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ISO 14001 Certified

September 6, 2007

E-MAIL TO JConcialdi@aempower.com

Mr. John Concialdi
Advanced Engine Management, Inc. (AEM)
Research & Development Division
2205 W. 126th Street, Unit A
Hawthorne, CA 90250

Subject: Southwest Research Institute® (SwRI®) Test Report Project No. 08.12717.01.004, "Air Filter Testing"

Reference: Advanced Engine Management Purchase Order Number PO-011288

Dear Mr. Concialdi:

1.0 Introduction and Test Arrangement

This report presents results of airflow resistance, initial and cumulative efficiency, and dust capacity testing conducted on an AEM-215-3059-215/45P and Competitor (4" opening x 9" tall, round) air filter elements provided by AEM for evaluation. Each element is identified in Table 1. Six (6) dust loading tests were accomplished on each element. During the initial and final tests, dust loading was accomplished to a terminal restriction increase of 10 inches of water. During the four (4) intermediate tests, dust loading was accomplished to a terminal restriction increase of 5 inches of water. Each element was cleaned between each test using AEM DRYFLOW Filter Cleaner (P/N 2-1002), to the procedure given on the bottle (except the element was rinsed by hose -inside/out- before washing). Following cleaning, the three non-"dryflow" elements (AFE 72-40035, Airaid 700-470 and K&N RE-0870) were re-oiled using K&N Aerosol Air Filter Oil (P/N 99-0504) to the procedure given on the paper instructions accompanying the oil.

All testing was conducted in accordance with ISO 5011:2000, Inlet air cleaning equipment for internal combustion engines and compressors - Performance testing. Clean element and "after cleaning" airflow resistance measurements were made without upstream ducting, and with a 4" dia downstream piezometer. A 7" dia x 33.5" upstream duct was used during dust loading to provide a control volume for dust feeding. Efficiency and dust capacity testing were conducted at 240 scfm (101.3 kPa, 20°C), using PTI SAE/ISO Fine Test Dust (Batch 5390F) at a concentration of 1.0 g/m^3 air (0.028 g/ft^3 air). Initial efficiency testing was conducted using Fine dust (at concentration of 0.0057 g/ft^3) for thirty (30) minutes. Particle size data for the test dust is given in Appendix A.

The test sequence for each test was as follows:

- Measure element restriction as a function of airflow rate.
- Measure "initial" efficiency.
- Conduct cumulative efficiency testing while measuring dust capacity to 10 inches of water restriction increase across the element (terminal R = initial R + 10 inches of water).
- Wash and dry element, then conduct cumulative efficiency testing while measuring dust capacity to 5 inches of water restriction increase across the element (terminal R = initial R + 5 inches of water) and conduct post-test airflow resistance measurement.
- After 5th washing, drying and airflow resistance measurement, repeat “initial efficiency” and cumulative efficiency/dust capacity testing to 10 inches of water restriction increase across the element (terminal R = initial R + 10 inches of water).

The elements were inspected before and after each test run.

2.0 Test Results

Test results are given in Tables 1 and 2 and Figures 1 through 10. Table 1 gives clean element restriction, initial and cumulative efficiency, incremental efficiency and dust capacity as a function of the amount of dust retained by the filter elements during each test run. Dust capacities in Table 1 represent the amount of dust retained by the elements in reaching a terminal restriction increase of 10 or 5 inches of water across the test unit, as noted. Table 2 gives initial restriction and restriction after the final washing and drying. Figure 1 shows clean element restriction as a function of airflow rate for each element. Figure 2 shows final “clean” element restriction (after 5th washing and drying) as a function of airflow rate for each element. Figure 3 shows restriction increase as a function of dust retained by the elements during initial and final dust loading test runs. Figure 4 shows restriction increase as a function of dust retained by the elements during the intermediate dust loading test runs. Figures 5 through 9 show restriction as a function of airflow after each intermediate cleaning, for each filter.

Table 1. Efficiency and Dust Capacity: AEM and Competitor Filter Elements; PTI ISO 12103-1, (Batch 5390F) at a concentration of 1.0 g/m^3 air (0.028 g/ft^3 air), Except for Initial Efficiency: Fine dust at a concentration of 0.2 g/m^3 air (0.0057 g/ft^3), for thirty (30) minutes; Airflow Rate: 240 scfm; Elements Tested in Accordance with ISO 5011 Test Procedures

Efficiency, %	AEM 21-3059-215/45P	AFE 72-40035	AFE 21-40035	Airaid 700-470	K&N RE-0870	Comments
$\eta_i(i)$	98.14	96.86	97.39	95.77	93.73	* - initial
$\eta_o(i)$	99.47	98.54	96.76	97.95	95.63	**/*** - initial
						After Washing:
η_a	99.38	98.50	96.90	97.38	95.43	**/****
η_b	99.25	98.37	96.77	96.62	95.39	**/****
η_c	99.30	97.96	97.25	96.82	92.55	**/****
η_d	99.29	97.87	97.19	96.58	94.64	**/****
$\eta_i(f)$	97.77	96.74	96.91	96.09	92.26	* - final
$\eta_o(f)$	99.35	97.90	96.21	97.55	94.71	**/*** - final

Elements tested: July - Aug 2007

* $$\text{Efficiency} = \left[1 - \frac{\text{wt. gain of absolute}}{\text{wt. of dust fed}}\right] \times 100$$

** $$\text{Efficiency} = \left[\frac{\text{wt. gain of element}}{\text{wt. gain of element} + \text{wt. gain of absolute}}\right] \times 100$$

*** Based on dust retained by element after a restriction increase of 10 inches of water, at 240 scfm.
**** Based on dust retained by element after a restriction increase of 5 inches of water, at 240 scfm.

Dust Capacity, g	AEM 21-3059-215/45P	AFE 72-40035	AFE 21-40035	Airaid 700-470	K&N RE-0870	Comments
DC(i)	249	116	58	117	141	*** (initial)
						After Washing:
DC_a	156	76	45	85	112	****
DC_b	158	79	45	91	115	****
DC_c	158	72	44	75	117	****
DC_d	163	71	43	77	122	****
DC(f)	245	87	58	86	139	*** (final)

*** Dust retained by element after a restriction increase of 10 inches of water, at 240 scfm.
**** Dust retained by element after a restriction increase of 5 inches of water, at 240 scfm.

