# PAP-1027

# Cylindrical Screen Performance Tests
# WTEV75

By

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# Background

The Hydraulics Investigations and Laboratory Services Group at the U.S. Bureau of Reclamation (Reclamation) in Denver Colorado was contracted to test the performance of a cylindrical fish screen for providing an effective positive barrier for fish exclusion. In this study an 18-inch diameter cylindrical screen with an internal tapered baffle (developed and funded by C.E. Toland & Son) was sent to Reclamation for testing and performance evaluation. The screen provided was nearly identical to the WT screen previously tested (transmittal date 4/9/10), however the collection header (baffle) was modified from its original design, to provide more open area near the leading edge of the screen. In addition the screen was further modified to provide greater headloss across the header. Both modifications were intended to provide more uniform distribution of approach velocities along the length of the screen. For the purposes of this report this screen configuration will be referenced as the WTEV75 cylindrical screen.

# The Model

The cylindrical screen was installed in an 8 ft deep by 4 ft wide by 85 ft long flume for testing. The screen was centered along the length of the flume and was mounted 18 inches above the flume floor supported by two mounting stands designed to minimize flow disturbance around the screen (Figure 1). The screen was located beside a clear plexiglass window to allow clear viewing during screen operation and was attached to a pipe leading to the suction side of a recirculating pump. The outer cylinder of the screen was 18 inches in diameter and was made up of perforated openings, 3/32 inch in diameter in a staggered hole pattern around the circumference of the screen. Inside the outer cylinder, the screen contained a tapered collection header designed with openings intended to provide a uniform intake flow distribution through all areas of the screen (proprietary). The collection header was also designed with an opening and an adjustable valve at the narrow end, so that flow intake near the leading edge of the screen could be adjusted. For the WTEV75 experiments, all tests were conducted with the end valve 100 percent open. In addition, as a result of previous experiments, 75 percent of the openings around the circumference of the header were blocked to produce greater headloss, thus forcing more flow to sweep toward the leading edge. To accomplish this, one row of openings around the circumference was left fully open followed by 3 rows of completely blocked holes. This pattern was repeated starting from the suction end and continuing along the full length of the collection header (figure 2).

Figure 1. WTEV75 Cylindrical screen inside test flume.

Flow into the flume and through the screen was controlled by adjusting control valves on pipes extending from the recirculating pump. Flow was set and measured using a Controlotron transit-time acoustic flow meter. The test set-up was designed so that once the flume was filled to a depth of 5 ft, all flow drawn through the screen was recirculated back into the flume. Only one screen intake flow condition, 5.0 $ft^3/s$, was tested for this configuration.

**Figure 2. Collection header – holes 75% blocked.**

Flow from the screen was split equally after exiting the pump, with half of the flow recirculated back into each end of the flume. Baffling panels, installed across the width of the flume at both ends, were used to still the flow before entering into the main channel to create reasonably uniform approach conditions. This set-up produced an average flume velocity of 0.20 ft/s approaching from each end of the screen for the 5.0 $ft^3/s$ test case.

Screen performance was evaluated by measuring approach velocities at a 3-in distance from the screen surface, as required to meet resource agency screen velocity criteria. Velocities were measured with a Sontek acoustic Doppler velocimeter (ADV probe) at 3-in. intervals at the top, left, and right center lines along the length of the screen, starting 1/2 inch from the leading edge, to determine the overall flow distribution.

In each test case, approach velocity is defined as the component perpendicular to the screen surface, and sweeping velocity is defined as the component parallel to the screen surface. In addition, positive approach velocities indicate flow is going into the screen, while positive sweeping velocities indicate flow is in the downstream direction toward the suction end of the screen. It is worth noting that because it is impossible to measure velocities over the entire screen control surface, the velocities measured at positions along the three centerlines cannot necessarily be extrapolated to represent total through-screen flow and to satisfy continuity. There may also be some flow recirculation that occurs between the outside cylinder and the collection header. However, although assessing the total through-screen flow is important information for the manufacturer and designer of the screen, it does not affect the screen's ability to meet required screen criteria.

