TRC
Results you can rely on

TEST RESULTS

Acceptance Testing and Distribution of CY-2014 Glass Fiber Filters

EPA Contract No. EP-D-10-079

TRC Reference No. 176922.2003.0000

Prepared for:

Margaret Dougherty (C404-02)
OAR/OAQPS/CORE
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Prepared by:

TRC Environmental Corporation
5540 Centerview Drive
Suite 100
Raleigh, North Carolina 27606

September 4, 2013

TABLE OF CONTENTS

LIST OF APPENDICES

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	GLASS	% MEETING CRITERIA/MET CRITERIA
Visual	X	100%
Length, Width	X	100%
Brittleness	X	100%
Thickness	X	100%
Tensile Strength	X	100%
Flow Rate	X	100%
Retention	X	100%
Lead Content	X	100 %

2.0 ACCEPTANCE TESTING RESULTS

2.1 VISUAL INSPECTION

TRC 's statement of work called for the visual inspection of 500 randomly selected glass fiber 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, loose-appearing fibers that cannot be brushed off, individual fiber on filter surface, coloration, 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 500 glass filters, the maximum number of rejected glass filters (5%) allowed is 25, and the maximum number of defective filters (20%) allowed is 100. The detailed results for the glass fiber filters are presented in Appendix A.

From the total batch of 20,995 EPA-supplied glass fiber filters, 500 filters were randomly selected for visual inspection. Of the 500 filters, 9 filters (0.18%) were rejected thus meeting the reject (acceptance criteria of 25 (5%), while 52 filters (10.4%) were defective, thereby meeting the defect acceptance criteria of 100 (20%). Of the 9 rejected filters, four had a pin hole; three had 2 or more dark spots; and two had multiple defects (two dark spots and multiple thin spots). Of the 52 defective filters, 5 had thin spots, 28 had a dark spot; 3 multiple thin spots and a dark spot, 5 had a dark thread, and 11 were non-uniform.

2.2 LENGTH AND WIDTH

One subset of 50 filters was 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 for the glass fiber filters are presented in Appendix B.

2.3 BRITTLENESS

For this test, brittleness was measured by TRC for the 50 glass fiber filters used for length and width measurements. 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 for the glass fiber filters are presented in Appendix C.

All fifty of the filters tested (100%) were acceptable, with only 1 having a crack of 1/8 inch, which is within the allowable limit of less than one inch.

2.4 GLASS THICKNESS AND TENSILE STRENGTH

A set of 75 glass fiber filters was tested for thickness using ASTM Method D645M-97 and tensile strength using ASTM Method D828-97 by Integrated Paper Services, Appleton, WI. The same glass filters were used for both the thickness and tensile strength tests. The results for the 75 glass fiber filter thickness and tensile strength tests are presented in Appendix D.

2.4.1 Glass Fiber Filters Thickness

All 75 glass fiber filters tested met the requirements of 0.30 mm minimum thickness and 0.60 mm maximum thickness. The average thickness of all 75 filters was 0.386 mm with an average standard deviation of 0.0119 mm when including one filter having a maximum thickness of 0.448 mm, which is still within the acceptable criteria of 0.30 mm minimum thickness and 0.60 mm maximum thickness.

2.4.2 Glass Fiber Filters Tensile Strength

All 75 glass filters tested (100%) met the requirement of a minimum of 200 gram force/20 mm. The average of all 75 filters was 1276 gram force/20 mm with an average standard deviation of 132 gram force/20 mm.

2.5 FLOW RATE

For this flow rate test, 75 glass fiber filters were tested by TRC using a modification of the procedure specified in EPA's flow rate acceptance test. All 75 glass fiber filters met the flow rate acceptance criteria. The EPA roots meter was not available for use in conducting this test so a 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 K and 760 mm Hg. After five filters were tested, the 7-hole resistance plate was reinserted, and the flow rate was checked to see if it remained at 1.13m^3/min. These steps were repeated after 5 filters were tested.

The acceptance criteria for the glass filter flow rate are 1.75 m^3/minute maximum and 1.34 m^3/minute minimum. All 75 of the glass fiber filters (100%) met the acceptance criteria for flow rate. The standard average flow rate was 1.642 m^3/minute and a standard deviation of 0.020 m^3/minute. The results for the 75 glass fiber filters tested are presented in Appendix E.

2.6 RETENTION

A set of 50 glass fiber filters was 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 99.9975% with a standard deviation of 0.00061%.

2.7 LEAD CONTENT

For this test, 50 glass fiber 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 0.685 with a standard deviation of 0.342. The lead results for the glass fiber filters are presented in Appendix G.

Appendix A

Visual Inspection Results

CY 2014 Glass Fiber Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
1	G4500913	✓			
2	G4500914	✓			
3	G4500922	✓			
4	G4500926			✓	Dark thread 3:30 middle
5	G4500932	✓			
6	G4500937	✓			
7	G4500941	✓			
8	G4500942			✓	Multiple thin spots
9	G4500948	✓			
10	G4500950			✓	Dark spot 11:30 top
11	G4500954	✓			
12	G4500955	✓			
13	G4500957			✓	Thin spot 8:30 center
14	G4500963			✓	Dark spot 2:30
15	G4500964	✓			
16	G4500965	✓			
17	G4500968	✓			
18	G4500969	✓			
19	G4500972	✓			
20	G4500975			✓	Dark spot at center
21	G4502212	✓			
22	G4502213	✓			
23	G4502218			✓	Dark spot center at 10
24	G4502219	✓			
25	G4502224	✓			
26	G4502227	✓			
27	G4502230			✓	Dark spot at 6
28	G4502231	✓			
29	G4502234			✓	Dark spot at 4 edge
30	G4502238			✓	Dark spot at 6:30
31	G4502249			✓	Dark spot at 3
32	G4502252	✓			
33	G4502253	✓			
34	G4502258			✓	Dark spot at 9 center

CY 2014 Glass Fiber Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
35	G4502259	✓			
36	G4502260	✓			
37	G4502270	✓			
38	G4502271	✓			
39	G4502272			✓	Dark spot at 3
40	G4502273	✓			
41	G4503772	✓			
42	G4503774	✓			
43	G4503775	✓			
44	G4503784	✓			
45	G4503785	✓			
46	G4503793	✓			
47	G4503799	✓			
48	G4503801	✓			
49	G4503802	✓			
50	G4503805	✓			
51	G4503808	✓			
52	G4503810	✓			
53	G4503812		✓		Pinhole at 6
54	G4503817	✓			
55	G4503818	✓			
56	G4503823	✓			
57	G4503824	✓			
58	G4503829	✓			
59	G4503831	✓			
60	G4503835	✓			
61	G4505396	✓			
62	G4505401	✓			
63	G4505409	✓			
64	G4505410	✓			
65	G4505414	✓			
66	G4505416	✓			
67	G4505421	✓			
68	G4505423	✓			

CY 2014 Glass Fiber Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
69	G4505426	✓			
70	G4505427	✓			
71	G4505429	✓			
72	G4505433	✓			
73	G4505434	✓			
74	G4505440			✓	Thin spot and dark spot at 12
75	G4505441	✓			
76	G4505444	✓			
77	G4505447	✓			
78	G4505448	✓			
79	G4505454			✓	Multiple thin spots near 8
80	G4505459	✓			
81	G4505466	✓			
82	G4505474	✓			
83	G4505477	✓			
84	G4505478	✓			
85	G4505479	✓			
86	G4505486	✓			
87	G4505490	✓			
88	G4505499			✓	Dark spot center at 4
89	G4505500	✓			
90	G4505501	✓			
91	G4505503	✓			
92	G4505504	✓			
93	G4505505	✓			
94	G4505507	✓			
95	G4505511	✓			
96	G4505514	✓			
97	G4505515	✓			
98	G4505517	✓			
99	G4505518	✓			
100	G4505523			✓	Dark spot back at 9
101	G4506894	✓			
102	G4506897			✓	Dark spot at 11

