

Date: December 6, 2019
 To: Dr. Stuart Styles, ITRC Director
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 Subject: **ITRC Flap Gate Corrosion**

There have been reports of unexpected corrosion of hot-dipped galvanized ITRC flap gates in the field. There are several factors that can accelerate corrosion, as listed in Table 1.

Table 1. Factors affecting corrosion on some hot-dipped galvanized ITRC flap gates

Potential factors accelerating corrosion and pitting in submerged, hot-dip galvanized structures	Can be mitigated by the ITRC flap gate owner
Water chemistry – acids, alkalis, chlorides, and other aggressive constituents (e.g., fluorides) and elevated dissolved oxygen	
Galvanic corrosion between dissimilar metals where the galvanized flap gate is touching steel or other metals	X
Mechanically damaged (as opposed to chemically damaged) areas of protective galvanized coating	X
Lack of anodes protecting both the steel and zinc-based galvanizing coating	X

As shown in Table 1, there are three major factors that are both a potential cause of accelerated corrosion and can be potentially mitigated by the ITRC flap gate owner. As such, the following actions are recommended:

1. Clean and repair the damaged galvanized coating.
2. Install additional material to reduce:
 - a. further mechanical damage (rubbing)
 - b. unnecessary contact between dissimilar metals
3. Install anodes to protect both the underlying mild carbon steel structure and the zinc coating.

Details for each recommendation are provided in the remainder of this memo. Funding to develop this memo was provided by the United States Bureau of Reclamation California-Great Basin Region (USBR CGB).

Field Repair to Damaged Galvanized Coatings

Spray paint (CRC Bright Zinc-It; see Figure 1) with zinc dust can be used to repair damaged galvanizing. It is recommended that the ASTM Standard Practice A780 (2015) procedure outlined in this section be followed for such repairs. CRC Bright Zinc-It datasheets state that it is compliant with the requirements of ASTM A780.



Figure 1. CRC Bright Zinc-It

ASTM A780 guidelines, plus additional ITRC commentary and paint manufacturer information, are as follows:

1. Clean the damaged area using power tools (grinders/sanding discs) to bare metal.
2. Finish with a fine grit (120 grit or above) sanding disc until the metal is smooth and free of pitting.
3. Wipe the area with a rag and acetone to remove any grease, oils and other contaminants.
4. Spray or brush apply the paint containing zinc dust to the prepared area.
5. Apply the paint in a single application (single event) using multiple passes to achieve a dry film thickness of 2 mils. For reference, a typical 8.5" x 11" piece of 20lb bond paper (printer paper) is about 3.8 mils thick.
6. Apply all paint (single or multiple passes) for a given area within 20 minutes.
7. Allow 48 hours before handling the repaired area or reinstalling the gate.

Adding Material to the Flap Gate

As outlined below, it is anticipated that mechanical damage to the galvanized coating can be minimized by adding:

1. A soft gasket material between the gate and the static frame, otherwise referred to as "sealing" the gate. See the ITRC memo entitled ***ITRC Flap Gate Sealing*** for more details.
2. Abrasion-resistant material between the static frame and the structure slot holding the flap gate into position.

Adding Material Between the Frame and Slot

Step 1. Install the ITRC flap gate static frame in the slots, as if it were the final installation.

Step 2. Measure the available clearance (see Figure 2) between the gate and structural slot to select an appropriate rubber material thickness and avoid future installation issues (see Figure 2). When the flap gate is (or will be) installed in a concrete slot, it is important to measure the slot widths and depths at several locations because concrete slot dimensions are rarely uniform.

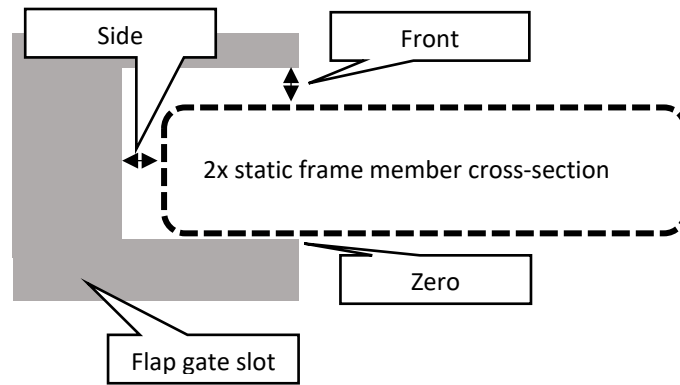


Figure 2. Key measurements and clearances needed prior to installing isolation material (plan view)

Step 3. Select EPDM rubber strip material thickness that will allow for at least a ¼" (0.25") of clearance between the slot and frame after the rubber strips are installed.

Step 4. Install material to isolate the gate frame from the slot and minimize damage to the galvanizing coating as shown in Figure 3.

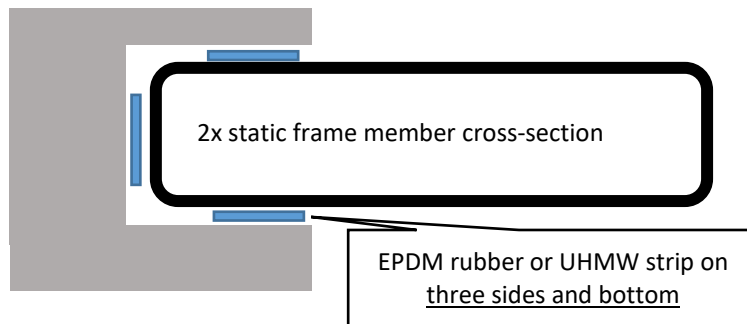


Figure 3. Isolation material placement between the static frame and the slot (plan view)

Rubber Strip Material

The rubber strip material shall be:

- 0.75" wide x 0.5" thick – cut to length
- Material: Neoprene, EPDM or equal
- Reinforcement: Not required, but may help extend the lifespan of the material

The rubber strip can be sourced from most local rubber supply companies. Two examples are:

Capital Rubber Corp
1725 19th St
Sacramento, CA 95811

California Industrial Rubber
2280 Cooper Ave
Merced, CA 95348

An alternative source of rubber strip material is McMaster-Carr (www.mcmaster.com) as part number 8990K14. That part number is for 2" x 36" EPDM rubber strips.

