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MEMORANDUM

Date: December 6, 2019
To: Dr. Stuart Styles, ITRC Director
From: Kyle Feist, MS, P.E., ITRC Senior Engineer
**Subject: ITRC Flap Gate Sealing**

The standard ITRC flap gate design will leak when closed, as shown in Figure 1. Reducing leakage through the gate may be desired for some applications. This memo describes a method used at several irrigation districts for minimizing flap gate leakage when closed. Funding to develop this memo was provided by the United States Bureau of Reclamation California-Great Basin Region (USBR CGB).

**Figure 1. Galvanized "standard" flap gates without seals showing with some leakage at Chowchilla Water District, CA. It appears the gate on the left is operating and not fully closed, whereas the gate on the right seems to be fully closed.**

The sealing surface of interest is shown in Figure 2 and Figure 3.

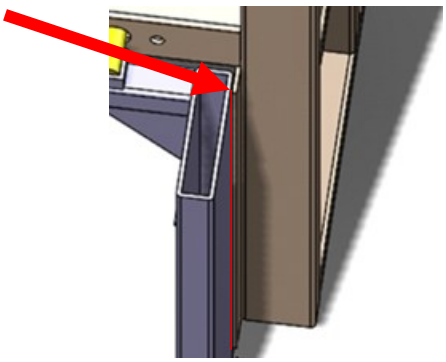

**Figure 2. The sealing material will be installed to reduce leakage at the gate/frame interface indicated in red**

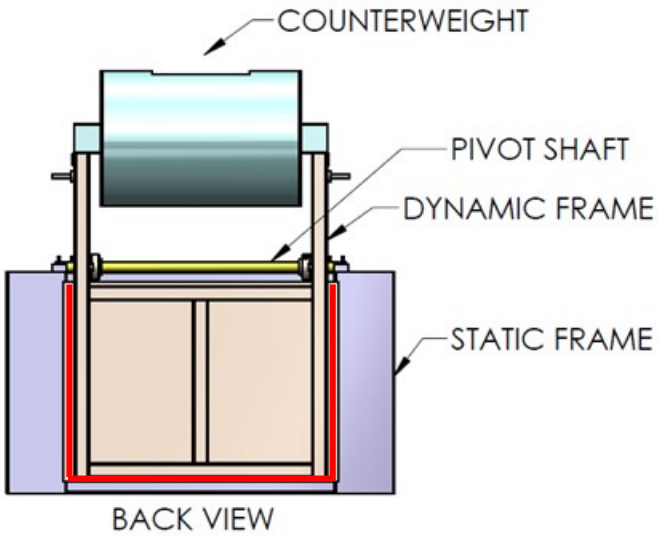


**Figure 3. The extent of the seals along the bottom and both sides of the flap gate opening**

## Seal Design Options

There are two sealing options:

**Design Option 1**. Installing a ½" thick EPDM rubber seal in a special steel c-channel welded to the gate frame during initial design and fabrication. Alternatively, an existing gate could be modified to accept these materials.

> *NOTE: This option has been successfully used within several California irrigation districts, including Henry Miller Reclamation District (HMRD) and Central California Irrigation District (CCID). District staff contributions to this memo is greatly appreciated.*

**Design Option 2**. Adding a thin seal to an existing "standard" ITRC flap gate (without seals) to avoid or minimize physical gate alterations after initial fabrication.

> *NOTE: ITRC is unaware if this option has been used in the field or how well it might perform over time. Consider this option a starting point for potential experimentation and proceed with caution.*

If minimizing leakage is important for the application, incorporating the seal during the initial design and fabrication process is recommended. It will be more difficult to add seals later.

### *Design Option 1*

Fully assembled cross-sectional and front view drawings are provided in Figure 4 and Figure 5.

