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UNIFIED FACILITIES CRITERIA (UFC)

INDUSTRIAL WATER TREATMENT OPERATION AND MAINTENANCE

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INDUSTRIAL WATER TREATMENT OPERATION AND MAINTENANCE

U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND (Preparing Activity)

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

Record of Changes (changes are indicated by **1**\ ... /**1**/)

Change No.	**Date**	**Location**
1	Dec 2005	FOREWORD

FOREWORD

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CHAPTER 8

NON-CHEMICAL/NON-TRADITIONAL WATER TREATMENT DEVICES

8-1 **POLICY**. Most non-chemical water treatment devices or equipment are not currently authorized for use on military installations, as stated in paragraph 1-1.5. The Air Force will allow their use only under an Energy Saving Performance Contract (ESPC) in which the contractor assumes all performance-based risk. The performance standards for system component protection must meet or exceed those that are achievable with chemical treatment. For the Navy's policy see NAVFACINST 11300.37A, "Energy and Utilities Policy Manual."

8-1.1 **Function**. Non-chemical devices for use in industrial water systems are designed to require little or no chemical treatment to solve or prevent one or more types of water-related problems, including scale, corrosion, slime, and odor. Some of the technologies are represented as non-chemical, when in fact they produce chemicals (e.g., ozone, and copper and silver ions). These technologies could be better described as non-traditional water treatment chemical devices. The various types of non-chemical devices are described in paragraph 8-2.

8-1.2 **Acceptance**. To date, there has not been a general acceptance of most non-chemical devices. Manufacturer's representations as to their effectiveness and adequacy in performing the intended functions may not be supported by adequate performance data. Non-biased, independent verification of performance conducted by a third-party entity is an important component of the process that should be used to establish performance criteria of new technologies and equipment. This verification step has not always been performed for a given technology. Recognition of the adequacy of a non-chemical technology and acceptance of its use by professional societies such as ASHRAE, the National Association of Corrosion Engineers (NACE International), and CTI could provide an increased level of confidence that the technology does in fact work, at least on some basis and to some extent.

8-1.3 **Performance Standards**. Traditional water treatment evaluation techniques and performance results provide the standard by which non-chemical devices should be measured. A complete water treatment program must address deposit control, corrosion control, microbiological control, and water conservation. These standards are described in Chapter 10. If a non-chemical water treatment device addresses only deposit control, but not corrosion or microbiological control, then it cannot make a claim to eliminate the need for all chemicals. The water treatment program would still require chemicals to control the problems that the non-chemical device cannot control.

8-2 **TYPES OF NON-CHEMICAL WATER TREATMENT DEVICES**. Non-chemical devices for water treatment are hardware devices that do not use chemicals for the purpose of controlling or preventing corrosion, deposition, and biological growth in industrial water systems. This Chapter discusses the various types of non-chemical devices on the market. It is not intended to endorse or validate any of these technologies, nor to describe all types offered; however, the known effectiveness of these devices will be stated where performance results have been verified.

8-2.1 **Electrical Impressed Current Devices**. Electrical impressed current devices are a proven corrosion control technology, known as cathodic protection that is used to protect lengths of underground outside surfaces of steel piping and mild steel heat exchanger water boxes. An electrical current is applied to offset the natural potential difference between an anode and a cathode. This technology does not prevent scale deposition or microbiological concerns and is mainly used to protect mild steel.

8-2.2 **Grounded Wire Devices**. Grounded wire devices use a wire to ground a pipe or structure to prevent corrosion. This device is useful when stray currents (electrical) are causing corrosion. These devices have been touted as being able to prevent and remove scale. The principle of operation is uncertain, but it may be based on the fact that water impurities are charged ions and grounding affects the ions from forming scale. The scale control properties of this technology have not been conclusively and unambiguously verified.

8-2.3 **Sacrificial Anodes**. The use of sacrificial anodes is a proven technology that uses blocks of metal that corrode (sacrifice) to protect the metal to which they are attached. A sacrificial anode is more anodic than the metal to which it is attached (see paragraph 4-5.1). This technology is actually a form of chemical corrosion protection. As an example, a zinc or magnesium metal sacrificial anode, when attached to a mild steel surface, becomes the anode in a corrosion reaction. The sacrificial anode is corroded preferentially while the mild steel is provided some localized corrosion protection. The action of sacrificial anodes is limited by the distance over which they can be effective; usually about 0.18 to 0.56 square meters (2 to 6 square feet) around the anode is protected, depending upon the water quality.

