THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

NSF International

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**BAG FILTRAION USED IN DRINKING WATER TREATMENT SYSTEMS**	
APPLICATION:	**REMOVAL OF *GIARDIA*- AND *CRYPTOSPORIDIUM*-SIZED PARTICLES IN DRINKING WATER**	
TECHNOLOGY NAME:	**AQUA-RITE POTABLE WATER FILTRATION SYSTEM**	
COMPANY:	**LAPOINT INDUSTRIES**	
ADDRESS:	**48 COMMERCIAL STREET** **LEWISTON, ME 04240**	PHONE: **(207) 777-3100** FAX: **(207) 777-3177**
WEB SITE: EMAIL:	**www.lapointindustries.com** **dmosley@lapointindustries.com**	

The U.S. Environmental Protection Agency (EPA) has created the Environmental Technology Verification (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 substantially 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; stakeholders groups which consist 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.

NSF International (NSF) in cooperation with the EPA operates the Drinking Water Treatment Systems (DWTS) Pilot, one of 12 technology areas under ETV. The DWTS Pilot recently evaluated the performance of a bag filtration system used in package drinking water treatment system applications. This verification statement provides a summary of the test results for the Lapoint Industries Aqua-Rite Potable Water Filtration System. Gannett Fleming, an NSF-qualified field testing organization (FTO), performed the verification testing.

ABSTRACT

Verification testing of the Lapoint Industries Aqua-Rite Potable Water Filtration System was conducted from April of 2000 to January of 2001. The treatment system consisted of a prefilter and a bag filter connected in series. The treatment system underwent microsphere removal challenge testing at 0% headloss of the bag filter, at 50% headloss of the bag filter and at greater than 90% headloss of the bag filter. The microsphere challenges utilized microspheres of 3.7µm and 6.0µm size, which were selected due to their similarity in size to *Cryptosporidium* oocysts and *Giardia* cysts, respectively. The treatment system demonstrated a 3.2 $\log_{10}$ removal of the 3.7 µm microspheres and a 3.5 $\log_{10}$ removal of the 6.0µm microspheres during the 0% headloss challenge. The system demonstrated 1.9 $\log_{10}$ removal of the 3.7µm microspheres and a 2.4 $\log_{10}$ removal of the 6.0µm microspheres during the 50% headloss challenge. The system demonstrated 2.2 $\log_{10}$ removal of the 3.7µm microspheres and a 2.6 $\log_{10}$ removal of the 6.0µm microspheres during the greater 90% headloss challenge. Source water characteristics were: turbidity average 0.75 Nephlometric Turbidity Units (NTU), pH 7.1, and temperature 12.1^{o}C. During the verification test, the system was operated at a flow rate of 20.69 gallon per minute (gpm). Each bag filter was operated to the 25 pounds per square inch (psi) of headloss and filtered on average 92,900 gallons. At approximately 20 gpm, each filter bag was in service for an average of 98 hours before changeout was required. Filter changeout was done manually and took approximately five minutes to complete. A total of eight bag filters and three prefilters were used during the testing.

TECHNOLOGY DESCRIPTION

Bag filtration is generally used for the removal of particulate material from ground water or high quality surface waters with turbidity less than or equal to 1 NTU that do not contain fine colloidal clays or algae. The Aqua-rite Potable Water Filtration System consisted of a prefilter mounted in a pressure vessel and a bag filter mounted in a pressure vessel. A bag filter is defined as a non-rigid, disposable, fabric filter in which flow generally is from the inside of bag to the outside. The filter bags are contained within pressure vessels designed to facilitate rapid change of the filter bags when the filtration capacity has been used up. The Aqua-Rite Potable Water Filtration System does not employ any chemical coagulation. The pretreatment employed consists of prefiltration. The manufacturer reports that the pore sizes in the filter bags designed for protozoa removal are generally small enough to remove protozoan cysts and oocysts but large enough that bacteria, viruses and fine colloidal clays would pass through.

The treatment system required a pressurized stream of feed water. Water passes first through the prefilter, which removes larger particulate material. This serves to exclude the larger debris from the feed water, which would tend to clog the finer pored bag filter and cause premature clogging of the bag. After prefiltration, the water passes through the bag filter itself where the finer particulate is removed.

VERIFICATION TESTING DESCRIPTION

Test Site

The verification testing site was Burnside Borough's water system chlorination station located in the Borough of Burnside, Clearfield County, Pennsylvania. The chlorination building is located on Cemetery Road approximately 1 ¼ mile west of U.S. Route 219. The Aqua-Rite Filtration System was installed in the basement of the Burnside Borough's chlorination building.

The source water for the verification testing was from the water system's 208,000 gallon in-ground covered reservoir located approximately 100 feet in elevation and about one-half mile away from the chlorination building, which housed the treatment unit. The reservoir is primarily supplied by a natural spring identified as Spring No. 1 via gravity feed. Spring No. 2, a secondary supply that must be pumped up to the reservoir, was used on 208 days in 1999. A third spring, Chura Spring, flows into Spring No. 2.