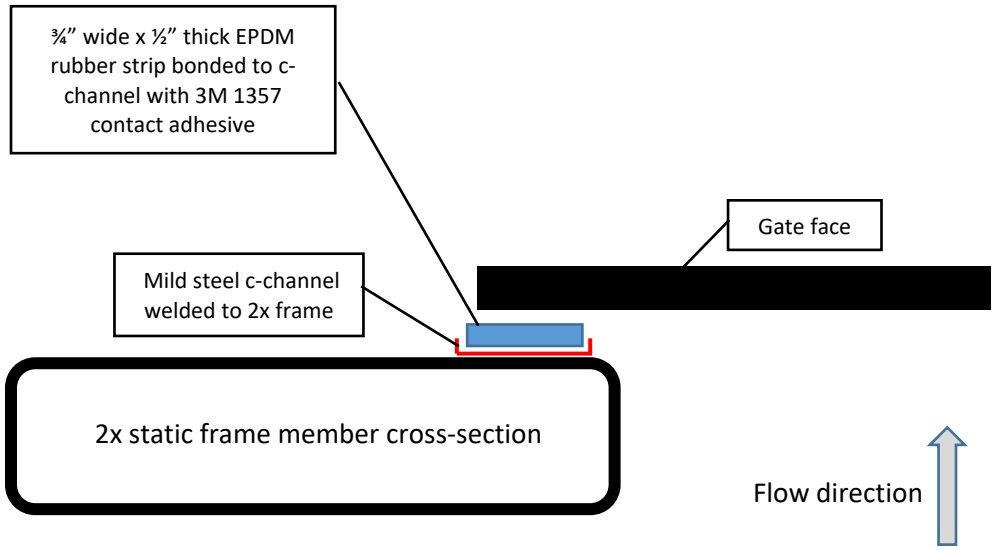


**Figure 4. Cross-section view of the final gate to frame gasket assembly (plan view)**

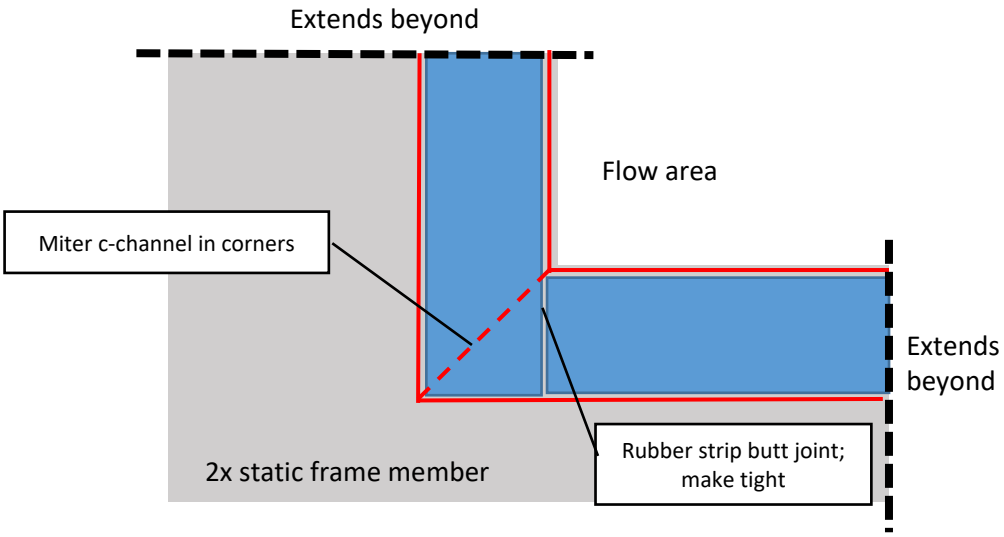


**Figure 5. Front view facing seal**

### C-Channel

The use of mild steel c-channel provides mechanical support to the ½" thick gasket. One option for the c-channel material is provided in Figure 6.

