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July 17, 2005

Peter K. Caldwell
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Reference: Performance Evaluation of DEL MAR "AquaMyzer" water conservation Inner Cap to ASME A112.19.6M and A112.19.2.
Subject: Laboratory evaluation and study, Report No. DEL072604R

Dear Mr. Caldwell:

We have completed our work evaluating hydraulic performance of closet equipped with DEL MAR "AquaMyzer" water conservation inner cap to ASME A112.19.6M and A112.19.2. We transfer our finding to you in the enclosed report.

Very truly yours,

Tsan-Liang Su, Ph.D.
Director, Laboratory Operations

HYDRAULIC PERFORMANCE OF CLOSET WITH DEL MAR "AQUAMYZER" WATER CONSERVATION FLUSH VALVE KIT

Final Summary Report

By

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REPORT NO. DEL072604R

July 5th, 2005

Prepared for

Del Mar Lighting, LLC
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Prepared by

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Hydraulic Performance of Closet with DEL MAR "AquaMyzer" Water Conservation Flush Valve Kit

INTRODUCTION

Stevens Institute of Technology, a private university dedicated to excellence in science and engineering, has acquired unique expertise in water supply and drainage systems for building. The Center for Environmental System (CES) is an EN ISO/ 17025 certified and independent research center under Stevens' organization. It provides a full range of environmental control solutions, chemical analysis services, testing of plumbing and mechanical products and water closet performance evaluation/ testing to industrial, engineering/ consulting and government clients throughout the world.

Del Mar Lighting, LLC has asked our center to assist them in the evaluation of hydraulic performance of Del Mar "AquaMyzer" low water consumption product. This report presents the finding of the work.

OBJECTIVE

There are large numbers of 3.5-gallon per flush (gpf) water closets equipped with Sloan or Zurn flush valves installed in commercial and public buildings, public facilities, public housing and dormitories. The DEL MAR "AquaMyzer" low water consumption device is designed to help water conservation by reducing the water volume per flush of water closets and urinals.

The purpose of this lab work is to determine the minimum level of water required by the 3.5 gpf water closet equipped with DEL MAR "AquaMyzer" Low Water Consumption Device in order to provide acceptable hydraulic performance level, defined by the ASME A112.19.6, Hydraulic Requirements for Water Closets and Urinals.

PRODUCT TESTED

The DEL MAR "AquaMyzer" flush valve kit which was evaluated includes a plastic 2.75 gpf or 2.50 gpf water conservation Inner Cap (Blue Cap and Red Cap, respectively) and a Sloan diaphragm flush valve replacement kit. All products were provide by DEL MAR Lighting, LLC.

REFERENCED STANDARD

ASME A112.19.2-2003, Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals

METHODOLOGY

The work plan includes three steps on the following,

Step 1: A ¾ inches and/or 1 inch inlet pipe was installed on a selected American Standard 3.5 gpf water closet with original Inner Cap (black). Evaluate for functional performance using the procedures outlined in the industry standard, ASME A112.19.6, Hydraulic Requirements for Water Closets and Urinals and their discharge curves acquired. Established baseline of water consumption for tested water closet

Step 2: Replace original 3.5 gpf Inner Cap (black) with DEL MAR "AquaMyzer" Low Water Consumption device, 2.75 gpf Blue Inner Cap and/or 2.50 gpf Red Inner Cap in the above tested water closet. Evaluate parameters of water consumption based on established baseline and find an optimum condition for the best of water saving.

Step 3: Adjust opening of flush valve resulted from Step 2 for each "AquaMyzer" device, Blue Inner Cap and Red Inner Cap, respectively. Evaluate for functional performance using the procedures outlined in ASME A112.19.6 standard.

PERFORMANCE TEST AND RESULTS

Water Consumption

Water closet was tested at the static pressure of 80 psi. The opening of valve was adjusted accordingly for ¾ inches inlet pipe and 1-inch inlet pipe. The flush release device was activated and held for 1 sec. The total flush volume after cessation of flow of the excess trap refill water (after-flow) was recorded.

There was good total flush volume; it saved 0.78 gallon or 23.93% of water for Blue Inner Cap and 0.97 gallon or 30.00% of water for Red Inner Cap. Based on the results, we chose a set of parameter for each size of inlet pipe and valve that saved at least 24% of water to evaluate the functional performance.

