TEST RESULTS

Acceptance Testing and Distribution of CY-2014 Quartz Filters

Purchase Order No. EP-D-10-079

TRC Reference No. 176922.3003.0000

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September 10, 2013

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is responsible for procuring, testing, and distributing quartz and glass fiber 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. The quartz filters are used with a size selective sampler (SSI) to collect PM_{10} (particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers). The glass fiber filters are used to collect Total Suspended Particulate (TSP) matter and for lead and trace metal analysis. The testing process assures filters with uniform characteristics and known quality assurance testing for use in the national particulate matter ambient air monitoring networks. The filters were subjected to the following tests in order to determine whether or not they could be accepted for use in the national network:

TEST	QUARTZ	% MEETING CRITERIA/MET CRITERIA
Visual	X	180 defects (34.3%) found versus criteria of 105 (20%) 43 rejects (8.2%) found versus criteria of 26 (5%)
Length, Width	X	100%
Brittleness	X	100%
Thickness	X	100%
Tensile Strength	X	100%
Flow Rate	X	100%
Retention	X	100%

2.0 ACCEPTANCE TESTING RESULTS

2.1 VISUAL INSPECTION

TRC 's statement of work called for the visual inspection of 525 randomly selected quartz fiber filters. The filters had to pass this test before any additional acceptance tests could be performed. EPA's visual acceptance criteria are 20% defective filters and 5% reject filters.

The filters were individually examined for various imperfections, which were broken down into two categories: imperfections that cause a filter to be rejected and imperfections that cause a filter to be considered defective. Filters having one or more of the following imperfections were classified as rejects: pinhole, two or more dense spots or one dense spot larger than 0.25 inches in diameter, two or more dark spots, or loose-appearing fibers that cannot be brushed off, coloration, individual fiber on filter surface, or other imperfections (such as major frayed edges or indentations) which are judged to be considered a reject. Defective filters, which can still be used for the samplers, contain one or more of the following visual defects: line, thin spot, dense spot less than 0.25 inches in diameter, dark spot, loose fibers that can be brushed off, filter non-uniformity, or any imperfection not mentioned above.

Based on a visual inspection of 525 quartz filters, the maximum number of rejected quartz filters allowed is 26 and the maximum number of defective filters allowed is 105. The detailed results for the quartz filters are presented in Appendix A.

From the total batch of 33,540 EPA-supplied quartz filters, 525 filters were randomly selected for visual inspection. Of these 525 filters, 43 (8.2%) filters were rejected, thus not meeting the acceptance criteria of 26 (5%) rejects, and 180 filters (34.3%) were defective, thus not meeting the acceptance criteria of 105 (20%). Of the 43 filters that were rejected, 10 had colorations, 4 had a very large dark spot, 22 had two or more dark spots, 1 had a pinhole, 2 had large scraped areas, 1 had a torn edge, and 3 had multiple defects (thin spots and darks spots, loose fibers and dark spots, and thin spot, dark spot and a vertical line). Of the 180 defective filters, 93 had a thin spot or multiple thin spots, 44 had a dark spot, 15 had a dark spot and multiple thin spots, 11 had a thin spot and vertical line/crease, 2 had a dark spot and vertical line, and 15 had a vertical line.

2.2 LENGTH AND WIDTH

From the filters which underwent the visual inspection, one set of 50 quartz filters were additionally tested for length and width by TRC. The length and width were measured using a certified standard ruler with divisions for one-thirty second of an inch. The filters must be 8 by 10 inches (±1/16 inch). The results are presented in Appendix B.

All of the quartz filters tested (100%) met the criteria and are considered acceptable.

2.3 BRITTLENESS

For this test, brittleness was measured by TRC for 50 quartz filters. Each filter was folded lengthwise so that it was 4 x 10 inches, with the rough side inward. Moderate pressure was applied to crease the filter along the length of the fold. The filter was unfolded and placed on a light box to detect any cracks or splits. The length of any crack or split would be reported to the nearest ½ inch. The results are presented in Appendix C.

All 50 of the filters tested (100%) were acceptable, with none having any cracks.

2.4 QUARTZ THICKNESS AND TENSILE STRENGTH

Of the filters which underwent the visual inspection, a set of 75 quartz filters were tested for thickness using ASTM Method D645M-97 and for tensile strength using ASTM Method D828-97 by Integrated Paper Services, Appleton, WI. In order for the filters to be acceptable, the filters must be no thinner than 0.30 mm (0.0118 in.) and no thicker than 0.60 mm (0.0236 in.) in thickness. The same quartz filters were used for both the thickness and tensile strength tests. The results of the quartz filter tests are presented in Appendix D.

2.4.1 Quartz Filters Thickness

All 75 quartz filters tested (100%) met the requirements and were considered acceptable. The average thickness was 0.429 mm. with a standard deviation of 0.0104 mm. The following table lists the thickness of five defective filters and five reject filters that were included in the thickness measurements. All five of the defective filters had multiple thin spots while the reject filters had two or more dark spots. The average thickness of the defective filters was 0.432 mm. comparing very

close to the average thickness of 0.429 mm. The average thickness of the reject filters was 0.433 mm.

Thickness of Defective Filters

	Caliper (mm)
Sample Identification	Average
Q4500423	0.433
Q4505480	0.432
Q4516197	0.438
Q4521094	0.426
Q4529419	0.430
Average	**0.432**
Std. Dev.	**0.004**

Thickness of Reject Filters

	Caliper (mm)
Sample Identification	**Average**
Q4503762	0.434
Q4522097	0.442
Q4526077	0.436
Q4526736	0.435
Q4522335	0.416
Average	**0.433**
Std. Dev.	**0.010**

2.4.2 Quartz Filters Tensile Strength

All 75 quartz filters tested (100%) met the requirement of 200 gramforce/20mm.minimum. The average was 572 gramforce/20mm. with a standard deviation of 43.8 gramforce/20mm. The table below shows the tensile strength of five defective filters and five reject filters. The average of the defective filters was 595 gf/20 mm and the average of the reject filters was 575 gf/20 mm which compares favorable with the overall average of 572 gf/20 mm.

Tensile Strength of Defective Filters

	MD Tensile Strength (gf/20 mm)
Q4500423	658
Q4505480	572
Q4516197	609
Q4521094	574
Q4529419	564
Average	**595**
Std Dev.	**39.0**

Tensile Strength of Reject Filters

Q4503762	547
Q4522097	548
Q4526077	572
Q4526736	639
Q4522335	570
Average	**575**
Std Dev.	**37.6**

2.5 FLOW RATE

For this test, 75 quartz filters were tested by TRC using a modification of the procedure specified in EPA's flow rate acceptance test. The EPA roots meter was not available for use in conducting this test so a newly certified calibrated orifice was used in its place. The calibrated orifice was used to prepare a flow rate calibration curve for the hi-volume sampler using the pressure difference measured with a water manometer at the motor housing pressure tap as the indicator of flow. A standard 7-hole resistance plate was inserted in the filter holder and the hi-volume sampler was turned on and allowed to warm up for a minimum of one minute. The voltage was adjusted to obtain a flow rate of 1.13m^3/min. The sampler motor was turned off and the resistance plate removed. A filter to be tested was then placed in the filter holder; the motor was turned on and allowed to stabilize. The pressure drop across the water manometer was recorded along with the atmospheric pressure and temperature. The flow rate corresponding to the pressure differential was recorded and corrected to standard conditions of 298 °C and 760 mm Hg. After testing 5 filters, the

7-hole resistance plate was reinserted and the flow rate was adjusted to 1.13m^3/min. These steps were repeated after 5 filters were tested. The results for the quartz fiber filters are presented in Appendix E.

The acceptance criteria for the quartz filter flow rate are 1.75 m^3/minute maximum and 1.34 m^3/minute minimum. All 75 of the quartz filters (100%) met the acceptance criteria for flow rate. The average flow rate at standard conditions of 760 mm Hg and 298 °K for the 75 filters was 1.564 m^3/minute with a standard deviation of 0.026m^3/minute. The average flow rate for 65 of the filters having no defects or rejects was also 1.564 m^3/minute with a standard deviation of 0.026m^3/minute.

There were five defective filters and five reject filters included in the 75 filters tested for flow rates. All of the defective filters had multiple thin spots. The defective filters average flow rate at standard conditions of 760 mm Hg and 298°K was 1.566 m^3/min which compares very favorably with the average flow rate for the 75 filters. The reject filters all had two or more dark spots. The reject filters had an average flow rate of 1.560m^3/min with a standard deviation of 0.017m^3/min. Appendix E includes three tables: the first table shows the flow rate for all 75 filters; the second table shows the flow rate for the 65 passing filters; and the third table shows the flow rate for the five defective and reject filters.

Flow Rate of Defective Filters

Filter Identification	Delta P Hi-Vol	Delta P Orifice	Q, m^3/min measured	Qstd, m^3/min
Q4500398	6.00	5.3	1.570	1.578
Q4504432	6.00		1.570	1.578
Q4508661	5.90		1.550	1.558
Q4516528	5.90		1.550	1.558
Q4526730	5.90	5.3	1.550	1.558
Average	**5.94**		**1.558**	**1.566**
Std. Dev.	**0.05**		**0.011**	**0.011**

Flow Rate of Reject Filters

Filter Identification	Delta P Hi-Vol	Delta P Orifice	Q, m^3/min measured	Qstd, m^3/min
Q4500113	6.10	5.3	1.580	1.588
Q4503740	5.80		1.540	1.548
Q4508249	5.90		1.550	1.558
Q4511567	5.90		1.550	1.558
Q4526069	5.80	5.3	1.540	1.548
Average	**5.90**		**1.552**	**1.560**
Std.Dev.	**0.12**		**0.017**	**0.017**

2.6 RETENTION

Fifty (50) quartz filters were tested for retention by Air Techniques International, Owings Mills, MD using ASTM Method D2986a-99. In order to be acceptable, the retention should be no less than 99.95%. The results of the test are presented in Appendix F.

All 50 filters tested (100%) passed with a retention equal to or greater than the required 99.95%. The average was 99.9974% with a standard deviation of 0.0014%. Five defective and four reject filters were included in the retention tests. The average retention efficiency of the defective filters was 99.9958% with standard deviation of 0.0033% and the average retention efficiency of the reject filters was 99.9968% with a standard deviation of 0.0010% thus meeting the acceptance criteria of 99.95%.

Retention of the Defective Filters

Sample	Penetration	Efficiency	Resistance	Resistance
Q4500066	0.01	99.9900	26	1.0
Q4503732	0.002	99.9980	26	1.0
Q4508243	0.003	99.9970	26	1.0
Q4516195	0.003	99.9970	26	1.0
Q4522089	0.003	99.9970	28	1.1
Average		**99.9958**		**1.02**
Std. Dev.		**0.0033**		**0.04**

Retention of the Reject Filters

Sample	Penetration	Efficiency	Resistance	Resistance
Q4500084	0.004	99.9960	26	1.0
Q4503718	0.004	99.9960	26	1.0
Q4508649	0.003	99.9970	26	1.0
Q4526081	0.002	99.9980	28	1.1
Average		**99.9968**		**1.03**
Std. Dev		**0.0010**		**0.05**

2.7 LEAD CONTENT

For this test, 50 quartz filters were selected to be analyzed for lead content by a method equivalent to that in 40 CFR 50. The test for lead content was performed by Chester Laboratories, using the hotplate option from the method for sample digestion and the equivalent graphite furnace atomic absorption method for sample analysis. The acceptance criteria for lead content for this Method are 15 µg/filter.

