

## Western Water and Power Solution Bulletin

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### Improved Clamshell Gate Design

*New simplified design reduces leakage and improves discharge flow characteristics*

#### What Is The Problem?

The most significant problem with large, high-velocity gates (used on dams or large canals) is damage caused by a phenomenon known as cavitation. Cavitation occurs when extreme pressure differences cause formation and implosion of air bubbles. Other common problems include the inability to pass debris, inspection and maintenance difficulties, and high rates of head loss (drop in pressure). To overcome these issues, Reclamation engineers developed and patented the original clamshell gate design in the late 1970s. The first prototypes were installed in the early 1990s.

Although the original clamshell gate design significantly reduced or eliminated these problems, other issues with the original design became apparent during the fabrication, installation, and testing of the first prototype. These issues included undesirable discharge flow characteristics (water fanning out from the outlet), excessive leakage, and problems associated with adapting the gate control mechanism from the model to the full-size prototype.

#### What Is The Solution?

Engineers in Reclamation's Technical Service Center, Mechanical Equipment Group, have developed and patented an improved clamshell gate design. The new design includes a simplified and more efficient control mechanism, a more sophisticated sealing system, and a reconfigured portal shape that provides for better discharge characteristics.

The clamshell gate can be used on large or small flow outlet structures. It is an ideal solution for high-velocity conditions with either free or submerged discharge.



48-inch clamshell gate pre-installation.

#### Who Can Benefit?

The primary benefit provided by using a clamshell gate rather than another device for high-velocity discharge is that there is no cavitation damage potential. Repair and replacement costs associated with cavitation damage can be significant, and undetected cavitation damage can lead to catastrophic failure of conduits and structures. Other benefits include low head loss, the ability to pass debris, and good discharge characteristics.

#### Where Have We Applied This Solution?

Clamshell gates have been installed at Reclamation's Grassy Lake Dam (1991), Salt River Siphon Replacement—Evacuation Structure (1995), Syar Tunnel (1996), and Arrowrock Dam (2004).



48-inch clamshell gates installed at Arrowrock Dam.

#### Future Development Plans

Reclamation will continue to consider clamshell gate installation for new facilities and replacements of existing outlet works gates and valves, where they are a feasible option. Reclamation is also interested in partnering with a private industry entity to manufacture and commercialize clamshell gates. Interested parties should contact Reclamation to learn about required qualifications and explore partnership opportunities.

#### More Information

Test reports and other info on clamshell gates are available at:  
[http://www.usbr.gov/pmts/hydraulics\\_lab/pubs/R/R-90-16.pdf](http://www.usbr.gov/pmts/hydraulics_lab/pubs/R/R-90-16.pdf)  
[http://www.usbr.gov/pmts/hydraulics\\_lab/pubs/R/R-2001-02.pdf](http://www.usbr.gov/pmts/hydraulics_lab/pubs/R/R-2001-02.pdf)  
[http://www.usbr.gov/pmts/hydraulics\\_lab/accomplishments/arrowrock.html](http://www.usbr.gov/pmts/hydraulics_lab/accomplishments/arrowrock.html)

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#### Collaborators

Reclamation's Science and Technology Program, Mechanical Equipment Group, and Hydraulic Investigations and Laboratory Services