CERTIFICATE

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Document Name: WQA S-400: Point-of-Use Distillation Drinking Water Systems

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APPROVED

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THE EXECUTIVE DIRECTOR
OFFICE OF THE FEDERAL REGISTER
WASHINGTON, D.C.

S-400-86

FOR POINT-OF-USE DISTILLATION DRINKING WATER SYSTEMS

A Voluntary Industry Standard

Water Quality Association®

WATER QUALITY ASSOCIATION

A not-for-profit international trade association representing firms and individuals engaged in the design, manufacture, production, distribution and sale of equipment, products, supplies and services for providing quality water for specific uses in residential, commercial, industrial and institutional establishments. Membership is voluntary.

One of the basic purposes of WQA is to promote the acceptance and use of industry equipment, products, and services. Activities, programs and services are designed to enable the industry to perform with the greatest economy and efficiency and to provide the greatest service to the public. The benefits of this shared experience accrue to all, and might otherwise be unobtainable.

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VOLUNTARY INDUSTRY STANDARD FOR POINT-OF-USE DISTILLATION DRINKING WATER SYSTEMS

SECTION 1. GENERAL

1.1 The point-of-use systems covered by this voluntary Standard use a process that consists of evaporation and condensation of water as the principal method to enhance the quality of water obtained from public or private drinking water supplies. It is recognized that these systems, which reduce the total dissolved solids concentration and other identifiable contaminants, may also include other types of treatment to further enhance the quality of the final water. This Standard establishes the minimum requirements for Distillation Systems in the reduction of total dissolved solids. The focus of this Standard is to determine the performance of Distillation Systems in reducing the concentration of total dissolved solids and, where so claimed by the manufacturer, in reducing the concentration of other non-organic contaminants. This Standard should not be interpreted to limit system or performance quality in any way.

1.2 This Standard relates to the physical integrity and performance of systems which improve the quality of water.

1.3 Electrical standards are not addressed in this Standard inasmuch as nationally recognized standards for electrical safety exist.

1.4 This Standard is intended to be used in the verification of contaminant removal claims by the individual manufacturer.

1.5 This Standard is not intended to be used in the verification of claims for improvement of taste, odor, and color, although these properties are often improved by distillation systems.

1.6 Many on-site conditions that could affect service life are beyond control of the system manufacturer. Therefore, this Standard is not intended to be used to verify service life claims.

1.7 Many on-site conditions that could affect product performance also are beyond the control of the system manufacturer. Therefore, the performance claims verifiable under this Standard are minimum performance claims that may be used only as a basis for comparison of contaminant removal capabilities of similar products under identical conditions.

SECTION 2. DEFINITIONS

ACCESSIBLE: Exposable for proper and thorough cleaning and inspection with the use of only simple tools, such as a screwdriver, pliers, or open-end wrench.

READILY ACCESSIBLE: Exposed or easily exposed without the use of tools for proper and thorough cleaning and visual inspection.

CHALLENGE WATER: Water specially prepared for Standard tests.

CONDENSING: To change a gas or vapor to a liquid.

CONTAMINANT: Any undesirable physical, chemical, or microbiological substance or matter in water.

CORROSION RESISTANT MATERIAL: A material which maintains its original surface characteristics under prolonged exposure to the intended use environment and does not contribute unacceptable amounts of substances into the water.

CYCLE: The period of operation of a manual distiller between a normal start with a properly filled evaporating chamber and the normal automatic cutoff of operation.

DISPOSABLE COMPONENT: A component that requires periodic replacement as defined by the manufacturer.

DISTILLATION: A process that consists of vaporizing water and condensing it to a liquid product.

DISTILLED WATER: Water delivered from the system to user. (Terms used synonymously: drinking water, product water, distillate.)

DRINKING WATER: Water which is intended for human consumption. (Terms used synonymously: product water, distilled water, distillate.)

EVAPORATING CHAMBER: A part of a distillation system in which the process of changing a liquid into a vapor is accomplished.

FEED WATER: The solution that enters the system.