All the filters passed the test. The average lead content was 0.250 µg/filter (using 0.245 as the value for <MDL) with a standard deviation of 0.018 µg/filter. The lead results for the quartz filters are presented in Appendix G. There were five defective filters but no reject filters included in the lead measurements. All five of the defective filters had multiple thin spots. The average lead content of the defective filters was 0.247 µg/filter with a standard deviation of 0.004 µg/filter. Four of the five defective filters had a concentration <MDL so a value of 0.245 µg was used in the calculations for the filters having concentration reports as <MDL.

Lead in Quartz Defective Filters

Sample	Pb Conc.
Q4505470	0.245
Q4507242	0.254
Q4511514	0.245
Q4518196	0.245
Q4526745	0.245
Average	0.247
Std. Dev.	0.004

Appendix A

Visual Inspection Results

CY 2014 Quartz Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
1	Q4500066			✓	Dark spot at 9 center
2	Q4500069			✓	Thin spots at 6 and 7
3	Q4500072	✓			
4	Q4500073	✓			
5	Q4500081			✓	Dark spot at 7:30 and multiple thin spots
6	Q4500084		✓		Coloration (red spot at 8:30 on back)
7	Q4500087	✓			
8	Q4500088	✓			
9	Q4500106	✓			
10	Q4500111	✓			
11	Q4500113		✓		Two dark spots at 9 and 10
12	Q4500115			✓	Dark spot center at 3
13	Q4500117			✓	Two thin spots at 11 and 9
14	Q4500119		✓		Two dark spots at 9 and 1
15	Q4500122			✓	Thin spot at 9
16	Q4500123		✓		Two dark spots at 4 and 8
17	Q4500125			✓	Thin spot at 12; vertical line at center
18	Q4500126	✓			
19	Q4500129			✓	Thin spot center between 3 and 9
20	Q4500130			✓	Multiple thin spots
21	Q4500395			✓	Vertical line 11:30 to 6:30
22	Q4500396	✓			
23	Q4500398			✓	Multiple thin spots
24	Q4500402			✓	Thin spot at 8
25	Q4500408	✓			
26	Q4500414		✓		Thin spot center; Vertical line 12 to 6; Dark spot at 5
27	Q4500420			✓	Thin spot at 12
28	Q4500421			✓	Dark spot at 9
29	Q4500423			✓	Dark spot at 6:30
30	Q4500425	✓			
31	Q4500426	✓			
32	Q4500431	✓			
33	Q4500433			✓	Dark spot at left corner
34	Q4500439	✓			
35	Q4500441	✓			
36	Q4500443		✓		Coloration (red spot at 12 center)
37	Q4500446			✓	Dark spot at 11; vertical line left side

CY 2014 Quartz Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
38	Q4500447	✓			
39	Q4500450			✓	Dark spot at 4 center
40	Q4500454	✓			
41	Q4503709			✓	Multiple thin spots
42	Q4503712			✓	Vertical line 12:30 to 5:30
43	Q4503715			✓	Multiple thin spots
44	Q4503716			✓	Dark spot center
45	Q4503718		✓		Multiple dark spots at 5, 5:30 and 7
46	Q4503720	✓			
47	Q4503727			✓	Dark spot at 5:30
48	Q4503728	✓			
49	Q4503732			✓	Vertical line 12:30 to 5:30, Multiple thin spots
50	Q4503734	✓			
51	Q4503737	✓			
52	Q4503739	✓			
53	Q4503740		✓		Two dark spots at 5 and 6
54	Q4503743	✓			
55	Q4503745	✓			
56	Q4503750		✓		Coloration (red spot at 3)
57	Q4503754	✓			
58	Q4503755	✓			
59	Q4503762		✓		Pinhole center 12
60	Q4503770			✓	Thin spot at 12
61	Q4504427	✓			
62	Q4504429	✓			
63	Q4504432			✓	Multiple thin spots
64	Q4504435			✓	Vertical line 12 to 6
65	Q4504436			✓	Multiple thin spots
66	Q4504438			✓	Thin spot center
67	Q4504447	✓			
68	Q4504448			✓	Dark spot center at 9
69	Q4504449	✓			
70	Q4504452		✓		Large dark spot at 4; dark spot at 12:30
71	Q4504455	✓			
72	Q4504461	✓			
73	Q4504464		✓		Coloration (red spot at 3)
74	Q4504465	✓			

CY 2014 Quartz Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
75	Q4504470			✓	Vertical line 1 to 5; thin spot at 3
76	Q4504471			✓	Dark spot at 9; thin spot at 2
77	Q4504477			✓	Dark spot at 1
78	Q4504480			✓	Vertical line 12 to 6; thin spot center
79	Q4504483			✓	Thin spot at 8:30
80	Q4504485	✓			
81	Q4505461		✓		Two dark spots at 3:30
82	Q4505462			✓	Dark spot at 4
83	Q4505466			✓	Dark spot at 6
84	Q4505468			✓	Multiple thin spots
85	Q4505470	✓			
86	Q4505476	✓			
87	Q4505477			✓	Vertical line 12:30 to 5:30
88	Q4505480			✓	Dark spot at 9; thin spot at 3
89	Q4505485		✓		Large scraped area on back
90	Q4505486			✓	Dark spot at 11:30
91	Q4505487			✓	Two thin spots at 4
92	Q4505489	✓			
93	Q4505492	✓			
94	Q4505494			✓	Multiple thin spots
95	Q4505496			✓	Multiple thin spots
96	Q4505503			✓	Dark spot at 9
97	Q4505510			✓	Dark spot at 9
98	Q4505512	✓			
99	Q4505522			✓	Multiple thin spots
100	Q4505524	✓			
101	Q4507219			✓	Thin spot at 9
102	Q4507221	✓			
103	Q4507225			✓	Thin spot at 12
104	Q4507229	✓			
105	Q4507233	✓			
106	Q4507235	✓			
107	Q4507242			✓	Multiple thin spots
108	Q4507244			✓	Multiple thin spots; dark spot at 9
109	Q4507245	✓			
110	Q4507247	✓			
111	Q4507250			✓	Dark spot center 2:30

CY 2014 Quartz Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
112	Q4507251			✓	Multiple thin spots
113	Q4507253			✓	Multiple thin spots
114	Q4507256			✓	Multiple thin spots
115	Q4507258	✓			
116	Q4507264			✓	Vertical line 12 to 6
117	Q4507266	✓			
118	Q4507269	✓			
119	Q4507271			✓	Multiple thin spots
120	Q4507273	✓			
121	Q4508197		✓		Coloration (red spot at 6)
122	Q4508198	✓			
123	Q4508201	✓			
124	Q4508209	✓			
125	Q4508211	✓			
126	Q4508215			✓	Dark spot at 2
127	Q4508216			✓	Multiple thin spots
128	Q4508217			✓	Multiple thin spots
129	Q4508218	✓			
130	Q4508221	✓			
131	Q4508222			✓	Multiple thin spots; dark spot at 9 center
132	Q4508223			✓	Multiple thin spots
133	Q4508243			✓	Thin spot center at 8; dark spot at 9:30
134	Q4508244	✓			
135	Q4508245	✓			
136	Q4508247	✓			
137	Q4508248		✓		Large dark spot at 9 center and at 11
138	Q4508249		✓		Large thin spot at 10; dark spot at center left 8:30
139	Q4508250	✓			
140	Q4508255	✓			
141	Q4508648	✓			
142	Q4508649		✓		Two dark spots center at 4 and 8
143	Q4508651	✓			
144	Q4508655	✓			
145	Q4508657			✓	Multiple thin spots
146	Q4508660	✓			
147	Q4508661			✓	Multiple thin spots
148	Q4508662	✓			

CY 2014 Quartz Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
149	Q4508668		✓		Coloration (red spot 9:30)
150	Q4508670	✓			
151	Q4508677	✓			
152	Q4508679	✓			
153	Q4508680	✓			
154	Q4508684			✓	Vertical line 12:30 to 5:30; Multiple thin spots
155	Q4508685	✓			
156	Q4508687	✓			
157	Q4508706	✓			
158	Q4508707	✓			
159	Q4508709	✓			
160	Q4508710	✓			
161	Q4511441	✓			
162	Q4511449	✓			
163	Q4511450	✓			
164	Q4511451	✓			
165	Q4511452	✓			
166	Q4511458	✓			
167	Q4511459	✓			
168	Q4511460	✓			
169	Q4511466	✓			
170	Q4511468			✓	Vertical line center 12 to 6; Dark spot at 9
171	Q4511474	✓			
172	Q4511479			✓	Dark spot at 2
173	Q4511484			✓	Dark spot at 4
174	Q4511487		✓		Coloration (red spot 5)
175	Q4511488	✓			
176	Q4511489	✓			
177	Q4511490	✓			
178	Q4511493			✓	Thin spot at 8
179	Q4511494	✓			
180	Q4511497	✓			
181	Q4511506			✓	Thin spot at 8:30; dark spot at 1
182	Q4511513			✓	Dark spot center at 4
183	Q4511514			✓	Multiple thin spots
184	Q4511516	✓			
185	Q4511517	✓			

CY 2014 Quartz Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
186	Q4511521	✓			
187	Q4511528			✓	Multiple thin spots
188	Q4511529			✓	Multiple thin spots
189	Q4511531			✓	Two thin spots
190	Q4511537	✓			
191	Q4511544			✓	Vertical line 12:30 to 5:30; multiple thin spots
192	Q4511550		✓		Coloration (red spot at 3:30)
193	Q4511551			✓	Thin spot top at 12; small crease at 12
194	Q4511552	✓			
195	Q4511553	✓			
196	Q4511555	✓			
197	Q4511557	✓			
198	Q4511558			✓	Multiple thin spots
199	Q4511567		✓		Two dark spots at 9:30 and 12
200	Q4511568	✓			
201	Q4516191	✓			
202	Q4516192			✓	Dark spot at 2; thin spot at 3
203	Q4516193	✓			
204	Q4516195			✓	Multiple thin spots
205	Q4516197			✓	Multiple thin spots
206	Q4516198			✓	Multiple thin spots
207	Q4516199			✓	Multiple thin spots
208	Q4516207			✓	Two thin spots at 3 and 5
209	Q4516208			✓	Multiple thin spots
210	Q4516209			✓	Multiple thin spots
211	Q4516212			✓	Multiple thin spots
212	Q4516214	✓			
213	Q4516228			✓	Multiple thin spots
214	Q4516231			✓	Multiple thin spots
215	Q4516232			✓	Multiple thin spots
216	Q4516237		✓		Coloration (red spot at 6)
217	Q4516239			✓	Dark spot at 9
218	Q4516247			✓	Thin spot center
219	Q4516248			✓	Multiple thin spots
220	Q4516249			✓	Multiple thin spots
221	Q4516511			✓	Dark spot center between 8 and 4
222	Q4516512	✓			