# Testing and Results

Velocities were measured along the top, left, and right centerlines to determine performance of the WTEV75 configuration. Approach velocities for the three centerlines are shown in figure 3 and appear reasonably uniform although they are slightly higher near the suction end.

The overall trend or flow pattern of approach velocities remains consistent for all three centerlines and range from about 0.1 ft/s to 0.17 ft/s with an average approach velocity of about 0.12 ft/s. The black line represents the average velocity of all measurements (0.12 ft/s) and therefore represents the value if screen approach velocities were perfectly uniform. Actual percent deviation from the normalized value, for each data set, is shown in figure 4.

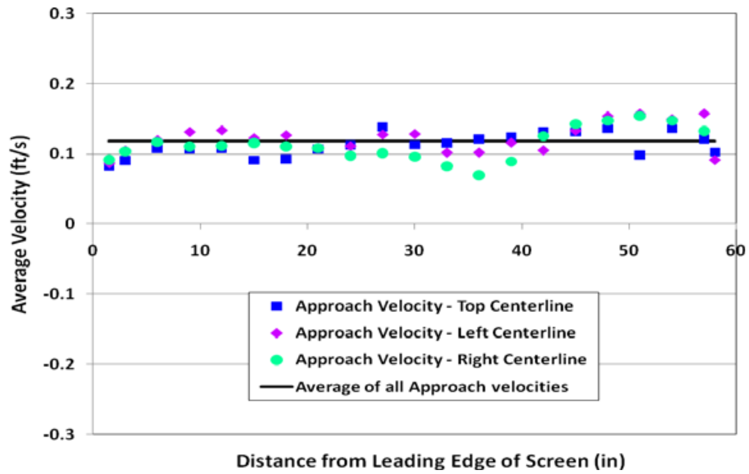


**Figure 3. Approach velocities measured 3 in from the screen face, along the top, left and right centerlines for the WTEV75 configuration.**

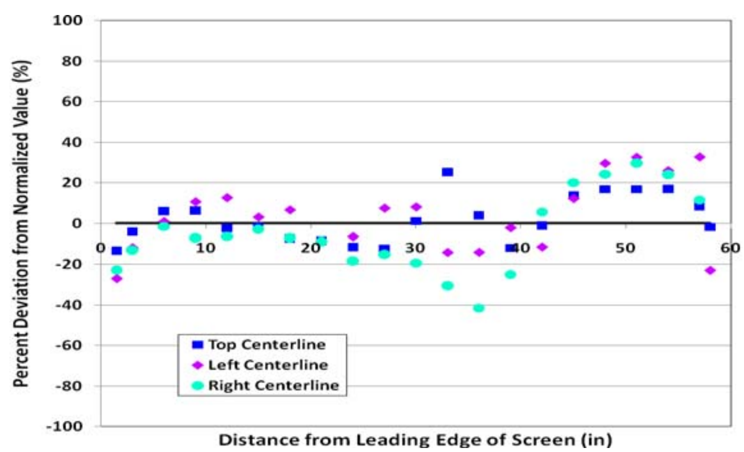


**Figure 4. Percent deviation from normalized value for the right, left and top centerline approach velocities – WTEV75 configuration.**

The approach velocities shown in figure 3 are also shown in figures 5 through7 with their corresponding sweeping velocities for each of the 3 centerlines. The sweeping component data shows a lot of scatter where flow coming from each direction comes together, causing some flow recirculation. The figures also demonstrate that by creating significant headloss along the length of the header, flow is forced to sweep toward the leading edge of the screen (as indicated by negative values), thus resulting in reasonable uniformity of approach velocities.