MCL: Abbreviation for Maximum Contaminant Level: the maximum allowable concentration of a contaminant in water as established in the U.S. EPA Drinking Water Regulations.

POINT-OF-USE: A system or device that may be used on the user's premises to improve the quality of a water supply.

PRODUCT WATER: Water delivered from the system to user. (Terms used synonymously: drinking water, distilled water, distillate.)

PRODUCTION RATE: The quantity of water produced by the system per unit of time.

QUALIFICATION TEST: Tests and verifications performed to validate conformance to this Standard.

REMOVABLE: Capable of being taken away from the unit with the use of only simple tools, such as a screwdriver, pliers, or open-end wrench.

READILY (OR EASILY) REMOVABLE: Capable of being taken away from the unit without the use of tools.

REJECT WATER: That portion of the feedwater that is not converted to product water.

REJECTION: Reduction of specified contaminants in product water as related to feed water, expressed as percentage.

RESERVOIR TANK: A compartment used to collect the product water from a distiller.

REPLACEMENT COMPONENTS: Those components whose performance may deteriorate with system use and are intended to be periodically replaced.

STORAGE CAPACITY: The maximum volume available for use from the storage tank as tested in accordance with procedures outlined in Appendix C.

SYSTEM: A complete, integrated distillation unit which may consist of various components which will be tested as a singular unit of equipment.

TDS: Abbreviation for "Total Dissolved Solids."

USER: The product water consumer.

SECTION 3. MATERIALS, DESIGN AND CONSTRUCTION

3.1 General

The system shall be so designed and constructed that its intended purpose will be accomplished when installed and operated in accordance with the manufacturer's instructions.

System materials in contact with water shall be selected for their strength and resistance to corrosion by water; shall be free of objectionable taste and odor; and shall not impart toxic substances to the water. All non-metallic materials of construction must be certified by the manufacturer that such materials will not impart any objectionable taste or odor to the water and that the material will not impart toxic substances to the water.

Systems shall be capable of withstanding exposure to the intended use environment as specified by the manufacturer, and shall be durable and capable of withstanding normal mechanical and thermal stresses incident to shipping, installation, operation, and maintenance.

Systems shall be designed and constructed so that when installed in accordance with the manufacturer's instructions they will meet generally established public health and safety requirements. Suitable evidence must be submitted to the Water Quality Association Laboratory to support compliance.

All parts and components shall be free of rough or sharp edges or other hazards which could cause injuries to persons adjusting, servicing, or using the unit.

3.2 Minimum Quality Assurance Provisions
A label shall be permanently affixed to every system stating as follows: "It is the user's responsibility to periodically test the unit in order to determine whether it maintains the performance levels claimed by the manufacturer."

3.3 Flow Control
If performance of the system is dependent on flow rate, a flow rate control shall be provided as an integral part. The manufacturer shall clearly identify controls requiring adjustments. The adjustment procedures shall be explained in the instructions.

3.4 Waste Connections
Waste connections, if provided as part of the system, shall be capable of conforming to applicable national, county, and local municipal codes.

3.5 Dispensing Outlet
Faucet spouts (except for drinking fountain orifices), if provided with the system, shall be constructed and located so the discharge orifice is directed downward. The lower edge of the outlet shall be at an elevation not less than one inch above the flood rim of the sink.

SECTION 4. PERFORMANCE

4.1 Chemical Performance Requirements

4.1.1 All chemical performance tests shall be conducted in accordance with Appendix C.

4.1.2 Systems must reduce the total dissolved solids below 10 ppm when using a General Test Water of 1075 mg/l TDS when tested in accordance with Appendix C.

Optional. Where the levels of a substance other than total dissolved solids, which substance is regulated by the EPA's Primary and Secondary Drinking Water Regulations, are to be tested, the concentration of the substance in the product water shall be not more than the MCL specified in those regulations. Testing of other contaminants whose reduction is claimed shall have these claims confirmed by test, but a minimum of 50% rejection of other contaminants whose reduction is claimed is required.

