For Distribution

ENGINEERING BULLETIN

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WHITE RUST

This engineering bulletin will address the issue of WHITE RUST, an undesirable surface condition that can develop on galvanized steel evaporative cooling equipment. WHITE RUST is a premature failure of the zinc layer on mill or hot dip galvanized steel. It develops because the galvanized steel has not been properly passivated before operation or after start up with water quality that promotes WHITE RUST.

The topics that will be covered in this bulletin:

1) Galvanized steel.
2) WHITE RUST's affect on evaporative cooling equipment constructed of galvanized steel.
3) How to prevent and control WHITE RUST.

Galvanized steel construction has proven to be the most effective and economic material of construction for evaporative cooling equipment and is EVAPCO's standard material of construction **(G-235 HMG or 2.35 oz/ zinc per square foot of Heavy Mill Galvanized Steel is used in addition to some HDG (Hot Dip Galvanized steel).**

Heavy mill galvanizing or HMG is the continuous application of zinc on sheet steel. This zinc application provides a *mechanically and chemically* bonded coating to the substrate steel which protects it from the environment. The permanent galvanized coating will not fall off after minimal use and will provide a long useful cooling tower life with proper water treatment.

In order for this zinc layer to protect the underlying steel, steel mills perform a chromate wash after processing. This chromate wash **passivates** the zinc coating and temporarily protects the steel during storage, unit construction and start-up. **Passivation** of galvanized steel is defined as allowing a "basic zinc carbonate" layer to form on the surface of the galvanized steel. The zinc carbonate layer protects the galvanized surface by sacrificing itself **slowly** over time.

Important Note: The mill applied passivation is only a temporary passivation program. The unit must be passivated during the start-up phase, and must be part of the water treatment program. Passivation of the galvanized steel surface is critical to prevent the formation of white rust and to extend the life of evaporative cooling equipment.

White rust is technically defined as "rapid formation of non-protective zinc carbonate cells on the surface of galvanized steel." These deposits appear as white powdery cells and are considered to be a zinc corrosion by-product. These cells are porous and allow continued corrosion of any

non-passivated galvanized surface. This type of corrosion is most prevalent in the wetted areas of the unit and is more likely with operation at a pH of 8.0 or greater.

There is a difference between the protective zinc carbonate formed during the passivation process and the rapid formation of non-protective zinc carbonate cells defined as White Rust found on non-passivated galvanized steel (See Photos 1 and 2 below).

