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 CHEMICAL CONTAMINANTS IN DRINKING WATER**
PRODUCT NAME:	**WATTS PREMIER WP-4V**
COMPANY:	**WATTS PREMIER, INC.**
ADDRESS:	**1725 WEST WILLIAMS DR.**
	SUITE C-20
	PHOENIX, AZ 85027
PHONE:	**800-752-5582**

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 Watts Premier WP-4V point-of-use (POU) 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 Watts Premier WP-4V POU drinking water treatment system was tested for removal of aldicarb, benzene, cadmium, carbofuran, cesium, chloroform, dichlorvos, dicrotophos, fenamiphos, mercury, mevinphos, oxamyl, strontium, and strychnine. The WP-4V employs a reverse osmosis (RO) membrane, a sediment filter, and activated carbon filters to treat drinking water. The system was first tested with only the RO membrane component in place. The target challenge concentration for each chemical for the RO membrane tests was 1 mg/L. Following the RO membrane challenges, the post-membrane carbon filter component was challenged alone with each chemical the RO membrane did not remove to below 30 µg/L. Based on this criterion, the carbon filter was challenged with benzene, chloroform and mercury. The target challenge concentration for the carbon filter tests was the maximum effluent level measured during the RO membrane tests.

A total of 20 RO membrane components were tested, divided into ten pairs. Only one pair of membranes was tested for removal of each chemical. Each RO membrane chemical challenge was conducted over a one-day period. Influent and effluent samples were collected during the operation period, and also the next morning. The post-membrane carbon filter challenges were conducted over a 15-hour duration. Two filters were tested for each chemical challenge, and each pair was only used for one challenge. Influent and effluent samples were collected at the beginning, middle, and end of the challenge period.

The WP-4V as a whole, considering both the RO membrane challenge and post-membrane carbon filter challenge results combined, reduced all of the challenge chemicals 98% or more.

TECHNOLOGY DESCRIPTION

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

The WP-4V is a four-stage POU drinking water treatment system, using sediment filtration, activated carbon filtration, and reverse osmosis. Treated water is stored in a three-gallon storage tank. The WP-4V is certified by NSF to NSF/ANSI Standard 58 – *Reverse Osmosis Drinking Water Treatment Systems*. It has a certified production rate of 9.06 gallons per day.

Incoming water first passes through a sediment filter to remove particulate matter, such as rust and silt, and then through a carbon filter to remove chlorine or other contaminants. The third stage of treatment is the reverse osmosis membrane, which removes a wide variety of inorganic and larger molecular weight organic contaminants, and also protozoan cysts such as cryptosporidium and Giardia. The permeate water is sent to a 3-gallon maximum capacity storage tank. Upon leaving the storage tank, the water passes through a second carbon filter to remove organic chemicals and other taste and odor causing substances before dispensing through the faucet. The pre-membrane carbon and sediment filters were not tested, because they are only designed to remove chlorine and particulate matter to protect the RO membrane.

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 November 2004 through March 2005.

Methods and Procedures

Verification testing followed the procedures and methods detailed in the *Test/QA Plan for Verification Testing of the Watts Premier WP-4V Point-of-Use Drinking Water Treatment System for Removal of Chemical Contamination Agents*. Because any contamination event would likely be short-lived, the challenge period for each chemical lasted only one day. Long-term performance over the life of the membrane was not evaluated.

The system was first tested with only the RO membrane component in place. A total of 20 RO membranes were challenged with the chemicals in Table 1. The target challenge concentration for each chemical was 1 mg/L. The 20 membrane test units were divided into ten pairs. One pair of systems was tested for removal of each chemical. The reduction of TDS was also measured during the challenges to evaluate whether any organic chemicals damaged the membrane material or membrane seals.

Table 1. Challenge Chemicals

Organic Chemicals	Inorganic Chemicals
Aldicarb	Cadmium Chloride
Benzene	Cesium Chloride (nonradioactive isotope)
Carbofuran	Mercuric Chloride
Chloroform	Strontium Chloride (nonradioactive isotope)
Dicrotophos	
Dichlorvos	
Fenamiphos	
Mevinphos	
Oxamyl	
Strychnine	

Each RO membrane chemical challenge was conducted over a one-day period. The systems were operated for six tank-fill periods, and then were allowed to rest overnight. Influent and effluent samples were collected at start-up, after the 3rd tank fill, after 15 hours of operation, and the next morning after the membranes rested under pressure overnight. During the chloroform, dichlorvos, and fenamiphos challenges, the systems were still in operation for the 3rd tank fill at 15 hours, so the 3rd tank-fill samples were not collected.