CY 2014 Glass Fiber Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
103	G4506899	✓			
104	G4506900	✓			
105	G4506901	✓			
106	G4506903	✓			
107	G4506909	✓			
108	G4506917	✓			
109	G4506921	✓			
110	G4506922	✓			
111	G4506928	✓			
112	G4506930	✓			
113	G4506932	✓			
114	G4506938	✓			
115	G4506940			✓	Dark spot at 11:30
116	G4506946	✓			
117	G4506950	✓			
118	G4506951	✓			
119	G4506952	✓			
120	G4506953	✓			
121	G4507804	✓			
122	G4507805	✓			
123	G4507818	✓			
124	G4507819	✓			
125	G4507820	✓			
126	G4507825	✓			
127	G4507826			✓	Dark spot at 9 center
128	G4507827	✓			
129	G4507829	✓			
130	G4507833	✓			
131	G4507838	✓			
132	G4507839	✓			
133	G4507840	✓			
134	G4507842	✓			
135	G4507851	✓			
136	G4507852	✓			

CY 2014 Glass Fiber Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
137	G4507854	✓			
138	G4507856	✓			
139	G4507857	✓			
140	G4507860	✓			
141	G4508256	✓			
142	G4508265	✓			
143	G4508266	✓			
144	G4508267	✓			
145	G4508270	✓			
146	G4508272	✓			
147	G4508278	✓			
148	G4508284	✓			
149	G4508287	✓			
150	G4508299	✓			
151	G4508304	✓			
152	G4508305	✓			
153	G4508307	✓			
154	G4508308			✓	Dark thread center
155	G4508310	✓			
156	G4508312	✓			
157	G4508313	✓			
158	G4508317	✓			
159	G4508319	✓			
160	G4508320	✓			
161	G4510990	✓			
162	G4510991			✓	Dark thread at 10
163	G4510992	✓			
164	G4510994	✓			
165	G4510997	✓			
166	G4510998			✓	Dark spot at 3
167	G4511002	✓			
168	G4511004	✓			
169	G4511009			✓	Dark spot center at 2:30
170	G4511011		✓		Two dark spots at 7 and 7:30

CY 2014 Glass Fiber Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
171	G4511012	✓			
172	G4511014	✓			
173	G4511024			✓	Dark spot at 7
174	G4511029	✓			
175	G4511030	✓			
176	G4511031	✓			
177	G4511035	✓			
178	G4511044	✓			
179	G4511048	✓			
180	G4511050	✓			
181	G4511186	✓			
182	G4511190	✓			
183	G4511191	✓			
184	G4511192	✓			
185	G4511193	✓			
186	G4511194	✓			
187	G4511195	✓			
188	G4511198	✓			
189	G4511199		✓		Pinhole at 7
190	G4511203	✓			
191	G4511205	✓			
192	G4511208	✓			
193	G4511211	✓			
194	G4511216	✓			
195	G4511217	✓			
196	G4511219	✓			
197	G4511221	✓			
198	G4511232		✓		Pinhole top at 12
199	G4511236	✓			
200	G4511237	✓			
201	G4512615	✓			
202	G4512619	✓			
203	G4512626			✓	Dark spot at center
204	G4512632			✓	Dark spot at 5

CY 2014 Glass Fiber Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
205	G4512634	✓			
206	G4512636	✓			
207	G4512638			✓	Dark spot at 8
208	G4512639	✓			
209	G4512641	✓			
210	G4512643	✓			
211	G4512648			✓	Dark spot at 5
212	G4512653	✓			
213	G4512656			✓	Multiple thin spots 6 to 7
214	G4512657	✓			
215	G4512659	✓			
216	G4512660	✓			
217	G4512666	✓			
218	G4512669	✓			
219	G4512671		✓		Pinhole at 6:30
220	G4512674		✓		Two dark spots at 6 center
221	G4513847	✓			
222	G4513854	✓			
223	G4513858	✓			
224	G4513860	✓			
225	G4513862	✓			
226	G4513865	✓			
227	G4513872	✓			
228	G4513873	✓			
229	G4513879			✓	Non-uniform (thin area 6 to 7)
230	G4513881	✓			
231	G4513888	✓			
232	G4513889	✓			
233	G4513891	✓			
234	G4513898			✓	Dark spot at 4
235	G4513899	✓			
236	G4513901	✓			
237	G4513904	✓			
238	G4513905	✓			

CY 2014 Glass Fiber Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
239	G4513907	✓			
240	G4513908	✓			
241	G4513911	✓			
242	G4513912	✓			
243	G4513914	✓			
244	G4513915	✓			
245	G4513917	✓			
246	G4513918	✓			
247	G4513920	✓			
248	G4513921	✓			
249	G4513929	✓			
250	G4513932			✓	Dark spot at 4; multiple thin spots
251	G4513933	✓			
252	G4513934	✓			
253	G4513938	✓			
254	G4513940	✓			
255	G4513943	✓			
256	G4513950			✓	Dark thread at 8:30
257	G4513951	✓			
258	G4513952	✓			
259	G4513957	✓			
260	G4513963		✓		Three dark spots at 10
261	G4514757	✓			
262	G4514758	✓			
263	G4514760	✓			
264	G4514761	✓			
265	G4514762	✓			
266	G4514768	✓			
267	G4514769	✓			
268	G4514771	✓			
269	G4514774	✓			
270	G4514777	✓			
271	G4514778	✓			
272	G4514783	✓			

CY 2014 Glass Fiber Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
273	G4514789	✓			
274	G4514793			✓	Non-uniform (thin area at 4)
275	G4514799			✓	Dark spot at 6
276	G4514805	✓			
277	G4514810	✓			
278	G4514813	✓			
279	G4514814	✓			
280	G4514820	✓			
281	G4514887	✓			
282	G4514888	✓			
283	G4514890	✓			
284	G4514891	✓			
285	G4514893	✓			
286	G4514894			✓	Dark spot at 3:30 center (back)
287	G4514902	✓			
288	G4514907	✓			
289	G4514908	✓			
290	G4514909	✓			
291	G4514914		✓		Two dark spots at 4 and 10; thin spot at 6
292	G4514916	✓			
293	G4514919	✓			
294	G4514920	✓			
295	G4514921	✓			
296	G4514926	✓			
297	G4514935	✓			
298	G4514938	✓			
299	G4514941	✓			
300	G4514948	✓			
301	G4515213	✓			
302	G4515214	✓			
303	G4515215	✓			
304	G4515216	✓			
305	G4515221	✓			
306	G4515222	✓			

CY 2014 Glass Fiber Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
307	G4515230	✓			
308	G4515231	✓			
309	G4515234	✓			
310	G4515238	✓			
311	G4515239	✓			
312	G4515241	✓			
313	G4515243	✓			
314	G4515247	✓			
315	G4515250	✓			
316	G4515258	✓			
317	G4515269	✓			
318	G4515271	✓			
319	G4515272	✓			
320	G4515273	✓			
321	G4515799	✓			
322	G4515801	✓			
323	G4515802	✓			
324	G4515803	✓			
325	G4515811	✓			
326	G4515812	✓			
327	G4515813	✓			
328	G4515819	✓			
329	G4515822	✓			
330	G4515824	✓			
331	G4515835	✓			
332	G4515840	✓			
333	G4515845			✓	Thin spot at 8; dark spot at 6
334	G4515847	✓			
335	G4515851	✓			
336	G4515852	✓			
337	G4515854	✓			
338	G4515856	✓			
339	G4515857	✓			
340	G4515859	✓			

CY 2014 Glass Fiber Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
341	G4515876	✓			
342	G4515878	✓			
343	G4515882	✓			
344	G4515884	✓			
345	G4515885			✓	Dark spot at 12
346	G4515888	✓			
347	G4515889	✓			
348	G4515892	✓			
349	G4515900	✓			
350	G4515903	✓			
351	G4515906	✓			
352	G4515907	✓			
353	G4515908	✓			
354	G4515911	✓			
355	G4515914	✓			
356	G4515915	✓			
357	G4515916	✓			
358	G4515919	✓			
359	G4515920	✓			
360	G4515921	✓			
361	G4515926	✓			
362	G4515931	✓			
363	G4515932	✓			
364	G4515933	✓			
365	G4515937	✓			
366	G4515945	✓			
367	G4515953	✓			
368	G4515960	✓			
369	G4515961	✓			
370	G4515963	✓			
371	G4515965	✓			
372	G4515967	✓			
373	G4515970	✓			
374	G4515972	✓			

