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May 19, 2005

E-MAIL TO JConcialdi@aempower.com AND FIRST CLASS MAIL

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

Subject: Southwest Research Institute® Test Report (SwRI®) Project No. 03.10955.008, "Air Filter Testing"

Reference: Advanced Engine Management Purchase Order Number 006220-00

Dear Mr. Concialdi:

This report presents results of airflow resistance, initial and cumulative efficiency, and dust capacity testing conducted on three (3) conical air filter elements provided by AEM for evaluation. The elements were identified as shown in Table 1. Testing was conducted in accordance with normal SAE/ISO procedures with respect to the SAE J726 JUN93 Air Cleaner Test Code and ISO 5011:2000, Inlet air cleaning equipment for internal combustion engines and compressors - Performance testing. The elements were installed in a mating 7" diameter upstream duct and 3" and 4" diameter downstream piezometers, for the 5" and 9" tall elements, respectively, as shown schematically in Figure 14 of the SAE test code. Efficiency and dust capacity testing was conducted at 160 scfm (101.3 kPa, 20°C) for the Ingen Tech X-1014 BR element and 240 scfm (101.3 kPa, 20°C) for the Airaid 700-470 and K&N RE0870 elements, using PTI SAE/ISO Fine Test Dust (Batch 5190F) 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 a concentration of 0.0042 g/ft^3, for thirty (30) minutes. Particle size data for the test dust is given in Appendix A.

The test sequence was as follows:

- Measure clean element pressure drop as a function of airflow rate.
- Measure initial efficiency (to 20 and 29 grams nominally, for the 5" and 9" tall elements, respectively).
- Conduct the cumulative efficiency test while measuring dust capacity to 10 inches of water pressure drop increase across the element and housing (terminal ΔP = initial ΔP + 10 inches of water).

Each element was inspected before and after testing.

Test results are given in Table 1 and Figures 1 and 2. Table 1 gives net clean element pressure drop, initial and cumulative efficiency, and dust capacity as a function of the amount of dust retained by the elements. Dust capacities in Table 1 represent the amount of dust retained by each element in reaching a terminal pressure drop increase of 10 inches of water across each test unit. Figure 1 shows net clean element pressure drop as a function of airflow rate, while Figure 2 shows pressure drop increase as a function of dust retained by each element. There were no visible manufacturing flaws for any of the elements and no dust leakage paths were observed, although dust tracks were noted between the pleats at the closed end of the elements. These tracks are thought to be from normal dust penetration of the media rather than from leakage at the end cap-media interfaces.

Table 1. AEM Conical Filter Elements: Net Clean Element Pressure Drop, Initial and Cumulative Efficiency and Dust Capacity; PTI ISO 12103-1, A2 Fine Test Dust at a Concentration of 0.028 g/ft^3 air; Except for Initial Efficiency (Fine dust at 0.0042 g/ft^3 air, for 30 minutes); Airflow: 160 and 240 scfm, as noted; Elements Tested Per Figures 4 and 14 of the SAE J726 Air Cleaner Test Code

Test	Element ID	Pleats	Test Airflow, scfm	Initial ΔP, "H_2O*	Initial Efficiency, % **	Cumulative Efficiency, % ***	Dust Capacity, g ****	Comments
1	Ingen Tech X-1014 BR	50	160	1.13	90.10	92.54	44	No dust leakage
2	Airaid 700-470	62	240	1.04	95.79	98.43	126	No dust leakage
3	K&N RE0870	60	240	0.81	93.23	96.13	167	No dust leakage

Elements tested: April 2005

* Tested per Figure 4 of SAE J726 with 3" and 4" dia. downstream piezometers, for the 5" and 9" tall elements, respectively, without ideal flow orifices.

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

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

**** Dust retained by element after a pressure drop increase of 10 inches of water, at 160 and 240 scfm, for the 5" and 9" tall elements respectively.