Functional Performance

Granule and Ball Test

The test media were (a) 65g (approximately 2,500 pieces) cylindrically shaped, high-density polyethylene (HDPE) granules of 0.150 ± 0.015 inch diameter, 0.105 ± 0.015 inch thickness, and an average bulk density of 58.7-59.3 lb/ft^3.
(b) 100 nylon balls, 0.25 ± 0.01 inch diameter, with an average bulk density of 71.8-74.3 lb/ft^3.

The granules were flushed once before beginning the test. The test media were added to water in the bowl. The actuator was tripped and held for 1 sec and released. After completion of this initial flush, the granules and balls remaining visible in the bowl were counted. For ¾" inlet pipe and flush valve, it showed up to 19 granules and 12 granules for

Blue cap and Red cap, respectively remaining in the bowl after flush. For 1" inlet pipe and valve, there were up to 9 granules remaining in the bowl for Red cap. Those findings were much less than 125 granules (5% of total granules used) per flush as requirement. Meanwhile, it showed great results on ball test for both ¾ " and 1" inlet pipe and valve with Blue or Red cap. There were nearly no Nylon balls remaining in the bowl after flush.

We conclude that the "AquaMyzer" passed the *Granule and Ball* performance test.

Surface Wash Test

The test medium was a wet-erase fine-point transparency marker. The color of the ink was red, which is contrasting to the color of the test bowl. The flushing surface of water closet was scrubbed clean to remove any buildup or deposits on the walls of the test bowl. Then, it was rinsed and dried. Draw a line around the circumference of the flushing surface of the test bowl at 1 inch below the rim jets of the bowl. Trip the actuator and hold it for 1 sec. After the flush cycle, the lengths of the unwashed line segments where the ink has remained were measured, and their approximate position in the bowl was observed and recorded. Repeat this procedure and three sets of data were obtained.

For total length segments, it measured average of 1.18 inches or less for both Blue and Red cap with either ¾" or 1" inlet pipe and valve. These total length remaining segments are much less than 2.0 inches, performance criteria of surface wash test.

It suggested that the AquaMyzer meets the requirement of surface wash section for functional test standards.

Dye Flushing Test

The dye solution was made of 5 grams of methylene blue powder with 1 liter of water and mixed thoroughly in a beaker. The clean bowl under test was flushed once and allowed to complete its filling cycle. A 30 ml of dye solution was added to the water in the bowl and mixed thoroughly. A 10 ml of this solution was removed from the bowl and was added to 1000 ml of distilled water in a beaker (i.e. dilution ratio of 100:1). A sample of the solution was set-aside in the vial as control sample. Then, the bowl was flushed several times to ensure that all trace of the dye solutions was removed. A 30 ml of the dye solution was added to the bowl. The actuator was tripped and held for 1 sec and released. A sample was collected after the bowl was complete the filling cycle. The absorbance of samples and control were measured by HP 8452A Diode-Array Spectrophotometer at 630 nm wavelengths.

The concentrations of methylene blue (i.e. dye solution) of all samples were much less. The more total flush volume was used per flush, the less concentration of methylene blue was measured. The remaining concentration of methylene blue also depends upon homogeneity of water in the bowl prior to be flushed. That is why we found the concentration of methylene of Red cap for ¾" inlet pipe is 0.75 ppb and 0.89 ppb for 1" inlet pipe even though the total flush volume of ¾" inlet pipe is slightly less than that of 1" inlet pipe. The dilution ratio of each condition is between 386 and 786.

It is clear that the AquaMyzer suppressed the minimum dilution ration of 100 as performance criteria.

CONCLUSION

More water is used in the bathroom than any other place in a building. Toilets account for 26.7% of all indoor water use, according to a 1999 study by the American Water Works Association Research Foundation. Simply changing water flush device can save thousands gallons of water per year.

It is clear that Del Mar "AquaMyzer" low water consumption device does save water with proper installation on existing toilets. It saved 24% of total flush volume of water for Blue Inner Cap and 30.00% for Red Inner Cap. Moreover, water closets under those conditions satisfied the performance criteria for *Granule and Ball Test*, *Surface Wash Test* , and *Dye Flushing Test* as set by ASME standards.

REFERENCE

ASME A112.19.6-1995, Hydraulic Requirements for Water Closets and Urinals

ASME A112.19.2-2003, Vitreous china Plumbing fixtures and Hydraulic Requirements for Water Closets and Urinals