CY 2014 Glass Fiber Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
375	G4515973	✓			
376	G4515975			✓	Non-uniform (multiple thin spots throughout filter)
377	G4515976	✓			
378	G4515985	✓			
379	G4515989	✓			
380	G4515990	✓			
381	G4516972	✓			
382	G4516975	✓			
383	G4516976	✓			
384	G4516977	✓			
385	G4516978	✓			
386	G4516994	✓			
387	G4516995	✓			
388	G4516996	✓			
389	G4517000	✓			
390	G4517001	✓			
391	G4517004	✓			
392	G4517008	✓			
393	G4517009	✓			
394	G4517010	✓			
395	G4517011	✓			
396	G4517013	✓			
397	G4517015	✓			
398	G4517018	✓			
399	G4517024	✓			
400	G4517026	✓			
401	G4517688	✓			
402	G4517690	✓			
403	G4517696	✓			
404	G4517703	✓			
405	G4517704	✓			
406	G4517711	✓			
407	G4517715	✓			
408	G4517717	✓			

CY 2014 Glass Fiber Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
409	G4517720	✓			
410	G4517722	✓			
411	G4517724	✓			
412	G4517727	✓			
413	G4517728	✓			
414	G4517730	✓			
415	G4517731	✓			
416	G4517736	✓			
417	G4517738	✓			
418	G4517740	✓			
419	G4517744	✓			
420	G4517745	✓			
421	G4517747	✓			
422	G4517750	✓			
423	G4517751	✓			
424	G4517757	✓			
425	G4517758	✓			
426	G4517760	✓			
427	G4517765	✓			
428	G4517768	✓			
429	G4517773	✓			
430	G4517774	✓			
431	G4517780	✓			
432	G4517781	✓			
433	G4517782	✓			
434	G4517785	✓			
435	G4517791			✓	Dark spot at 3
436	G4517792	✓			
437	G4517795	✓			
438	G4517807	✓			
439	G4517808			✓	Non-uniform (multiple thin spots 9 to 10 center)
440	G4517810	✓			
441	G4517879	✓			
442	G4517886	✓			

CY 2014 Glass Fiber Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
443	G4517887	✓			
444	G4517889			✓	Non-uniform (multiple thin spots)
445	G4517893	✓			
446	G4517894			✓	Non-uniform (multiple thin spots near 4)
447	G4517902	✓			
448	G4517903	✓			
449	G4517904	✓			
450	G4517907	✓			
451	G4517910	✓			
452	G4517918	✓			
453	G4517919	✓			
454	G4517921	✓			
455	G4517922	✓			
456	G4517924	✓			
457	G4517926	✓			
458	G4517932	✓			
459	G4517935	✓			
460	G4517937	✓			
461	G4519502			✓	Non-uniform (multiple thin spots)
462	G4519506	✓			
463	G4519510	✓			
464	G4519511	✓			
465	G4519515	✓			
466	G4519518	✓			
467	G4519521	✓			
468	G4519526	✓			
469	G4519529	✓			
470	G4519532	✓			
471	G4519534	✓			
472	G4519540	✓			
473	G4519547			✓	Multiple thin spots
474	G4519550	✓			
475	G4519552	✓			
476	G4519554			✓	Non-uniform (light area near bottom)

CY 2014 Glass Fiber Filters Visual Inspection Results

Sample No.	Filter No.	Pass	Reject	Defect	Reason for Failure or Defect/Comments
477	G4519558	✓			
478	G4519560	✓			
479	G4519563	✓			
480	G4519565	✓			
481	G4520158	✓			
482	G4520159			✓	Non-uniform ~ 7:30
483	G4520160	✓			
484	G4520162			✓	Dark thread at 6:30
485	G4520163	✓			
486	G4520164	✓			
487	G4520168	✓			
488	G4520170	✓			
489	G4520171		✓		Two dark spots at 3:30 non-uniform (multiple thin spots)
490	G4520172	✓			
491	G4520176	✓			
492	G4520177	✓			
493	G4520179	✓			
494	G4520181	✓			
495	G4520187			✓	Non-uniform (multiple thin spots at 7 to 8)
496	G4520194			✓	Non-uniform (multiple thin spots)
497	G4520195	✓			
498	G4520205	✓			
499	G4520207	✓			
500	G4520210			✓	Dark spot at 4
	Total	**439**	**9**	**52**	

Appendix B

Length and Width Test Results

CY-2014 Glass Filters Width and Length

Filter #	Width	Maximum	Minimum	Acceptable	Length	Maximum	Minimum	Acceptable
G4500954	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4500932	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4502224	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4502270	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4503775	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4503818	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4505410	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4505447	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4505479	7 31/32"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4505514	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4506901	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4506946	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4507820	7 31/32"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4507851	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4508270	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4508312	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4510997	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4511029	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4511193	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4511217	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4512639	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4512666	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4513862	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4513904	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4513917	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4513940	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4514762	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4514789	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4514891	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4514926	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔

CY-2014 Glass Filters Width and Length

Filter #	Width	Maximum	Minimum	Acceptable	Length	Maximum	Minimum	Acceptable
G4515221	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4515238	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4515811	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4515851	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4515888	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4515919	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4515937	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4505976	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4516977	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4517011	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4517704	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4517730	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4517758	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4517792	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4517893	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4517924	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4519515	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4519552	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4520164	8"	8" + 1/16"	8" – 1/16"	✔	10"	10" + 1/16"	10" – 1/16"	✔
G4520176	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 Glass Filter Brittleness Test

Filter	Crack	Length	Acceptable	Filter	Crack	Length	Acceptable
G4500954			✔	G4513940			✔
G4500932			✔	G4514762			✔
G4502224			✔	G4514789			✔
G4502270			✔	G4514891			✔
G4503775			✔	G4514926			✔
G4503818			✔	G4515221			✔
G4505410			✔	G4515238			✔
G4505447			✔	G4515811			✔
G4505479	✔	1/8"	✔	G4515851			✔
G4505514			✔	G4515888			✔
G4506901			✔	G4515919			✔
G4506946				G4515937			✔
G4507820			✔	G4505976			✔
G4507851			✔	G4516977			✔
G4508270			✔	G4517011			✔
G4508312			✔	G4517704			✔
G4510997			✔	G4517730			✔
G4511029			✔	G4517758			✔
G4511193			✔	G4517792			✔
G4511217			✔	G4517893			✔
G4512639			✔	G4517924			✔
G4512666			✔	G4519515			✔
G4513862			✔	G4519552			✔
G4513904			✔	G4520164			✔
G4513917			✔	G4520176			✔

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 glass filters

Date received: July 31, 2013

Tests requested: Caliper and tensile

Purchase Order: 59760

Analysis of Glass Filters

Integrated Paper Services, Inc. performed caliper and tensile testing on seventy-five glass filter 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 Glass Filters

