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January 25, 2012

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S&B Filters
15461 Slover Ave
Fontana, CA, 92337

Subject: Letter Report, Test Results, Southwest Research Institute® (SwRI®)
Project No. 08.16927.06.001, “Water Spray Removal Testing”

Reference: S&B Filters P.O. No. P2166

Dear S&B Filters:

This is a revision of the original report sent December 27, 2011, in which results were presented for water spray removal testing of two different systems. The purpose for revision is to provide results separately for each system. This report presents results of water spray removal testing conducted on a model 75-5050 intake with the AS-1007 scoop, with the fender vent closed. Testing was conducted in accordance with SAE J2554, Engine Intake Air Water Separation Test Procedure, APR2003. Water spray removal testing was accomplished at 381 cfm, as specified. Proper droplet size and flow delivery were achieved by nozzle selection and pressure control. The spray nozzle was sized to provide a spray with a median volume diameter (MVD) of 1000 microns, based on nozzle performance specifications. The MVD is a value where 50% of the total volume (or mass) of liquid sprayed is made up of drops with diameters larger than the median value and 50% smaller than the median value. The MVD and the actual droplet size distribution (DSD) were not measured. For the specified airflow rate, SAE J2554 called for a water feed rate of 500 ml/min. Both were accomplished, using the same general experimental arrangements and test protocols as used in the previous testing, as reported in our September 29, October 29, and December 21, 2009 test reports, with two notable exceptions. The inlet ducting, which served as a control volume for droplet injection differed from that used in previous testing in order to accommodate the new unit's size and design; and of great significance, the fender vent remained open for the AS-1007 scoop, whereas the fender vents in previous testing were closed. The decision to leave the vent of the AS-1007 scoop open was made in consultation with S&B personnel while reviewing results from testing with the AS-1002 scoop. While the open vent configuration better simulates the on-vehicle situation, both scenarios still lack the affect of ram air. As such, during testing, the flow function in the scoops was fully developed by suction rather than by a combination of engine induced suction and vehicle induced ram air. It was determined that this would be remedied in future testing, but not altered for the testing conducted here. The results should be reviewed with this in mind. The general



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test arrangement for this test is shown in Figure1.

Test results are given in Tables 1 and 2 Figures 2 and 3. Table 1 gives quantitative results in term of water penetration and removal. Table 2 gives before and end of test airflow resistance data. Figure 2 shows pre-test airflow resistance as a function of flow rate, and Figure 3 shows general photographs taken during testing. While SAE J2554 is primarily intended to measure separation efficiency, it is apparent in this case that the parameter of most importance is water penetration to the upper filter unit and beyond. In particular, the target for allowable penetration is zero, since the filter should remain dry during vehicle operation in all weather and road conditions. Penetration for the 75-5050 intake with the AS-1007 scoop, operating at 381 scfm with the fender vent open, was virtually zero. It is likely that having the fender vent open is a major contributor to the improved performance of this unit relative to that of previously tested units for which the fender vents were closed, although it must be recognized that the current unit also differs significantly in size, configuration and flow. When the airflow was turned off after testing, a certain amount of water drained back to the scoop area, and was retained in the scoop's vertical depressions.

Table 1. Water Spray Penetration: S&B 5-5050 Intake with AS 1007 Scoop; 1000 µm Mean Volume Diameter (MVD) Spray (Single, Spray Systems Co. 1/8 G-1, 0.031" Dia., Full Jet Nozzle at 24 psi,); Unit Airflow: 381 scfm*.

Test	Configuration	Test Airflow Rate, scfm	Water Penetrating Unit, % (a)	Water Penetrating Scoop Section, % (b)	Water Retained by Upper Unit/ and by Filter, % (c)	Scoop Ejection, % of total	Water Retained by Scoop when Airflow Turned Off after Testing, % (d)
1	75-5050 intake with AS-1007 scoop	381	0.097	1.89	1.79/1.09	94.79	3.32

Tests conducted: Dec 2011

*cfm At 20°C and 101.3 kPa

$$a. \text{ Water penetration} = \left[\frac{\text{wt. of water collected downstream of unit}}{\text{total wt. of water collected}} \right] \times 100$$

$$b. \text{ Water penetration} = \left[\frac{\text{wt. of water collected downstream of scoop section}}{\text{total wt. of water collected}} \right] \times 100$$

$$c. \text{ Water retained} = \left[\frac{\text{wt. of water collected in upper unit/and by the filter}}{\text{total wt. of water collected}} \right] \times 100$$

$$d. \text{ Water retained} = \left[\frac{\text{wt. of water collected in scoop depressions}}{\text{total wt. of water collected}} \right] \times 100$$

It is important to understand the above terminology. Water penetrating the scoop section is the amount of water presented to the upper filtration section, as a percent of the total water collected during the test. Water retained by the upper unit is the amount of water retained in the filtration section (filter and filter housing area) as a percent of the total amount of water collected during the test run. The amount of water collected by the filter is also based on the total amount of water collected during the test run.