Table 2. Initial Restriction and Restriction after the Final Washing and Drying, Inches of water (Elements Tested in Accordance with ISO 5011 Test Procedures)

	AEM 21-3059-215/45P	AFE 72-40035	AFE 21-40035	Airaid 700-470	K&N RE-0870
Initial Restriction	1.23	1.18	0.98	0.99	0.83
Restriction after Final Washing and Drying	1.36	1.49	0.99	1.34	0.85

Elements tested: July - Aug 2007

No visible manufacturing flaws were noted, and no post-test dust tracking was observed, except for dust spot through the media for the AFE 21-40035 element. These spot were visible on the initial and final test runs, and to a much lesser extent, on the first intermediate test run to 5" of water restriction. Dust spots were not evident on the subsequent three intermediate test runs. The dust spots are illustrated in Figure 10, which are post-test photographs of the final test run. These minor leaks likely explain the decrease in cumulative efficiency, relative to initial efficiency, at the higher dust loading (10" of water restriction). Cumulative efficiency for each of the other filters was higher than initial efficiency, as expected.

The following can be concluded:

- Washing and intermediate dust loading had little effect on dust capacity for all elements. This is clearly shown in Table 1 and Figure 3.
- Initial and cumulative efficiency and dust capacity were notably higher for the AEM filter compared to the competitive filters.
- Initial, cumulative and intermediate efficiencies were relatively stable for each filter.
- Dust capacities for the AEM, AFE 21-40035 and K&N RE-0870 elements did not change appreciably with repeated washing and dust loading.
- Dust capacities for the AFE 72-40035 and Airaid 700-470 elements decreased significantly with repeated washing and dust loading.