Sample Identification	G4500914	G4500941	G4500972	G4502212	G4502231	G4502271	G4503772
Caliper (mils)							
Average	15.2	15.5	14.9	15.5	15.9	15.1	15.3
Std. Dev.	0.24	0.36	0.30	0.14	0.23	0.05	0.11
Max	15.5	15.9	15.3	15.6	16.2	15.2	15.5
Min	14.9	15.0	14.5	15.3	15.7	15.1	15.2
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.385	0.394	0.379	0.394	0.404	0.385	0.390
Std. Dev.	0.0061	0.0091	0.0075	0.0036	0.0060	0.0014	0.0029
Max	0.394	0.404	0.389	0.396	0.411	0.386	0.394
Min	0.378	0.381	0.368	0.389	0.399	0.384	0.386
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	1149	1383	1287	1268	1587	1276	1319
Std. Dev.	136.9	110	78.0	109	51.9	117	81.2
Max	1311	1560	1420	1406	1656	1429	1424
Min	930	1197	1179	1066	1470	1012	1175
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	2.53	3.05	2.84	2.80	3.50	2.81	2.91
Std. Dev.	0.302	0.243	0.172	0.241	0.114	0.257	0.179
Max	2.89	3.44	3.13	3.10	3.65	3.15	3.14
Min	2.05	2.64	2.60	2.35	3.24	2.23	2.59
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	0.889	0.918	0.929	0.920	0.970	0.913	0.968
Std. Dev.	0.149	0.106	0.0659	0.0901	0.0617	0.0947	0.0255
Max	1.03	1.04	1.03	1.01	1.05	1.04	1.02
Min	0.563	0.658	0.805	0.768	0.854	0.670	0.941
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	3.03	3.64	3.46	3.44	4.41	3.44	3.76
Std. Dev.	0.855	0.626	0.467	0.640	0.456	0.649	0.233
Max	3.99	4.45	4.30	4.07	4.92	4.49	4.19
Min	1.44	2.24	2.88	2.44	3.49	1.90	3.35
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Glass Filters (continued)

Sample Identification	G4503785	G4503823	G4505396	G4505421	G4505448	G4505466	G4505503
Caliper (mils)							
Average	15.5	15.0	14.7	15.3	15.4	15.3	15.4
Std. Dev.	0.19	0.38	0.34	0.15	0.18	0.14	0.15
Max	15.8	15.4	15.1	15.5	15.7	15.5	15.6
Min	15.3	14.5	14.3	15.1	15.3	15.1	15.2
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.393	0.380	0.373	0.389	0.392	0.389	0.392
Std. Dev.	0.0049	0.0098	0.0086	0.0038	0.0045	0.0036	0.0038
Max	0.401	0.391	0.384	0.394	0.399	0.394	0.396
Min	0.389	0.368	0.363	0.384	0.389	0.384	0.386
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	1512	1219	1273	1212	1334	1177	1108
Std. Dev.	98.6	159	62.1	147	94.3	126	46.2
Max	1624	1402	1356	1361	1465	1311	1175
Min	1275	857	1116	975	1134	916	1012
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	3.33	2.69	2.81	2.67	2.94	2.59	2.44
Std. Dev.	0.217	0.350	0.137	0.323	0.208	0.278	0.102
Max	3.58	3.09	2.99	3.00	3.23	2.89	2.59
Min	2.81	1.89	2.46	2.15	2.50	2.02	2.23
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	0.965	0.873	0.994	0.943	1.04	0.951	0.946
Std. Dev.	0.0706	0.113	0.0634	0.117	0.059	0.138	0.0882
Max	1.06	1.00	1.05	1.04	1.15	1.10	1.08
Min	0.805	0.629	0.830	0.704	0.950	0.639	0.803
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	4.23	3.15	3.80	3.45	4.08	3.38	3.19
Std. Dev.	0.589	0.752	0.438	0.794	0.360	0.795	0.470
Max	4.98	3.84	4.23	4.28	4.66	4.12	3.87
Min	2.83	1.53	2.69	1.94	3.50	1.67	2.53
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Glass Filters (continued)

Sample Identification	G4505515	G4506894	G4506922	G4506950	G4507804	G4507833	G4507857
Caliper (mils)							
Average	15.1	15.3	15.3	15.3	15.4	15.3	15.2
Std. Dev.	0.26	0.11	0.23	0.17	0.11	0.13	0.17
Max	15.5	15.4	15.5	15.4	15.6	15.5	15.5
Min	14.8	15.2	14.9	15.0	15.3	15.2	15.1
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.385	0.389	0.389	0.389	0.392	0.389	0.387
Std. Dev.	0.0066	0.0028	0.0060	0.0044	0.0029	0.0033	0.0043
Max	0.394	0.391	0.394	0.391	0.396	0.394	0.394
Min	0.376	0.386	0.378	0.381	0.389	0.386	0.384
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	1266	1266	1304	1404	1416	1231	1066
Std. Dev.	61.4	93.9	56.1	58.9	80.1	119	139
Max	1370	1383	1411	1506	1506	1352	1306
Min	1166	1070	1229	1324	1275	1025	798
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	2.79	2.79	2.88	3.10	3.12	2.71	2.35
Std. Dev.	0.135	0.207	0.124	0.130	0.177	0.262	0.306
Max	3.02	3.05	3.11	3.32	3.32	2.98	2.88
Min	2.57	2.36	2.71	2.92	2.81	2.26	1.76
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	0.985	0.981	0.992	1.01	1.03	1.01	0.888
Std. Dev.	0.108	0.0703	0.0591	0.055	0.035	0.031	0.124
Max	1.09	1.09	1.06	1.07	1.08	1.04	1.04
Min	0.791	0.820	0.865	0.922	0.984	0.950	0.613
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	3.76	3.74	3.86	4.21	4.36	3.77	2.88
Std. Dev.	0.648	0.527	0.409	0.377	0.331	0.457	0.718
Max	4.50	4.36	4.36	4.85	4.95	4.21	3.80
Min	2.73	2.69	3.01	3.60	3.92	2.94	1.36
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Glass Filters (continued)

Sample Identification	G4508256	G4508299	G4508317	G4510990	G4511002	G4511044	G4511186
Caliper (mils)							
Average	15.2	15.3	15.3	15.8	16.3	16.2	15.1
Std. Dev.	0.13	0.00	0.26	0.21	0.22	0.21	0.15
Max	15.3	15.3	15.6	16.1	16.5	16.4	15.3
Min	15.0	15.3	15.0	15.6	16	15.9	14.9
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.385	0.389	0.388	0.402	0.415	0.412	0.385
Std. Dev.	0.0034	0.0000	0.0066	0.0053	0.0055	0.0053	0.0039
Max	0.389	0.389	0.396	0.409	0.419	0.417	0.389
Min	0.381	0.389	0.381	0.396	0.406	0.404	0.378
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	1199	1168	1288	1457	1379	1425	1371
Std. Dev.	70.8	93.5	73.3	113	78.9	54.5	56.9
Max	1306	1275	1361	1579	1497	1501	1492
Min	1048	957	1157	1252	1288	1334	1279
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	2.64	2.58	2.84	3.21	3.04	3.14	3.02
Std. Dev.	0.156	0.206	0.162	0.250	0.174	0.120	0.125
Max	2.88	2.81	3.00	3.48	3.30	3.31	3.29
Min	2.31	2.11	2.55	2.76	2.84	2.94	2.82
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	1.00	0.967	1.01	0.964	1.02	1.05	0.978
Std. Dev.	0.051	0.0529	0.065	0.0991	0.042	0.043	0.0836
Max	1.08	1.05	1.07	1.08	1.08	1.11	1.09
Min	0.925	0.871	0.842	0.770	0.940	0.991	0.869
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	3.64	3.40	3.90	4.02	4.20	4.49	4.01
Std. Dev.	0.357	0.437	0.460	0.679	0.375	0.343	0.599
Max	4.02	4.00	4.43	4.76	4.70	4.97	4.94
Min	2.98	2.59	2.79	2.81	3.55	3.88	3.18
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Glass Filters (continued)

