THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

NSF International

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**POINT-OF-USE DRINKING WATER TREATMENT SYSTEM**	
APPLICATION:	**REMOVAL OF MICROBIAL CONTAMINATION AGENTS IN DRINKING WATER**	
PRODUCT NAME:	**SEARS KENMORE ULTRAFILTER 500**	
VENDOR:	**SEARS ROEBUCK, AND COMPANY**	
MANUFACTURER:	**ECOWATER SYSTEMS, INCORPORATED**	
ADDRESS:	**1890 WOODLANE DRIVE**	PHONE: **1-800-808-9899**
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NSF International (NSF) manages the Drinking Water Systems (DWS) Center under the U.S. Environmental Protection Agency's (EPA) Environmental Technology Verification (ETV) Program. The DWS Center recently evaluated the performance of the Sears Kenmore Ultrafilter 500 point-of-use (POU) reverse osmosis (RO) drinking water treatment system. NSF performed all of the testing activities and also authored the verification report and this verification statement. The verification report contains a comprehensive description of the test.

EPA created the ETV Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by accelerating the acceptance and use of improved and more cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the design, distribution, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations, stakeholder groups (consisting of buyers, vendor organizations, and permitters), and with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

ABSTRACT

The Sears Kenmore Ultrafilter 500 RO system was tested for removal of bacteria and viruses at NSF's Drinking Water Treatment Systems Laboratory. EcoWater Systems submitted ten units for testing, which were split into two groups of five. One group received 25 days of conditioning prior to challenge testing, while the second group was tested immediately. Both groups were identically challenged. The challenge organisms were the bacteriophage viruses fr, MS2, and Phi X 174, and the bacteria *Brevundimonas diminuta* and *Hydrogenophaga pseudoflava*. The test units were challenged at two different inlet pressures – 40 and 80 pounds per square inch, gauge (psig). The virus challenges were conducted at three different pH settings (6, 7.5, and 9) to assess whether pH influences the performance of the test units. The bacteria challenges were conducted only at pH 7.5.

The $\log_{10}$ reduction data is shown in Tables 2 through 5. The test units removed all challenge organisms to less-than-detectible levels in all challenges but the pH 9, 80 psig challenge. The data does not show whether conditioning, inlet pressure or pH influenced bacteria and virus removal.

TECHNOLOGY DESCRIPTION

The following technology description was provided by the manufacturer and has not been verified.

The Ultrafilter 500 is a three-stage POU drinking water treatment system. In addition to the RO membrane, the system employs carbon filtration. The first stage of treatment is carbon filtration to remove chlorine as well as suspended particles such as silt, dirt, and rust. The second stage is the RO membrane, which removes a wide variety of contaminants. The RO treated water is sent to the storage tank. When the user opens the faucet, the water leaves the storage tank and travels through a second carbon filter that removes any remaining tastes and odors before it is dispensed. The Ultrafilter 500 is designed to produce approximately five gallons of wastewater for every gallon of treated water.

The test units were evaluated without the carbon filters in place to eliminate the possibility that these filters could temporarily trap a portion of the challenge organisms, causing a positive bias of system performance.

VERIFICATION TESTING DESCRIPTION

Test Site

The testing site was the Drinking Water Treatment Systems Laboratory at NSF in Ann Arbor, Michigan. A description of the test apparatus can be found in the test/QA plan and verification report. The testing was conducted in January through March of 2004.

Methods and Procedures

The testing methods and procedures are detailed in the Test/QA Plan for Verification Testing of the Sears Kenmore Ultrafilter 500 Point-of-Use Drinking Water Treatment System for Removal of Microbial Contamination Agents. Ten Ultrafilter 500 systems were tested for bacteria and virus removal performance using the bacteriophage viruses fr, MS2, and Phi X 174, and the bacteria B. diminuta and H. pseudoflava. The challenge organisms were chosen because they are smaller than most other viruses and bacteria, and so provide a conservative estimate of performance.