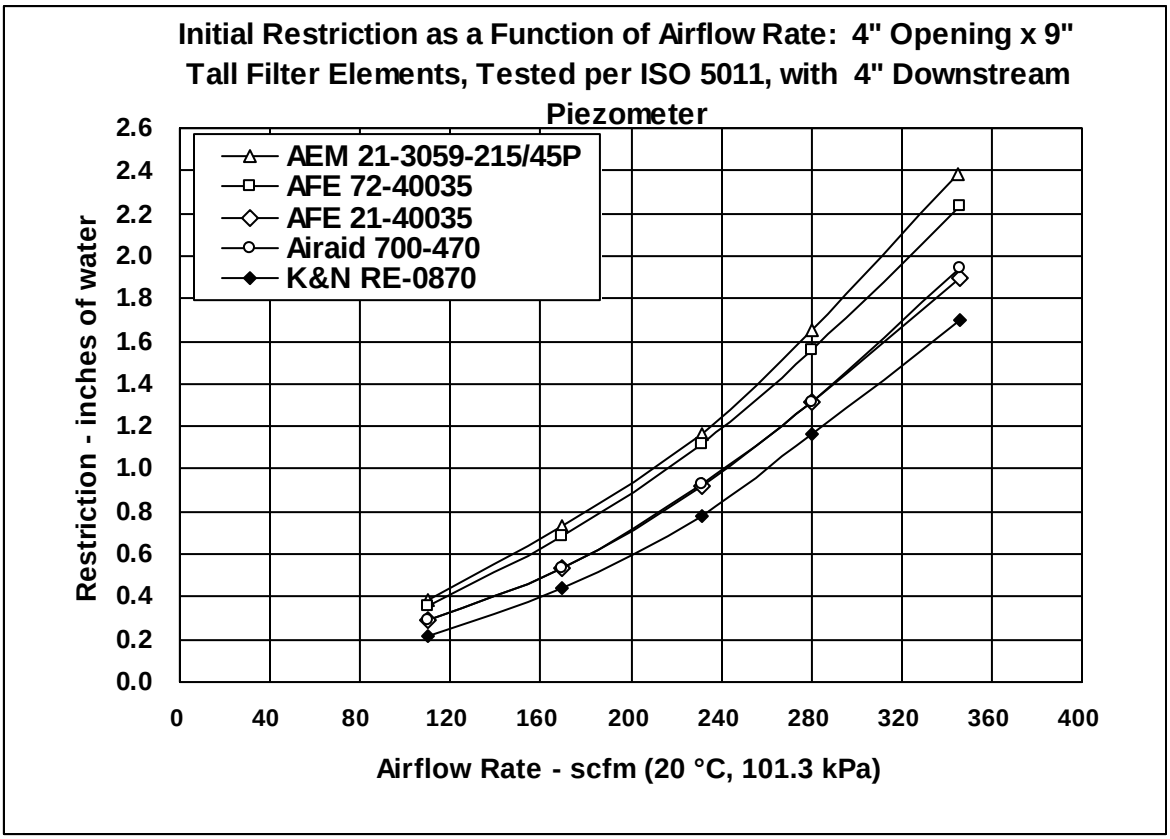

Figure 1

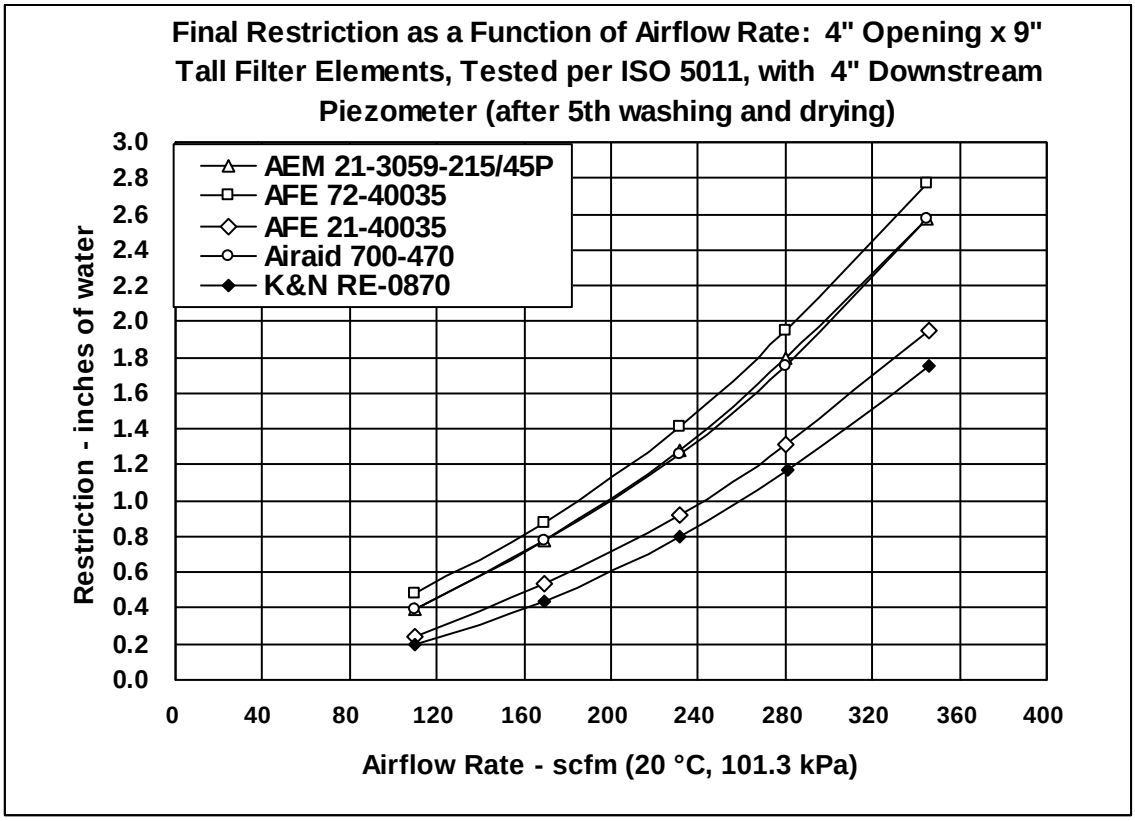

Figure 2

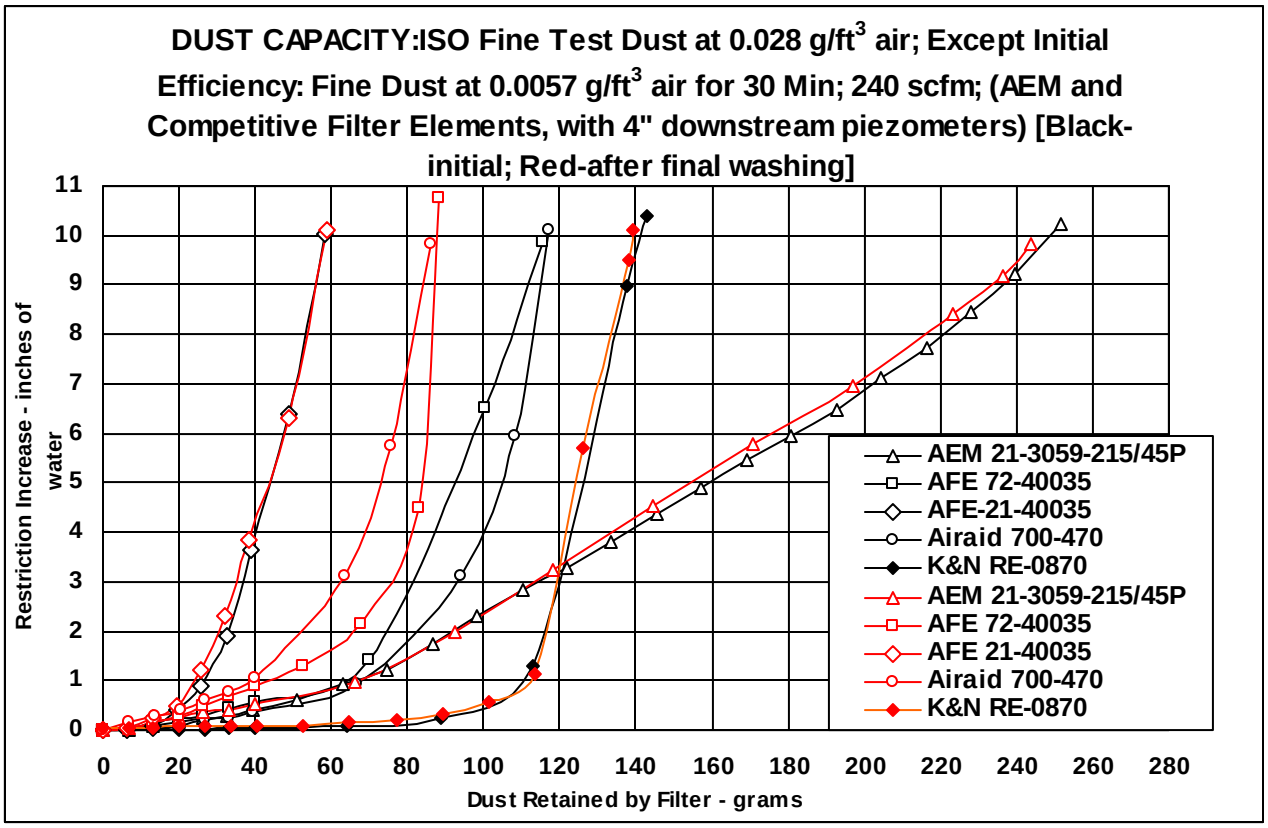

Figure 3

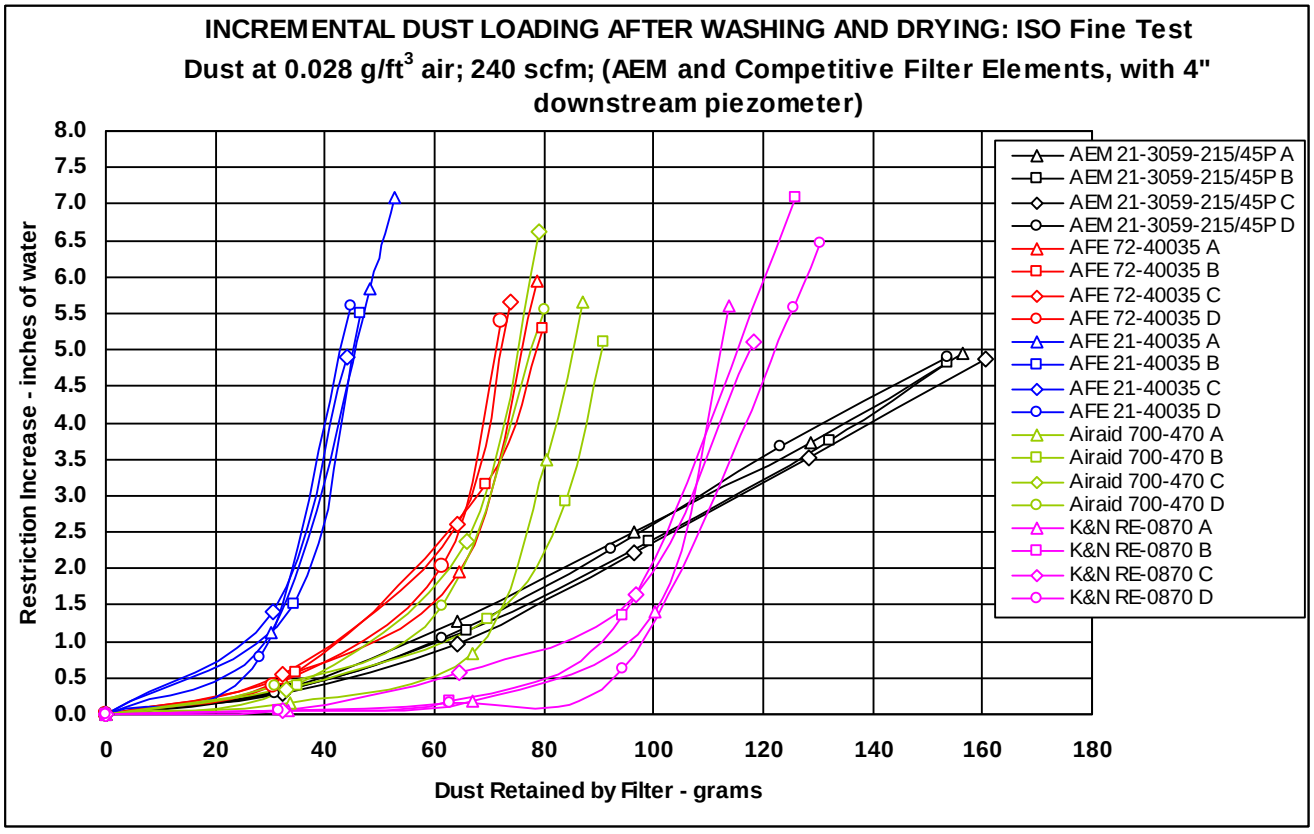

Figure 4