Sample Identification	G4511208	G4511236	G4512619	G4512653*	G4512669	G4513847	G4513881
Caliper (mils)							
Average	15.4	15.8	15.9	16.3 / 15.9	16.0	15.5	15.4
Std. Dev.	0.19	0.22	0.15	0.92 / 0.13	0.08	0.14	0.21
Max	15.7	16.0	16.2	17.9 / 16.0	16.1	15.6	15.7
Min	15.2	15.5	15.8	15.7 / 15.7	15.9	15.3	15.2
n =	5	5	5	5 / 4	5	5	5
Caliper (mm)							
Average	0.391	0.402	0.405	0.413 / 0.403	0.406	0.394	0.392
Std. Dev.	0.0048	0.0055	0.0039	0.0235 / 0.0033	0.0021	0.0036	0.0053
Max	0.399	0.406	0.411	0.448 / 0.406	0.409	0.396	0.399
Min	0.386	0.394	0.401	0.339 / 0.339	0.404	0.389	0.386
n =	5	5	5	5 / 4	5	5	5
MD Tensile (gf/20 mm)							
Average	1367	1239	1197	1202	1309	1228	1149
Std. Dev.	83.3	59.4	89.2	61.7	79.4	79.9	89.4
Max	1538	1306	1343	1306	1411	1334	1270
Min	1279	1111	1080	1116	1188	1120	980
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	3.01	2.73	2.64	2.65	2.89	2.71	2.53
Std. Dev.	0.184	0.131	0.197	0.136	0.175	0.176	0.197
Max	3.39	2.88	2.96	2.88	3.11	2.94	2.80
Min	2.82	2.45	2.38	2.46	2.62	2.47	2.16
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	1.00	0.983	0.920	0.947	1.01	0.983	0.984
Std. Dev.	0.076	0.0655	0.0738	0.0865	0.067	0.0714	0.0751
Max	1.12	1.08	1.02	1.05	1.08	1.09	1.08
Min	0.858	0.875	0.780	0.809	0.875	0.835	0.884
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	4.10	3.66	3.25	3.36	3.95	3.62	3.42
Std. Dev.	0.536	0.439	0.465	0.514	0.492	0.341	0.455
Max	4.87	4.25	3.78	4.03	4.54	4.07	4.16
Min	3.14	2.83	2.56	2.56	3.15	2.95	2.84
n =	10	10	10	10	10	10	10

*Note: Statistical analysis for caliper testing of filter G4512653 includes and excludes a high caliper reading of 17.9 mils.

Table 1. Physical Properties of Glass Filters (continued)

Sample Identification	G4513907	G4513912	G4513929	G4513952	G4514758	G4514777	G4514814
Caliper (mils)							
Average	15.4	15.5	15.6	15.7	15.2	15.0	14.5
Std. Dev.	0.16	0.10	0.08	0.21	0.15	0.20	0.15
Max	15.6	15.6	15.7	15.9	15.4	15.3	14.7
Min	15.2	15.4	15.5	15.4	15.0	14.8	14.3
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.391	0.394	0.396	0.399	0.385	0.381	0.368
Std. Dev.	0.0040	0.0025	0.0021	0.0054	0.0039	0.0051	0.0038
Max	0.396	0.396	0.399	0.404	0.391	0.389	0.373
Min	0.386	0.391	0.394	0.391	0.381	0.376	0.363
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	1123	1381	1367	1260	1434	1302	1123
Std. Dev.	118	91.5	97.7	67.9	69.4	66.5	56.1
Max	1252	1520	1492	1374	1547	1411	1220
Min	889	1225	1143	1139	1338	1193	1012
n =	10	10	11	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	2.48	3.04	3.01	2.78	3.16	2.87	2.48
Std. Dev.	0.259	0.202	0.215	0.150	0.153	0.147	0.124
Max	2.76	3.35	3.29	3.03	3.41	3.11	2.69
Min	1.96	2.70	2.52	2.51	2.95	2.63	2.23
n =	10	10	11	10	10	10	10
MD Stretch (%)							
Average	0.940	0.961	0.993	0.943	1.03	1.01	1.00
Std. Dev.	0.0897	0.0886	0.0871	0.0853	0.064	0.084	0.075
Max	1.04	1.08	1.09	1.07	1.09	1.09	1.08
Min	0.781	0.841	0.770	0.846	0.932	0.835	0.851
n =	10	10	11	10	10	10	10
MD TEA (J/m^2)							
Average	3.18	3.90	4.07	3.53	4.38	3.96	3.45
Std. Dev.	0.624	0.603	0.664	0.587	0.458	0.588	0.451
Max	3.78	4.64	4.93	4.43	4.97	4.77	3.93
Min	1.98	2.98	2.40	2.74	3.70	2.82	2.54
n =	10	10	11	10	10	10	10

Table 1. Physical Properties of Glass Filters (continued)

Sample Identification	G4514887	G4514919	G4514938	G4515214	G4515243	G4515258	G4515799
Caliper (mils)							
Average	15.0	15.0	15.2	15.0	14.6	14.6	15.0
Std. Dev.	0.22	0.33	0.34	0.15	0.27	0.13	0.18
Max	15.3	15.5	15.6	15.3	14.9	14.8	15.2
Min	14.7	14.7	14.8	14.9	14.3	14.5	14.8
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.382	0.382	0.385	0.382	0.372	0.372	0.380
Std. Dev.	0.0056	0.0083	0.0085	0.0039	0.0069	0.0034	0.0045
Max	0.389	0.394	0.396	0.389	0.378	0.376	0.386
Min	0.373	0.373	0.376	0.378	0.363	0.368	0.376
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	1349	1335	1325	1338	1232	1211	1349
Std. Dev.	44.5	100	48.3	106	68.4	80.0	72.3
Max	1402	1447	1388	1488	1324	1302	1465
Min	1288	1166	1229	1125	1111	1034	1229
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	2.97	2.94	2.92	2.95	2.72	2.67	2.97
Std. Dev.	0.098	0.221	0.106	0.234	0.151	0.176	0.159
Max	3.09	3.19	3.06	3.28	2.92	2.87	3.23
Min	2.84	2.57	2.71	2.48	2.45	2.28	2.71
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	1.11	1.06	0.978	1.00	1.04	0.992	1.06
Std. Dev.	0.111	0.112	0.0748	0.091	0.056	0.0998	0.109
Max	1.32	1.17	1.10	1.09	1.09	1.09	1.23
Min	0.967	0.785	0.843	0.787	0.923	0.776	0.894
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	4.52	4.32	3.82	3.93	3.87	3.62	4.26
Std. Dev.	0.563	0.803	0.501	0.637	0.480	0.587	0.772
Max	5.17	5.22	4.63	4.69	4.37	4.35	5.58
Min	3.54	2.56	2.94	2.51	2.90	2.37	3.27
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Glass Filters (continued)

Sample Identification	G4515824	G4515856	G4515876	G4515911	G4515920	G4515926	G4515945
Caliper (mils)							
Average	15.1	14.5	14.9	14.6	14.6	14.8	15.0
Std. Dev.	0.28	0.22	0.39	0.24	0.22	0.12	0.22
Max	15.4	14.7	15.6	14.9	14.8	15.0	15.3
Min	14.8	14.2	14.6	14.3	14.4	14.7	14.8
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.384	0.368	0.379	0.371	0.372	0.376	0.382
Std. Dev.	0.0072	0.0055	0.0099	0.0061	0.0056	0.0031	0.0055
Max	0.391	0.373	0.396	0.378	0.376	0.381	0.389
Min	0.376	0.361	0.371	0.363	0.366	0.373	0.376
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	1369	1140	1141	1118	1093	1251	1327
Std. Dev.	47.5	73.1	50.9	50.5	47.3	121	72.6
Max	1438	1234	1207	1207	1170	1383	1383
Min	1288	1030	1061	1039	1034	1007	1134
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	3.02	2.51	2.52	2.46	2.41	2.76	2.93
Std. Dev.	0.105	0.161	0.112	0.111	0.104	0.268	0.160
Max	3.17	2.72	2.66	2.66	2.58	3.05	3.05
Min	2.84	2.27	2.34	2.29	2.28	2.22	2.50
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	1.05	1.03	1.04	1.02	1.01	0.960	1.06
Std. Dev.	0.063	0.085	0.097	0.083	0.086	0.125	0.055
Max	1.14	1.15	1.17	1.16	1.10	1.12	1.13
Min	0.954	0.885	0.899	0.889	0.831	0.707	0.943
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	4.31	3.57	3.63	3.46	3.34	3.61	4.27
Std. Dev.	0.458	0.504	0.590	0.454	0.514	0.867	0.469
Max	4.91	4.36	4.49	4.28	4.01	4.72	4.76
Min	3.62	2.66	2.80	2.77	2.43	2.01	3.10
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Glass Filters (continued)