There is a well that supplements the production of the springs at the reservoir site. It is used only on an as needed basis when the production from the springs is inadequate to meet system demand.

Methods and Procedures

All field analyses (i.e. pH, turbidity and temperature) were conducted daily using portable field equipment according to Standard Methods for the Examination of Water and Waste Water, 18th Ed., (APHA, et. al., 1992). Likewise, Standard Methods, 19th Ed., (APHA, 1995) were used for analyses conducted by CWM laboratory. These analyses included total alkalinity, total hardness, iron, manganese, total organic carbon (TOC), algae (number and species), and total coliform, Total alkalinity, total hardness, total coliform and TOC analyses were conducted monthly. Iron and manganese analyses were conducted twice during the verification testing. Algae analyses were conducted weekly.

Microsphere removal challenge testing was performed using fluorescent microspheres of 3.7µm and 6.0µm size. These sizes were selected due to their similarity in size to *Cryptosporidium* oocysts and *Giardia* cysts respectively. There were four separate challenges conducted. The first challenge was conducted at 0% of the terminal headloss of the bag filter the second and third challenges were done at approximately 50% of the terminal headloss of the bag filter, and the last challenge was conducted at greater than 90% of the terminal headloss of the bag filter. The seeding, sampling, and analyses were conducted using methods as outlined in the Protocol for Equipment Verification Testing for the Physical Removal of Microbiological and Particulate Contaminants (EPA/NSF, 1999). The microspheres were added to 500 ml of deionized water to which 0.01% of Tween 20 had been added. This suspension was constantly mixed and added as a slug dose to the treatment system using diaphragm pumps. The pumps were operated at about 250 ml per minute and were capable of overcoming the pressure in the feed water line of the pilot unit. Samples of the filtrate were collected into five gallon containers at a flow rate 10% of the system flow. A total of 20 gallons was collected and shipped to the laboratory for analysis. In addition, aliquots of the stock suspension and the feed water were collected and analyzed to calculate concentrations of the microspheres in the feed water. The two 50% headloss challenges included a stop and start of the treatment system to simulate conditions likely to occur during normal operation of the system.

VERIFICATION OF PERFORMANCE

System Operation

The treatment system was capable of normal operations without manual intervention. All operational data, flows, pressures, turbidity and particle counts were recorded on data logging software that was not provided as part of the treatment system. Manual intervention was required only to change out the spent prefilters and bag filters. Daily site visits were conducted to record the operational data, make adjustments as necessary to maintain the desired flow, and to conduct the required daily onsite testing and sample collection.

The average feed water flow rate during the ETV study was 20.69 gallon per minute (gpm) and ranged from 22.04 gpm to 18.12 gpm. The average bag filter effluent flow rate was 20.01 gpm and ranged from 21.19 gpm to 17.45 gpm. The difference between the feed water flow and the bag filter effluent flow was due to samples being drawn off for the online analytical equipment. The flow rate was recorded twice per day.

Headloss through the system was calculated from inlet and outlet pressure readings taken from the prefilter and bag filter. According to the manufacturer, maximum headloss permissible for the prefilter and the bag filter was 25 psi for each unit. Changeout of the prefilter and bag filter was conducted according to these criteria. On average, the bag filter produced 92,900 gallons of effluent for every bag filter used. The maximum amount of effluent produced with one bag filter was 237,600 gallons; the minimum effluent produced was 26,700 gallons. The reason for the differences in effluent production per bag filter is unknown but most likely relates to feed water quality. The average run time per bag filter was 98 hours. The maximum run time for a bag filter was 164 hours; the minimum run time was 24 hours. A total of eight bag filters were used during the testing. A total of three prefilters were used during the testing.

Water Quality Results

The initial evaluation of the treatment system involved a verification of consistent performance of bag filters from the same and from different production lots. This evaluation consisted of quantifying the rate of headloss development, turbidity and particle removal for bags from the same and different lots. Analysis of the collected data indicated that there was not a significant difference in bag filter performance for bag filters from the same and different lots.

The average effluent turbidities as measured by the online turbidimeters during the 10 day variability testing of filters from the same lot were 0.35, 0.30, and 0.30 NTU in housings #1, #2, and #3, respectively. The average effluent cumulative particle counts (>2 µm) during the 10 day variability testing of filters from the same lot were 15.09, 15.99, and 18.21 total counts per ml in housings #1, #2, and #3, respectively.

The average effluent turbidities as measured by the online turbidimeters during the 10 day variability testing of filters from three different lots were 0.85, 0.70, and 0.70 NTU in housings #1, #2, and #3, respectively. The average effluent cumulative particle counts (>2 µm) during the 10 day variability testing of filters from three different lots were 25.16, 25.62, and 31.39 total counts per ml in housings #1, #2, and #3, respectively.