The test units were randomly split into two groups of five. One group was conditioned for 25 days by operating the units daily using the test water without challenge organisms. The second group was

challenged without receiving the 25-day conditioning period. The test units were challenged at both 40 and 80 psig inlet pressure. The test water for the bacteria challenges was set to pH 7.5 ± 0.5, while the virus challenges were conducted at pH 6.0 ± 0.5, 7.5 ± 0.5, and 9.0 ± 0.5. The challenge schedule is shown in Table 1. The different challenge conditions were intended to evaluate whether inlet pressure or pH influenced bacteria and virus removal. However, the test water chemistry gave it little buffering capacity, which made it difficult to keep the pH below 6.5 for the pH 6.0 virus challenges. As a result, the pH was above 6.5 for three of the four pH 6.0 virus challenges.

Table 1. Challenge Schedule

Day	Surrogate Challenge	pH	Inlet Pressure (psig)
1	*H. pseudoflava*	7.5 ± 0.5	40 ± 3
2	*H. pseudoflava*	7.5 ± 0.5	80 ± 3
3	*B. diminuta*	7.5 ± 0.5	40 ± 3
4	*B. diminuta*	7.5 ± 0.5	80 ± 3
5	All Viruses	*6.0 ± 0.5	40 ± 3
6	All Viruses	*6.0 ± 0.5	80 ± 3
7	All Viruses	7.5 ± 0.5	40 ± 3
8	All Viruses	7.5 ± 0.5	80 ± 3
9	All Viruses	9.0 ± 0.5	40 ± 3
10	All Viruses	9.0 ± 0.5	80 ± 3

*actual pH ranged from 6.7 – 6.9 in three of four days.

On each challenge day, the test units were operated for one tank-fill period (approximately two hours). The end of this period was evident through engagement of each system's automatic shutoff mechanism, which causes the flow of reject water to cease. Influent water samples were collected at the beginning and end of each challenge period. After each test unit ceased operation, the entire contents of the product water storage tank were emptied into a sterile container, and a subsample was collected for microbiological analysis. All samples were enumerated in triplicate. Following each challenge period, the test units were flushed by operating them for one tank-fill period using the test water without challenge organisms.

VERIFICATION OF PERFORMANCE

Tables 2 and 3 show the bacteria reduction data for the unconditioned units and conditioned units, respectively. In all challenges for both sets of test units, the bacteria were removed to less than detectible levels (< 1 CFU/100mL). The predominance of non-detectable results does not allow any evaluation of whether conditioning, inlet pressure or pH influenced the bacteria reduction performance of the RO membranes.

Tables 4 and 5 show the virus reduction data for the unconditioned units and conditioned units, respectively. In all challenges but the pH 9, 80 psig challenge, both sets of test units removed all three viruses to less than detectible levels (< 1 PFU/mL). The maximum mean effluent count for the pH 9, 80 psig challenges was 11 PFU/mL, which corresponds to the 3.0 $\log_{10}$ reduction of fr for unconditioned unit 3. As with the bacteria, the predominance of non-detectable results does not allow an evaluation of the effect of conditioning, inlet pressure, or pH on RO membrane performance. Complete descriptions of the verification testing results are included in the verification report.

Table 2. Bacteria Log Reduction Data for Unconditioned Units

pH	Pressure (psig)	Challenge Organisms	Log_{10} Influent Challenge	Log_{10} Reduction Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
7.5	40	*H. pseudoflava*	6.6	All effluents non-detect				
		B. diminuta	6.4	Log reductions equal to influents				
7.5	80	*H. pseudoflava*	6.0	All effluents non-detect				
		B. diminuta	6.6	Log reductions equal to influents				

