ACCEPTANCE TESTING AND DISTRIBUTION OF CY-2011 46.2 MM TEFLON FILTERS

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is responsible for procuring, testing, and distributing 46.2 mm Teflon filters of high purity and strict quality control requirements to State and local air pollution control agencies for use in their ambient air monitoring networks for particulate matter. The 46.2 mm Teflon filters are used in particulate matter samplers used to collect $PM_{2.5}$ (particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers) ambient air samples. The process of procuring and distributing filters with homogeneous characteristics and known and acceptable quality assures uniformity in the collection of data from the national particulate network. Before being used in the national network, the filters are subjected to the following acceptance tests: (1) visual inspection, (2) filter weight stability, which include a test for loose surface particles (drop test) and a test for temperature stability, (3) trace metal analysis, (4) alkalinity, (5) maximum moisture pick-up, (6) filter support ring which includes ring thickness, ring outer diameter and ring width, and (7) collection efficiency (DOP test) including maximum pressure drop across the filter.

Calendar year 2011 Teflon filters are supplied by (MTL) Measurements Technology Laboratory. These filters differ in their numbering system in that the filter numbers are on the filter material itself rather than on the filter ring. This does not interfere with the use of the filters for collecting $PM_{2.5}$ particulate matter. Filter acceptance criteria were met for all tests conducted.

The following test results reflect the findings for this work assignment.

1.1 Visual Inspection

The maximum number of filter rejects allowed for all physical characteristics combined is 6 percent. No defect is permitted for individual filter identification or for filter container identification and the maximum number allowed for visual inspection is 10 percent for defective filters and 5 percent for rejected filters. EPA considers a **reject** filter as one not useable for sampling. A **defective** filter is considered suitable for sampling but contains one or more useable defects.

Imperfections that will cause a filter to be classified as a **reject** filter includes:

Pinhole:

A small hole appearing (1) as a distinct and obvious bright point of light when examined over a light table or screen, or (2) as a dark spot when viewed over a black surface.

Separation of ring:

Any separation or lack of seal between the filter and reinforcing ring.

Chaff or flashing:

Any extra attached residual material on the ring or heat seal area which would prevent obtaining an airtight seal when the ring is placed under compression.

Discoloration:

Any obvious visible discoloration which might be evidence of a contaminant.

Imperfections that will cause a filter to be classified as a defective filter includes:

Loose-material:

Any extra loose material or dirt particles on the filter that would require removal by brushing prior to weighing.

Filter non-uniformity:

Any obvious visible non-uniformity in the appearance of the filter when viewed over a light table or black surface which might indicate gradation in porosity across the face of the filter.

Other:

A filter with any imperfections not described above, such as irregular surfaces or other results of poor workmanship.

From the total batch of 190,550 EPA CY-2011 Teflon filters supplied by Measurement Technology Laboratory (MTL), 525 filters were randomly selected for inclusion in the visual inspection testing. Of the 525 filters that were visually inspected, 8 filters (1.5 percent) were rejected, and 24 filters (4.57 percent) were defective, thus the batch of filters passed the visual inspection tests. Of the 8 rejected filters, 6 had a pinhole, 1 had a small cut, and 1 had a thin deep line. Of the 24 defective filters, 3 were non-uniform, and 21 had other defects (17 had light lines/areas/spots on the filter, and 4 had dark spots/lines on the filters). The results of the visual inspection are presented in Appendix A.

1.2 Filter Weight Stability Tests

1.2.1 Loose Surface Material Drop Test

Fifty of the filters passing the visual inspection test were subjected to the two parts of the filter weight stability tests. Chester LabNet, Tigard, OR conducted the tests. The first part, which is for loose surface material is sometimes called the Adrop test.@ The filter is conditioned and then weighed. After the initial weighing, each test filter was placed in a filter cassette and the cassette dropped from a height of 25 cm to a flat hard surface, such as a particle-free wood bench. The filter was removed from the cassette and reweighed. The average change in weight for the batch of 50 filters must be less than 20 Φg/filter.

The average change in weight for the 50 filters tested was -2 Φg with a standard deviation of 6.7 Φg. The maximum change was -27Φg. See Appendix B for details.

1.2.2 Temperature Stability

Fifty filters were subjected to the second part of the filter stability test which is the test for temperature stability. Each of the test filters was weighed, placed in a drying oven set at 40^{o} C ∀2^{o}C for 48 hours. The filters were removed from the oven, conditioned, and reweighed. The average change in weight for the fifty filters must be less than 20 Φg/filter.

The average change in weight for the 50 filters tested was -3 Φg with a standard deviation of 4.8Φg. The maximum change in weight was 13/-13Φg. Appendix B contains the complete test results.

1.3 Trace Elements Analysis

Fifty filters were analyzed for 42 trace elements using X-ray fluorescence analysis. A list of the trace elements tests to be conducted along with the allowable average concentrations are listed below. The acceptance criteria state that 90 percent (or 45 of the 50 filters) shall meet the following criteria. The average concentrations for the 42 trace elements in 90 percent of the filters shall be less than the concentrations listed in Table 1 (which is twice the minimum detectable concentrations). The EPA shall reject the filters if the concentration of any trace element is five times the concentration listed in Table 1.