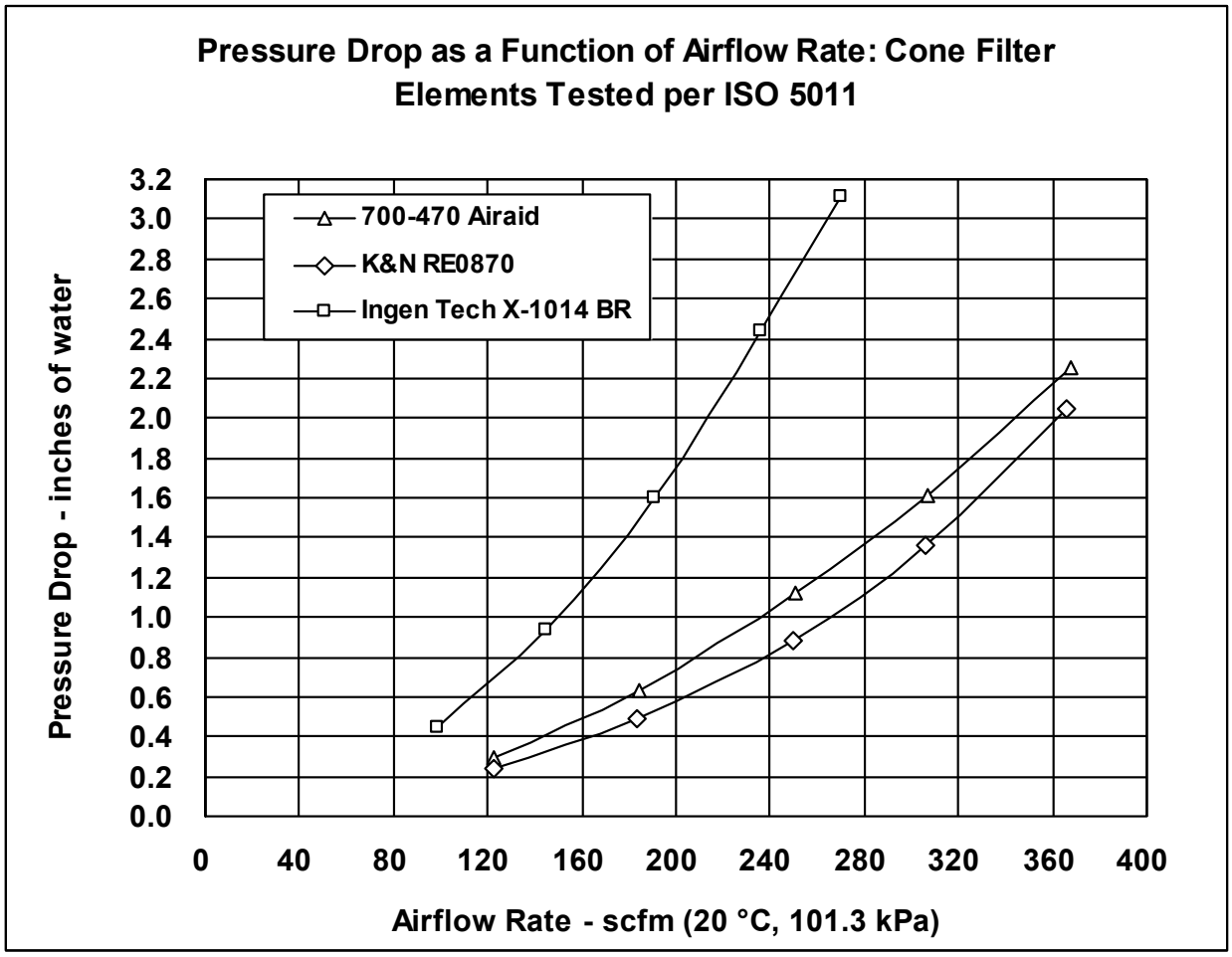
Pressure Drop as a Function of Airflow Rate: Cone Filter Elements Tested per ISO 5011
Pressure Drop - inches of water
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
700-470 Airaid
K&N RE0870
Ingen Tech X-1014 BR
0
40
80
120
160
200
240
280
320
360
400
Airflow Rate - scfm (20 °C, 101.3 kPa)