Table 3. Bacteria Log Reduction Data for Conditioned Units

pH	Pressure (psig)	Challenge Organisms	Log_{10} Influent Challenge	Log_{10} Reduction Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
7.5	40	*H. pseudoflava*	6.6	All effluents non-detect				
		B. diminuta	7.1	Log reductions equal to influents				
7.5	80	*H. pseudoflava*	6.0	All effluents non-detect				
		B. diminuta	6.8	Log reductions equal to influents				

Table 4. Virus Log_{10} Reduction Data for Unconditioned Units

Challenge Conditions					Log_{10} Reduction				
Target pH	Measured pH	Pressure (psig)	Challenge Organisms	Log_{10} Influent Challenge	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
6.0 ± 0.5	6.86	40	fr	5.0	All effluents non-detect				
			MS2	4.8	Log reductions equal to influents				
			Phi X 174	4.5					
6.0 ± 0.5	6.88	80	fr	5.4	All effluents non-detect				
			MS2	5.2	Log reductions equal to influents				
			Phi X 174	4.0					
7.5 ± 0.5	7.69	40	fr	4.3	All effluents non-detect				
			MS2	5.0	Log reductions equal to influents				
			Phi X 174	5.3					
7.5 ± 0.5	7.91	80	fr	4.0	All effluents non-detect				
			MS2	4.9	Log reductions equal to influents				
			Phi X 174	4.4					
9.0 ± 0.5	8.71	40	fr	5.3	All effluents non-detect				
			MS2	5.1	Log reductions equal to influents				
			Phi X 174	4.4					
9.0 ± 0.5	8.67	80	fr	4.1	3.8	3.6	3.0	4.1	4.1
			MS2	3.9	3.9	3.6	2.9	3.9	3.9
			Phi X 174	3.7	3.7	3.7	3.7	3.7	3.7

Table 5. Virus Log_{10} Reduction Data for Conditioned Units

Challenge Conditions					Log_{10} Reduction				
Target pH	Measured pH	Pressure (psig)	Challenge Organisms	Log_{10} Influent Challenge	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
6.0 ± 0.5	6.48	40	fr	4.8	All effluents non-detect Log reductions equal to influents				
			MS2	4.5					
			Phi X 174	3.8					
6.0 ± 0.5	6.69	80	fr	4.5	All effluents non-detect Log reductions equal to influents				
			MS2	4.4					
			Phi X 174	4.2					
7.5 ± 0.5	7.45	40	fr	5.3	All effluents non-detect Log reductions equal to influents				
			MS2	5.0					
			Phi X 174	4.3					
7.5 ± 0.5	7.56	80	fr	4.9	All effluents non-detect Log reductions equal to influents				
			MS2	4.7					
			Phi X 174	3.9					
9.0 ± 0.5	8.73	40	fr	5.6	All effluents non-detect Log reductions equal to influents				
			MS2	5.4					
			Phi X 174	3.8					
9.0 ± 0.5	8.73	80	fr	5.1	5.1	4.6	5.1	5.1	5.1
			MS2	4.8	4.5	4.3	4.8	4.8	4.5
			Phi X 174	4.5	4.5	4.5	4.5	4.5	4.5

Quality Assurance/Quality Control (QA/QC)

NSF provided technical and quality assurance oversight of the verification testing as described in the verification report, including an audit of nearly 100% of the data. NSF personnel also conducted a technical systems audit during testing to ensure the testing was in compliance with the test plan. A complete description of the QA/QC procedures is provided in the verification report.

Orginal signed by
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Availability of Supporting Documents

Copies of the test protocol, the verification statement, and the verification report (NSF report # NSF 04/14/EPADWCTR) are available from the following sources:

(NOTE: Appendices are not included in the verification report. Appendices are available from NSF upon request.)

1. ETV Drinking Water Systems Center Manager (order hard copy)
   NSF International
   P.O. Box 130140
   Ann Arbor, Michigan 48113-0140
2. NSF web site: http://www.nsf.org/etv (electronic copy)
3. EPA web site: http://www.epa.gov/etv (electronic copy