CY 2014 Quartz Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
223	Q4516514	✓			
224	Q4516515			✓	Dark spot at 10 center; thin spot at 8
225	Q4516521			✓	Multiple thin spots
226	Q4516522			✓	Dark spot at 12 center
227	Q4516523			✓	Dark spot center
228	Q4516528			✓	Multiple thin spots
229	Q4516530	✓			
230	Q4516532	✓			
231	Q4516537	✓			
232	Q4516538	✓			
233	Q4516543	✓			
234	Q4516545	✓			
235	Q4516546	✓			
236	Q4516551	✓			
237	Q4516553	✓			
238	Q4516556	✓			
239	Q4516561	✓			
240	Q4516563	✓			
241	Q4518137	✓			
242	Q4518138			✓	Dark spot at 4
243	Q4518145	✓			
244	Q4518148	✓			
245	Q4518155			✓	Thin spot at 3
246	Q4518157	✓			
247	Q4518158	✓			
248	Q4518162	✓			
249	Q4518167			✓	Thin spot at 1
250	Q4518169	✓			
251	Q4518170	✓			
252	Q4518174			✓	Dark spot at 8:30 center
253	Q4518182	✓			
254	Q4518190			✓	Vertical line 11:30 to 6:30
255	Q4518192	✓			
256	Q4518194	✓			
257	Q4518196			✓	Multiple thin spots
258	Q4518198	✓			
259	Q4518199	✓			

CY 2014 Quartz Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
260	Q4518200			✓	Multiple thin spots
261	Q4518526			✓	Multiple thin spots
262	Q4518528	✓			
263	Q4518529	✓			
264	Q4518535	✓			
265	Q4518545	✓			
266	Q4518546	✓			
267	Q4518547	✓			
268	Q4518548	✓			
269	Q4518549	✓			
270	Q4518554	✓			
271	Q4518557	✓			
272	Q4518558	✓			
273	Q4518568	✓			
274	Q4518573	✓			
275	Q4518576	✓			
276	Q4518578			✓	Thin spot at 9:30; dark spot at 9
277	Q4518580	✓			
278	Q4518585	✓			
279	Q4518588			✓	Large thin spot at 9 center
280	Q4518590	✓			
281	Q4521063	✓			
282	Q4521065	✓			
283	Q4521068	✓			
284	Q4521071	✓			
285	Q4521074	✓			
286	Q4521077	✓			
287	Q4521087	✓			
288	Q4521089	✓			
289	Q4521094			✓	Vertical line 12:30 to 5:30; Thin spot at 3
290	Q4521095	✓			
291	Q4521097	✓			
292	Q4521106			✓	Vertical line 12 to 6; Thin spot center at 9
293	Q4521107	✓			
294	Q4521109	✓			
295	Q4521110	✓			
296	Q4521112	✓			

CY 2014 Quartz Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
297	Q4521115	✓			
298	Q4521116			✓	Dark spot at 1:15
299	Q4521123	✓			
300	Q4521125	✓			
301	Q4522037	✓			
302	Q4522039	✓			
303	Q4522044			✓	Multiple thin spots
304	Q4522046			✓	Multiple thin spots
305	Q4522051			✓	Multiple thin spots
306	Q4522056		✓		Two dark spots center at 8 and 9
307	Q4522060	✓			
308	Q4522067	✓			
309	Q4522076			✓	Vertical line 1 to 5
310	Q4522077	✓			
311	Q4522079		✓		Large dark spots at 6 and 11:30
312	Q4522081	✓			
313	Q4522083			✓	Dark spot 12:30 top edge
314	Q4522084	✓			
315	Q4522085	✓			
316	Q4522086			✓	Vertical line 12 to 6; thin spot at 9:30
317	Q4522089			✓	Dark spot center at 2:30
318	Q4522092	✓			
319	Q4522097		✓		Very large dark spot at 5
320	Q4522099	✓			
321	Q4522301	✓			
322	Q4522302	✓			
323	Q4522304	✓			
324	Q4522306	✓			
325	Q4522307			✓	Thin spot at 2
326	Q4522316			✓	Thin spot at 3
327	Q4522318			✓	Dark thread at 12; thin spot at 2:30
328	Q4522325	✓			
329	Q4522329	✓			
330	Q4522342	✓			
331	Q4522343			✓	Dark spot center
332	Q4522344	✓			
333	Q4522347	✓			

CY 2014 Quartz Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
334	Q4522349		✓		Large scraped area at 6; two thin spots at 6
335	Q4522350	✓			
336	Q4522352	✓			
337	Q4522354	✓			
338	Q4522355	✓			
339	Q4522356	✓			
340	Q4522360	✓			
341	Q4522947			✓	Dark spot at 12
342	Q4522953	✓			
343	Q4522956			✓	Vertical line 12 to 6
344	Q4522961	✓			
345	Q4522963	✓			
346	Q4522964	✓			
347	Q4522965			✓	Thin spot at 2:30; dark spot at 6:45
348	Q4522966			✓	Dark spot at 6; thin spot at 9
349	Q4522972	✓			
350	Q4522973	✓			
351	Q4522976	✓			
352	Q4522977		✓		Two dark spots at 10 center
353	Q4522978	✓			
354	Q4522979	✓			
355	Q4522981	✓			
356	Q4522990		✓		Loose fibers back 5 & 6; dark spots 7:30 & 8 center
357	Q4522995	✓			
358	Q4522996	✓			
359	Q4522997	✓			
360	Q4523007	✓			
361	Q4526067	✓			
362	Q4526069		✓		Two dark spots at 3 and 10
363	Q4526071			✓	Dark spot at 8
364	Q4526073			✓	Dark spot at 6; thin spot at 5
365	Q4526077		✓		Very large dark spot at 12
366	Q4526081		✓		Two dark spots at 4 and 6
367	Q4526083			✓	Dark spot at 4
368	Q4526084			✓	Two thin spots at 9 and 3 center
369	Q4526085	✓			
370	Q4526088	✓			

CY 2014 Quartz Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
371	Q4526096	✓			
372	Q4526102			✓	Dark spot at 4
373	Q4526107	✓			
374	Q4526110	✓			
375	Q4526117		✓		Two dark spots at 10 and 3
376	Q4526120			✓	Thin spot at 9:30
377	Q4526122	✓			
378	Q4526124	✓			
379	Q4526125	✓			
380	Q4526129	✓			
381	Q4526717		✓		Torn bottom edge
382	Q4526720	✓			
383	Q4526721			✓	Dark spot at 6
384	Q4526723			✓	Vertical line 12 to 6
385	Q4526730			✓	Multiple thin spots
386	Q4526733		✓		Two dark spots at 9 and 10
387	Q4526736		✓		Two dark spots at 2 and 2:30
388	Q4526739			✓	Dark spot at 8:30
389	Q4526744	✓			
390	Q4526745			✓	Multiple thin spots
391	Q4526747			✓	Thin spot at 10
392	Q4526754	✓			
393	Q4526755	✓			
394	Q4526763			✓	Vertical line 12 to 6
395	Q4526764			✓	Multiple thin spots
396	Q4526768			✓	Multiple thin spots
397	Q4526769		✓		Two dark spots at 9 and 10
398	Q4526778			✓	Multiple thin spots
399	Q4526779			✓	Vertical line 12 to 6; multiple thin spots
400	Q4526780			✓	Multiple thin spots
401	Q4528341	✓			
402	Q4528342	✓			
403	Q4528345			✓	Thin spots at 6 and 9:30
404	Q4528346	✓			
405	Q4528348	✓			
406	Q4528352			✓	Thin spot at 3
407	Q4528358	✓			

CY 2014 Quartz Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
408	Q4528364	✓			
409	Q4528365	✓			
410	Q4528366	✓			
411	Q4528367	✓			
412	Q4528376	✓			
413	Q4528384			✓	Dark spot at 4
414	Q4528388	✓			
415	Q4528393	✓			
416	Q4528394	✓			
417	Q4528396	✓			
418	Q4528397	✓			
419	Q4528400	✓			
420	Q4528402	✓			
421	Q4528667	✓			
422	Q4528668	✓			
423	Q4528669	✓			
424	Q4528671	✓			
425	Q4528673	✓			
426	Q4528675	✓			
427	Q4528686	✓			
428	Q4528690	✓			
429	Q4528695	✓			
430	Q4528696	✓			
431	Q4528698	✓			
432	Q4528700	✓			
433	Q4528703	✓			
434	Q4528705	✓			
435	Q4528706	✓			
436	Q4528712			✓	Dark spot at 9
437	Q4528720	✓			
438	Q4528722	✓			
439	Q4528723	✓			
440	Q4528725	✓			
441	Q4529387	✓			
442	Q4529392	✓			
443	Q4529394	✓			
444	Q4529396	✓			

CY 2014 Quartz Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
445	Q4529397	✓			
446	Q4529398	✓			
447	Q4529400	✓			
448	Q4529403			✓	Thin spot bottom at 6
449	Q4529405	✓			
450	Q4529408	✓			
451	Q4529410			✓	Thin spot at 9
452	Q4529413	✓			
453	Q4529419			✓	Thin spot center at 3:30
454	Q4529429	✓			
455	Q4529433	✓			
456	Q4529435			✓	Thin spot center at 4
457	Q4529437			✓	Thin spots at 6 and 8
458	Q4529438	✓			
459	Q4529440			✓	Dark spot center at 2
460	Q4529444	✓			
461	Q4531331			✓	Thin spot at 6:30
462	Q4531332	✓			
463	Q4531335	✓			
464	Q4531342	✓			
465	Q4531344			✓	Dark spot at 12:30
466	Q4531347			✓	Thin spots at 6 and 8
467	Q4531349	✓			
468	Q4531358	✓			
469	Q4531359	✓			
470	Q4531362	✓			
471	Q4531373			✓	Vertical line 11:30 to 6:30
472	Q4531374	✓			
473	Q4531377	✓			
474	Q4531381	✓			
475	Q4531382			✓	Thin spot center at 9
476	Q4531383			✓	Dark spot at 6
477	Q4531384	✓			
478	Q4531386			✓	Dark spot at 6:30
479	Q4531388			✓	Vertical line 11:30 to 6:30
480	Q4531390	✓			
481	Q4533411			✓	Thin spot center at 3

CY 2014 Quartz Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
482	Q4533412	✓			
483	Q4533413			✓	Thin spots center at 4 and 5
484	Q4533422	✓			
485	Q4533429	✓			
486	Q4533430	✓			
487	Q4533431	✓			
488	Q4533433			✓	Thin spots at 6 and 9
489	Q4533434	✓			
490	Q4533435	✓			
491	Q4533436	✓			
492	Q4533442			✓	Dark spot at 7; thin spot at 12:30
493	Q4533445	✓			
494	Q4533448			✓	Thin spot at 3
495	Q4533452	✓			
496	Q4533458	✓			
497	Q4533461	✓			
498	Q4533468	✓			
499	Q4533470	✓			
500	Q4533474			✓	Vertical line 12:30 to 5:30
501	Q4500099			✓	Vertical line 12 to 6
502	Q4500405		✓		Very large dark spot at 3
503	Q4503767		✓		Multiple dark spots
504	Q4504444	✓			
505	Q4507280			✓	Two thin spots center
506	Q4508238			✓	Multiple thin spots center
507	Q4508647	✓			
508	Q4511443		✓		Coloration (red spot at 6:30)
509	Q4511507	✓			
510	Q4516220			✓	Multiple thin spots
511	Q4516572	✓			
512	Q4518136	✓			
513	Q4518552			✓	Dark spot at 8
514	Q4521076		✓		Very large dark spot at 7
515	Q4522074		✓		Dark spots at 3, 3:30 and 9
516	Q4522335		✓		Two dark spots at 9 and 3
517	Q4523004			✓	Two thin spots at 1 and 3
518	Q4526068			✓	Multiple thin spots