Following the RO membrane challenges, the post-membrane carbon filters were challenged with the chemicals that the RO membranes did not remove to below 30 μg/L. The filters were attached to a separate manifold that was of the same design as the manifold in the full RO system. Two carbon filters were tested for each chemical challenge, and each filter was only used for one challenge. The target challenge concentrations were the maximum effluent levels measured during the RO membrane tests.

Prior to testing, each carbon filter was service-conditioned by feeding water containing chloroform to simulate the possible contaminant loading on the carbon halfway through the filter's effective lifespan.

The post-membrane carbon filter challenges were 15 hours in duration. Influent and effluent samples were collected at the beginning, middle, and end of the challenge period. The carbon filters were operated at 0.3 gallons per minute on an operating cycle where the "on" portion was 19 minutes (the time required to empty the system storage tank when full), and the "off" portion was 3 hours and 45 minutes (the time required to fill the storage tank).

VERIFICATION OF PERFORMANCE

The results of the RO membrane challenges are presented in Table 2. The RO membrane treatment process removed 98% or more of all challenge chemicals but mercury, benzene, and chloroform. The membranes removed 44% of mercury, 85% of benzene, and 84% of the chloroform challenge.

The TDS reduction by each membrane component for all challenge tests was 95% or higher. The TDS reduction data does not indicate that any of the membranes or membrane seals were adversely affected by exposure to the challenge chemicals.

The post-membrane carbon filter components were challenged with benzene, chloroform, and mercury.

Table 2. RO Membrane Challenge Data

Chemical	Mean Influent (µg/L)	Mean Effluent (µg/L)	Percent Reduction (%)
Cadmium	910	0.4	> 99
Cesium	660	11	99
Mercury	1200	670	44
Strontium	920	1	> 99
Aldicarb	1100	10	> 99
Benzene	1100	160	85
Carbofuran	1100	5	> 99
Chloroform	1100	180	84
Dichlorvos	560	10	98
Dicrotophos	840	10	99
Fenamiphos	1200	11	> 99
Mevinphos	1200	16	99
Oxamyl	1100	4	> 99
Strychnine	1000	6	> 99

The carbon challenge results are shown below in Table 3. The carbon filter removed 98% or more of all three substances. The RO membrane and carbon challenge data combined shows that the two treatment technologies working in concert within the WP-4V system removed 98% or more of all challenge chemicals.

Complete descriptions of the verification testing results are included in the verification report.

Table 3. Post-Membrane Carbon Filter Challenge Data

Chemical	Target Influent[(1)] (µg/L)	Measured Mean Influent (µg/L)	Mean Effluent (µg/L)	Percent Reduction (%)
Benzene	290	300	0.5	> 99
Chloroform	300	300	ND (0.5)	> 99
Mercury	740	760	12	98

(1) Target influent level set at maximum single effluent level from RO challenge.

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

NSF ETV and QA staff monitored the testing activities to ensure that the testing was in compliance with the test plan. NSF also conducted a data quality audit of 100% of the data. Please see the verification report referenced below for more QA/QC information.

Original signed by Andrew Avel *01/18/06*	*Original signed by Robert Ferguson 01/24/06*
Andrew P. Avel Date	Robert Ferguson Date
Acting Director	Vice President
National Homeland Security Research Center	Water Systems
United States Environmental Protection Agency	NSF International

NOTICE: Verifications are based on an evaluation of technology performance under specific, predetermined criteria and the appropriate quality assurance procedures. EPA and NSF make no expressed or implied warranties as to the performance of the technology and do not certify that a technology will always operate as verified. The end-user is solely responsible for complying with any and all applicable federal, state, and local requirements. Mention of corporate names, trade names, or commercial products does not constitute endorsement or recommendation for use of specific products. This report is not an NSF Certification of the specific product mentioned herein.

Availability of Supporting Documents

Copies of the test protocol, the verification statement, and the verification report (NSF report # NSF 04/12c/EPADWCTR) are available from the following sources:
(NOTE: Not all of the appendices are included in the verification report. The 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/dws/dws_reports.html, and from http://www.nsf.org/etv/dws/dws_project_documents.html (electronic copy)
   EPA web site: http://www.epa.gov/etv (electronic copy)