable water system. Eliminating cross-connections in the water system and using backflow prevention devices or air gaps to provide an interconnection barrier between the water systems are ways to achieve this prevention.

Cross-connections. A cross-connection is a physical connection between a potable water supply system and a non-potable water system (such as an industrial water system) through which contaminated water can enter the potable water system. Cross-connections are eliminated to maintain the safety of potable water supplies. Backflow prevention devices are installed to prevent cross-connections where potable water is supplied to industrial water systems.

Backflow Prevention Devices. Class III backflow prevention devices (air gap or reduced pressure principal devices) are required when connecting a potable water supply system to an industrial water system that uses a source of non-potable water. They are also required when connecting a potable water supply system to an industrial water system to which chemicals have been added.

Air Gaps. If potable makeup water is supplied to a tank or other type of open system, provide an air gap between the water inlet and the maximum overflow level of the tank, device, or system.

Restrictions on Direct Steam Use. Neutralizing amine chemicals, which are added to the steam to protect the condensate lines from corrosion, make the steam and condensate unfit for consumption or for other uses normally reserved for potable water. Treated steam should not come into direct contact with food and should not be used for heating food trays or for humidification. For these applications, steam-to-steam heat exchangers can be used to provide amine-free steam.

1-1.9 **Record-Keeping Requirements**. Procedures for industrial water treatment and testing may vary from one facility to another based on differences in the characteristics and quality of the water, as well as on differences in the type and size of the systems. Water system specifications are developed to address local factors such as the facility's purpose, geographic location, and climate. The data and information records and logs used to record the results of industrial water treatment and testing can be developed to reflect the minimum documentation requirements needed to verify adequate operation and control of the treatment program. Computer-generated logs require regularly scheduled backup. Chapter 6 provides recommended frequencies for sampling and testing various industrial water systems.

1-1.9.1 **Control Charts**. Control charts can be developed to identify the following information: the treatment chemicals used; the chemical levels required to be maintained in the system; other required testing procedures (e.g., conductivity, pH); and the information specific to the particular water system (especially for the larger boilers

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