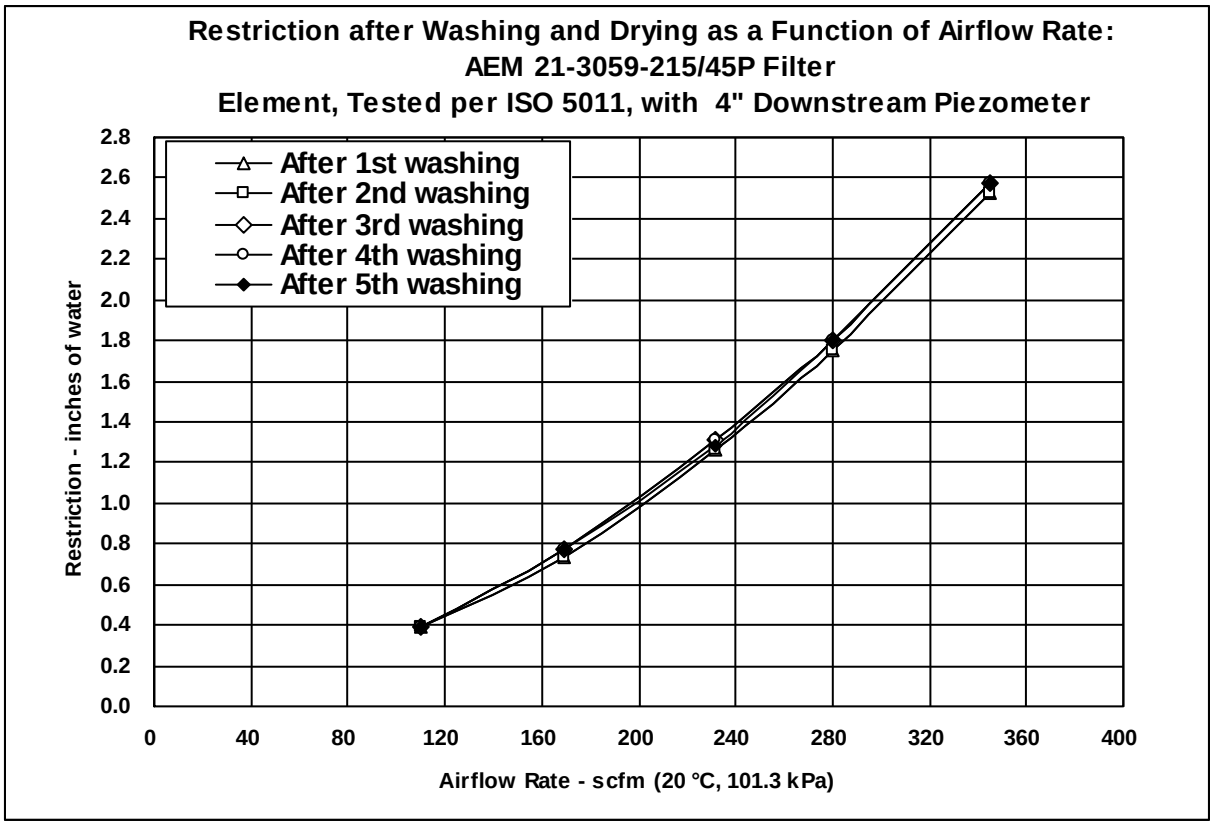

Figure 5

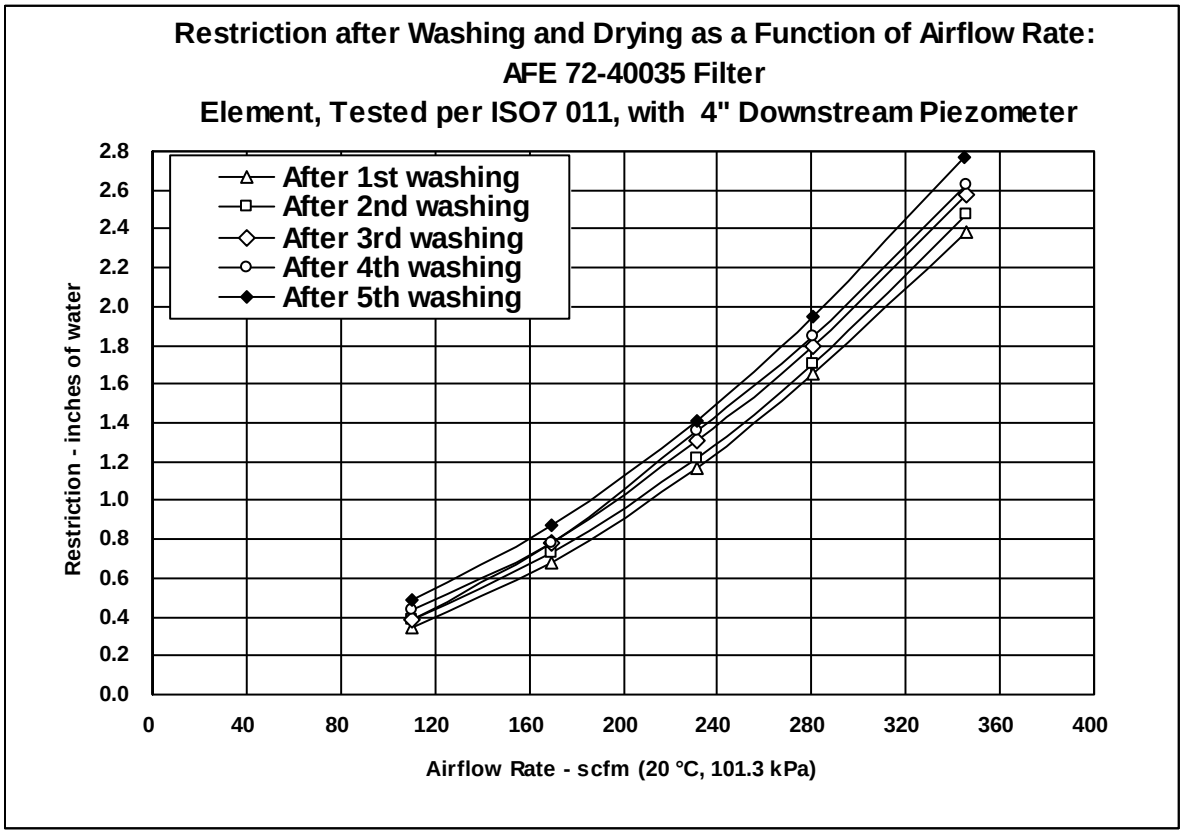

Figure 6

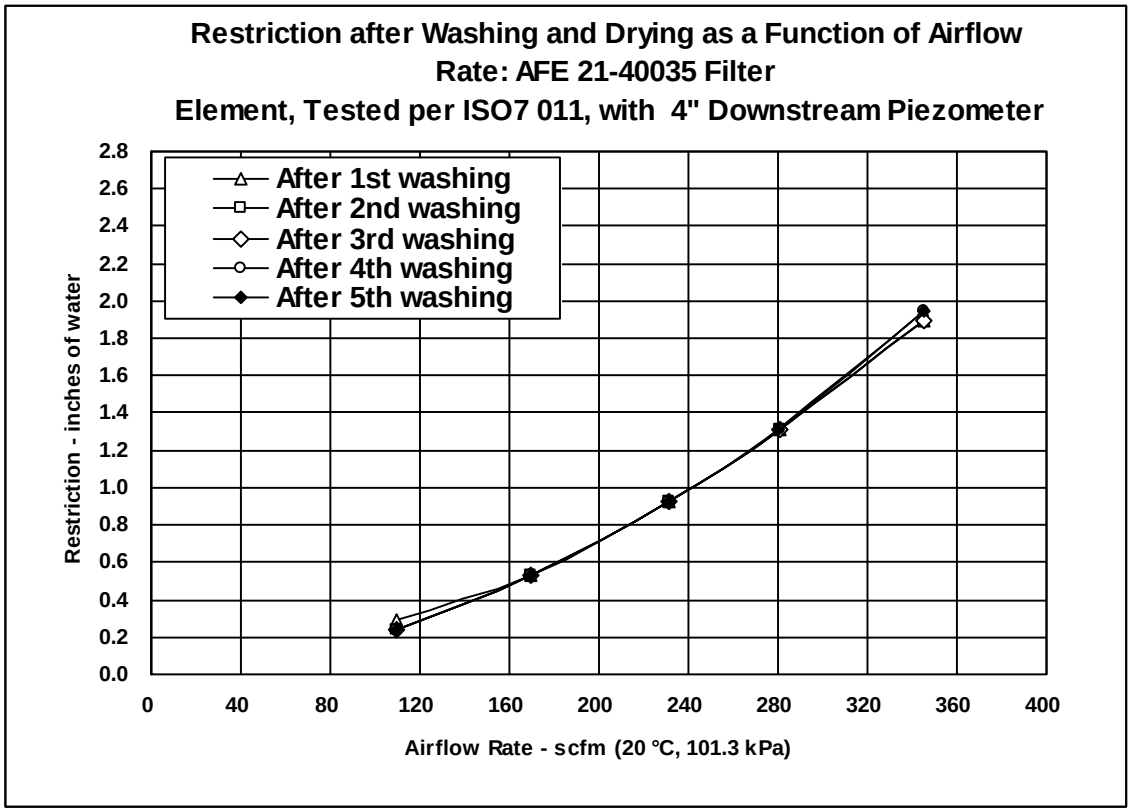

Figure 7

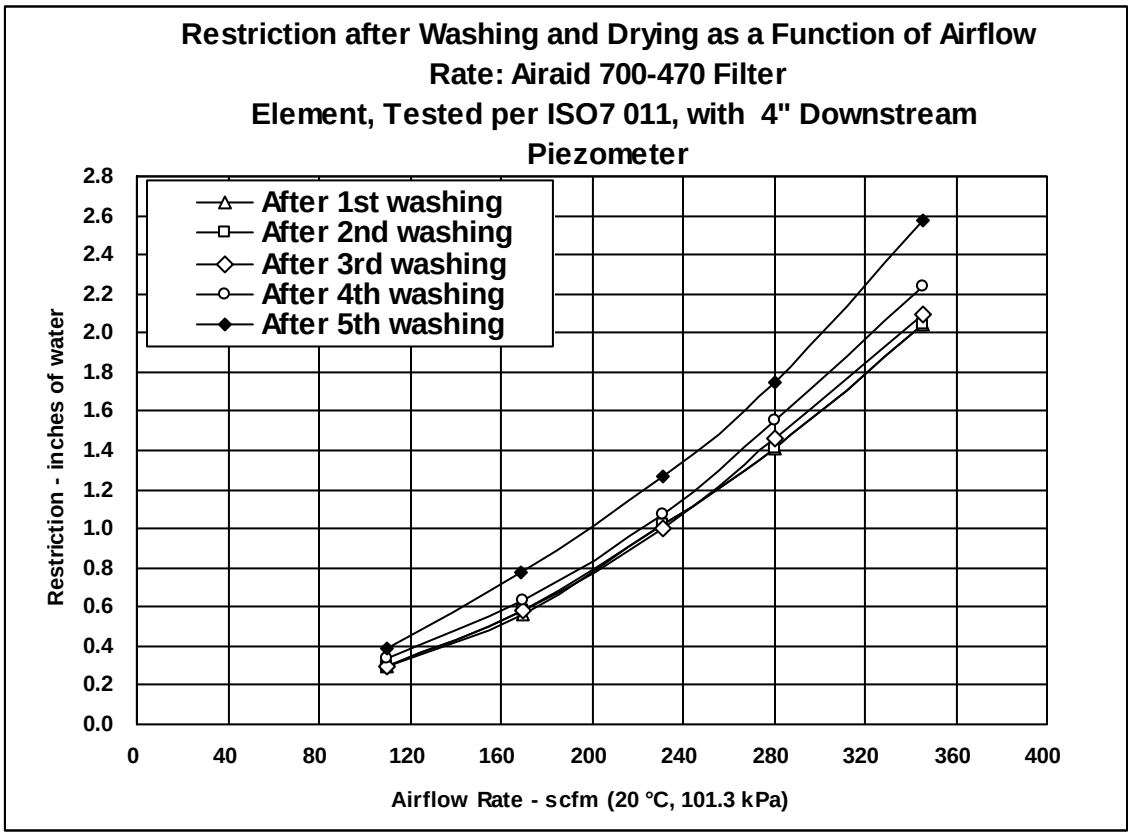

Figure 8

