

1. **Non-Chemical Water Treatment Specification**

a **Description**

This Section specifies the furnishing and installation of complete and operable water treatment for cooling towers and chilled water systems. The water treatment system shall be of non-chemical type and shall utilize Ultra Low Frequency (ULF) electromagnetic technology for effective control of scaling, corrosion and biological growth. The entire system must operate electronically to provide consistent and uniform treatment to the cooling system's water.

b **Criteria of Non-Chemical Water Treatment System/Technology**

- i. All bleed off water must be re-useable and must be suitable for recycling, use for plant watering, cleaning, and flushing. No secondary pollutions such as in situ Cu/Ag ions, biocides generation, or controlled leaching of heavy metal or active chemical substances shall be allowed.
- ii. Based on PUB water supply as makeup water, minimum 7 Cycle of Concentration (COC) must be achieved and preferably more than 10 COC.
- iii. Must be a Singapore Green Building Council certified product.

2. **System Provider Qualifications**

- i. The Ultra-Low Frequency electromagnetic water treatment equipment must be patented and the technology has been applied successfully with proven site records in the Singapore industry for no less than 10 years. It must also deliver proven records of site with at least 10,000RT.
- ii. To provide the service of a water treatment specialist qualified by the equipment maker for the monthly cooling water analysis and the maintenance of the non-chemical water treatment system

3. **Submissions**

- i. Submit complete catalogue information and shop drawings for all materials and equipment including power requirements, wiring and control diagrams.
- ii. Maintenance and operating instructions for the non-chemical water treatment system.
- iii. Submit a copy of the monthly servicing report and water analysis results of the treated water

4. **Design Criteria**

The water treatment system shall be designed to control corrosion and calcium carbonate hard scale deposition in the cooling water system. The treatment should also compile with NEA's Code of Practice for Cooling Tower and Fountain for the control of bacteria. Sizing of the treatment system shall be according to the makeup water quality, flow rates and number and type of cooling towers as well as the type of heat exchangers and cooling system equipment. The ULF system shall be designed to suit and treat the cooling and chilled water of the following controlled quality.

a. **Cooling Water**

pH	6.5-9
Conductivity	< 1500 μ s/cm
Total Dissolved Solid	< 750 ppm
Total Iron Ions	< 1 ppm
Total Bacteria Count	< 100,000 cfu/ml
Total Legionella Bacterial Count	< 10 cfu/ml (cfu colony forming unit)



b. Chilled Water

pH	7-12
Conductivity	< 6000 $\mu\text{s/cm}$
Total Dissolved Solid	< 3000 ppm
Total Iron Ions	< 5 ppm

5. Treatment System

Cooling Water Treatment System

(a) System Function

The water treatment for condenser water shall be an effective Ultra Low Frequency (ULF) electromagnetic water treatment system for control of scaling, corrosion and biological growth in the cooling system. The treatment should comply with NEA's Code of Practice for the control of Legionella Bacteria in Cooling Tower for control of bacteria.

(b) System Component

The system shall comprise of the following systems:

ULF Electromagnetic System — Comprises microprocessor-controlled ULF wave generator and power unit coupled to G-Emitter or Rod-Emitter placed in the cooling tower basin.

(c) System Operation

(i) Scale Control

Scale formation is controlled by first increasing the solubility of Calcium ions in the water and subsequently encouraging the precipitation of Calcium in bulk water as powdery calcium carbonate instead of allowing the calcium ions to form Calcium carbonate (calcite) on heat exchange surface. This controls the scaling effectively and completely eliminate the use of water treatment chemicals. The powdery Calcium carbonates fine powder which is not affecting the heat transfer can be easily removed by filtration or bleed off.

(ii) Corrosion Control

The ULF Electromagnetic System provided shall produce a time varying Ultra Low Frequency (ULF) waves specifically for the promotion of magnetite formation on steel surface for effective corrosion control. Instead of the formation of the non-protective red rust when steel is corroded. Under the ULF time varying wave treatment, higher energy black rust magnetite (Fe_3O_4) is formed. Magnetite is stable, magnetic, very dense and adhere strongly on steel surface. Once formed on the surface, it acts as protective layer and protects the underlying steel surface from further corrosion.

(iii) Bacteria Control and Algae Growth

The ULF waves generated by the ULF Electromagnetic System inhibit the growth of bacteria and algae by interfering with the cell division process and terminate algae metabolic process by bursting the chloroplast in the algae. This effectively controls bacteria colonization in the cooling system hence effectively control the bacterial count and controls algae growth in cooling water system.



6. **Chilled Water System**

(a) **System Function**

The water treatment for chilled water shall be by Ultra Low Frequency (ULF) electromagnetic technology with no chemicals added to control corrosion.

(b) **System Component**

The system shall comprise: -

ULF Electromagnetic System— Comprises microprocessor controlled ULF wave generator and power unit coupled to inductor coil coiling on chilled water pipe-

(c) **System Operation**

(i) **Scaling Control**

Due to the low water temperature of chilled water, CaCO₃ scaling do not take place in chilled water system hence not considered.

(ii) **Corrosion Control**

Corrosion in chilled water system is controlled by the same principle as cooling water corrosion control. In chilled water system, the ULF wave is produced by the inductor coil coiling on the chilled water pipe and the ULF wave generator generates a specific range of ULF wave to promote the formation of magnetite protective layer steel pipe internal surface for corrosion control.

With the BacComber magnetite generator ULF wave excitement, protective magnetite (Fe₃O₄) is formed on the steel surface instead of the common non-protective red rust (Fe₂O₃). Protective magnetite is self repairing and controls further corrosion.

7. **Maintenance of the Water Treatment System**

The maintenance service of the ULF Water Treatment System must be performed by experienced ULF specialist and qualified ULF system maintenance personnel. Maintenance services shall be carried out for a period of 12 months starting from the commissioning of the ULF water treatment system. The ULF specialist shall also provide advice/training to plant operator on the monitoring of the ULF system and basic ULF water treatment knowledge and operating procedures

The maintenance service shall include: -

- i. Monthly servicing of the water treatment equipment on site.
- ii. Monthly water sampling. The samples collection and transportation procedures to an accredited laboratory must be according to NEA code of practice.
- iii. Submission of water testing report on basic water quality control parameters.
- iv. Submission of reports for Standard Plate Count (SPC) monthly and Legionella bacteria count quarterly accordingly to NEA's requirement.