Sample Identification	G4515985	G4516972	G4517001	G4517024	G4517688	G4517724	G4517744
Caliper (mils)							
Average	15.1	15.1	14.4	15.0	15.0	15.1	14.6
Std. Dev.	0.14	0.08	0.32	0.15	0.17	0.15	0.37
Max	15.3	15.2	14.8	15.2	15.3	15.3	15.0
Min	15.0	15.0	14.0	14.8	14.9	14.9	14.0
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.384	0.383	0.367	0.380	0.382	0.383	0.371
Std. Dev.	0.0036	0.0021	0.0082	0.0038	0.0043	0.0039	0.0094
Max	0.389	0.386	0.376	0.386	0.389	0.389	0.381
Min	0.381	0.381	0.356	0.376	0.378	0.378	0.356
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	1289	1275	1168	1349	1366	1380	1162
Std. Dev.	72.1	75.2	42.7	75.3	39.4	58.2	46.5
Max	1415	1365	1216	1442	1420	1479	1220
Min	1157	1175	1080	1211	1302	1275	1061
n =	10	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	2.84	2.81	2.58	2.98	3.01	3.04	2.56
Std. Dev.	0.159	0.166	0.094	0.166	0.087	0.128	0.102
Max	3.12	3.01	2.68	3.18	3.13	3.26	2.69
Min	2.55	2.59	2.38	2.67	2.87	2.81	2.34
n =	10	10	10	10	10	10	10
MD Stretch (%)							
Average	0.997	1.03	1.04	1.03	1.03	1.03	0.981
Std. Dev.	0.0875	0.088	0.078	0.108	0.082	0.112	0.0561
Max	1.10	1.16	1.15	1.15	1.14	1.13	1.09
Min	0.849	0.877	0.879	0.828	0.897	0.866	0.882
n =	10	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	3.85	3.94	3.71	4.17	4.29	4.27	3.44
Std. Dev.	0.606	0.542	0.419	0.730	0.579	0.715	0.36
Max	4.73	4.79	4.24	5.11	5.01	5.04	4.10
Min	2.96	3.00	2.94	2.89	3.36	3.10	2.92
n =	10	10	10	10	10	10	10

Table 1. Physical Properties of Glass Filters (continued)

Sample Identification	G4517750	G4517780	G4517807	G4517879	G4517919	G4517935	G4519506
Caliper (mils)							
Average	14.5	14.4	14.9	14.9	15.0	15.1	15.2
Std. Dev.	0.11	0.15	0.19	0.16	0.21	0.25	0.34
Max	14.6	14.6	15.1	15.2	15.3	15.4	15.5
Min	14.4	14.2	14.6	14.8	14.8	14.8	14.7
n =	5	5	5	5	5	5	5
Caliper (mm)							
Average	0.368	0.367	0.377	0.379	0.380	0.384	0.385
Std. Dev.	0.0028	0.0039	0.0050	0.0042	0.0053	0.0065	0.0087
Max	0.371	0.371	0.384	0.386	0.389	0.391	0.394
Min	0.366	0.361	0.371	0.376	0.376	0.376	0.373
n =	5	5	5	5	5	5	5
MD Tensile (gf/20 mm)							
Average	1097	1131	1280	1329	1314	1348	1245
Std. Dev.	31.4	84.4	47.9	69.3	64.6	59.1	143
Max	1157	1261	1347	1442	1406	1424	1370
Min	1043	1002	1207	1197	1188	1238	975
n =	11	10	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)							
Average	2.42	2.49	2.82	2.93	2.90	2.97	2.75
Std. Dev.	0.069	0.186	0.105	0.153	0.142	0.130	0.316
Max	2.55	2.78	2.97	3.18	3.10	3.14	3.02
Min	2.30	2.21	2.66	2.64	2.62	2.73	2.15
n =	11	10	10	10	10	10	10
MD Stretch (%)							
Average	1.01	0.953	1.03	1.01	1.03	1.01	0.871
Std. Dev.	0.067	0.110	0.062	0.108	0.058	0.073	0.107
Max	1.07	1.10	1.11	1.15	1.09	1.10	0.975
Min	0.865	0.788	0.924	0.792	0.921	0.878	0.619
n =	11	10	10	10	10	10	10
MD TEA (J/m^2)							
Average	3.38	3.27	4.01	3.98	4.06	4.04	3.13
Std. Dev.	0.360	0.651	0.418	0.689	0.470	0.535	0.734
Max	3.74	4.02	4.52	4.69	4.56	4.75	3.89
Min	2.62	2.34	3.27	2.64	3.27	3.11	1.67
n =	11	10	10	10	10	10	10

Table 1. Physical Properties of Glass Filters (continued)

Sample Identification	G4519534	G4519565	G4520158	G4520177	G4520195
Caliper (mils)					
Average	15.2	15.1	15.2	15.5	15.4
Std. Dev.	0.15	0.41	0.19	0.33	0.28
Max	15.4	15.7	15.3	15.9	15.6
Min	15.0	14.7	14.9	15.1	14.9
n =	5	5	5	5	5
Caliper (mm)					
Average	0.385	0.384	0.385	0.393	0.391
Std. Dev.	0.0039	0.0103	0.0050	0.0085	0.0070
Max	0.391	0.399	0.389	0.404	0.396
Min	0.381	0.373	0.378	0.384	0.378
n =	5	5	5	5	5
MD Tensile (gf/20 mm)					
Average	1205	1224	1375	1279	1282
Std. Dev.	73.4	113	95.4	123	115
Max	1324	1388	1488	1447	1429
Min	1093	1089	1220	1093	1066
n =	10	10	10	10	10
MD Tensile Strength (lbf/20 mm)					
Average	2.66	2.70	3.03	2.82	2.83
Std. Dev.	0.162	0.249	0.210	0.271	0.254
Max	2.92	3.06	3.28	3.19	3.15
Min	2.41	2.40	2.69	2.41	2.35
n =	10	10	10	10	10
MD Stretch (%)					
Average	1.02	0.935	0.983	0.893	0.978
Std. Dev.	0.071	0.0879	0.0498	0.0818	0.0771
Max	1.11	1.10	1.09	1.01	1.15
Min	0.913	0.763	0.890	0.750	0.887
n =	10	10	10	10	10
MD TEA (J/m^2)					
Average	3.74	3.40	4.01	3.37	3.74
Std. Dev.	0.454	0.665	0.444	0.607	0.561
Max	4.22	4.62	4.64	4.24	4.71
Min	3.11	2.29	3.12	2.37	3.15
n =	10	10	10	10	10

Table 2. Summary Data for Glass Filters

Sample Identification	Glass Filters*
Caliper (mils)	
Average	15.2 / 15.2
Std. Dev.	0.47 / 0.45
Max	17.9 / 16.5
Min	14.0 / 14.0
n =	375 / 374
Caliper (mm)	
Average	0.386 / 0.386
Std. Dev.	0.0119 / 0.0113
Max	0.455 / 0.419
Min	0.356 / 0.356
n =	375 / 374
MD Tensile (gf/20 mm)	
Average	1276
Std. Dev.	132
Max	1656
Min	798
n =	752
MD Tensile Strength (lbf/20 mm)	
Average	2.81
Std. Dev.	0.291
Max	3.65
Min	1.76
n =	752
MD Stretch (%)	
Average	0.987
Std. Dev.	0.0931
Max	1.32
Min	0.563
n =	752
MD TEA (J/m^2)	
Average	3.77
Std. Dev.	0.656
Max	5.58
Min	1.36
n =	752

*Note: Statistical analysis for caliper testing includes and excludes a high caliper reading of 17.9 mils.

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 49.7% RH.
Temperature conditions during testing were 72.8°F to 73.4°F.
Humidity conditions during testing were 49.4% RH to 50.5% 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, MAG
Quality review by LAH
Dates tested August 1 - 14, 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 TAPPI test method(s) cited above for estimates of measurement uncertainty.