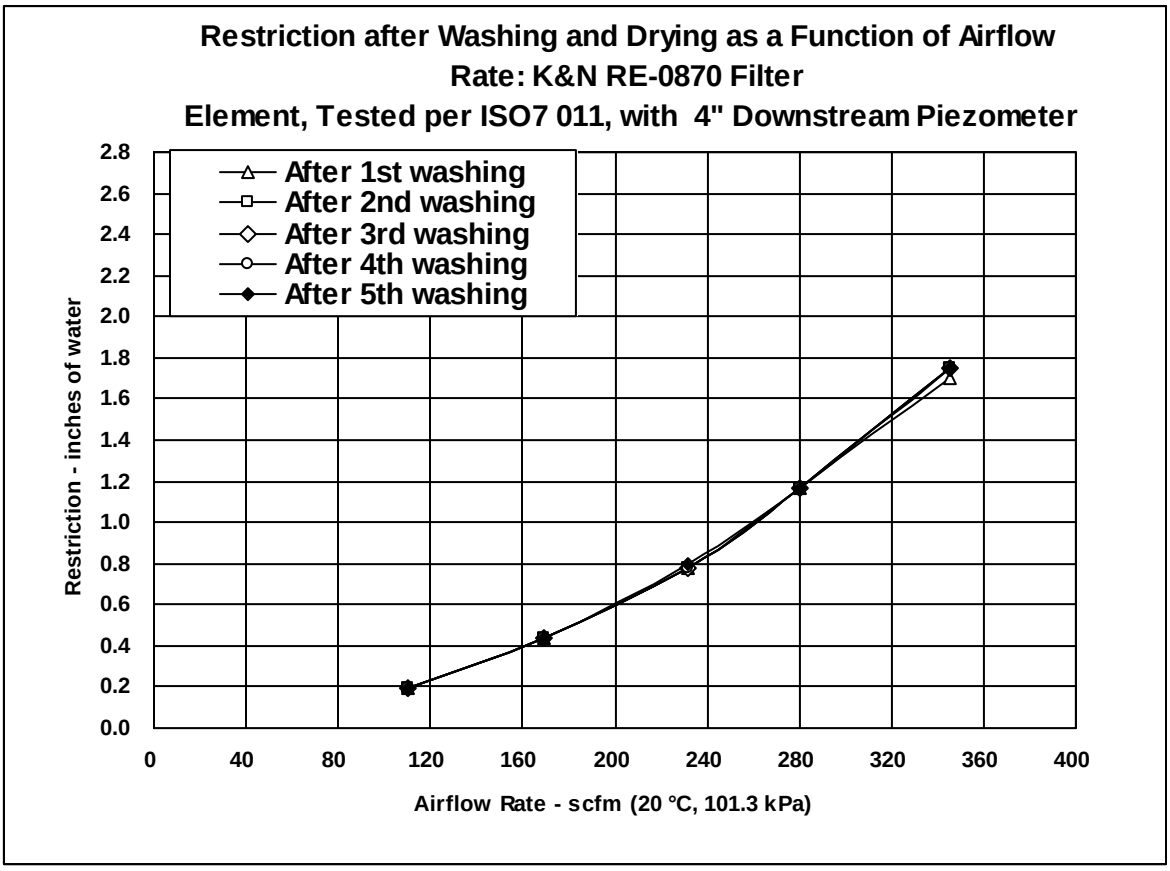
Restriction after Washing and Drying as a Function of Airflow Rate: K&N RE-0870 Filter Element, Tested per ISO7 011, with 4" Downstream Piezometer
After 1st washing
After 2nd washing
After 3rd washing
After 4th washing
After 5th washing
Restriction - inches of water
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
40
80
120
160
200
240
280
320
360
400
Airflow Rate - scfm (20 °C, 101.3 kPa)