8-2.4 **Filters**. Filters are a proven non-chemical method for removing SS in water. The removal of SS (dirt, silt, sand, corrosion products, and microbiological organisms) serves to minimize both the formation of deposits and the potential for under-deposit corrosion. Filtration affects biological control by reducing the presence of macro- and microbiological organisms in water. Removal of SS via filtration can improve the performance of all chemical control agents. This is comparable to a person washing a wound before applying a disinfectant. Filters do not address deposition due to scale nor do they control corrosion.

8-2.5 **Magnetic Filters**. Magnetic filters are a proven method for removing magnetic iron oxides from a water stream. The most common application is the use of magnetic filters to remove iron oxide before the condensate is returned to the boiler in steam condensate systems. Magnetic filters usually are high capital costs.

8-2.6 **Ultraviolet Light Generators**. Ultraviolet light generators are a proven method for microbiological disinfection of water. However, their effectiveness is limited to the distance through which the ultraviolet light can penetrate a water stream. This technology would not be effective for controlling (destroying) sessile bacteria that are already attached to a surface that the light cannot reach or for controlling (destroying) anaerobic bacteria that live underneath deposits that the light cannot penetrate. This technology has limited effectiveness with highly turbid water.

8-2.7 **Magnetic and Electromagnetic Devices**. Magnetic and electromagnetic devices use an unproven technology based on the theory that magnetic fields change the physics of water and the water impurities. Water is a polar molecule. Most water impurities are positively or negatively charged ions. These are the physical properties that the magnetic fields are supposed to act on and to alter. The magnetic device is installed at a point where the water passes by, usually at a point where the water enters the system. A claim made commonly by the manufacturer of the device is that calcium carbonate scale, and possibly other scales, can be conditioned and often prevented. Most of the literature fails to provide a performance envelope of various water qualities. Most manufacturers also fail to mention how corrosion or microbiological control is achieved or even addressed. Magnetic filters used to remove magnetic iron oxide have been shown to work, as described in paragraph 8-2.5.

8-2.8 **Electrostatic Devices**. Electrostatic devices use an unproven technology based on the theory that an electric field changes the physics of water or the water impurities. Some manufacturers market their devices for scale control only. Other manufacturers state, without providing adequate verification data, that these devices address corrosion and microbiological concerns. Performance results are not included in the marketing literature.

8-2.9 **Non-Traditional Water Treatment Chemical Devices**

8-2.9.1 **Ozone**. Ozone (O_3) is a chemical gas consisting of three atoms of oxygen. It has been used in cooling tower water systems. Ozone is a very effective disinfectant for the control of aerobic bacteria and is somewhat effective for sessile bacteria. Ozone has been shown to have a limited and unpredictable effect on calcium carbonate scale. The scale that may form does not adhere to heat exchange equipment, but rather forms SS that can be removed with filtration. The performance envelope for prevention of calcium carbonate scale on heat exchange equipment is very limited and is much less than what is possible when using traditional chemical treatment. Ozone does not prevent corrosion of most metals. It provides some reduction of mild steel corrosion, but will increase the corrosion of copper at rates up to 10 times versus traditional chemical treatment. Ozone also attacks galvanized steel. Increasing the level of ozone in water increases the corrosiveness of the water. Levels of 0.1 mg/l or less are acceptable. Ozone has a short half-life and must be generated on-site. Ozone-generating equipment can have high capital costs. It is difficult to maintain an effective residual of ozone throughout the entire cooling water system because of the extreme reactiveness of ozone. It is also very volatile and can be lost from the system as the water passes through the cooling water system, resulting in biomass within the tower fill.

8-2.9.2 **Copper and Silver Ionizing Devices**. Copper and silver ionizing devices use copper and silver metal rods that are electrically corroded and thus put copper and silver ions in the cooling water. Copper and silver ions are known microbiocides. Both copper and silver ions are toxic to bacteria and algae. Performance envelopes are ambiguous. There is also a potential for the copper and silver ions to plate out on mild steel pipe, galvanized steel, and other metal surfaces, creating a galvanic corrosion cell and resulting in pitting corrosion.