Appendix E

Flow Rate Test Results

CY 2014 Glass Flow Rates

Number	Sm.#s	Filter Identification	Delta P Hi-Vol	Delta P Orifice	Q, m^3/min measured	Qstd, m^3/min
1	6	G4500937	6.75	5.3	1.660	1.675
2	15	G4500964	6.50		1.630	1.645
3	17	G4500968	6.75		1.660	1.675
4	26	G4502227	6.90		1.680	1.695
5	32	G4502252	6.80		1.670	1.685
6	33	G4502253	7.00	5.3	1.690	1.705
7	40	G4502273	6.50		1.630	1.645
8	46	G4503793	6.40		1.620	1.634
9	57	G4503824	6.35		1.615	1.629
10	62	G4505401	6.40		1.620	1.634
11	69	G4505426	6.40	5.3	1.620	1.634
12	80	G4505459	6.30		1.610	1.624
13	82	G4505474	6.30		1.610	1.624
14	92	G4505504	6.40		1.620	1.634
15	98	G4505517	6.60		1.640	1.655
16	103	G4506899	6.40	5.3	1.620	1.634
17	111	G4506928	6.40		1.620	1.634
18	120	G4506953	6.35		1.615	1.629
19	123	G4507818	6.40		1.620	1.634
20	132	G4507839	6.40		1.620	1.634
21	140	G4507860	6.50	5.3	1.630	1.645
22	142	G4508265	6.45		1.625	1.639
23	151	G4508304	6.40		1.620	1.634
24	159	G4508219	6.60		1.640	1.655
25	163	G4510992	6.20		1.590	1.604
26	171	G4511012	6.20	5.3	1.590	1.604
27	180	G4511050	6.30		1.610	1.624
28	182	G4511190	6.60		1.640	1.655
29	193	G4511211	6.30		1.610	1.624
30	200	G4511237	6.30		1.610	1.624
31	205	G4512634	6.20	5.3	1.590	1.604
32	210	G4512643	6.20		1.590	1.604
33	214	G4512657	6.40		1.620	1.634
34	222	G4513854	6.50		1.630	1.645
35	231	G4512888	6.70		1.655	1.670
36	240	G4513908	6.70	5.3	1.655	1.670
37	243	G4513914	6.60		1.640	1.655
38	251	G4513933	6.70		1.655	1.670
39	259	G4513957	6.60		1.640	1.655
40	263	G4514760	6.30		1.610	1.624
41	271	G4514778	6.40	5.3	1.620	1.634
42	280	G4514820	6.30		1.610	1.624
43	282	G4514888	6.60		1.640	1.655
44	294	G4514920	6.60		1.640	1.655
45	300	G4514948	6.50		1.630	1.645
46	303	G4515215	6.40	5.3	1.620	1.634
47	314	G4515247	6.30		1.610	1.624
48	319	G4515272	6.50		1.630	1.645
49	322	G4515801	6.60		1.640	1.655
50	332	G4515840	6.50		1.630	1.645
51	339	G4515857	6.40	5.3	1.620	1.634
52	342	G4515878	6.50		1.630	1.645
53	356	G4515915	6.30		1.610	1.624
54	360	G4515921	6.20		1.590	1.604
55	362	G4515931	6.40		1.620	1.634

Appendix F

Retention Test Results

CY-2014 Glass Filter Retention Test

Sample #	Penetration %	Efficiency %	Resistance mm/H_2O	Resistance In/H_2O
G4500922	0.004	99.9960	18	0.70
G4500948	0.002	99.9980	26	1.00
G4502213	0.003	99.9970	26	1.00
G4502259	0.002	99.9980	26	1.00
G4503774	0.002	99.9980	26	1.00
G4503799	0.001	99.9990	26	1.00
G4505409	0.003	99.9970	26	1.00
G4505444	0.003	99.9970	26	1.00
G4505477	0.002	99.9980	28	1.10
G4505505	0.002	99.9980	28	1.10
G4506900	0.003	99.9970	28	1.10
G4506938	0.002	99.9980	26	1.00
G4507819	0.003	99.9970	26	1.00
G4507842	0.002	99.9980	28	1.10
G4508267	0.002	99.9980	28	1.10
G4508310	0.003	99.9970	28	1.10
G4510994	0.003	99.9970	28	1.10
G4511014	0.003	99.9970	28	1.10
G4511191	0.002	99.9980	26	1.00
G4511216	0.003	99.9970	28	1.10
G4512636	0.002	99.9980	28	1.10
G4512660	0.003	99.9970	28	1.10
G4513860	0.002	99.9980	26	1.00
G4513889	0.003	99.9970	26	1.00
G4513915	0.002	99.9980	26	1.00
G4513934	0.002	99.9980	26	1.00
G4514761	0.003	99.9970	26	1.00
G4514783	0.003	99.9970	26	1.00
G4514890	0.001	99.9990	26	1.00
G4514921	0.003	99.9970	26	1.00
G4515216	0.002	99.9980	26	1.00
G4515239	0.002	99.9980	26	1.00
G4515802	0.002	99.9980	26	1.00
G4515847	0.002	99.9980	26	1.00
G4515882	0.003	99.9970	26	1.00
G4515916	0.003	99.9970	26	1.00
G4515933	0.003	99.9970	26	1.00
G4515973	0.002	99.9980	26	1.00
G4516976	0.002	99.9980	26	1.00
G4517010	0.003	99.9970	28	1.10
G4517703	0.002	99.9980	26	1.00
G4517728	0.003	99.9970	28	1.10
G4517757	0.003	99.9970	26	1.00
G4517782	0.002	99.9980	26	1.00
G4517887	0.002	99.9980	26	1.00
G4517922	0.003	99.9970	26	1.00
G4519511	0.003	99.9970	28	1.10
G4519550	0.002	99.9980	26	1.00
G4520163	0.003	99.9970	26	1.00
G4520181	0.003	99.9970	26	1.00
Average		99.9975		1.02
Std Dev.		0.00061		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		NUMBER ORDERED 50	DATE RECEIVED 31 Jul 13
PURCHASE ORDER NUMBER 176922.2003.0000		DOP PENETRATION .03 % @ RATED FLOW	N/A % @ 20% RATED FLOW	NUMBER RECEIVED 50	DATE TESTED 05 Aug 13
FILTER MODEL NUMBER Glass		RESISTANCE N/A W.G. @ 100 % RATED FLOW		NUMBER ACCEPTED 50	DATE SHIPPED
MANUFACTURER TRC		SPECIFICATION AST2986a-99		REJECTS	
FILTER DESCIPTION 8X10 Glass Flat Sheet		TEST CONDITIONS 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%	20%	
1	G4500922	Accepted	.7	.004	N/A	CAH
2	G4500948	"	1.0	.002	N/A	CAH
3	G4502213	"	1.0	.003	N/A	CAH
4	G4502259	"	1.0	.002	N/A	CAH
5	G4503774	"	1.0	.002	N/A	CAH
6	G4503799	"	1.0	.001	N/A	CAH
7	G4505409	"	1.0	.003	N/A	CAH
8	G4505444	"	1.0	.003	N/A	CAH
9	G4505477	"	1.1	.002	N/A	CAH
10	G4505505	"	1.1	.002	N/A	CAH
11	G4506900	"	1.1	.003	N/A	CAH
12	G4506938	"	1.0	.002	N/A	CAH
13	G4507819	"	1.0	.003	N/A	CAH
14	G4507842	"	1.1	.002	N/A	CAH
15	G4508267	"	1.1	.002	N/A	CAH
16	G4508310	"	1.1	.003	N/A	CAH
17	G4510994	"	1.1	.003	N/A	CAH
18	G4511014	"	1.1	.003	N/A	CAH

DISTRIBUTION
Email 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.
176922.2003.0000