Figure 1

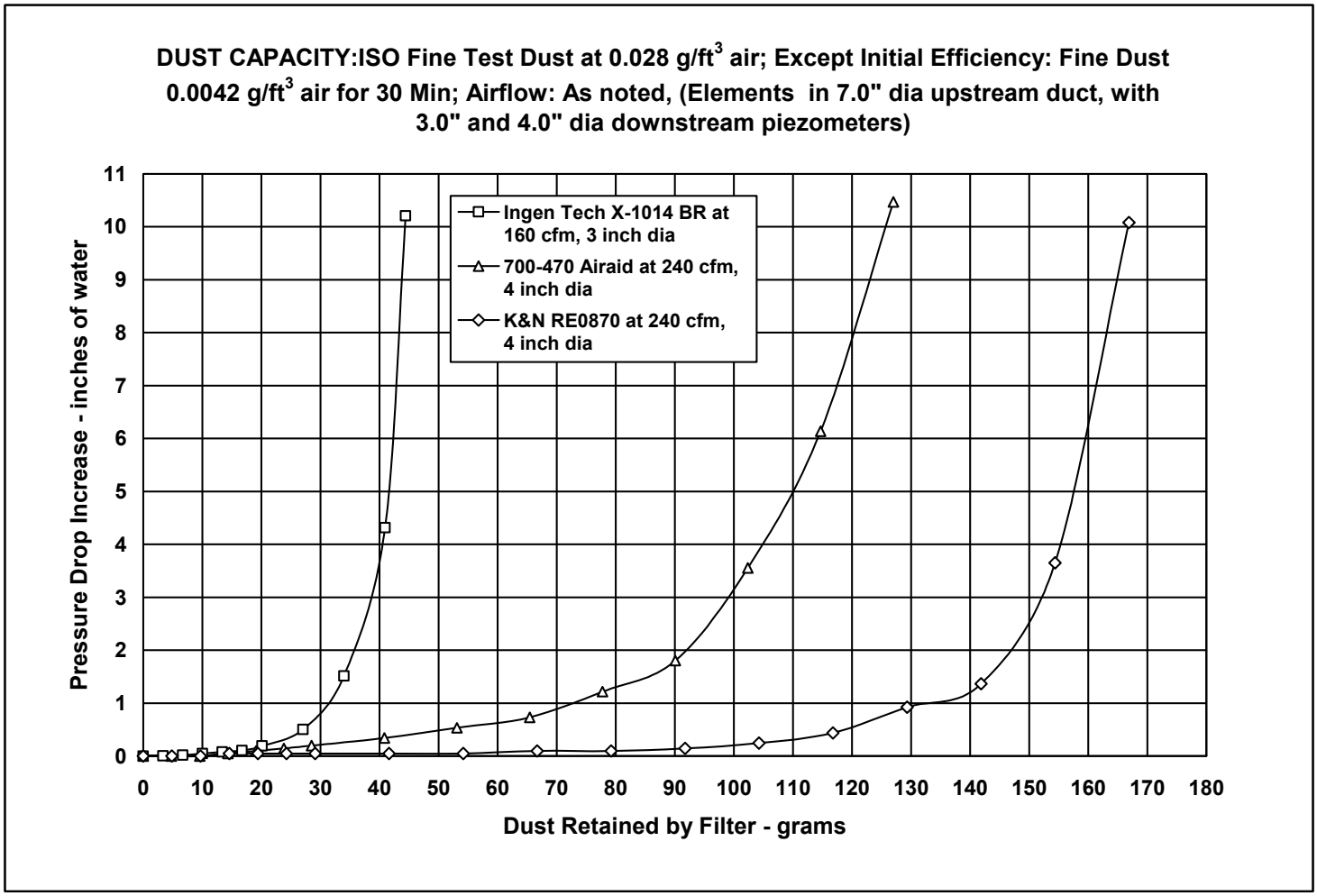
DUST CAPACITY:ISO Fine Test Dust at 0.028 g/ft3 air; Except Initial Efficiency: Fine Dust 0.0042 g/ft3 air for 30 Min; Airflow: As noted, (Elements in 7.0" dia upstream duct, with 3.0" and 4.0" dia downstream piezometers)
Pressure Drop Increase - inches of water
Dust Retained by Filter - grams
Ingen Tech X-1014 BR at 160 cfm, 3 inch dia
700-470 Airaid at 240 cfm, 4 inch dia
K&N RE0870 at 240 cfm, 4 inch dia
0
1
2
3
4
5
6
7
8
9
10
11
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180

Figure 2

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 and Fine Particle Technology
Vehicle Systems Research Department

Approved:

Gary L. Stecklein, Director
Vehicle Systems Research Department
Engine, Emissions, and Vehicle Research Division

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Attachments

cc: S. Twilligear, Contracts
Liz Cura, SwRI

APPENDIX A

PARTICLE SIZE DATA FOR PTI ISO 12103-1, A2 FINE TEST DUST (BATCH 5190F)

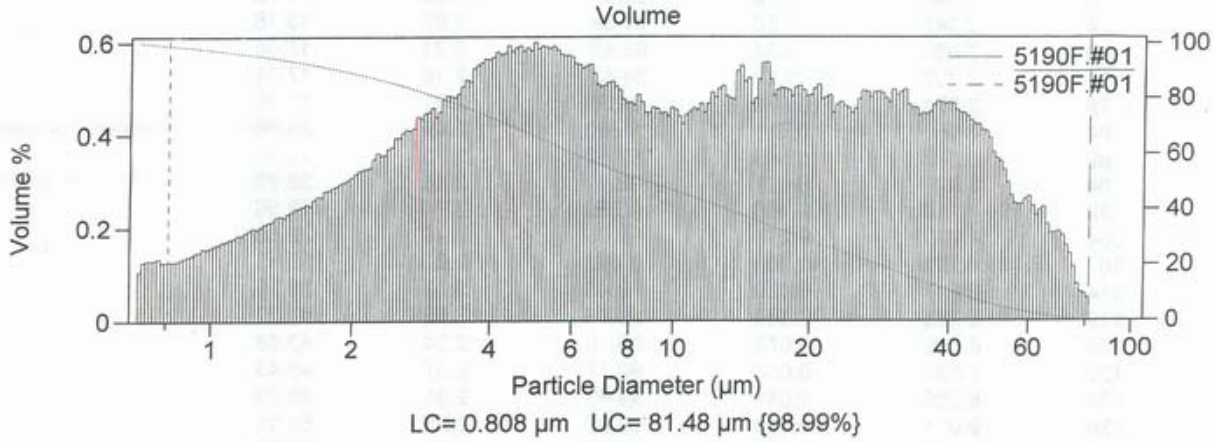
COULTER® MULTISIZER AccuComp® 1.19

9 Jun 200

POWDER TECHNOLOGY, INC.