CY 2014 Quartz Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
519	Q4526758	✓			
520	Q4528380			✓	Dark spot at 10 center
521	Q4528692	✓			
522	Q4529423			✓	Vertical line 11:30 to 6:30
523	Q4531366	✓			
524	Q4533455	✓			
525	Q4529381	✓			
	Total	**302**	**43**	**180**	

Appendix B

Length and Width Test Results

CY-2014 Quartz Filters Width and Length

Filter #	Width	Maximum	Minimum	Acceptable	Length	Maximum	Minimum	Acceptable
Q4500087	8"	8" + 1/16"	8" – 1/16"	✔	10 1/32"	10" + 1/16"	10" – 1/16"	✔
Q4503737	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4503743	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4504427	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4507233	8"	8" + 1/16"	8" – 1/16"	✔	9 31/32"	10" + 1/16"	10" – 1/16"	✔
Q4507247	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4508209	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4508250	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4508660	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4508687	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4511458	7 31/32"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4511517	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4516530	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4516546	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4516563	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4518545	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4518554	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4521063	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4521095	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4521109	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4521123	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4522039	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4522302	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4522325	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4522329	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4522953	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4522972	7 31/32"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4522976	7 31/32"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4522979	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4526085	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔

CY-2014 Quartz Filters Width and Length

Filter #	Width	Maximum	Minimum	Acceptable	Length	Maximum	Minimum	Acceptable
Q4526122	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4526129	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4526720	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4526755	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4528346	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4528366	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4528388	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4528393	7 31/32"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4528402	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4528671	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4528686	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4528696	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4528698	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4529398	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4529413	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4531349	8 1/32"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4531362	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4533412	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4526758	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
Q4533455	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔

Results: Percent Acceptable 100 %

Appendix C

Brittleness Test Results

CY-2014 Quartz Filter Brittleness Test

Filter	Crack	Length	Acceptable	Filter	Crack	Length	Acceptable
Q4500087			✔	Q4522953			✔
Q4503737			✔	Q4522972			✔
Q4503743			✔	Q4522976			✔
Q4504427			✔	Q4522979			✔
Q4507233			✔	Q4526085			✔
Q4507247			✔	Q4526122			✔
Q4508209			✔	Q4526129			✔
Q4508250			✔	Q4526720			✔
Q4508660			✔	Q4526755			✔
Q4508687			✔	Q4528346			✔
Q4511458			✔	Q4528366			✔
Q4511517			✔	Q4528388			✔
Q4516530			✔	Q4528393			✔
Q4516546			✔	Q4528402			✔
Q4516563			✔	Q4528671			✔
Q4518545			✔	Q4528686			✔
Q4518554			✔	Q4528696			✔
Q4521063			✔	Q4528698			✔
Q4521095			✔	Q4529398			✔
Q4521109			✔	Q4529413			✔
Q4521123			✔	Q4531349			✔
Q4522039			✔	Q4531362			✔
Q4522302			✔	Q4533412			✔
Q4522325			✔	Q4526758			✔
Q4522329			✔	Q4533455			✔

Results: Percent Acceptable 100%

Appendix D

Thickness & Tensile Strength Test Results

IPS
TESTING EXPERTS

Mr. Stan Sleva
Project Manager
TRC
5540 Centerview Drive, Suite 100
Raleigh, NC 27606

Sample identification: Seventy-five quartz filters

Date received: July 31, 2013

Tests requested: Caliper and tensile

Purchase Order: 59793

Analysis of Quartz Filters

Integrated Paper Services, Inc. performed caliper and tensile testing on seventy-five quartz filters samples provided by TRC. Caliper testing was done following ASTM D645 and tensile testing was done following ASTM D828 with the following modifications: 20 mm sample width, 50 mm gage length and a 0.5 in/min test speed. The results are summarized in Tables 1 and 2.

If you have any questions, please call me.

Authorized by: _____
Jeff Bushner
Laboratory Manager
920-749-3040 ext. 124

Signed _____
Lucy Hayter
Sr. Scientist
920-749-3040 ext. 110

Table 1. Physical Properties of Quartz Filters

Sample Identification	Q4500073	Q4500106	Q4500408	Q4500423	Q4500441	Q4500447	Q4500454
Caliper (mils)							
Average	16.4	16.5	16.4	17.0	16.4	16.2	16.3
Std. Dev.	0.20	0.20	0.18	0.24	0.22	0.30	0.16
Max	16.7	16.6	16.6	17.3	16.7	16.5	16.5
Min	16.2	16.2	16.1	16.7	16.2	15.7	16.1
n =	5	4	5	5	5	5	5
Caliper (mm)							
Average	0.417	0.419	0.416	0.433	0.417	0.411	0.415
Std. Dev.	0.0051	0.0051	0.0045	0.0061	0.0055	0.0076	0.0042
Max	0.424	0.422	0.422	0.439	0.424	0.419	0.419
Min	0.411	0.411	0.409	0.424	0.411	0.399	0.409
n =	5	4	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	577	555	590	658	581	570	589
Std. Dev.	50.1	42.8	49.1	36.8	50.6	23.2	31.8
Max	626	608	640	708	671	594	640
Min	463	449	481	585	490	522	549
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	1.27	1.22	1.30	1.45	1.28	1.26	1.30
Std. Dev.	0.111	0.094	0.108	0.081	0.112	0.051	0.070
Max	1.38	1.34	1.41	1.56	1.48	1.31	1.41
Min	1.02	0.99	1.06	1.29	1.08	1.15	1.21
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	2.40	3.32	4.46	3.90	3.72	3.34	2.76
Std. Dev.	1.05	1.14	0.653	0.907	0.837	0.880	1.01
Max	4.19	4.71	5.48	5.24	5.37	5.35	4.55
Min	1.08	0.971	3.70	2.09	2.79	2.37	1.43
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	5.73	7.61	11.2	11.1	9.28	7.94	6.83
Std. Dev.	3.11	3.06	2.47	3.21	2.94	2.53	2.91
Max	10.9	12.1	14.4	16.5	15.8	13.3	11.8
Min	1.64	1.44	7.64	5.27	6.32	5.02	3.37
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Quartz Filters (continued)

Sample Identification	Q4503720	Q4503728	Q4503762	Q4504429	Q4504455	Q4505480	Q4505489
Caliper (mils)							
Average	17.5	17.4	17.1	17.3	17.0	17.0	17.5
Std. Dev.	0.22	0.08	0.23	0.19	0.18	0.13	0.11
Max	17.8	17.5	17.4	17.6	17.3	17.1	17.6
Min	17.3	17.3	16.8	17.1	16.8	16.8	17.3
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.445	0.441	0.434	0.438	0.432	0.432	0.443
Std. Dev.	0.0055	0.0021	0.0058	0.0050	0.0045	0.0033	0.0029
Max	0.452	0.445	0.442	0.447	0.439	0.434	0.447
Min	0.439	0.439	0.427	0.434	0.427	0.427	0.439
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	613	561	547	582	535	572	561
Std. Dev.	26.7	31.8	41.2	15.8	39.6	15.6	20.3
Max	653	599	594	603	581	599	585
Min	558	494	454	562	463	544	531
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	1.35	1.24	1.21	1.28	1.18	1.26	1.24
Std. Dev.	0.059	0.070	0.091	0.035	0.087	0.034	0.045
Max	1.44	1.32	1.31	1.33	1.28	1.32	1.29
Min	1.23	1.09	1.00	1.24	1.02	1.20	1.17
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	4.42	3.08	3.09	3.97	2.16	3.25	2.97
Std. Dev.	0.418	0.526	0.808	0.880	0.862	0.898	0.747
Max	5.13	3.80	4.34	4.82	3.35	4.26	4.31
Min	3.73	2.29	1.43	2.04	0.969	1.95	1.77
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	11.5	7.31	7.22	9.88	4.81	8.01	7.09
Std. Dev.	1.02	1.58	2.31	2.46	2.30	2.61	2.09
Max	13.2	9.64	11.0	12.4	8.14	10.8	11.0
Min	9.95	4.47	2.28	4.46	1.47	4.09	3.69
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Quartz Filters (continued)

Sample Identification	Q4507221	Q4507245	Q4507258	Q4508198	Q4508244	Q4508247	Q4508648
Caliper (mils)							
Average	16.8	17.4	17.3	16.9	17.2	17.1	16.9
Std. Dev.	0.27	0.11	0.19	0.33	0.22	0.38	0.21
Max	17.2	17.5	17.6	17.4	17.5	17.4	17.1
Min	16.5	17.3	17.1	16.6	17.0	16.4	16.6
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.427	0.441	0.440	0.430	0.437	0.433	0.429
Std. Dev.	0.0070	0.0028	0.0049	0.0083	0.0055	0.0098	0.0054
Max	0.437	0.445	0.447	0.442	0.445	0.442	0.434
Min	0.419	0.439	0.434	0.422	0.432	0.417	0.422
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	579	590	577	565	575	591	548
Std. Dev.	36.7	14.5	34.9	41.3	21.3	39.7	50.8
Max	608	608	621	608	594	626	599
Min	481	562	499	481	522	485	458
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	1.28	1.30	1.27	1.25	1.27	1.30	1.21
Std. Dev.	0.081	0.032	0.077	0.091	0.047	0.087	0.112
Max	1.34	1.34	1.37	1.34	1.31	1.38	1.32
Min	1.06	1.24	1.10	1.06	1.15	1.07	1.01
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	1.32	3.27	2.89	2.36	2.47	2.45	2.02
Std. Dev.	0.319	0.644	1.04	0.820	0.752	0.841	0.712
Max	1.94	4.32	4.24	3.92	3.94	3.38	3.07
Min	0.918	2.05	1.06	1.18	1.67	0.830	0.815
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	2.79	8.10	6.97	5.52	5.88	6.10	4.52
Std. Dev.	0.624	1.80	2.81	2.44	2.19	2.40	2.01
Max	3.85	10.6	10.8	10.3	10.3	8.85	7.88
Min	1.85	5.01	2.12	2.26	3.60	1.33	1.23
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Quartz Filters (continued)

Sample Identification	Q4508706	Q4508670	Q4508685	Q4511449	Q4511474	Q4511494	Q4511516
Caliper (mils)							
Average	16.9	17.2	16.2	17.3	17.0	17.1	17.4
Std. Dev.	0.16	0.32	0.17	0.21	0.32	0.21	0.21
Max	17.0	17.6	16.4	17.6	17.3	17.3	17.6
Min	16.7	16.8	16.0	17.1	16.6	16.8	17.1
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.429	0.438	0.412	0.440	0.432	0.435	0.442
Std. Dev.	0.0042	0.0082	0.0043	0.0053	0.0082	0.0053	0.0054
Max	0.432	0.447	0.417	0.447	0.439	0.439	0.447
Min	0.424	0.427	0.406	0.434	0.422	0.427	0.434
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	627	580	589	571	577	581	601
Std. Dev.	30.0	32.3	32.4	44.2	23.1	35.2	25.4
Max	676	612	635	644	612	635	649
Min	585	499	531	494	535	531	558
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	1.38	1.28	1.30	1.26	1.27	1.28	1.32
Std. Dev.	0.066	0.071	0.071	0.097	0.051	0.078	0.056
Max	1.49	1.35	1.40	1.42	1.35	1.40	1.43
Min	1.29	1.10	1.17	1.09	1.18	1.17	1.23
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	2.94	2.98	2.27	2.45	2.68	2.12	3.48
Std. Dev.	1.12	0.675	0.917	0.989	0.755	0.887	0.795
Max	4.91	3.75	4.05	4.29	3.88	3.45	4.30
Min	1.51	1.80	1.32	1.23	1.74	0.938	2.07
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	7.86	7.16	5.47	5.55	6.36	4.98	8.83
Std. Dev.	3.46	2.16	2.77	2.95	2.01	2.39	2.31
Max	13.9	9.72	11.2	11.9	9.76	8.80	11.5
Min	3.26	3.78	2.48	2.34	3.74	1.66	4.83
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Quartz Filters (continued)