4.1.3 Claims for contaminant concentration reduction must specify the nature of the contaminant and specifically describe those instances when all forms of the contaminant will not be removed. For example, a claim of mercury reduction must specifically describe those instances when there will not be a reduction of each of the three common mercury forms: Mercury I, Mercury II, Organic Mercury.

4.1.4 The arithmetic mean of the percent TDS rejection measured on the last test day (the seventh day, as set out in Appendix C) shall be at least 98% of the arithmetic mean of the percent rejection measured on the second test day.

4.1.5 The arithmetic mean of the product flow rate measured on the last test day (the seventh day, as set out in Appendix C) shall be at least 90% of the arithmetic mean of the product flow rates measured on the first test day and shall be at least the claimed product flow.

4.1.6 Product water storage capacity, if provided, shall be at least equal to the manufacturer's claimed volume.

4.1.7 Manufacturer wishing to modify a specific test procedure, because the design of a system precludes effective testing in accordance with this standard, shall follow these basic procedures:

4.1.7.1 Modification of Test Procedures
The applicant manufacturer shall suggest applicable evaluation parameters and submit data to support the applicant's suggested modifications.

4.1.7.2 Special Task Committee
A special task committee shall evaluate the submission and render an opinion assuring that the request is within the scope of the Standard. The special task committee will then define test conditions and determine evaluation parameters. The committee shall be composed of, but not limited to, the following members.

1. WQA Technical Director
2. Manufacturer
3. Two (2) members of WQA Science Advisory Committee
4. Consultant who has expertise in the area of distillation systems
5. The chairperson of the WQA Distillation Committee

APPENDIX A.

TESTING SEQUENCE

1. The testing sequence shall be as follows:

   1.1 Data compliance and visual verification shall be considered pursuant to Appendix B.

   1.2 At least two test systems shall be subjected to the chemical performance tests found in Appendix C.

2. Failures
Upon encountering a failure during qualification procedure, the procedure shall be stopped, the submitting party so notified of the failure, and all data and test articles may be returned. Upon resubmission, the procedure shall start at Step 1.1 unless the submitting organization can provide an acceptable rationale, with supporting documentation, for starting the qualification procedure at another point. The submission will be reviewed by an appropriate independent technical review body for acceptability.

3. Testing by Similarity
Testing by similarity may be permitted if the submitting organization can substantiate areas of similarity and can provide an acceptable rationale for abbreviation of the procedures set out in paragraph 1. The submission will be reviewed by the Water Quality Association Technical Director for acceptability.

APPENDIX B.

DATA COMPLIANCE AND VISUAL VERIFICATION PROCEDURES

Prior to initiating performance tests pursuant to Appendix C, compliance with the requirements of Appendix B shall be satisfied.

1. Data Submitted

Data package shall include a letter certifying that any and all systems submitted for testing are representative of production articles, and that only non-toxic materials are used in construction of the system (see, paragraph 3.1 of the Standard). Special considerations (see, paragraphs 4.1 of the Standard) shall be noted in this document. Data package shall also include sales literature, operating instructions, installation and maintenance instructions.

2. Visual Inspection

2.1 If a wastewater connection is provided, the method to prevent wastewater cross connections must be substantiated.

2.2 If a product water outlet is provided, this outlet should be examined and, if necessary, operated to verify compliance with the requirements of paragraph 3.5 of the Standard.

APPENDIX C.

CHEMICAL TEST PROCEDURES

1. General

   1.1 The testing of distillation systems will be separated into two classifications:

      a. Manual fill system

      b. Automatic fill system

   1.2 At least two automatic fill systems will be tested in parallel using the loop as illustrated in Figure C-1.

   1.3 At least two manual fill systems will be tested utilizing the same challenge water.

   1.4 All systems shall meet the data requirements of Appendix B.

2. Equipment - Automatic Fill Systems

   2.1 A circulation pump will deliver the challenge water to the test units to ensure any manufacturer specified minimum pressure requirements are met.

      2.1.1 The operating challenge water will be at 60 psig $\pm$ 5.0 psi, and the temperature will be maintained at 72°F $\pm$ 5°F.