Table 1. Trace Elements

Element	Maximum Concentration (ng/cm^2)	Element	Maximum Concentration (ng/cm^2)
Al	94.4	Br	2.0
Si	32.8	Rb	2.0
P	22.6	Sr	2.2
S	13.4	Y	14.6
Cl	9.4	Zr	13.2
K	5.6	Mo	11.6
Ca	8.2	Rh	9.4
Sc	7.2	Pd	9.6
Ti	13.8	Ag	9.6
V	4.8	Cd	10.8
Cr	2.2	Sn	15.2
Mn	2.2	Sb	14.4
Fe	5.8	Te	16.2
Co	4.0	I	18.6
Ni	3.0	Cs	25.0
Cu	2.8	Ba	32.2
Zn	2.2	La	87.6
Ga	1.8	W	5.0
Ge	3.0	Au	4.4
As	2.8	Hg	4.4
Se	1.6	Pb	4.8

The test was conducted by Chester LabNet of Tigard, OR and the results show that the filters met the acceptance criteria of having the average concentrations of the 42 trace elements in 90 percent of the filters less than the concentrations listed in Table 1.

In addition, the test results show that the batch of 50 filters met the criteria of no trace element concentration exceeding five times the concentration of the 42 elements listed in Table 1. The detailed results of the trace element analysis are included in Appendix C.

1.4 Alkalinity

Fifty filters were selected for the alkalinity test. Testing was conducted by Chester LabNet of Tigard, OR. The method used to determine the alkalinity of the Teflon filters was a modification of the method for measuring alkalinity of filters presented in EPA's Appendix A of the Quality Assurance Handbook, Part II, Section 2.12 – $PM_{2.5}$ Reference/Class I Equivalent Methods. Based on the difference in pH readings that were made before and after the extractions, the alkalinity per gram of filter material was calculated. The corrected alkalinities for the filters ranged from –1.0653 to 1.3690 ΦEq/g of filter material with an average value of -0.0899 ΦEq/g and a standard deviation of 0.5204 ΦEq/g.

The acceptance criteria for this test are less than 25 alkalinity micro equivalents/gram of filter. The test results show that the filters met the acceptance criteria. Complete results are provided in Appendix D.

1.5 Maximum Moisture Pick-up

The acceptance criteria for this test is not more than a 10 Φg weight increase after 24-hour exposure to air of 40 percent relative humidity (RH), relative to weight after 24-hour exposure to air of 35 percent RH.

Fifty filters were subjected to this test. Testing was conducted by Research Triangle Institute, RTP, NC. The mean difference in filter weights recorded for the 50 test filters was 4.0 µg, with a maximum recorded difference of 12 µg and a minimum recorded difference of 0 µg. The standard deviation was 3.1 µg. The data were distributed between weight loss and weight gain with

the vast majority toward weight loss. Forty (40) of the 50 test filters lost weight, four (4) showed no weight change, and six (6) of the 50 filters gained weight. The details of the results are shown in Appendix E.

1.6 Filter Support Ring Dimensions

Three characteristics of the filter support or reinforcing ring are included in this test. They include the outside diameter of the reinforcing ring, the width of the ring, and the thickness of the ring. The acceptance criteria for these characteristics are that all filters must meet the following dimensions:

		Maximum	*Minimum*
X	Reinforcing ring, outside diameter	46.45 mm	45.95 mm
X	Reinforcing ring, inside diameter	3.68 mm	3.17 mm
X	Reinforcing ring, thickness	0.42 mm	0.31 mm

Fifty filters were selected for these tests and the average of two outside diameter measurements, ring width, and ring thickness were made on each filter. Of the 50 filters, 100 percent had the average diameter measurement within the outside diameter (OD) acceptance criteria. The mean of the OD diameter was 46.01 mm with a standard deviation of 0.05 mm.

All fifty filters passed the ring width dimension. Based on two measurements, the mean of the ring width measurements was 3.50 mm with a standard deviation of 0.15 mm.

All of the filters passed the ring thickness test. The mean thickness based on two measurements was 0.399 mm with a standard deviation of 0.007 mm. The results of the dimension tests are presented in Appendix F.

1.7 Collection Efficiency

Fifty filters were subjected to tests for the percent penetration of the filters and flow rate resistance at 16.67 L/min clean air flow. The tests were conducted by Air Techniques International, Baltimore, MD, using ASTM Method D2986-95, Standard Practice for Evaluation of Air Assay

Media by the Monodispersive DOP (Dioctyl Phthalate) Smoke Test (0.3 micron diameter DOP). Acceptance criteria are as follows:

X	A collection efficiency of greater than 99.7%	
		Maximum
X	Pressure drop at 16.67 L/min	30 cm H_2O

All but one of the 50 filters tested passed the collection efficiency tests. The one filter that did not passed the test was marred in the shipping process. The collection efficiency for this filter was 99.4 while the mean of the entire 50 filters was 99.9868 with a standard deviation of 0.0847. The mean of the pressure drop was 21.79 cm H_2O with a standard deviation of 2.80 cm H_2O. Details of the results of these tests are given in Appendix G.

Appendix A

Visual Inspection

Teflon Filters

Appendix B

Test Results Filter Stability

Appendix C

Test Results Trace Elements Analysis

Appendix D

Test Results Alkalinity

Appendix E

Test Results Maximum

Moisture Pick-up

Appendix F

Test Results Filter

Support Ring Dimensions

Appendix G

Test Results Collection Efficiency and Pressure Drop