Sample Identification	Q4511552	Q4511557	Q4516191	Q4516197	Q4516537	Q4516543	Q4518162
Caliper (mils)							
Average	17.2	17.3	17.3	17.3	17.1	16.9	16.5
Std. Dev.	0.17	0.22	0.28	0.24	0.11	0.21	0.19
Max	17.3	17.5	17.6	17.6	17.2	17.1	16.8
Min	16.9	17.0	16.9	17.0	16.9	16.6	16.3
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.436	0.440	0.439	0.438	0.433	0.430	0.420
Std. Dev.	0.0043	0.0055	0.0070	0.0061	0.0029	0.0053	0.0049
Max	0.439	0.445	0.447	0.447	0.437	0.434	0.427
Min	0.429	0.432	0.429	0.432	0.429	0.422	0.414
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	555	542	555	609	584	559	581
Std. Dev.	25.9	16.0	27.6	22.9	32.6	33.4	25.3
Max	585	572	594	635	621	612	626
Min	513	517	517	567	517	513	535
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	1.22	1.19	1.22	1.34	1.29	1.23	1.28
Std. Dev.	0.057	0.035	0.061	0.051	0.072	0.074	0.056
Max	1.29	1.26	1.31	1.40	1.37	1.35	1.38
Min	1.13	1.14	1.14	1.25	1.14	1.13	1.18
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	2.59	2.60	1.82	2.82	2.79	2.37	3.04
Std. Dev.	0.815	0.400	0.380	0.649	0.613	0.526	1.38
Max	4.31	3.15	2.57	3.55	3.78	3.08	5.03
Min	1.81	1.75	1.42	1.45	1.67	1.46	1.25
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	5.80	5.40	3.90	7.13	6.74	5.48	7.59
Std. Dev.	2.04	0.969	1.09	2.08	1.39	1.13	3.93
Max	9.41	6.89	6.18	9.30	8.64	6.81	13.9
Min	3.60	3.37	2.93	2.81	4.18	3.37	2.52
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Quartz Filters (continued)

Sample Identification	Q4518169	Q4518182	Q4518528	Q4518548	Q4518568	Q4518580	Q4521065
Caliper (mils)							
Average	16.9	17.4	17.1	17.2	16.3	16.9	17.0
Std. Dev.	0.17	0.27	0.24	0.13	0.29	0.24	0.29
Max	17.0	17.8	17.4	17.3	16.6	17.2	17.3
Min	16.6	17.2	16.9	17.0	16.0	16.6	16.6
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.428	0.442	0.435	0.436	0.415	0.429	0.431
Std. Dev.	0.0043	0.0068	0.0061	0.0033	0.0075	0.0061	0.0073
Max	0.432	0.452	0.442	0.439	0.422	0.437	0.439
Min	0.422	0.437	0.429	0.432	0.406	0.422	0.422
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	601	584	570	566	609	568	642
Std. Dev.	25.1	19.0	29.6	60.2	29.4	29.3	24.3
Max	635	612	612	621	649	621	676
Min	562	553	522	408	558	522	594
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	1.33	1.29	1.26	1.25	1.34	1.25	1.42
Std. Dev.	0.055	0.042	0.065	0.133	0.065	0.065	0.054
Max	1.40	1.35	1.35	1.37	1.43	1.37	1.49
Min	1.24	1.22	1.15	0.90	1.23	1.15	1.31
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	3.03	2.48	2.85	3.18	3.23	2.22	3.55
Std. Dev.	0.881	0.560	0.989	1.11	0.595	0.468	0.644
Max	3.91	3.47	4.31	4.49	4.03	2.88	4.30
Min	1.44	1.97	1.52	0.843	2.29	1.44	2.65
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	7.69	5.91	6.94	7.73	8.50	5.31	9.94
Std. Dev.	2.42	1.55	2.96	3.16	1.82	1.47	2.24
Max	11.0	8.29	11.4	12.1	11.1	7.80	12.9
Min	3.54	4.38	3.24	1.02	5.90	3.28	6.41
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Quartz Filters (continued)

Sample Identification	Q4521074	Q4521087	Q4521094	Q4522060	Q4522077	Q4522084	Q4522097
Caliper (mils)							
Average	16.7	16.8	16.8	17.2	17.2	17.1	17.4
Std. Dev.	0.43	0.16	0.21	0.29	0.24	0.38	0.40
Max	17.2	17.0	17.0	17.4	17.5	17.4	17.9
Min	16.0	16.6	16.5	16.7	17.0	16.6	16.9
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.423	0.426	0.426	0.437	0.438	0.433	0.442
Std. Dev.	0.0110	0.0042	0.0053	0.0074	0.0061	0.0096	0.0101
Max	0.437	0.432	0.432	0.442	0.445	0.442	0.455
Min	0.406	0.422	0.419	0.424	0.432	0.422	0.429
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	554	600	574	541	624	547	548
Std. Dev.	39.2	60.3	32.9	27.1	35.6	24.7	18.8
Max	608	694	617	576	671	585	572
Min	490	499	499	508	558	499	517
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	1.22	1.32	1.27	1.19	1.38	1.21	1.21
Std. Dev.	0.087	0.133	0.072	0.060	0.078	0.054	0.041
Max	1.34	1.53	1.36	1.27	1.48	1.29	1.26
Min	1.08	1.10	1.10	1.12	1.23	1.10	1.14
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	1.77	2.69	1.91	2.56	4.05	3.37	2.91
Std. Dev.	0.638	0.925	0.499	0.765	0.779	0.602	0.908
Max	2.91	4.13	2.76	3.68	5.00	4.49	4.54
Min	1.13	0.984	1.28	1.41	2.75	2.24	1.69
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	3.86	6.89	4.32	5.62	10.8	7.77	6.70
Std. Dev.	1.77	2.95	1.41	1.85	2.81	1.71	2.46
Max	7.39	11.3	6.65	8.12	14.7	10.7	11.1
Min	2.04	1.59	2.82	2.58	5.95	5.16	3.25
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Quartz Filters (continued)

Sample Identification	Q4522963	Q4522981	Q4526077	Q4526096	Q4526736	Q4526744	Q4528348
Caliper (mils)							
Average	16.9	17.0	17.2	17.1	17.1	16.9	16.5
Std. Dev.	0.23	0.07	0.36	0.30	0.31	0.34	0.27
Max	17.2	17.1	17.5	17.6	17.4	17.3	16.8
Min	16.6	16.9	16.6	16.9	16.6	16.6	16.2
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.430	0.432	0.436	0.433	0.435	0.429	0.420
Std. Dev.	0.0058	0.0018	0.0091	0.0077	0.0080	0.0087	0.0069
Max	0.437	0.434	0.445	0.447	0.442	0.439	0.427
Min	0.422	0.429	0.422	0.429	0.422	0.422	0.411
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	560	550	572	577	639	559	476
Std. Dev.	34.4	26.0	50.1	39.0	19.6	34.5	49.7
Max	590	576	644	635	667	617	522
Min	490	494	458	531	608	485	349
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	1.23	1.21	1.26	1.27	1.41	1.23	1.05
Std. Dev.	0.076	0.057	0.111	0.086	0.043	0.076	0.110
Max	1.30	1.27	1.42	1.40	1.47	1.36	1.15
Min	1.08	1.09	1.01	1.17	1.34	1.07	0.77
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	2.58	2.39	4.18	4.01	4.96	4.63	2.76
Std. Dev.	0.624	1.07	1.27	1.21	0.576	0.808	0.790
Max	3.70	4.00	5.75	5.26	5.73	5.40	3.57
Min	1.46	1.10	1.28	2.19	4.02	2.73	1.13
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	5.94	5.47	10.0	9.75	13.5	11.0	5.51
Std. Dev.	1.74	2.92	3.71	3.57	1.92	2.30	2.02
Max	9.38	10.0	15.6	13.1	16.0	13.4	7.45
Min	3.28	1.87	1.80	4.76	10.3	5.83	1.27
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Quartz Filters (continued)

Sample Identification	Q4528364	Q4508376 (Q4528376)	Q4528673	Q4528690	Q4528700	Q4528722	Q4529392
Caliper (mils)							
Average	16.3	16.5	16.8	16.6	16.7	16.5	16.8
Std. Dev.	0.37	0.25	0.16	0.11	0.16	0.13	0.11
Max	16.9	16.7	17.0	16.8	16.8	16.7	17.0
Min	16.0	16.2	16.6	16.5	16.4	16.4	16.7
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.415	0.418	0.427	0.423	0.424	0.419	0.427
Std. Dev.	0.0094	0.0064	0.0040	0.0029	0.0042	0.0033	0.0028
Max	0.429	0.424	0.432	0.427	0.427	0.424	0.432
Min	0.406	0.411	0.422	0.419	0.417	0.417	0.424
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	503	525	601	608	590	547	563
Std. Dev.	13.4	25.2	15.4	24.6	16.3	40.1	39.1
Max	531	558	621	644	617	603	612
Min	490	472	572	562	558	490	494
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	1.11	1.16	1.32	1.34	1.30	1.21	1.24
Std. Dev.	0.030	0.056	0.034	0.054	0.036	0.088	0.086
Max	1.17	1.23	1.37	1.42	1.36	1.33	1.35
Min	1.08	1.04	1.26	1.24	1.23	1.08	1.09
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	2.27	2.79	3.51	3.42	2.64	2.82	3.93
Std. Dev.	0.898	1.34	1.15	1.12	0.576	0.858	0.681
Max	3.88	5.25	5.21	4.67	3.26	3.89	5.37
Min	1.20	0.916	2.31	1.22	1.58	1.16	3.09
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	4.70	6.15	9.04	8.85	6.43	6.26	9.40
Std. Dev.	2.09	3.17	3.04	3.11	1.50	2.14	2.19
Max	8.38	11.3	13.2	11.8	8.03	8.75	13.86
Min	2.11	1.44	5.65	2.80	3.72	1.90	6.66
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Quartz Filters (continued)

Sample Identification	Q4529397	Q4529405	Q4529419	Q4529444	Q4521374 (Q4531374)	Q4531381	Q4533436
Caliper (mils)							
Average	16.8	17.0	16.9	16.4	17.0	16.7	16.1
Std. Dev.	0.251	0.195	0.167	0.329	0.245	0.130	0.195
Max	17.1	17.3	17.2	16.9	17.3	16.9	16.4
Min	16.6	16.8	16.8	16.1	16.7	16.6	15.9
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.428	0.433	0.430	0.416	0.432	0.425	0.410
Std. Dev.	0.0064	0.0050	0.0043	0.0083	0.0062	0.0033	0.0050
Max	0.434	0.439	0.437	0.429	0.439	0.429	0.417
Min	0.422	0.427	0.427	0.409	0.424	0.422	0.404
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	590	575	564	482	565	567	520
Std. Dev.	14.7	19.8	17.4	17.8	56.2	16.2	25.6
Max	608	608	590	517	635	594	544
Min	562	544	540	463	417	544	454
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	1.30	1.27	1.24	1.06	1.25	1.25	1.15
Std. Dev.	0.032	0.044	0.038	0.039	0.124	0.036	0.056
Max	1.34	1.34	1.30	1.14	1.40	1.31	1.20
Min	1.24	1.20	1.19	1.02	0.92	1.20	1.00
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	3.43	3.58	2.58	2.32	3.08	2.67	1.25
Std. Dev.	0.938	0.689	0.723	0.552	1.02	0.716	0.413
Max	4.73	4.41	3.56	3.56	4.62	3.90	2.17
Min	1.42	2.32	1.68	1.74	1.02	1.74	0.856
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	8.63	8.71	5.96	4.42	7.59	6.30	2.32
Std. Dev.	2.60	1.90	2.02	1.11	3.16	1.90	0.788
Max	12.0	11.7	8.83	6.56	13.0	9.43	3.72
Min	3.25	5.30	3.23	3.16	1.28	3.73	1.37
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Quartz Filters (continued)