      2.1.2 The ambient air temperature will be at 72°F $\pm$ 8°F.

   2.2 A pressure regulator will be included to maintain the desired operating pressure within $\pm$ 5.0 psig.

   2.3 Withdrawal of product water from each unit's storage tank (if applicable) shall be accomplished by means of manually draining a measured amount of water. Adequate records will be maintained to record the number and amount of draws.

   2.4 The challenge water reservoir shall be of sufficient size to contain the challenge water. It shall not impart any contaminants to the challenge water. Suitable mixing means shall be provided.

   2.5 A chart recording conductivity instrument shall be provided to monitor conductivity of challenge water in-line after the pump.

3. Equipment - Manual Fill System

3.1 The challenge water will be hand filled into the manual fill units according to the manufacturer's written instructions.

3.2 Withdrawal of product water from system will be accomplished by means of manually draining a measured amount of water. Adequate records will be maintained to record the amount and number of draws.

3.3 The challenge water reservoir shall be of sufficient size to contain an adequate supply of challenge water. It shall not impart any contaminants to the challenge water. Suitable mixing means shall be provided.

3.4 The challenge water temperature entering the evaporating chamber will be at 72°F ±5°F.

3.5 The ambient air temperature will be at 72°F ±8°F.

3.6 Conductivity measurement of the challenge water will be measured and recorded at the time the distiller system is filled.

4. Challenge Water Preparation

4.1 In all tests, a batch of challenge water shall be of sufficient volume to provide eight days operation. Every nine days the reservoir contents are to be discarded and replaced with a new batch. At this time, all product water and wastewater in the system will also be manually drained.

4.2 Wherever possible, a single challenge water batch is to be used for verifying contaminant removal claims. Where challenge water storage capacity prevents this, additional identical challenge waters shall be prepared for continuing testing.

4.2.1 General Challenge Water is used to verify reduction of TDS. The challenge water shall be deionized, or equivalent, water of at least 100,000 ohm-cm resistivity, with a turbidity of less than 1.0 NTU and a pH of 5.0 to 9.0 and must include the following listed chemicals which will provide an average challenge level of 1075 mg/l.

Chemical	Challenge Level (ppm)	Challenge Source
Chloride-Cl	508	$MgCl_2$, $CaCl_2$, NaCl
Magnesium-Mg	87	$MgCl_2$
Calcium-Ca	49	$CaCl_2$
Sodium-Na	171	NaCl, $NaHCO_3$
Bicarbonate-HCO_3	230	$NaHCO_3$
Nitrate-($N-NO_3$)	30	KNO_3
	1075	mg/l Total

To prepare this challenge water of 1075 mg/l, the following compounds shall be utilized in the proportions stated:

$CaCl_2$	-	0.13 g
$MgCl_2$	-	0.34 g
$NaHCO_3$	-	0.32 g
NaCl	-	0.21 g
KNO_3	-	0.14 g
		1.14 g total into 1 liter of distilled water.

After the challenge water is prepared for the volume of water that is need to test a unit, the contaminant levels should be checked so that accurate percentage removal can be determined. The procedures for analysis of the contaminants should be EPA approved.

4.2.2 Special Challenge Water is used to verify contaminant reduction claims other than TDS. The manufacturer shall specify the contaminants to be tested. Special Challenge Water shall be prepared by adding the specified contaminants to the General Challenge Water, unless any such contaminant is incompatible with the General Challenge Water (in which case the incompatible contaminant shall be tested using Unique Challenge Water (see 4.2.3 below)).

If the contaminant to be added to the Special Challenge Water is regulated by EPA's Primary and Secondary Drinking Water Regulations, it shall be added at a concentration equal to three times the MCL specified by EPA. If the contaminant to be added to the Special Challenge Water is not regulated by EPA, the contaminant shall be added at a concentration specified by the manufacturer.

4.2.3 Unique Challenge Water is used when contaminant incompatibility precludes the use of one Special Challenge Water. It shall be prepared by adding appropriate contaminants to the above qualified deionized water. The additional contaminants shall be added at concentrations equal to three times the MCL of product performance claims.