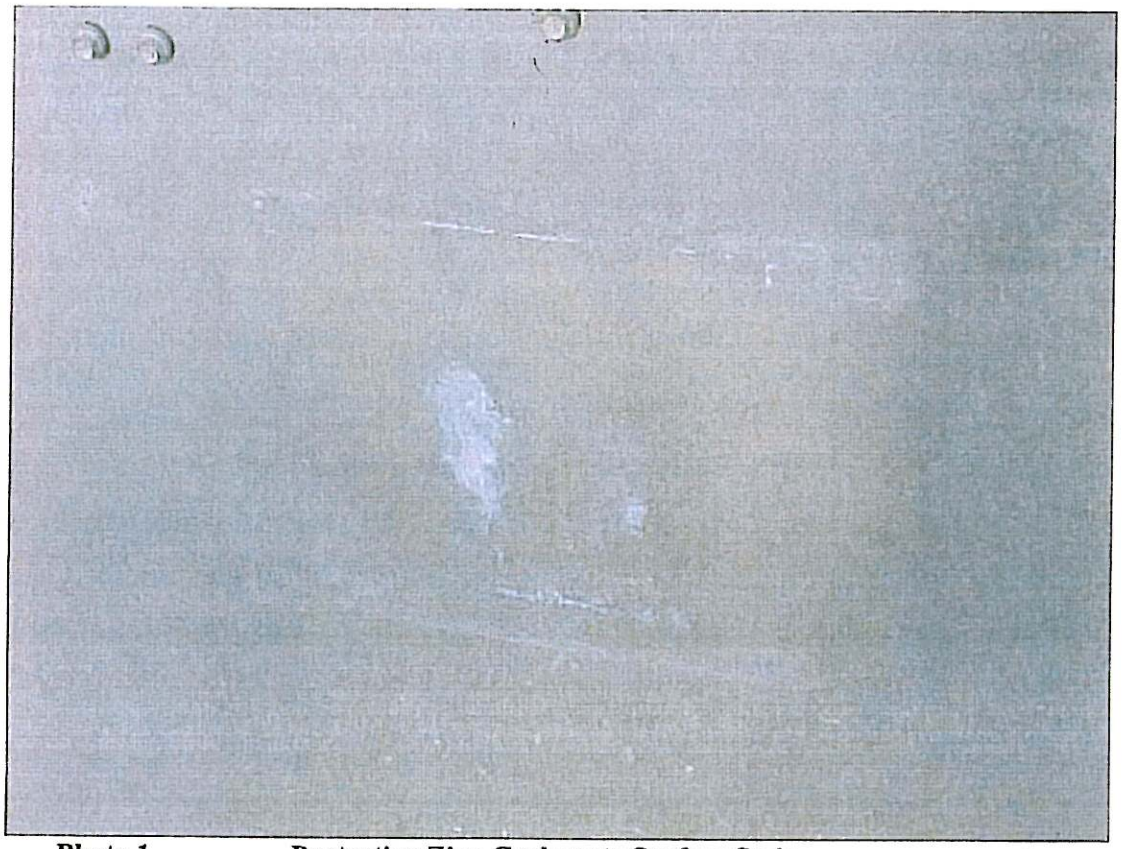

Photo 1 **Protective Zinc Carbonate Surface Stain**

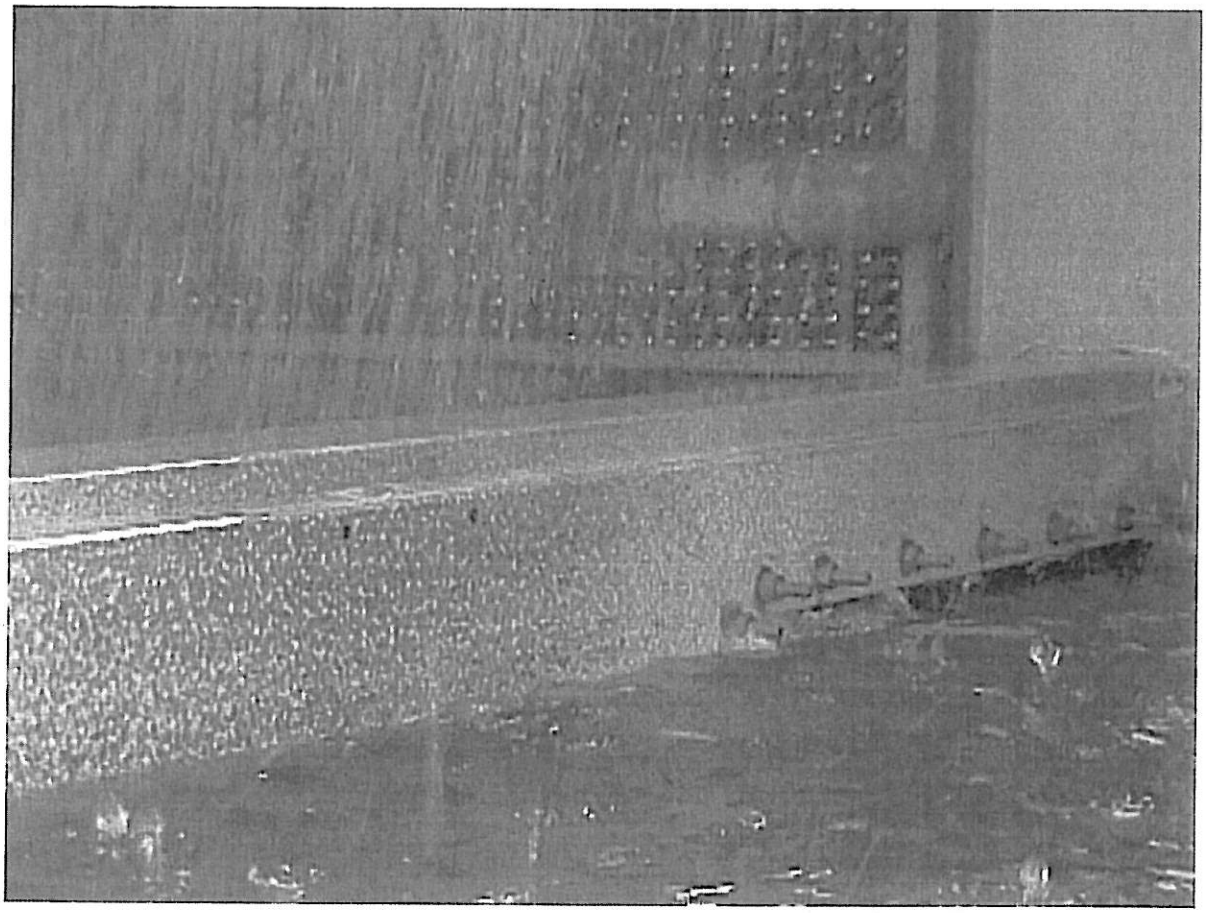

Photo 2 **White Rust Cells**

Passivation must be performed during the initial start up of the cooling tower, and may be required periodically throughout the life of the cooling tower. **Passivation** generally consists of a phosphate program and should be developed by the local water treatment company who is familiar with the local water quality.

The frequency of White Rust occurrences has increased as a result of changes to EPA guidelines which banned the use of **chromates** to passivate the outer layer of zinc on the galvanized steel.

Chromates have been banned in the water treatment industry since January 1990[2]. This chemical was extremely effective in providing a protective surface layer of Zinc Carbonate and Zinc Hydroxide on galvanized steel in the mill and during field start up water treatment programs. Since the ban, only phosphates are allowed in water treatment. Phosphates have not proven to be as effective in preventing white rust. Phosphates require a longer treatment program and frequent re-passivation if the water quality promotes white rust.
NOTE: White Rust is not a result of steel manufacturers providing lower grade steel or a change in the method of constructing evaporative cooling equipment.

The Cooling Technology Institute recommends the following WATER CHEMISTRY GUIDELINES and PASSIVATION PROGRAM in their "GUIDELINES FOR TREATMENT OF GALVANIZED COOLING TOWERS TO PREVENT WHITE RUST"[1]:

Water Chemistry that **prevents WHITE RUST:**

1. **A neutral pH between 7.0 to 8.0**
2. **Hardness of 100-300 ppm measured as CaCO3**
3. **Alkalinity of 100-300 ppm measured as CaCO3**

Water Chemistry that **promotes WHITE RUST:**

1. **pH levels less than 6.0 or greater than 9.0**
2. **Calcium hardness as CaCO3 less than 50 ppm**
3. **Anions of sulfates, chlorides and nitrates greater than 250 ppm**
4. **Soft water with calcium hardness (CaCO3) less than 50 ppm combined with a high alkalinity greater than 300 ppm (CaCO3) and a pH greater than 8.3.**