Figure 9

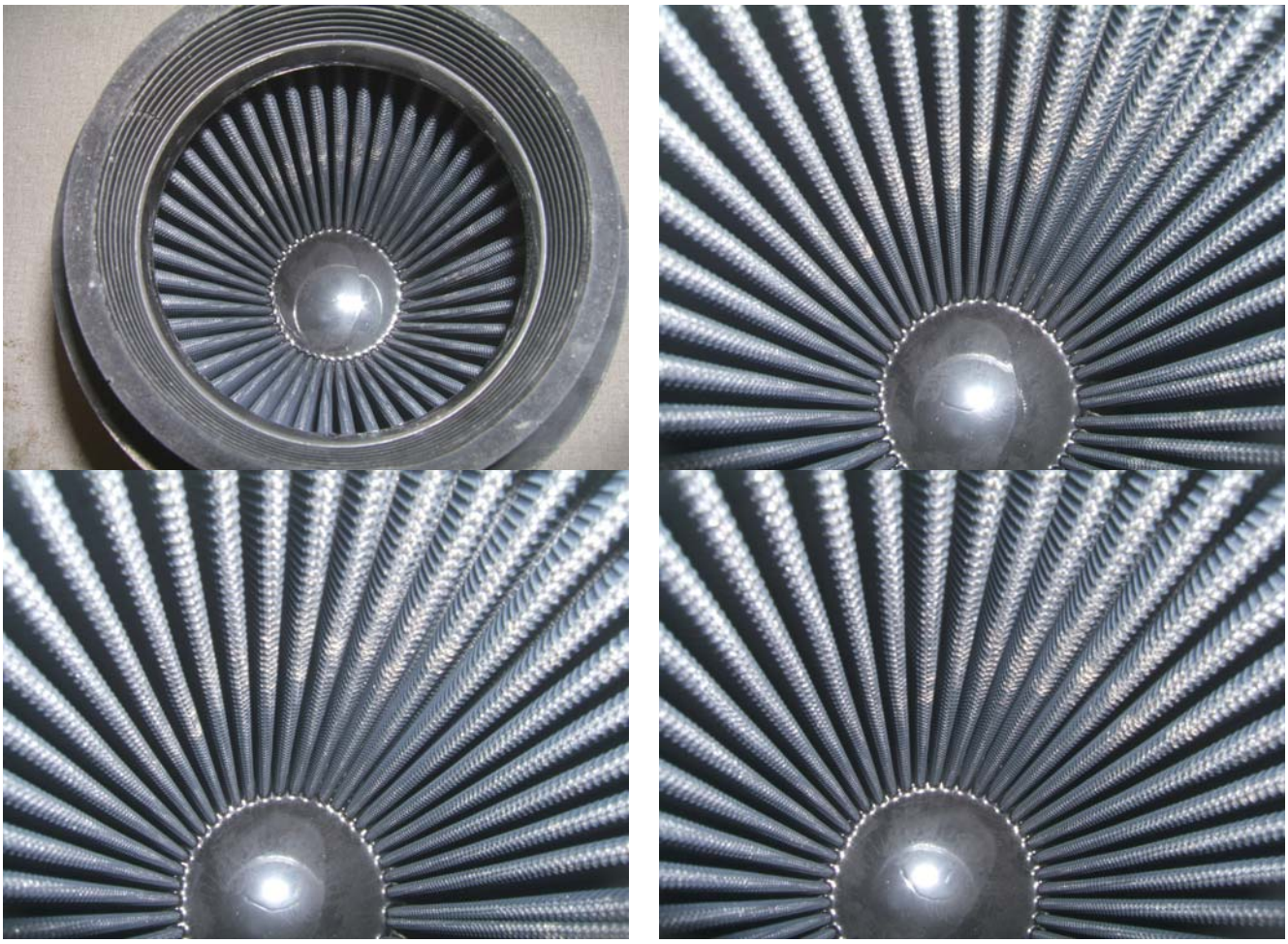

Figure 10. Post-test Photographs of the AFE 21-40035 Element after the Final Test Run

If you have any questions concerning the tests or the results, please do not hesitate to contact me at (210) 522-2626 during normal business hours. For your convenience, our facsimile number is (210) 522-5720 and my e-mail address is mtreuhaft@swri.org. SwRI is pleased to have been of service and we look forward to working with you in the future.