4.3 Suitable mixing means shall be provided.

5. Sampling and Analyses

5.1 All sampling and analyses will be conducted by approved methods of ASTM, EPA, or AWWA in a laboratory approved by WQA.

5.2 TDS estimates shall be made from conductivity measurements using a suitable laboratory conductivity meter.

5.3 All samples must be analyzed for conductivity plus the constituents of 4.2.1, 4.2.2, or 4.2.3.

6. Sampling Schedule - Automatic Fill Systems

6.1 Test duration shall not exceed one week. When individual determinations of three consecutive TDS readings do not vary by more than 5% from their average, the system shall be considered in a steady state condition. Such TDS readings shall be made on product water samples collected at least three hours apart. A maximum of one day shall be allowed to reach steady state condition: during this period, a continuous service draw shall be made, except as needed to measure reservoir capacity (if applicable), production rate, and flow rate as specified in this Appendix.

6.2 Each batch of challenge water must be sampled and analyzed to assure proper composition.

6.3 Samples of challenge water and product water shall be taken at the same time and appropriately analyzed. At a minimum, samples shall be taken at the mid use of each reservoir batch, and at the end of the last test day.

7. Sampling Schedule - Manual Fill System

7.1. Each fill of challenge water must be sampled and analyzed to assure proper conditions.

7.2 Test duration shall not exceed one week. TDS reading shall be made on representative samples of a complete batch of product water collected.

7.3 A minimum of three fills of challenge water will be sampled. The first sample will be taken on day two, the second sample on the fourth day, and the third sample on the seventh day.

8. Voltage Monitoring
A constant voltage supply will be required as part of the testing system to assure that the resistance heating elements will be operating under a constant test condition.

9. Data

Collect several samples periodically and record the following:

Date;
Time;
Operating Pressure (when required)
Challenge Water Temperature;
Challenge Water Conductivity;
Product Water Conductivity;
Challenge Water Contaminants Concentration;
Product Water Contaminants Concentration; and
Ambient Air Temperature.

10. Operating Sequence

10.1 Automatic Fill Systems

10.1.1 Systems shall operate continuously except when challenge water batch replenishment is necessary. Challenge Water batch replacement time shall not exceed eight hours.

10.1.2 Automatic fill systems shall have their product water reservoir tank (if applicable) drained on a time basis according to reservoir tank size. This draining time must be at least every six hours.