The Pre-Treatment Passivation Program at Start-Up:

Galvanized steel evaporative cooling equipment must be pre-treated with an inorganic phosphate passivation program at start-up to assist with the build up of the protective zinc-carbonate layer on galvanized steel.

The water treatment program shall be operated 45-60 days with the above **"Prevents White Rust"** water chemistry and an inorganic phosphate program of 100 ppm calcium as CaCO3 and 400-450 ppm PO4.

Procedure for White Rust Development after Start-up

The pre-treatment passivation program can be applied during the life of the cooling tower if white rust is detected some time after start-up. The tower should be inspected for white rust as recommended in our Operation and Maintenance Guidelines, Bulletin 112 and addressed if present. Follow this sequence of cleaning operations:

1) The water treatment company treating the equipment should be contacted to immediately begin the above recommended passivation program.

2) White rust deposits should be cautiously removed so that passivation layers are not disturbed. White rust can be removed using a soft bristle brush. Never use alkaline or acid cleaners. Do not pressure wash or use a wire brush to remove the deposits.

3) Areas that are cleaned of white rust deposits should be coated with a cold galvanizing compound.

4) Continue passivation program on a regular basis to prevent future white rust development.

EVAPCO recommends that the information presented in this engineering bulletin and the EVAPCO Operations and Maintenance Bulletin 112 is forwarded to the end-user and water treatment company before the equipment is installed. A water treatment program that includes passivation must be evaluated and set it place before start-up and during the operation of the equipment to reduce the chance of WHITE RUST formation.

References:

1. **Cooling Technology Institute-Guidelines for Treatment of Galvanized Cooling Towers to Prevent White Rust. Guide PFM 142 dated June 1994.**
2. **White Rust and Water Treatment-Garratt Callahan Company May 1997**