Adhesive Product

Several rubber supply companies have recommended 3M Scotch-Weld 1357 contact adhesive to bond the rubber strip to the c-channel. A picture of the product label is provided in Figure 4.



Figure 4. 3M Scotch-Weld 1357

Note, the material is considered hazardous and cannot be shipped using standard carriers in California. It may be best to find a local supplier for over-the-counter pickup. The product is available in several different sizes, including a 5-ounce tube and 1-pint or gallon cans.

Application and Use

- Step 1.** Move the materials to be bonded to a location with an ambient temperature of 65-120 degrees. Allow enough time for the materials to reach a similar, room temperature.
- Step 2.** Prepare the metal surface. Remove all dust, dirt, debris, oil and grease. Wipe the surface with a solvent such as Methy Ethyl Ketone (MEK).
- Step 3.** Stir or agitate the adhesive container well.
- Step 4.** Apply the adhesive to both surfaces using about 2.5-3.5 gm/ft². Brushes, rollers or knives can be used as application tools.
- Step 5.** Allow about 10-30 minutes for the adhesive to dry and become slightly tacky. If the adhesive becomes too dry, reapply an additional thin layer of adhesive.
- Step 6.** (Optional) Pre-assemble the two materials using spacers or dowls to aid in proper positioning of the two materials.
- Step 7.** Apply maximum body force with a 3-inch wide, firm roller for a good bond. Start in the center and work toward the edges.
- Step 8.** Excess adhesive can be cleaned off surfaces and tools using MEK or similar industrial solvents.

Refer to the 3M 1357 Technical Datasheets¹ (September 2016) for details.

Installing Sacrificial Anodes to Protect the Steel and Galvanizing Coating

As the name implies, sacrificial anodes are installed to provide corrosion protection of one material by sacrificing other material. The galvanizing coating used on some ITRC flap gates should inherently act as a sacrificial anode to the underlying mild steel flap gate structure. Regardless, reports from the field indicate that corrosion can still be a problem.

By adding magnesium sacrificial anodes to the hot-dipped galvanized ITRC flap gates, both the galvanizing coating and underlying mild steel structure should be protected from corrosion.

¹ <https://multimedia.3m.com/mws/media/661690/neoprene-hi-perf-contact-adhesive-1357-1357-l.pdf>

Key points:

1. Install the anode in a location that:
 - a. does not affect the performance of the flap gate
 - b. is almost always submerged in water (below the water line on the upstream side of the gate)
2. The anode can be bolted, riveted or otherwise mechanically fastened to the gate frame. Good contact between the anode and the frame is important.
3. Over time, anode material will be lost. Therefore, the anode will need to be replaced periodically.

Anodes are available through several online marine vendors. A blank 3-foot long by 1.75" thick magnesium bar can be found at: <https://www.boatzincs.com/MG-Strip-3.html>

The blank bar will need to be drilled to facilitate bolting or riveting for installation. A 12" long bar blank can be installed on one or both sides of the upstream static frame face, as shown in Figure 5.

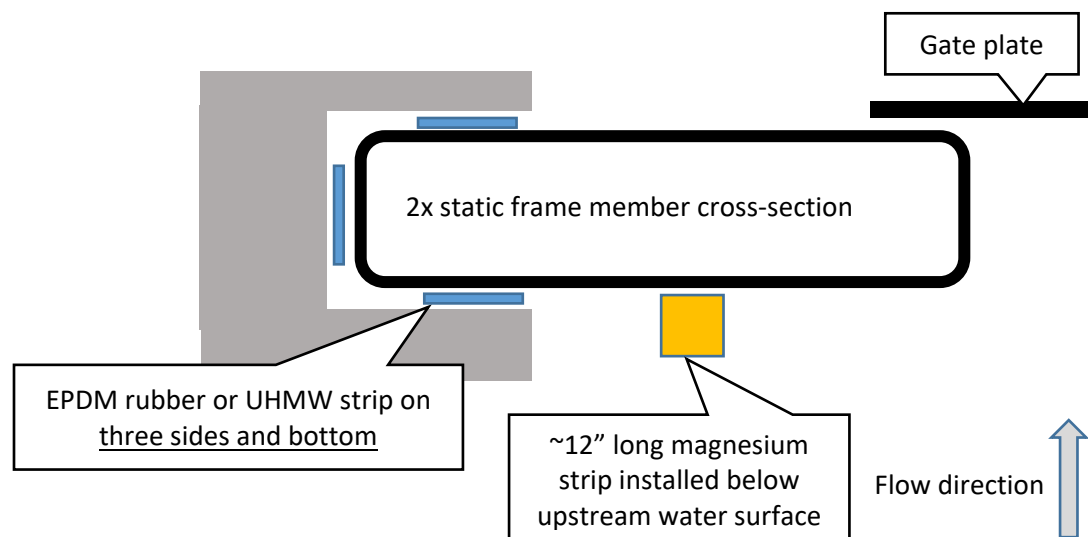


Figure 5. Gasket, isolation material and sacrificial magnesium anode installed on flap gate frame (plan view)