

COOLING TECHNOLOGY INSTITUTE

Recommended Guidelines for Corrosion Protection of Reinforced Concrete Mechanical and Natural Draft Cooling Towers



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and has been approved for publication by the CTI Board of Directors

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This guideline document summarizes the best current state of knowledge regarding the specific subject. This document represents a consensus of those individual members who have reviewed this document, its scope and provisions. It is intended to aid all users or potential users of cooling towers.

Approved by the CTI Executive Board.



This document has been revised and approved as part of CTI's Five Year review Cycle. This document is again subject to review in 2024.

Approved by the
CTI Executive Board

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1.0 INTRODUCTION

Protection of Cooling Tower assets should be the principal focus for all those responsible for the maintenance of critical cooling processes regardless of the industry. Concrete Cooling Towers are civil assets consisting typically of reinforced concrete that will generally be in contact with aggressive cooling fluids and potentially harsh environmental exposure conditions. These cooling fluids can include fresh water, salt water, waste water or a combination thereof with ambient service conditions ranging from tropical to sub-arctic climates. As such, prior to initiating a protective solution, it is important to understand the potential or current deterioration mechanisms present and how best to mitigate the damaging effects prior to implementing a specific protective strategy.

Although outside the scope of this document, many different strategies are available for the repair and restoration of reinforced concrete support structures and the reader is encouraged to reference CTI TOWER Guideline ESG-123 "Recommended Guidelines for Concrete Restoration & Repair to Natural & Mechanical Draft Cooling Towers". A recommended Reference exists that outlines reinforced concrete deterioration mechanisms, various protective strategies as well as additional cited references for specific site conditions. The reference is available from the American Concrete Institute (ACI) in their "Guide to Durable Concrete" as Reported by ACI Committee 201.

2.0 GLOSSARY OF TERMS

Anode: An anode is an electrode through which positive electric charge flows into a polarized electrical device. The flow of charge is an electric current.

Attenuation: Electrical losses in a conductor caused by current flow in the conductor.

Brackish Water: Brackish water or briny water is water that has more salinity than fresh water, but not as much as seawater. It may result from mixing of seawater with fresh water, as in estuaries, or it may occur in brackish fossil aquifers. Technically, brackish water contains between 0.5 and 30 grams of salt per liter—more often expressed as 0.5 to 30 parts per thousand (ppt or ‰), which is a specific gravity of between 1.005 and 1.010.

Carbonation: Carbonation is the result of the dissolution of CO₂ in the concrete pore fluid resulting in the creation of carbonic acid (H₂CO₃). This reacts with calcium from calcium hydroxide and calcium silicate hydrate to form calcite (CaCO₃). Carbonation has two effects: it increases mechanical strength of concrete, but it also decreases alkalinity, which is essential for corrosion prevention of the reinforcement steel. Below a pH of 10, the steel's thin layer of surface passivation dissolves and corrosion is promoted.

Cathode: A cathode is the electrode from which a conventional current leaves a polarized electrical device.

Cathodic Protection: A technique to reduce the corrosion of a metal surface by making that surface the cathode of an electrochemical cell.

Cover: In reinforced concrete the least distance between the surface of the reinforcement and the outside surface of the concrete.

Depolarization: The removal of factors resisting the current in an electrochemical cell.

Delamination: Failure of the concrete where the material separates in a layer above or below the plane of reinforcement.

Design Specifications: The drawings, specifications, documents and reference standards that define the scope of a project.

Drying Effect: Migration of water molecules away from the anode as a result of current flow (in relation to cathodic protection).

Electrical Continuity: A closed circuit (unbroken electrical path) between metal components under consideration.

Electrical Isolation: The condition of being electrically separated from other metallic structures or the environment.

Electrode: Electric conductor, usually metal, used as one of two terminals to conduct electric current through a conducting medium.

Electrode Potential: The potential of an electrode in an electrolyte as measured against a reference electrode.

Energizing: The process of initially applying power or establishing a connection(s) to a cathodic protection system.