Sample Identification	Q4533458	Q4533470	Q4508647	Q4522335	Q4528692
Caliper (mils)					
Average	16.9	16.6	16.8	16.4	16.6
Std. Dev.	0.152	0.089	0.432	0.277	0.167
Max	17.1	16.7	17.3	16.7	16.9
Min	16.7	16.5	16.3	16.0	16.5
n =	5	5	5	5	5
Caliper (mm)					
Average	0.428	0.421	0.427	0.416	0.423
Std. Dev.	0.0039	0.0023	0.0110	0.0070	0.0043
Max	0.434	0.424	0.439	0.424	0.429
Min	0.424	0.419	0.414	0.406	0.419
n =	5	5	5	5	5
MD Tensile (gf/20 mm)					
Average	559	566	539	570	582
Std. Dev.	24.2	23.1	22.6	28.1	23.3
Max	585	599	576	612	612
Min	513	526	499	517	540
n =	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)					
Average	1.23	1.25	1.19	1.26	1.28
Std. Dev.	0.053	0.051	0.050	0.062	0.051
Max	1.29	1.32	1.27	1.35	1.35
Min	1.13	1.16	1.10	1.14	1.19
n =	10	10	10	10	10
MD Stretch (%)					
Average	1.13	1.40	1.76	1.63	1.81
Std. Dev.	0.253	0.418	0.398	0.521	0.531
Max	1.64	2.43	2.35	2.32	2.63
Min	0.914	0.963	1.22	0.806	0.915
n =	10	10	10	10	10
MD TEA (J/m^2)					
Average	2.24	2.89	3.57	3.57	4.12
Std. Dev.	0.605	0.970	0.880	1.24	1.40
Max	3.37	5.09	4.92	5.42	6.48
Min	1.55	1.91	2.40	1.53	1.82
n =	10	10	10	10	10

Table 2. Summary Data for Quartz Filters

Sample Identification	Quartz Filters
Caliper (mils)	
Average	16.9
Std. Dev.	0.41
Max	17.9
Min	15.7
n =	374
Caliper (mm)	
Average	0.429
Std. Dev.	0.0104
Max	0.455
Min	0.399
n =	374
MD Tensile (gf/20 mm)	
Average	572
Std. Dev.	43.8
Max	708
Min	349
n =	750
MD Tensile Strength (lbf/20 mm)	
Average	1.26
Std. Dev.	0.097
Max	1.56
Min	0.770
n =	750
MD Stretch (%)	
Average	2.85
Std. Dev.	1.11
Max	5.75
Min	0.806
n =	750
MD TEA (J/m^2)	
Average	6.85
Std. Dev.	3.18
Max	16.5
Min	1.02
n =	750

Method(s) and Notes:

Sampling done by customer.
Samples were not preconditioned.
Samples were conditioned in the opened package for a minimum of four hours at a temperature of 73.3°F and a relative humidity of 50.1% RH.
Temperature conditions during testing were 72.5°F to 73.3°F.
Humidity conditions during testing were 50.1% RH to 50.8% RH.
All valid results are included in the statistical analyses.

ASTM D 645/D645M - 97 (Reapproved 2002) Standard Test Method for Thickness of Paper and Paperboard

ASTM D 828 - 97 Standard Test Method for Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus

Per customer request the following modifications were made: Specimen cut 20 mm wide, gauge length 50 mm and crosshead rate 0.5 in/min.
Basis weights were not determined, therefore breaking length and tensile index could not be calculated.
Flat gripping surface jaws were used.

Analysis by NRG. JRT
Quality review by LAH
Dates tested August 1 - 16, 2013

Notes: These results relate only to the items tested. This test report shall not be reproduced, except in full, without written consent of IPS. See the ASTM test method(s) cited above for estimates of measurement uncertainty.

Appendix E

Flow Rate Test Results

CY 2014 Quartz Flow Rates (75 Filters)

Number	Sm.#s	Filter Identification	Delta P Hi-Vol	Delta P Orifice	Q, m^3/min measured	Qstd, m^3/min
1	10	Q4500111	6.00	5.3	1.570	1.578
2	31	Q4500426	5.90		1.550	1.558
3	33	Q4500433	5.90		1.550	1.558
4	50	Q4503734	6.00	6532.0	1.570	1.578
5	52	Q4500111	6.00		1.570	1.578
6	57	Q4503754	6.00	5.3	1.570	1.578
7	58	Q4503755	6.00		1.570	1.578
8	100	Q4505524	6.10		1.580	1.588
9	104	Q4507229	5.90		1.550	1.558
10	117	Q4507266	6.00		1.570	1.578
11	123	Q4508201	6.00	5.3	1.570	1.578
12	125	Q4508211	5.80		1.540	1.548
13	135	Q4508245	5.80		1.540	1.548
14	143	Q4508651	5.90		1.550	1.558
15	152	Q4508679	5.70		1.530	1.538
16	153	Q4508680	5.90	5.3	1.550	1.558
17	160	Q4508710	5.80		1.540	1.548
18	165	Q4511452	5.70		1.530	1.538
19	167	Q4511459	5.80		1.540	1.548
20	168	Q4511460	5.70		1.530	1.538
21	180	Q4511497	5.70	5.3	1.530	1.538
22	190	Q4511537	5.70		1.530	1.538
23	195	Q4511553	5.80		1.540	1.548
24	200	Q4511568	5.80		1.540	1.548
25	230	Q4516532	5.80		1.540	1.548
26	234	Q4516545	5.70	5.3	1.530	1.538
27	236	Q4516551	5.65		1.525	1.533
28	237	Q4516553	5.70		1.530	1.538
29	264	Q4518535	6.00		1.570	1.578
30	267	Q4518547	6.00	5.3	1.570	1.578
31	269	Q4518549	5.90		1.550	1.558
32	271	Q4518557	5.85		1.545	1.553
33	284	Q4521071	5.70		1.530	1.538
34	288	Q4521089	5.70		1.530	1.538
35	291	Q4521097	5.80	5.3	1.540	1.548
36	293	Q4521107	5.80		1.540	1.548
37	301	Q4522037	5.90		1.550	1.558
38	297	Q4521115	5.70		1.530	1.538
39	312	Q4522081	5.80		1.540	1.548
40	315	Q4522085	5.80	5.3	1.540	1.548
41	321	Q4522301	5.70		1.530	1.538
42	324	Q4522306	5.70		1.530	1.538
43	330	Q4522342	5.80		1.540	1.548
44	340	Q4522360	5.80		1.540	1.548
45	344	Q4522961	5.80	5.3	1.540	1.548
46	353	Q4522978	5.75		1.535	1.543
47	361	Q4526067	6.10		1.550	1.558
48	374	Q4526110	5.80		1.540	1.548
49	378	Q4526124	5.70		1.530	1.538
50	392	Q4526754	5.90	5.3	1.550	1.558
51	401	Q4528341	6.30		1.610	1.618
52	407	Q4528358	6.20		1.590	1.598
53	411	Q4528367	6.20	5.3	1.590	1.598
54	423	Q4528669	6.30		1.610	1.618
55	426	Q4528675	6.40		1.620	1.628

CY 2014 Quartz Flow Rates (75 Filters)

Number	Sm.#s	Filter Identification	Delta P Hi-Vol	Delta P Orifice	Q, m^3/min measured	Qstd, m^3/min
56	429	Q4528695	6.20	5.3	1.590	1.598
57	441	Q4529387	6.40		1.620	1.628
58	447	Q4529400	6.20		1.590	1.598
59	450	Q4529408	6.20		1.590	1.598
60	455	Q4529433	6.20		1.590	1.598
61	462	Q4531332	6.10	5.3	1.580	1.588
62	469	Q4531359	6.20		1.590	1.598
63	477	Q4531384	6.30		1.600	1.608
64	512	Q4518136	5.90		1.550	1.558
65	523	Q4531366	6.20	5.3	1.590	1.598
66	23	Q4500398	6.00	5.3	1.570	1.578
67	63	Q4504432	6.00		1.570	1.578
68	147	Q4508661	5.90		1.550	1.558
69	228	Q4516528	5.90		1.550	1.558
70	385	Q4526730	5.90	5.3	1.550	1.558
71	11	Q4500113	6.10	5.3	1.580	1.588
72	53	Q4503740	5.80		1.540	1.548
73	138	Q4508249	5.90		1.550	1.558
74	199	Q4511567	5.90		1.550	1.558
75	362	Q4526069	5.80	5.3	1.540	1.548
		Average	5.92		1.556	1.564
		Std. Dev.	0.19		0.024	0.026

Q measured Conditions
Temp.° F. = 75 = 297.04° K
Press. 30.12 inches Hg, = 765.04 mm Hg

Q Standard Conditions
Temp. = 298 K
Press. 760 mm Hg.

CY 2014 Quartz Flow Rates (65 Passing Filters)

Number	Sm.#s	Filter Identification	Delta P Hi-Vol	Delta P Orifice	Q, m^3/min measured	Qstd, m^3/min
1	10	Q4500111	6.00	5.3	1.570	1.578
2	31	Q4500426	5.90		1.550	1.558
3	33	Q4500433	5.90		1.550	1.558
4	50	Q4503734	6.00	6532.0	1.570	1.578
5	52	Q4500111	6.00		1.570	1.578
6	57	Q4503754	6.00	5.3	1.570	1.578
7	58	Q4503755	6.00		1.570	1.578
8	100	Q4505524	6.10		1.580	1.588
9	104	Q4507229	5.90		1.550	1.558
10	117	Q4507266	6.00		1.570	1.578
11	123	Q4508201	6.00	5.3	1.570	1.578
12	125	Q4508211	5.80		1.540	1.548
13	135	Q4508245	5.80		1.540	1.548
14	143	Q4508651	5.90		1.550	1.558
15	152	Q4508679	5.70		1.530	1.538
16	153	Q4508680	5.90	5.3	1.550	1.558
17	160	Q4508710	5.80		1.540	1.548
18	165	Q4511452	5.70		1.530	1.538
19	167	Q4511459	5.80		1.540	1.548
20	168	Q4511460	5.70		1.530	1.538
21	180	Q4511497	5.70	5.3	1.530	1.538
22	190	Q4511537	5.70		1.530	1.538
23	195	Q4511553	5.80		1.540	1.548
24	200	Q4511568	5.80		1.540	1.548
25	230	Q4516532	5.80		1.540	1.548
26	234	Q4516545	5.70	5.3	1.530	1.538
27	236	Q4516551	5.65		1.525	1.533
28	237	Q4516553	5.70		1.530	1.538
29	264	Q4518535	6.00		1.570	1.578
30	267	Q4518547	6.00	5.3	1.570	1.578
31	269	Q4518549	5.90		1.550	1.558
32	271	Q4518557	5.85		1.545	1.553
33	284	Q4521071	5.70		1.530	1.538
34	288	Q4521089	5.70		1.530	1.538
35	291	Q4521097	5.80	5.3	1.540	1.548
36	293	Q4521107	5.80		1.540	1.548
37	301	Q4522037	5.90		1.550	1.558
38	297	Q4521115	5.70		1.530	1.538
39	312	Q4522081	5.80		1.540	1.548
40	315	Q4522085	5.80	5.3	1.540	1.548
41	321	Q4522301	5.70		1.530	1.538
42	324	Q4522306	5.70		1.530	1.538
43	330	Q4522342	5.80		1.540	1.548
44	340	Q4522360	5.80		1.540	1.548
45	344	Q4522961	5.80	5.3	1.540	1.548
46	353	Q4522978	5.75		1.535	1.543
47	361	Q4526067	6.10		1.550	1.558
48	374	Q4526110	5.80		1.540	1.548
49	378	Q4526124	5.70		1.530	1.538
50	392	Q4526754	5.90	5.3	1.550	1.558
51	401	Q4528341	6.30		1.610	1.618
52	407	Q4528358	6.20		1.590	1.598
53	411	Q4528367	6.20	5.3	1.590	1.598
54	423	Q4528669	6.30		1.610	1.618
55	426	Q4528675	6.40		1.620	1.628