The treatment system underwent microsphere challenge testing four times during the verification testing. During the 0% bag filter headloss microsphere challenge testing the system demonstrated a 3.2 $\log_{10}$ removal of the 3.7 µm microspheres and a 3.5 $\log_{10}$ removal of the 6.0µm microspheres. During the first 50% bag filter headloss microsphere challenge testing the system demonstrated a 1.9 $\log_{10}$ removal of the 3.7 µm microspheres and a 2.5 $\log_{10}$ removal of the 6.0µm microspheres. During the second 50% bag filter headloss microsphere challenge testing the system demonstrated a 1.9 $\log_{10}$ removal of the 3.7 µm microspheres and a 2.4 $\log_{10}$ removal of the 6.0µm microspheres. During the 90% bag filter headloss microsphere challenge testing the system demonstrated a 2.2 $\log_{10}$ removal of the 3.7 µm microspheres and a 2.6 $\log_{10}$ removal of the 6.0µm microspheres.

During the verification testing the Aqua-Rite Potable Water Filtration System samples of the feed water and bag filter effluent were tested for total alkalinity, total hardness, total coliform, iron, manganese, total organic carbon (TOC), and algae concentrations. No significant reductions were seen in total alkalinity, total hardness, iron, manganese or TOC. This was not unexpected since these constituents tend to be present in water in a soluble state and would not be removed by the straining process used by the bag filter. No reduction was seen in the presence of total coliform in the feed and filtered water. Although coliform bacteria are by their nature not soluble in water the small size of the organism would render it capable of passing through the bag filter unimpeded. Algae concentrations were reduced through the treatment system although given the low levels of algae in the feed water the difference between the feed water and bag filter effluent concentrations was not statistically significant.

The average turbidity concentration in the feed water was 0.75 NTU and 0.15 NTU in the bag filter effluent. Particle counts were reduced from an average of 451.017 total counts/ml (2-200µm) in the feed water to an average 21.518 total counts/ml (2-200 µm) in the bag filter effluent.

Temperature of the feed water during the verification testing was quite stable. The average temperature of the feed water was 12.2°C, and ranged from 11.0°C to 13.5°C.

The following table presents the results of the water quality testing of the feed water and filtered water samples collected during the verification testing:

Feed Water Quality / Filtered Water Quality
Lapoint Industries Aqua-Rite Potable Water Filtration System

	Total Alkalinity (mg/l)	Total Hardness (mg/l)	Total Coliforms (cfu/100 ml)	Iron (mg/l)	Manganese (mg/l)	TOC (mg/l)	Algae (cells/ml)	Benchtop Turbidity (NTU)	Particle Counts (particles/ml)
Average[1]	71/66	79/72	POS/POS	<0.05/ <0.05	0.028/ 0.029	<2.0/<2.0	1/<1	0.80/0.15	451/ 21.2
Minimum[1]	N/A	N/A	N/A	<0.05/ <0.05	0.021/ 0.022	N/A	<1/<1	0.50/0.05	123/0.450
Maximum[1]	N/A	N/A	N/A	<0.05/ <0.05	0.035/ 0.035	N/A	1/<1	1.2/0.50	1305/499
Std. Dev. [1]	N/A	N/A	N/A	N/A	N/A	N/A	1/NA*	0.20/0.10	----
95% Confidence Interval[1]	N/A	N/A	N/A	N/A	N/A	N/A	(<1,1)/ (N/A*)	(0.70, 0.80)/ (0.15, 0.20)	----

1 – Concentration of feed water/concentration of filtered water.
N/A = Not Applicable due to limited number of samples
N/A* = Not Applicable standard deviation = 0
---- = Statistical measurements on cumulative data not calculated.

Operation and Maintenance Results

Given the nature of the treatment system the maintenance requirements were minimal. Replacement of the prefilter and bag filter are the only major maintenance tasks required for operation. Care during the installation of new prefilter or bag filters should be exercised to assure that none of the components are damaged. Protection of the O-rings used to seal the system will minimize the need to replace these items.

The Operating and Maintenance (O&M) Manual provided by Lapoint outlined the procedures to be followed when relieving system pressure and installing new prefilters or bag filters. The manual was adequate although no trouble shooting procedures were provided to aid the operator in identifying possible causes rapid headloss increases, high filtrate turbidity, or other water quality or operational difficulties. Procedures to identify a mis-installation of the bag filter were not included.

Original Signed by
E. Timothy Oppelt *9/20/01*

E. Timothy Oppelt Date
Director
National Risk Management Research Laboratory
Office of Research and Development
United States Environmental Protection Agency

Original Signed by
Gordon Bellen *9/22/01*

Gordon Bellen Date
Vice President
Federal Programs
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 a NSF Certification of the specific product mentioned herein.

Availability of Supporting Documents

Copies of the *ETV Protocol for Equipment Verification Testing for Physical removal of Microbiological and Particulate Contaminants* dated May 14, 1999, the Verification Statement, and the Verification Report (NSF Report #01/24/EPADW395) are available from the following sources:

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

1. Drinking Water Systems ETV Pilot 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)