10.1.3 Automatic fill systems' boiling tanks shall be drained according to manufacturer's recommendations.

10.1.4 Test duration after equilibrium shall not exceed one week's operation.

10.2 Manual Fill Systems

10.2.1 Manual fill systems shall be operated for a minimum of two cycles per day.

10.2.2 Manual fill systems shall be drained according to the manufacturer's recommendations.

PARTS LIST OF TEST LOOP

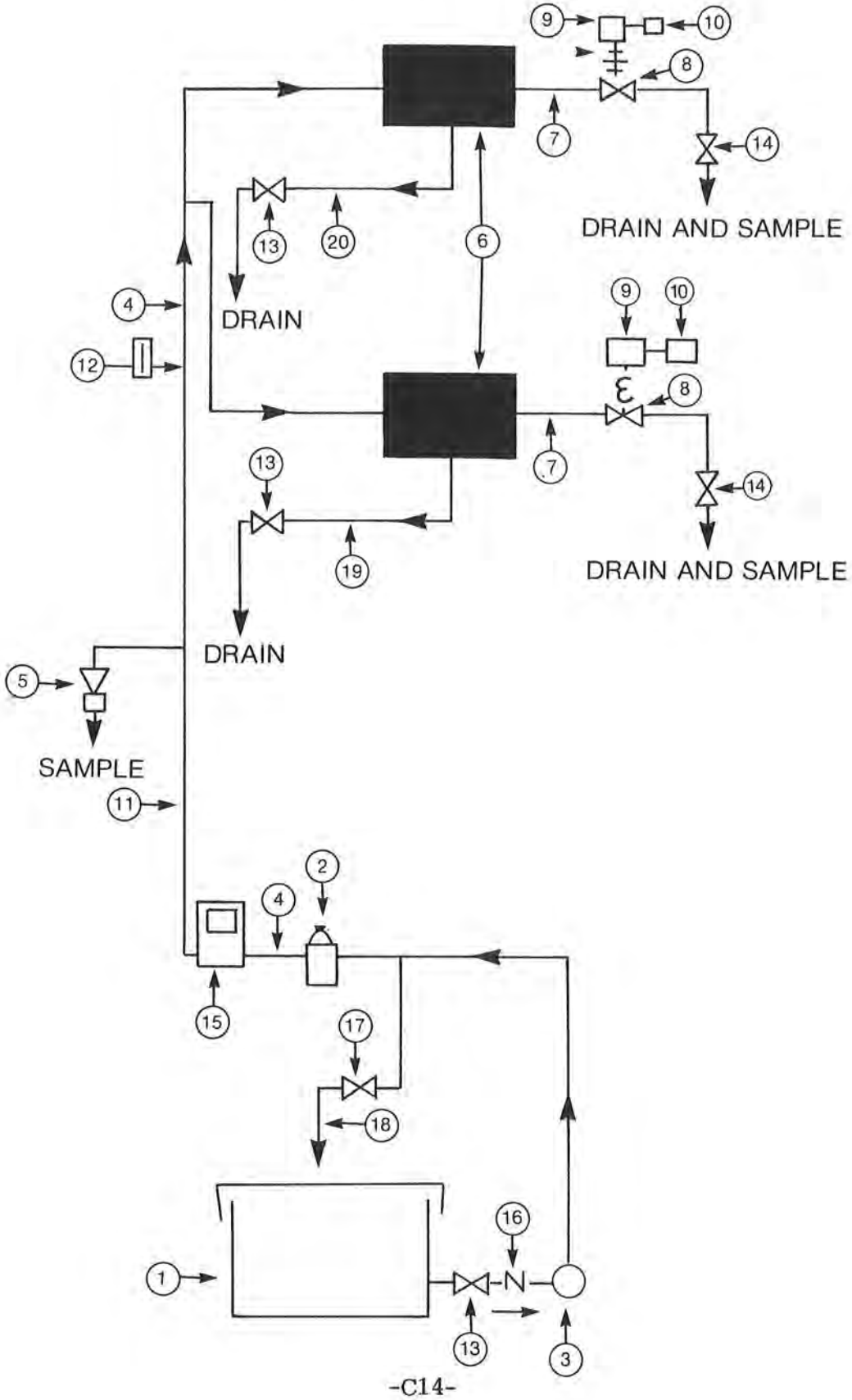
(Reference Figure C-1)

1. Reservoir, capacity at least equal to eight days total requirements
2. Pressure regulator
3. Corrosion resistant circulation centrifugal pump
4. Pressure gauge (Pressure recorder)
5. Sample valve, inlet
6. Manufacture unit under test
7. Distiller product line
8. Solenoid valve
9. Timer with impulse counter
10. Timer, electrical disconnect switch
11. Feed water to test systems
12. Thermometer (Temperature recorder)
13. Valve, stream isolation
14. Valve, system faucet (open at all times during tests)
15. Chart recorder, recording conductivity monitor
16. Check valve
17. Bypass flow throttling valve
18. Bypass return
19. Wastewater
20. Kilowatt hour meter (Recorder)*
21. Constant Voltage Regulator*

*Not shown on Schematic Figure C-1

FIGURE C-1

SCHEMATIC OF PRESSURE TEST LOOP



11.0 Performance Monitoring or Indicating Device
Systems provided with a performance monitoring device shall be subjected to the following additional tests (to be determined).

12.0 Product Water Production Rate

12.1 Automatic Fill Systems

12.1.1 After the final four hours of chemical performance test herein, and when each system has reached its stabilized condition, empty the system of product water through the appropriate outlet.