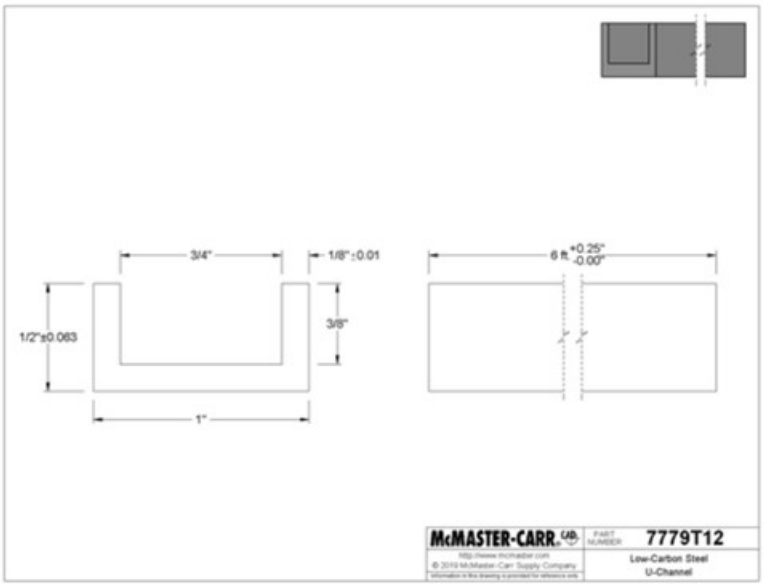


**Figure 6. Mild steel c-channel shop drawings (McMaster part number 7779T12 or equal)**

### Flap Gate Assembly/Fabrication

It is critical to test fit the rubber and c-channel prior to welding the shaft pockets to provide a tight and parallel interface between the gate and the rubber seal. Follow the directions in Figure 7.

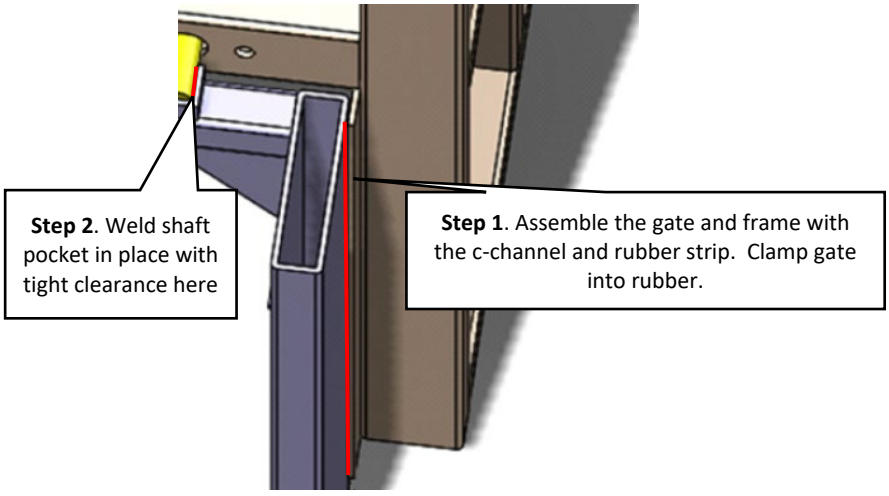


**Figure 7. Test fitting the seal and gate prior to welding the shaft pockets. Rubber strip and c-channel not shown.**

Additional material recommendations are provided in the following sections.

**Rubber Strip**

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

Prices can range from $3-$23 per lineal foot, depending on whether fiber reinforcement is provided. 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

**Adhesive**

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 8. 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/ft$^2$. 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 Datasheets[1] (September 2016) for details.

[1] https://multimedia.3m.com/mws/media/66169O/neoprene-hi-perf-contact-adhesive-1357-1357-l.pdf

## *Design Option 2*

Design Option 2 is provided for ITRC flap gate owners who are interested in adding seals to existing flap gates without significant modification (cutting, welding, etc.).

### Measuring the Available Gate-To-Frame Clearance

With the gate and frame assembled, check the clearances as illustrated in Figure 9.