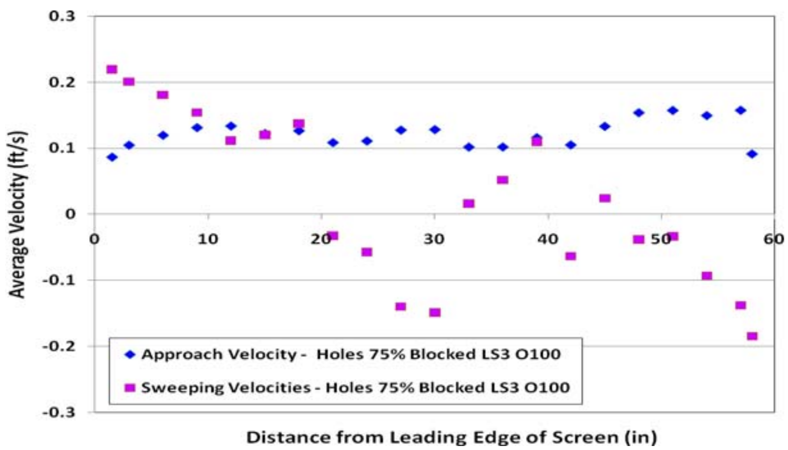


**Figure 5.** Approach and sweeping velocities measured 3 inches from the screen along the left side (LS3) **–** WTEV75 configuration.

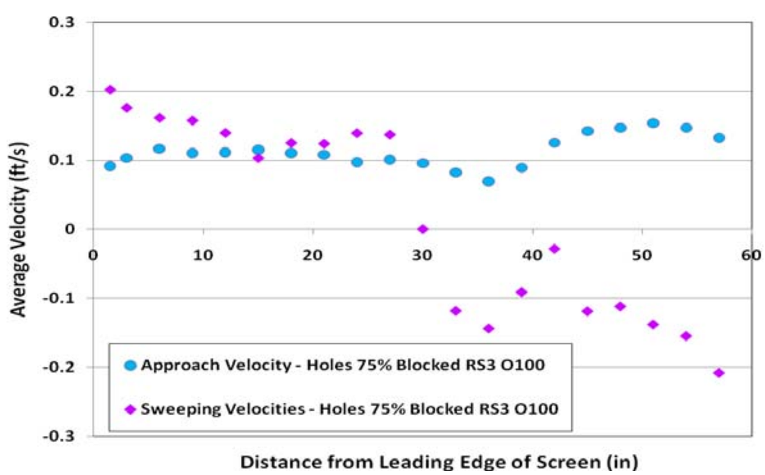


**Figure 6.** Approach and sweeping velocities measured 3 inches from the screen along the right side (RS3) centerline **–** WTEV75 configuration.

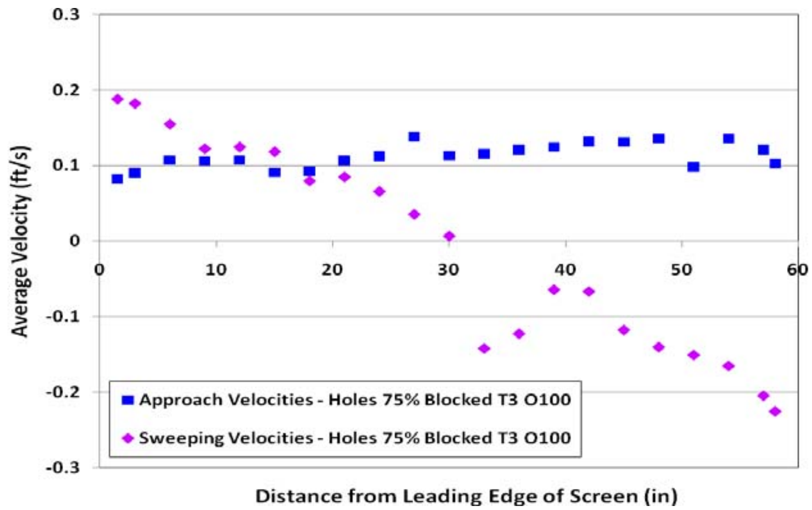


**Figure 7.** Approach and sweeping velocities measured 3 inches from the screen along the top (T3) centerline **–** WTEV75 configuration.

# Conclusions

The following conclusions were determined from the study:

- The modified screen design (WTEV75), shows reasonable uniformity in approach velocities ranging from about 0.1 ft/s to 0.17 ft/s, with an average approach velocity of about 0.12 ft/s. Therefore modifying the collection header as demonstrated here provides improved performance.

- Better distribution of openings along the length of the screen may also help to smooth data distribution.

The data provided here shows distribution of approach velocities and can be used as a basis to help modify the collection header design to produce desired performance.