PTI
POWDER TECHNOLOGY INC.
14331 Ewing Avenue South Burnsville, Minnesota 55306
Phone: 952-894-8757

Filename:	5190F.#01	Sample Number:	111
Group ID:	5190F		
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	5190a.#01	
	100 µm	5190a.#02	
	30 µm	5190a.#03	
Acquired:	18:01 9 Jun 2004		
Serial Number:	8308970		
Edited size data			



LC= 0.808 µm UC= 81.48 µm {98.99%}

Volume Statistics (Geometric) 5190F.#01

Calculations from 0.808 µm to 81.48 µm

Volume	905.7e6 µm^3		
Mean:	9.013 µm	S.D.:	18.7 µm
Median:	8.849 µm	Variance:	350 µm^2
Mean/Median Ratio:	1.019		
Mode:	4.955 µm		
Spec. surf. area:	1.272 m^2/ml		

% >	10	25	50	75	90
Size µm	41.27	22.96	8.849	3.805	1.974

Cumulative Volume Micron Size	Numeric Data % Less Than
1	2.6
2	11.1
3	19.4
4	27.3
5	34.2
7	44.4
10	53.7
20	71.7
40	89.3
80	99.9
120	100.0

COULTER® MULTISIZER AccuComp® 1.19

9 Jun 2004

POWDER TECHNOLOGY, INC.

5190F.#01

Channel Number	Particle Diameter µm	Diff Number %	Cum < Number %	Diff Volume %	Cum < Volume %
9	0.808	12.27	27.39	0.649	1.01
14	0.887	10.39	39.66	0.727	1.65
19	0.973	8.71	50.05	0.805	2.38
24	1.068	7.28	58.75	0.890	3.19
29	1.172	6.09	66.04	0.984	4.08
34	1.286	5.08	72.13	1.08	5.06
39	1.412	4.15	77.21	1.17	6.14
44	1.549	3.41	81.36	1.27	7.32
49	1.700	2.85	84.78	1.41	8.59
54	1.866	2.34	87.63	1.52	10.00
59	2.048	1.93	89.97	1.66	11.52
64	2.247	1.60	91.89	1.82	13.18
69	2.466	1.34	93.49	2.01	15.00
74	2.707	1.10	94.83	2.18	17.01
79	2.971	0.876	95.93	2.31	19.20
84	3.260	0.711	96.80	2.47	21.50
89	3.578	0.593	97.52	2.73	23.98
94	3.927	0.471	98.11	2.86	26.70
99	4.310	0.366	98.58	2.94	29.56
104	4.730	0.278	98.95	2.95	32.50
109	5.191	0.209	99.22	2.93	35.45
114	5.697	0.152	99.43	2.82	38.38
119	6.253	0.110	99.59	2.69	41.20
124	6.862	0.079	99.70	2.54	43.88
129	7.531	0.056	99.77	2.37	46.43
134	8.265	0.041	99.83	2.31	48.80
139	9.071	0.030	99.87	2.25	51.11
144	9.955	0.022	99.90	2.21	53.36
149	10.93	0.018	99.92	2.29	55.57
154	11.99	0.014	99.94	2.46	57.86
159	13.16	0.011	99.96	2.56	60.32
164	14.44	0.008	99.97	2.54	62.88
169	15.85	0.006	99.98	2.56	65.42
174	17.40	0.005	99.98	2.49	67.98
179	19.09	0.004	99.99	2.47	70.47
184	20.95	0.003	99.99	2.36	72.94
189	23.00	0.002	99.99	2.29	75.29
194	25.24	0.002	99.99	2.44	77.59
199	27.70	0.001	100.00	2.43	80.03
204	30.40	0.001	100.00	2.40	82.46
209	33.36	0.001	100.00	2.24	84.86
214	36.61	0.0048	100.00	2.34	87.10
219	40.18	0.0035	100.00	2.25	89.44
224	44.10	0.0024	100.00	2.09	91.69
229	48.40	0.0016	100.00	1.78	93.79
234	53.12	8.9E-5	100.00	1.32	95.56
239	58.29	6.3E-5	100.00	1.24	96.89
244	63.98	3.9E-5	100.00	1.02	98.13
249	70.21	2E-5	100.00	0.682	99.15