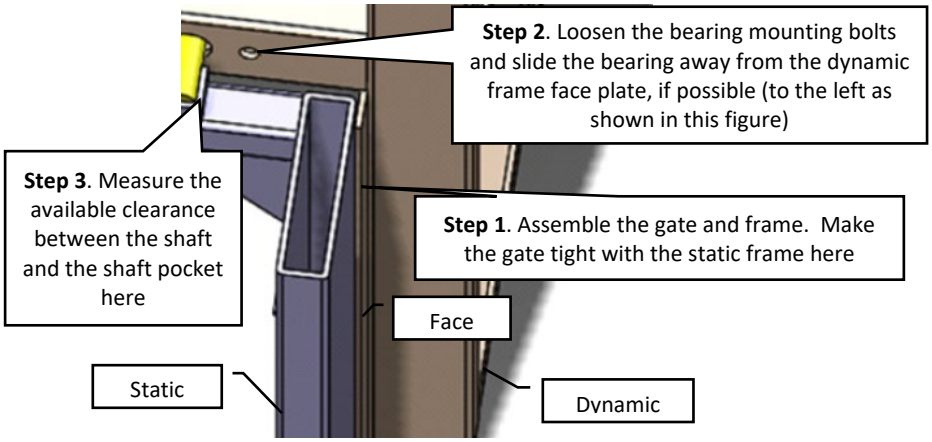


**Figure 9. Steps for measuring the existing gate-to-frame clearance**

The measurement will determine:

1. If there is enough clearance to install the seal without modifying the gate, or
2. The extent of the modifications needed to add a seal to the existing gate assembly. If there is no measurable clearance, there will be no room for a gasket unless the gate is modified by either grinding the shaft or moving the shaft pockets. To move the stake pockets, cut and remove the existing stake pockets and weld new stake pockets in the correct location.

If avoiding cutting and welding is desired, AND the gate-to-frame clearance is between 1/8" (0.125") to ½" (0.5"), a rubber strip can be added to the gate frame as shown in Figure 10.

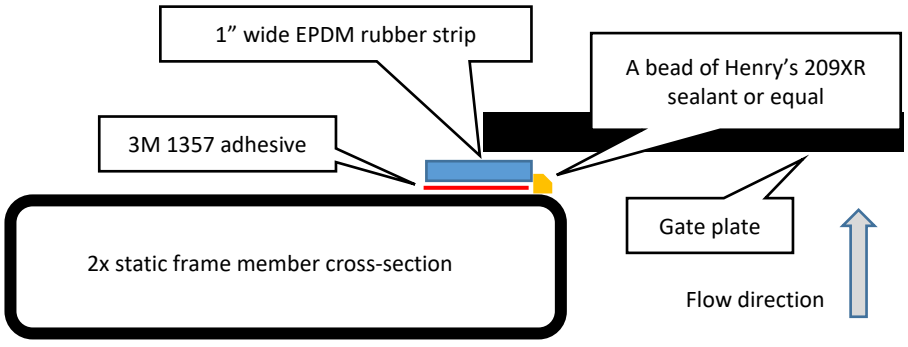


**Figure 10. Cross-section view of the final gate to frame gasket assembly (plan view)**

The thickness of the EPDM rubber strip, as shown in Figure 10, shall be equal to the gate-to-frame clearance plus 1/16" (0.0625").

**Between the Frame and Slot**

It is again important to measure the available clearance (see Figure 11) between the gate and structural slot to select an appropriate material size without causing future installation issues. In other words, if the material is too thick and there is insufficient clearance, reinstalling the gate frame into the slot will be difficult.

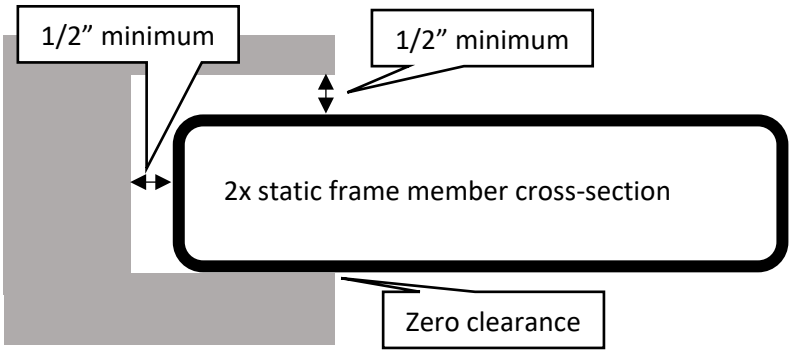


**Figure 11. Key measurements and clearances needed prior to installing isolation material (plan view)**

Assuming the minimum clearances are available, WRID can install material to isolate the gate frame from the slot and minimize damage to the galvanizing coating as shown in Figure 12.