CY 2014 Quartz Flow Rates (65 Passing Filters)

Number	Sm.#s	Filter Identification	Delta P Hi-Vol	Delta P Orifice	Q, m^3/min measured	Qstd, m^3/min
56	429	Q4528695	6.20	5.3	1.590	1.598
57	441	Q4529387	6.40		1.620	1.628
58	447	Q4529400	6.20		1.590	1.598
59	450	Q4529408	6.20		1.590	1.598
60	455	Q4529433	6.20		1.590	1.598
61	462	Q4531332	6.10	5.3	1.580	1.588
62	469	Q4531359	6.20		1.590	1.598
63	477	Q4531384	6.30		1.600	1.608
64	512	Q4518136	5.90		1.550	1.558
65	523	Q4531366	6.20	5.3	1.590	1.598
		Average	5.92		1.556	1.564
		Std. Dev.	0.20		0.026	0.026

Q measured Conditions
Temp.° F. = 75 = 297.04° K
Press. 30.12 inches Hg, = 765.04 mm Hg

Q Standard Conditions
Temp. = 298 K
Press. 760 mm Hg.

CY 2014 Quartz Flow Rates Five Defects and Five Rejects

Number	Filter Identification	Delta P Hi-Vol	Delta P Orifice	Q, m^3/min measured	Qstd, m^3/min
1	**Defects**				
2	Q4500398	6.00	5.3	1.570	1.578
3	Q4504432	6.00		1.570	1.578
4	Q4508661	5.90		1.550	1.558
5	Q4516528	5.90		1.550	1.558
6	Q4526730	5.90	5.3	1.550	1.558
7	**Average**	**5.94**		**1.558**	**1.566**
8	**Std. Dev.**	**0.05**		**0.011**	**0.011**
9					
10					
11	**Rejects**				
12	Q4500113	6.10	5.3	1.580	1.588
13	Q4503740	5.80		1.540	1.548
14	Q4508249	5.90		1.550	1.558
15	Q4511567	5.90		1.550	1.558
16	Q4526069	5.80	5.3	1.540	1.548
17	**Average**	**5.90**		**1.552**	**1.560**
18	**Std.Dev.**	**0.12**		**0.017**	**0.017**

Q measured Conditions
Temp. F. = K
Press. mm Hg,

Q Standard Conditions
Temp. = 298 K
Press. 760 mm Hg.

Appendix F

Retention Test Results

CY-2014 Quartz Filter Retention Test

Sample #	Penetration %	Efficiency %	Resistance mm/H_2O	Resistance In/H_2O
Q4500066	0.01	99.9900	26	1.0
Q4500084	0.004	99.9960	26	1.0
Q4500126	0.003	99.9970	26	1.0
Q4500396	0.003	99.9970	26	1.0
Q4500431	0.004	99.9960	26	1.0
Q4503718	0.004	99.9960	26	1.0
Q4503732	0.002	99.9980	26	1.0
Q4504449	0.002	99.9980	26	1.0
Q4504465	0.001	99.9990	26	1.0
Q4505476	0.001	99.9990	26	1.0
Q4505512	0.003	99.9970	26	1.0
Q4507235	0.004	99.9960	26	1.0
Q4507269	0.002	99.9980	26	1.0
Q4508221	0.003	99.9970	26	1.0
Q4508243	0.003	99.9970	26	1.0
Q4508255	0.002	99.9980	26	1.0
Q4508649	0.003	99.9970	26	1.0
Q4508662	0.001	99.9990	26	1.0
Q4511441	0.001	99.9990	26	0.8
Q4511488	0.002	99.9980	28	1.1
Q4511521	0.001	99.9990	26	1.0
Q4511555	0.003	99.9970	26	1.0
Q4516195	0.003	99.9970	26	1.0
Q4516512	0.002	99.9980	26	1.0
Q4516556	0.003	99.9970	28	1.1
Q4518192	0.004	99.9960	26	1.0
Q4518529	0.003	99.9970	26	1.0
Q4518573	0.003	99.9970	26	1.0
Q4521068	0.004	99.9960	28	1.1
Q4521110	0.003	99.9970	28	1.1
Q4521125	0.003	99.9970	28	1.1
Q4522089	0.003	99.9970	28	1.1
Q4522092	0.002	99.9980	28	1.1
Q4522304	0.001	99.9990	28	1.1
Q4522354	0.002	99.9980	28	1.1
Q4522964	0.001	99.9990	28	1.1
Q4522996	0.003	99.9970	28	1.1
Q4526081	0.002	99.9980	28	1.1
Q4526088	0.002	99.9980	28	1.1
Q4528365	0.003	99.9970	26	1.0
Q4528723	0.002	99.9980	26	1.0
Q4521076	0.002	99.9980	28	1.1
Q4528667	0.003	99.9970	26	1.0
Q4529396	0.001	99.9990	26	1.0
Q4529429	0.001	99.9990	26	1.0
Q4531335	0.003	99.9970	26	1.0
Q4531377	0.003	99.9970	26	1.0
Q4533430	0.002	99.9980	26	1.0
Q4533468	0.001	99.9990	26	1.0
Q4504444	0.001	99.9990	26	1.0
Average		99.9974		1.02
Std Dev.		0.0014		0.06

DOP @ 72 degrees Fahrenheit, B.P = 29.38 in Hg.
Testing performed in accordance with ASTM D2986a-99
Test flow rate 32slpm @ 100 cm2, 48%RH

ATI – Air Techniques International
TEST LABORATORY
FILTER TEST REPORT

CUSTOMER TRC	**TEST CRITERIA** DOP PENETRATION .03 % @ RATED FLOW N/A % @ 20% RATED FLOW	NUMBER ORDERED 50	DATE RECEIVED 31 Jul 13
PURCHASE ORDER NUMBER 176922.3003.0000	RESISTANCE N/A W.G. @ 100 % RATED FLOW	NUMBER RECEIVED 50	DATE TESTED 05 Aug 13
FILTER MODEL NUMBER Quartz	SPECIFICATION AST2986a-99	NUMBER ACCEPTED 50	DATE SHIPPED
MANUFACTURER TRC	**TEST CONDITIONS**	**REJECTS**	
FILTER DESCIPTION 8X10 Quartz Flat Sheet	Test Air Temperature 72 ° F TEST FLOW (ACFM) 32 lpm	PENETRATION	RESISTANCE
P.O. Approved By: JDR/CAH RATED FLOW (SCFM) 32 lpm	BAROMETRIC PRESS 751 mm Hg. Test Air Humidity in % RH 55	DAMAGE	OTHER

ITEM No.	FILTER SERIAL NUMBER	INSPECTION RESULTS	TEST RESULTS			FILTER TESTED BY:
			RESISTANCE	% PENETRATION 100%	% PENETRATION 20%	
1	Q4500066	Accepted	1.0	.010	N/A	CAH
2	Q4500084	"	1.0	.004	N/A	CAH
3	Q4500126	"	1.0	.003	N/A	CAH
4	Q4500396	"	1.0	.003	N/A	CAH
5	Q4500431	"	1.0	.004	N/A	CAH
6	Q4503718	"	1.0	.004	N/A	CAH
7	Q4503732	"	1.0	.002	N/A	CAH
8	Q4504449	"	1.0	.002	N/A	CAH
9	Q4504465	"	1.0	.001	N/A	CAH
10	Q4505476	"	1.0	.001	N/A	CAH
11	Q4505512	"	1.0	.003	N/A	CAH
12	Q4507235	"	1.0	.004	N/A	CAH
13	Q4507269	"	1.0	.002	N/A	CAH
14	Q4508221	"	1.0	.003	N/A	CAH
15	Q4508243	"	1.0	.003	N/A	CAH
16	Q4508255	"	1.0	.002	N/A	CAH
17	Q4508649	"	1.0	.003	N/A	CAH
18	Q4508662	"	1.0	.001	N/A	CAH

DISTRIBUTION Emailed test reports to Stan Sleva	TESTED BY: Original Signed by C.A.Hart APPROVED BY: Original Signed by J.D.Rivera

FILTER TEST REPORT (Continuation)

Customer: TRC

PURCHASE ORDER NO.: 176922.3003.0000

ITEM No.	FILTER SERIAL NUMBER	INSPECTION RESULTS	TEST RESULTS			FILTER TESTED BY:
			RESISTANCE	% PENETRATION		
				100%	20%	
19	Q4511441	Accepted	.8	.001	N/A	CAH
20	Q4511488	"	1.1	.002	N/A	CAH
21	Q4511521	"	1.0	.001	N/A	CAH
22	Q4511555	"	1.0	.003	N/A	CAH
23	Q4516195	"	1.0	.003	N/A	CAH
24	Q4516512	"	1.0	.002	N/A	CAH
25	Q4516556	"	1.1	.003	N/A	CAH
26	Q4518192	"	1.0	.004	N/A	CAH
27	Q4518529	"	1.0	.003	N/A	CAH
28	Q4518573	"	1.0	.003	N/A	CAH
29	Q4521068	"	1.1	.004	N/A	CAH
30	Q4521110	"	1.1	.003	N/A	CAH
31	Q4521125	"	1.1	.003	N/A	CAH
32	Q4522089	"	1.1	.003	N/A	CAH
33	Q4522092	"	1.1	.002	N/A	CAH
34	Q4522304	"	1.1	.001	N/A	CAH
35	Q4522354	"	1.1	.002	N/A	CAH
36	Q4522964	"	1.1	.001	N/A	CAH
37	Q4522996	"	1.1	.003	N/A	CAH
38	Q4526081	"	1.1	.002	N/A	CAH
39	Q4526088	"	1.1	.002	N/A	CAH
40	Q4528365	"	1.0	.003	N/A	CAH
41	Q4528723	"	1.0	.002	N/A	CAH
42	Q4521076	"	1.1	.002	N/A	CAH
43	Q4528667	"	1.0	.003	N/A	CAH
44	Q4529396	"	1.0	.001	N/A	CAH
45	Q4529429	"	1.0	.001	N/A	CAH
46	Q4531335	"	1.0	.003	N/A	CAH
47	Q4531377	"	1.0	.003	N/A	CAH
48	Q4533430	"	1.0	.002	N/A	CAH
49	Q4533468	"	1.0	.001	N/A	CAH
50	Q4504444	"	1.0	.001	N/A	CAH