ITEM No.	FILTER SERIAL NUMBER	INSPECTION RESULTS	TEST RESULTS			FILTER TESTED BY:
			RESISTANCE	% PENETRATION		
				100%	20%	
19	G4511191	Accepted	1.0	.002	N/A	CAH
20	G4511216	"	1.1	.003	N/A	CAH
21	G4512636	"	1.1	.002	N/A	CAH
22	G4512660	"	1.1	.003	N/A	CAH
23	G4513860	"	1.0	.002	N/A	CAH
24	G4513889	"	1.0	.003	N/A	CAH
25	G4513915	"	1.0	.002	N/A	CAH
26	G4513934	"	1.0	.002	N/A	CAH
27	G4514761	"	1.0	.003	N/A	CAH
28	G4514783	"	1.0	.003	N/A	CAH
29	G4514890	"	1.0	.001	N/A	CAH
30	G4514921	"	1.0	.003	N/A	CAH
31	G4515216	"	1.0	.002	N/A	CAH
32	G4515239	"	1.0	.002	N/A	CAH
33	G4515802	"	1.0	.002	N/A	CAH
34	G4515847	"	1.0	.002	N/A	CAH
35	G4515882	"	1.0	.003	N/A	CAH
36	G4515916	"	1.0	.003	N/A	CAH
37	G4515933	"	1.0	.003	N/A	CAH
38	G4515973	"	1.0	.002	N/A	CAH
39	G4516976	"	1.0	.002	N/A	CAH
40	G4517010	"	1.1	.003	N/A	CAH
41	G4517703	"	1.0	.002	N/A	CAH
42	G4517728	"	1.1	.003	N/A	CAH
43	G4517757	"	1.0	.003	N/A	CAH
44	G4517782	"	1.0	.002	N/A	CAH
45	G4517887	"	1.0	.002	N/A	CAH
46	G4517922	"	1.0	.003	N/A	CAH
47	G4519511	"	1.1	.003	N/A	CAH
48	G4519550	"	1.0	.002	N/A	CAH
49	G4520163	"	1.0	.003	N/A	CAH
50	G4520181	"	1.0	.003	N/A	CAH

Appendix G

Lead Content Test Results

TRC-Raleigh

Glass Fiber Filter Acceptance Test Data (GFAA) Report # 13-379

Lab ID	Client ID	Pb (µg/filter)	Pb MDL (µg/filter)
13-F1	G4500913	0.951	0.245
13-F2	G4500965	0.773	0.245
13-F3	G4502219	0.702	0.245
13-F4	G4502260	0.768	0.245
13-F5	G4503784	0.790	0.245
13-F6	G4503829	0.863	0.245
13-F7	G4505423	0.670	0.245
13-F8	G4505433	0.704	0.245
13-F9	G4505478	0.626	0.245
13-F10	G4505507	0.895	0.245
13-F11	G4506909	0.795	0.245
13-F12	G4506951	1.070	0.245
13-F13	G4507805	0.871	0.245
13-F14	G4507838	1.010	0.245
13-F15	G4508266	0.920	0.245
13-F16	G4508320	0.761	0.245
13-F17	G4511004	0.861	0.245
13-F18	G4511048	0.998	0.245
13-F19	G4511192	0.712	0.245
13-F20	G4511219	0.792	0.245
13-F21	G4512615	0.717	0.245
13-F22	G4512659	0.636	0.245
13-F23	G4513858	0.548	0.245
13-F24	G4513899	0.494	0.245
13-F25	G4513911	0.558	0.245
13-F26	G4513938	0.545	0.245
13-F27	G4514757	0.448	0.245
13-F28	G4514810	0.587	0.245
13-F29	G4514908	0.553	0.245
13-F30	G4514941	0.536	0.245
13-F31	G4515234	0.572	0.245
13-F32	G4515269	0.805	0.245
13-F33	G4515273	0.802	0.245
13-F34	G4515854	0.736	0.245
13-F35	G4515859	0.631	0.245
13-F36	G4515908	0.717	0.245
13-F37	G4515932	0.580	0.245
13-F38	G4515989	0.543	0.245
13-F39	G4516994	0.633	0.245
13-F40	G4517009	0.565	0.245
13-F41	G4517696	0.585	0.245
13-F42	G4517731	0.521	0.245
13-F43	G4517747	0.474	0.245
13-F44	G4517785	0.523	0.245
13-F45	G4517902	0.509	0.245
13-F46	G4517932	0.550	0.245
13-F47	G4519521	0.531	0.245
13-F48	G4519560	0.717	0.245
13-F49	G4520168	0.614	0.245
13-F50	G4520207	0.467	0.245
	Average	0.685	
	Std. Dev	0.342	

TRC ENVIRONMENTAL
RALEIGH

JOB # T010
REPORT # 13-379

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:	13-379
Sample Description:	8x10 Glass Fiber 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.

Paul Duda 8/14/13

Project Manager Date
Paul Duda

TRC-Raleigh

Glass Fiber Filter Acceptance Test Data (GFAA) Report # 13-379

Lab ID	Client ID	Pb (µg/filter)	Pb MDL (µg/filter)
13-F1	G4500913	0.951	0.245
13-F2	G4500965	0.773	0.245
13-F3	G4502219	0.702	0.245
13-F4	G4502260	0.768	0.245
13-F5	G4503784	0.790	0.245
13-F6	G4503829	0.863	0.245
13-F7	G4505423	0.670	0.245
13-F8	G4505433	0.704	0.245
13-F9	G4505478	0.626	0.245
13-F10	G4505507	0.895	0.245
13-F11	G4506909	0.795	0.245
13-F12	G4506951	1.070	0.245
13-F13	G4507805	0.871	0.245
13-F14	G4507838	1.010	0.245
13-F15	G4508266	0.920	0.245
13-F16	G4508320	0.761	0.245
13-F17	G4511004	0.861	0.245
13-F18	G4511048	0.998	0.245
13-F19	G4511192	0.712	0.245
13-F20	G4511219	0.792	0.245
13-F21	G4512615	0.717	0.245
13-F22	G4512659	0.636	0.245
13-F23	G4513858	0.548	0.245
13-F24	G4513899	0.494	0.245
13-F25	G4513911	0.558	0.245
13-F26	G4513938	0.545	0.245
13-F27	G4514757	0.448	0.245
13-F28	G4514810	0.587	0.245
13-F29	G4514908	0.553	0.245
13-F30	G4514941	0.536	0.245
13-F31	G4515234	0.572	0.245
13-F32	G4515269	0.805	0.245
13-F33	G4515273	0.802	0.245
13-F34	G4515854	0.736	0.245
13-F35	G4515859	0.631	0.245
13-F36	G4515908	0.717	0.245
13-F37	G4515932	0.580	0.245
13-F38	G4515989	0.543	0.245
13-F39	G4516994	0.633	0.245
13-F40	G4517009	0.565	0.245
13-F41	G4517696	0.585	0.245
13-F42	G4517731	0.521	0.245
13-F43	G4517747	0.474	0.245
13-F44	G4517785	0.523	0.245
13-F45	G4517902	0.509	0.245
13-F46	G4517932	0.550	0.245
13-F47	G4519521	0.531	0.245
13-F48	G4519560	0.717	0.245
13-F49	G4520168	0.614	0.245
13-F50	G4520207	0.467	0.245

QA/QC Report

Client Name: TRC-Raleigh
Project Number: T010
Analytical Technique: GFAA
Sample Description: 8x10 Glass Fiber
Report Number: 13-379

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	21.1	105.3
Pb	CCV	20.0	21.4	106.8
Pb	CCV	20.0	20.9	104.4
Pb	CCV	20.0	21.4	106.9

Duplicate Data

Analyte	Sample ID	Sample Conc. µg/L	Duplicate Conc. µg/L	RPD
Pb	13-F1	3.89	3.71	4.74 #

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	115.	100.	115.
Pb	13-F2	3.16	101.	100.	97.6

*: 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 Glass Fiber
Report Number: 13-379

==========

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	20.4	102.2
Pb	CCV	20.0	20.7	103.6
Pb	CCV	20.0	19.4	96.8
Pb	CCV	20.0	19.2	96.0

Duplicate Data

Analyte	Sample ID	Sample Conc. µg/L	Duplicate Conc. µg/L	RPD
Pb	13-F21	2.93	3.12	6.28 #

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	102.	100.	102.
Pb	13-F22	2.60	91.1	100.	88.5

*: 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 Glass Fiber
Report Number: 13-379

==========

Blank Data

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

Duplicate Data

Analyte	Sample ID	Sample Conc. µg/L	Duplicate Conc. µg/L	RPD
Pb	13-F41	2.39	2.24	6.48 #

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-F42	2.13	94.0	100.	91.9

*: 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%*