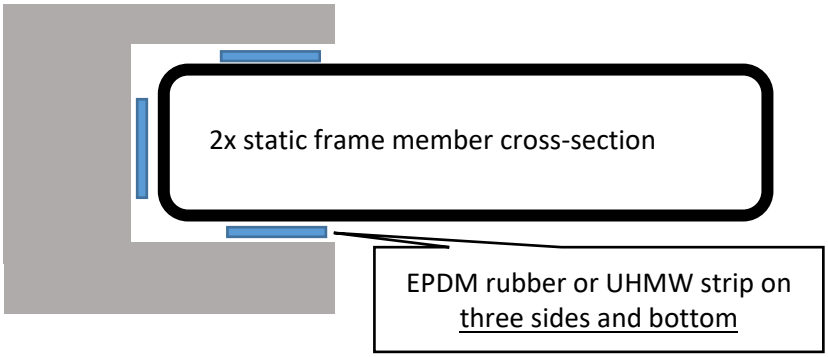


**Figure 12. Isolation material placement between the static frame and the slot (plan view)**

As shown in Figure 12, WRID can use EPDM rubber or ultra-high-molecular weight (UHMW) polyethylene strips. The EPDM rubber could be problematic during reinstallation because it is considered to have high friction. However, the UHMW material is similar to the material used for plastic cutting boards, which has low friction and excellent wear resistance. UHMW bars are also available through McMaster-Carr (www.mcmaster.com) as part number 8702K438. That part number is 1/8" thick by 1.5" wide UHMW bars.

The UHMW can be temporarily bonded for static frame reinstallation in the field with 3M VHB double-sided tape (https://www.3m.com/3M/en_US/vhb-tapes-us/). While the tape is unlikely to permanently bond the UHMW with a static gate frame, a permanent bond is unnecessary for the application.

## 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.

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.
3. If successful, 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

WRID will need to drill the blank bar 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 13.

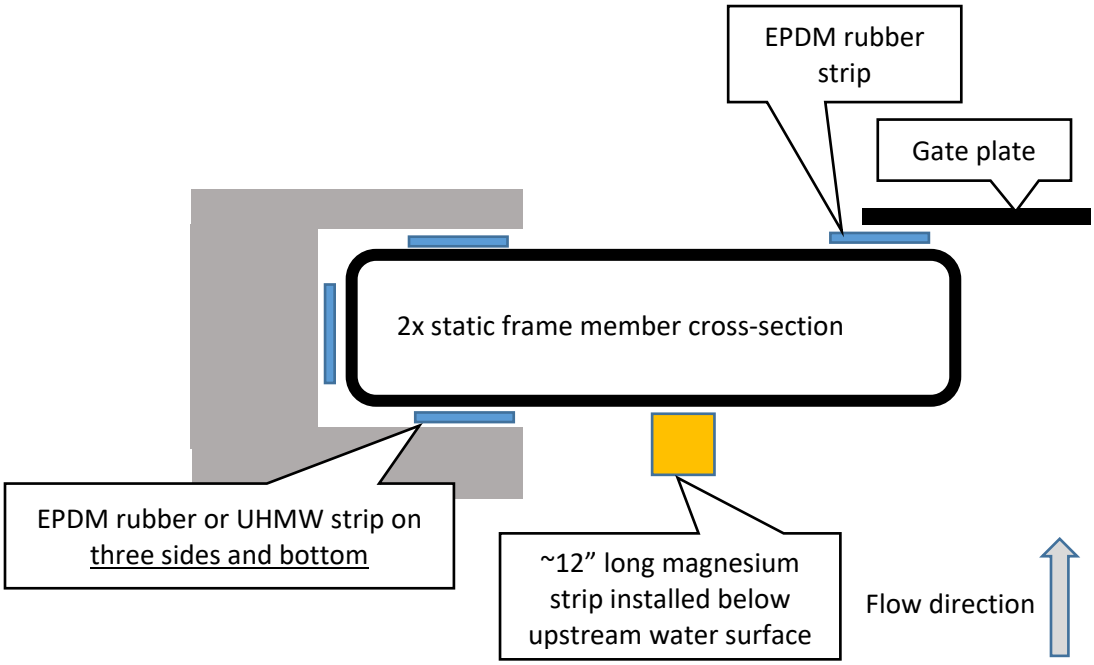


**Figure 13. Gasket, isolation material and sacrificial magnesium anode installed on flap gate frame (plan view)**