12.1.2 Collect the product water from the appropriate outlet for a period of four hours.

12.1.3 The measured volume, multiplied by 6, is the maximum daily production rate.

12.1.4 Repeat this test at the completion of the one week testing period.

12.1.5 The maximum daily production rate which may be claimed by the manufacturer shall not be greater than the lesser of the volumes determined herein.

12.2 Manual Fill Systems

12.2.1 During the first day of the chemical performance test herein, when each system is operating, the product water will be measured to determine production rates.

12.2.2 The product water produced per cycle will be measured volumetrically during a time period. A cycle is defined as the elapsed time from when the unit is turned on and turned off.

12.2.3 The measured volume obtained during a cycle multiplied by the number of cycle periods in a time period of 24 hours is considered the maximum daily production rate.

12.2.4 Repeat this test at the completion of the one week testing period.

12.2.5 The maximum daily production rate which may be claimed by the manufacturer shall not be greater than the lesser of the volumes determined herein.

13. Product Water Storage Capacity

13.1 During the week of the chemical performance test herein, and with each system operating, interrupt discharge from the system in such a manner to allow the system storage tank to fill per the manufacturer's recommendation. When the storage tank is filled, shut off the system influent to interrupt the water supply to the storage tank.

13.2 Open dispensing outlet and collect discharge from storage tank.

13.3 Measure and record collected volume. This volume shall be the claimed storage capacity for the system.

14. Wastewater Flow Rate And/Or Volume

14.1 During the week of chemical testing, the wastewater flow rate and/or volume ratios of wastewater to product water produced will be measured and verified when product claims include such statements.

14.2 With the system operating, the amount of wastewater and product water will be measured at a time period of four (4) hours.

14.3 The measured volumes, multiplied by 6, is the maximum daily production of wastewater and product water respectively.

15. Efficiency of the System

The efficiency of either the manual fill or automatic fill systems will be reported as kilowatt hours per gallon of product water produced.

APPENDIX D

PUBLISHED DATA

1. REFERENCES TO THESE STANDARDS IN SALES AND PROMOTIONAL MATERIALS

To promote consumer safety and to avoid improper product application by installers or consumers, all sales or other promotional materials for a particular product, system, or unit stating or implying that the product, system, or unit meets this Standard, shall include at least the following data:

Conditions of use;

Description of water quality assurance program;

Model number of unit;

Name and address of manufacturer and/or servicing organization;

Minimum and maximum operating pressure, where applicable;

Optimum operating temperature range; and

Electrical characteristics.

2. OPERATION, MAINTENANCE, AND INSTALLATION INSTRUCTIONS

At least the following information should be made available to the installer: detailed instructions for installation, operation, maintenance, and initiation of service. Specific instructions shall include arrangement of plumbing connections, electrical wiring where applicable, disinfection procedures and other requirements of this Standard, with details referring to the particular model. Installation instructions shall note the need for compliance with all applicable state and local laws and regulations. Representative sources of supply for expendable components and supplies for the unit or system shall be clearly stated.

The manufacturer should also furnish the following data with the system:

Model number;

Functional description of unit;

Conditions of use;

limits of feed water pressure,

optimum operating temperature in degrees F, and

appropriate electrical voltage, where applicable;

Functional description of unit including instructions for user and means for user to verify system performance;

A statement that the system was tested in accordance with the standard;

1. Product water production rate, gpd;

2. Capacity of product water storage, where applicable.

3. **LABELING**

A permanent plate or label should be affixed, by the manufacturer or servicing organization, in a conspicuous location on each unit and should contain the following:

Name and address of manufacturer and/or servicing organization;

Model number of unit;

Serial number of unit;

Electrical characteristics (where applicable).

4. **REPLACEMENT COMPONENTS**

Data regarding replaceable components shall be provided on the component:

Conditions of use;

Part number;

Model number of unit or units in which the component is to be used;

Name and address of manufacturer and/or supplier.

The industry served by WQA and its members encompasses water quality improvement for homes, businesses, industry, and institutions in these broad areas; • drinking water
• working water

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