Sincerely,

Martin B. Treuhaft, Manager
Filtration & Fine Particle Technology

Approved:

for Ed Owens, Director
Fuels & Lubricants Technology Department

/lsr

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Attachments

APPENDIX A

PARTICLE SIZE DATA FOR PTI ISO 12103-1, A2 FINE TEST DUST (BATCH 5390F)

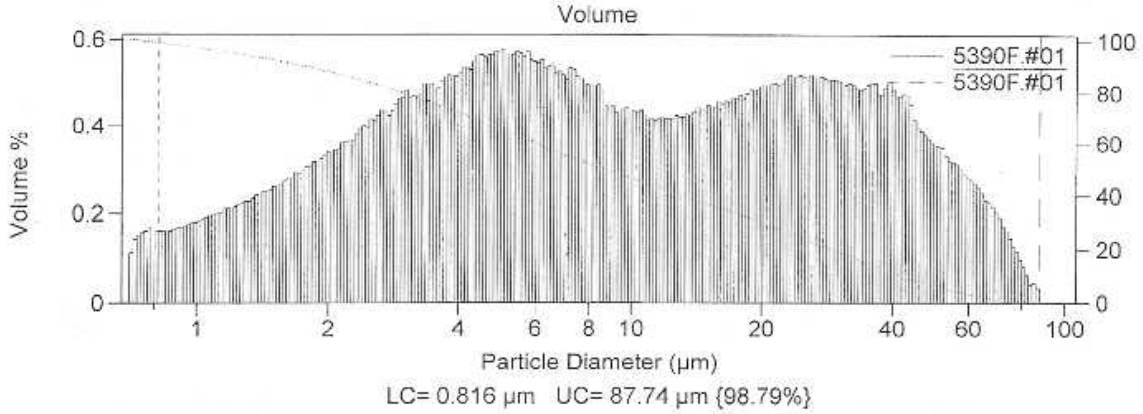
COULTER® MULTISIZER AccuComp® 1.19

1 Aug 2006

POWDER TECHNOLOGY, INC.

PTI
Powder Technology Inc.
14331 Ewing Avenue South Burnsville, Minnesota 55306
Phone: 952-894-9237

Filename:	5390F.#01	Sample Number:	200
Group ID:	5390F		
Sample ID:	ISO 12103-1, A2 FINE TEST DUST		
Comment:	SAE FINE TEST DUST, NIST TRACEABLE		
Operator:	LHA		
Electrolyte:	ISOTON II		
Dispersant:	TYPE IC		
Aperture Size:	280 µm	5390a.#01	
	100 µm	5390a.#02	
	30 µm	5390a.#03	
Acquired:	18:40 1 Aug 2006		
Serial Number:	8308970		
Edited size data			



LC= 0.816 µm UC= 87.74 µm {98.79%}

Volume Statistics (Geometric) 5390F.#01

Calculations from 0.816 µm to 87.74 µm

Volume	1.423e9 μm^3		
Mean:	9.028 µm	S.D.:	19.7 µm
Median:	8.712 µm	Variance:	386 μm^2
Mean/Median Ratio:	1.036		
Mode:	5.039 µm		
Spec. surf. area:	1.317 m^2/ml		

% >	10	25	50	75	90
Size µm	42.42	24.27	8.712	3.664	1.876

Cumulative volume micron size	Numeric data % less than
1	3.0
2	12.2
3	20.8
4	28.3
5	35.0
7	44.8
10	53.8
20	70.1
40	88.6
80	99.8
120	100.00

COULTER® MULTISIZER AccuComp® 1.19

1 Aug 2006

POWDER TECHNOLOGY, INC.

5390F.#01

Channel Number	Particle Diameter µm	Diff Number %	Cum < Number %	Diff Volume %	Cum < Volume %
9	0.816	13.41	28.76	0.812	1.21
14	0.897	10.70	42.17	0.861	2.03
19	0.986	8.78	52.87	0.937	2.89
24	1.083	7.22	61.64	1.02	3.82
29	1.190	5.84	68.86	1.10	4.85
34	1.308	4.78	74.70	1.19	5.95
39	1.438	3.89	79.48	1.29	7.14
44	1.580	3.22	83.36	1.41	8.42
49	1.736	2.64	86.58	1.54	9.84
54	1.908	2.16	89.21	1.67	11.37
59	2.096	1.76	91.37	1.80	13.04
64	2.304	1.46	93.13	1.99	14.84
69	2.531	1.18	94.59	2.14	16.83
74	2.782	0.962	95.77	2.31	18.97
79	3.057	0.751	96.73	2.39	21.28
84	3.359	0.578	97.48	2.44	23.67
89	3.691	0.464	98.06	2.60	26.11
94	4.056	0.366	98.52	2.72	28.70
99	4.457	0.288	98.89	2.84	31.43
104	4.898	0.218	99.18	2.85	34.27
109	5.382	0.163	99.40	2.83	37.12
114	5.915	0.119	99.56	2.73	39.96
119	6.500	0.086	99.68	2.63	42.69
124	7.142	0.064	99.77	2.59	45.32
129	7.849	0.046	99.83	2.46	47.91
134	8.625	0.031	99.87	2.20	50.37
139	9.478	0.023	99.91	2.18	52.57
144	10.41	0.017	99.93	2.11	54.75
149	11.44	0.013	99.95	2.10	56.87
154	12.58	0.010	99.96	2.13	58.96
159	13.82	0.008	99.97	2.21	61.09
164	15.19	0.006	99.98	2.27	63.30
169	16.69	0.005	99.98	2.34	65.57
174	18.34	0.004	99.99	2.41	67.91
179	20.15	0.003	99.99	2.50	70.32
184	22.15	0.002	99.99	2.56	72.82
189	24.34	0.002	99.99	2.59	75.38
194	26.74	0.001	100.00	2.57	77.97
199	29.39	0.001	100.00	2.51	80.54
204	32.29	0.001	100.00	2.46	83.06
209	35.49	0.0049	100.00	2.45	85.52
214	39.00	0.0037	100.00	2.41	87.97
219	42.85	0.0024	100.00	2.13	90.38
224	47.09	0.0016	100.00	1.82	92.51
229	51.75	0.0011	100.00	1.62	94.32
234	56.86	6.9E-5	100.00	1.41	95.94
239	62.49	4.3E-5	100.00	1.17	97.35
244	68.66	2.5E-5	100.00	0.876	98.53
249	75.45	1E-5	100.00	0.480	99.40