Appendix G

Lead Content Test Results

TRC-Raleigh
Quartz Filter Acceptance Test Data (GFAA) Report # 13-380

Lab ID	Client ID	Pb (µg/filter)	Pb MDL (µg/filter)
13-U936	Q4500072	< MDL	0.245
13-U937	Q4500088	< MDL	0.245
13-U938	Q4500425	< MDL	0.245
13-U939	Q4500439	< MDL	0.245
13-U940	Q4503715	< MDL	0.245
13-U941	Q4503745	< MDL	0.245
13-U942	Q4504447	< MDL	0.245
13-U943	Q4504461	< MDL	0.245
13-U944	Q4505470	< MDL	0.245
13-U945	Q4505492	< MDL	0.245
13-U946	Q4507242	0.254	0.245
13-U947	Q4507273	< MDL	0.245
13-U948	Q4508218	0.298	0.245
13-U949	Q4508655	0.333	0.245
13-U950	Q4508677	< MDL	0.245
13-U951	Q4511450	< MDL	0.245
13-U952	Q4511466	< MDL	0.245
13-U953	Q4511489	< MDL	0.245
13-U954	Q4511514	< MDL	0.245
13-U955	Q4516193	0.249	0.245
13-U956	Q4516214	0.245	0.245
13-U957	Q4516514	0.311	0.245
13-U958	Q4516538	0.252	0.245
13-U959	Q4516561	< MDL	0.245
13-U960	Q4518196	< MDL	0.245
13-U961	Q4518546	0.289	0.245
13-U962	Q4518576	< MDL	0.245
13-U963	Q4521077	< MDL	0.245
13-U964	Q4521112	< MDL	0.245
13-U965	Q4522067	< MDL	0.245
13-U966	Q4522099	< MDL	0.245
13-U967	Q4522344	< MDL	0.245
13-U968	Q4522355	< MDL	0.245
13-U969	Q4522973	< MDL	0.245
13-U970	Q4522997	< MDL	0.245
13-U971	Q4526107	< MDL	0.245
13-U972	Q4526125	< MDL	0.245
13-U973	Q4526745	< MDL	0.245
13-U974	Q4528342	< MDL	0.245
13-U975	Q4528397	< MDL	0.245
13-U976	Q4528668	< MDL	0.245
13-U977	Q4528725	< MDL	0.245
13-U978	Q4529394	< MDL	0.245
13-U979	Q4529438	< MDL	0.245
13-U980	Q4531342	< MDL	0.245
13-U981	Q4531390	< MDL	0.245
13-U982	Q4533422	< MDL	0.245
13-U983	Q4533434	< MDL	0.245
13-U984	Q4511507	< MDL	0.245
13-U985	Q4516572	< MDL	0.245
	Average	0.279	
	Std. Dev	#DIV/0!	

TRC ENVIRONMENTAL
RALEIGH

JOB # T010
REPORT # 13-380

SUBMITTED BY:
CHESTER LabNet
12242 S.W. GARDEN PLACE
TIGARD, OR 97223
(503)624-2183/FAX (503)624-2653
www.ChesterLab.Net

CHESTER LabNet

12242 SW Garden Place ❖ Tigard, OR 97223-8246 ❖ USA
Telephone 503-624-2183 ❖ Fax 503-624-2653 ❖ www.chesterlab.net

Case Narrative

Date: August 14, 2013

General Information

Client:	TRC Environmental - Raleigh
Job Number:	T010
Report Number:	13-380
Sample Description:	8x10 Quartz Filters

Analysis

Analytes:	Pb
Analytical Protocols:	40 CFR 50 Appendix G (modified)
Analytical Notes:	No problems were encountered during analyses. The samples were digested using the hotplate option from the method. Graphite furnace AA was used to analyze the filters instead of flame AA.
QA/QC Review:	All of the data have been reviewed by the analysts performing the analyses and the project manager. All of the quality control and sample-specific information in this package is complete and meets or exceeds the minimum requirements for acceptability.
Comments:	If you have any questions or concerns regarding this analysis, please feel free to contact the project manager.
Disclaimer:	This report shall not be reproduced, except in full, without the written approval of the laboratory. The results only represent that of the samples as received into the laboratory.

8/14/13

Project Manager — Date
Paul Duda

TRC-Raleigh

Quartz Filter Acceptance Test Data (GFAA) Report # 13-380

Lab ID	Client ID	Pb (µg/filter)	Pb MDL (µg/filter)
13-U936	Q4500072	< MDL	0.245
13-U937	Q4500088	< MDL	0.245
13-U938	Q4500425	< MDL	0.245
13-U939	Q4500439	< MDL	0.245
13-U940	Q4503715	< MDL	0.245
13-U941	Q4503745	< MDL	0.245
13-U942	Q4504447	< MDL	0.245
13-U943	Q4504461	< MDL	0.245
13-U944	Q4505470	< MDL	0.245
13-U945	Q4505492	< MDL	0.245
13-U946	Q4507242	0.254	0.245
13-U947	Q4507273	< MDL	0.245
13-U948	Q4508218	0.298	0.245
13-U949	Q4508655	0.333	0.245
13-U950	Q4508677	< MDL	0.245
13-U951	Q4511450	< MDL	0.245
13-U952	Q4511466	< MDL	0.245
13-U953	Q4511489	< MDL	0.245
13-U954	Q4511514	< MDL	0.245
13-U955	Q4516193	0.249	0.245
13-U956	Q4516214	0.245	0.245
13-U957	Q4516514	0.311	0.245
13-U958	Q4516538	0.252	0.245
13-U959	Q4516561	< MDL	0.245
13-U960	Q4518196	< MDL	0.245
13-U961	Q4518546	0.289	0.245
13-U962	Q4518576	< MDL	0.245
13-U963	Q4521077	< MDL	0.245
13-U964	Q4521112	< MDL	0.245
13-U965	Q4522067	< MDL	0.245
13-U966	Q4522099	< MDL	0.245
13-U967	Q4522344	< MDL	0.245
13-U968	Q4522355	< MDL	0.245
13-U969	Q4522973	< MDL	0.245
13-U970	Q4522997	< MDL	0.245
13-U971	Q4526107	< MDL	0.245
13-U972	Q4526125	< MDL	0.245
13-U973	Q4526745	< MDL	0.245
13-U974	Q4528342	< MDL	0.245
13-U975	Q4528397	< MDL	0.245
13-U976	Q4528668	< MDL	0.245
13-U977	Q4528725	< MDL	0.245
13-U978	Q4529394	< MDL	0.245
13-U979	Q4529438	< MDL	0.245
13-U980	Q4531342	< MDL	0.245
13-U981	Q4531390	< MDL	0.245
13-U982	Q4533422	< MDL	0.245
13-U983	Q4533434	< MDL	0.245
13-U984	Q4511507	< MDL	0.245
13-U985	Q4516572	< MDL	0.245

QA/QC Report

Client Name: TRC-Raleigh
Project Number: T010
Analytical Technique: GFAA
Sample Description: 8x10 Quartz Filter
Report Number: 13-380

==========

Blank Data

Analyte	Sample ID	Measured Conc. µg/L	MDL Conc. µg/L
Pb	ICB	< MDL	1.00
Pb	Prep_Blk	< MDL	1.00
Pb	CCB	< MDL	1.00
Pb	CCB	< MDL	1.00
Pb	CCB	< MDL	1.00

*: Method Blank concentration in µg/filter

Calibration QC

Analyte	Sample ID	Standard Conc. µg/L	Measured Conc. µg/L	Percent Recovery
Pb	ICV	20.0	20.7	103.4
Pb	CCV	20.0	20.4	101.8
Pb	CCV	20.0	20.2	101.2
Pb	CCV	20.0	21.3	106.4

Duplicate Data

Analyte	Sample ID	Sample Conc. µg/L	Duplicate Conc. µg/L	RPD
Pb	13-U936	< 1	< 1	N/C #

RPD = {(sample-duplicate)/[(sample+duplicate)/2]}x100
N/C: RPD is not calculated when sample or duplicate is below detection limit
#: per EPA CLP protocol, control limits do not apply if sample and/or duplicate concentration is less than 5x the detection limit

Laboratory Control Sample/Matrix Spike Analysis

Analyte	Sample ID	Sample Conc. µg/L	Spike Conc. µg/L	Spike Amount µg/L	Percent Recovery
Pb	LCS	< 1	101.	100.	101.
Pb	13-U937	< 1	92.9	100.	92.9

*: per EPA CLP protocol, control limits do not apply if spike concentration is less than 25% of the sample concentration

QA/QC Limits
Continuing Calibration: ± 10% *LCS: ± 20%*
Duplicates: ± 20% RPD *Spikes: ± 25%*

QA/QC Report

Client Name: TRC-Raleigh
Project Number: T010
Analytical Technique: GFAA
Sample Description: 8x10 Quartz Filter
Report Number: 13-380

Blank Data

Analyte	Sample ID	Measured Conc. µg/L	MDL Conc. µg/L
Pb	ICB	< MDL	1.00
Pb	Prep_Blk	< MDL	1.00
Pb	CCB	< MDL	1.00
Pb	CCB	< MDL	1.00
Pb	Prep_Blk	< MDL	1.00
Pb	CCB	< MDL	1.00
Pb	CCB	< MDL	1.00
Pb	CCB	< MDL	1.00
Pb	CCB	< MDL	1.00

*: Method Blank concentration in µg/filter

Calibration QC

Analyte	Sample ID	Standard Conc. µg/L	Measured Conc. µg/L	Percent Recovery
Pb	ICV	20.0	21.1	105.4
Pb	CCV	20.0	20.2	101.2
Pb	CCV	20.0	20.4	102.1
Pb	CCV	20.0	20.4	101.8
Pb	CCV	20.0	19.9	99.4
Pb	CCV	20.0	19.8	98.9
Pb	CCV	20.0	19.7	98.4

Duplicate Data

Analyte	Sample ID	Sample Conc. µg/L	Duplicate Conc. µg/L	RPD
Pb	13-U946	1.04	< 1	N/C #
Pb	13-U966	< 1	< 1	N/C #

RPD = {(sample-duplicate)/[(sample+duplicate)/2]}x100
N/C: RPD is not calculated when sample or duplicate is below detection limit
#: per EPA CLP protocol, control limits do not apply if sample and/or duplicate concentration is less than 5x the detection limit

Laboratory Control Sample/Matrix Spike Analysis

Analyte	Sample ID	Sample Conc. µg/L	Spike Conc. µg/L	Spike Amount µg/L	Percent Recovery
Pb	LCS	< 1	100.	100.	100.
Pb	13-U947	< 1	96.5	100.	96.5
Pb	LCS	< 1	93.0	100.	93.0
Pb	13-U967	< 1	86.3	100.	86.3

*: per EPA CLP protocol, control limits do not apply if spike concentration is less than 25% of the sample concentration

QA/QC Limits

Continuing Calibration: ± 10% *LCS: ± 20%*
Duplicates: ± 20% RPD *Spikes: ± 25%*