Table 2. Pre-and Post-test Airflow Restriction Values*

Test	Test Airflow Rate, scfm	Configuration	Pre-test Restriction, "of water	Post-test Restriction, "of water
1	381	75-5050 intake with AS-1007 scoop	4.8	4.7

Tests conducted: Dec 2011

*Corrected to 20°C and 101.3 kPa

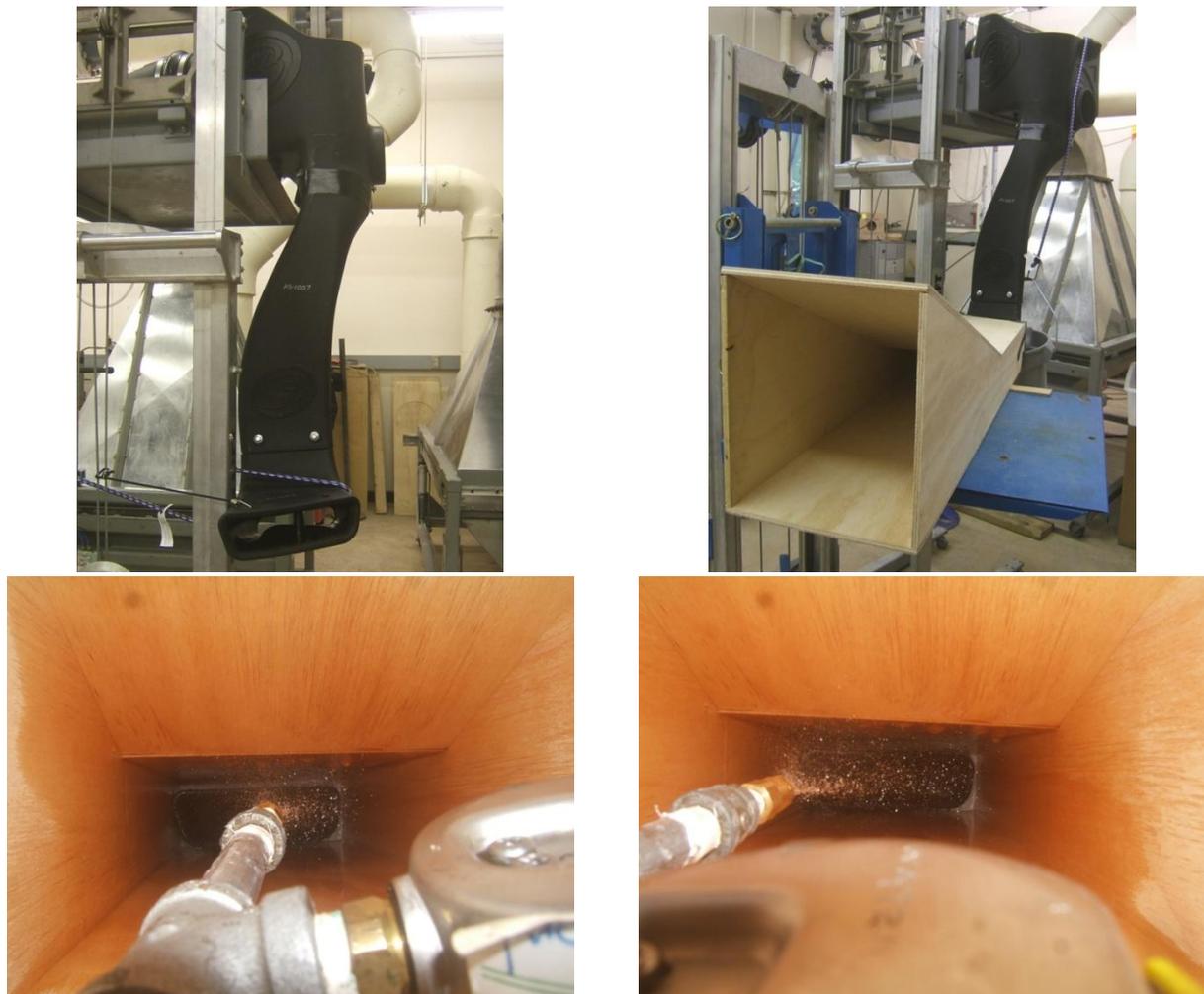


Figure 1. General Test Arrangement for 75-5050 Intake with AS-1007 Scoop [Top Row Left: for Airflow Resistance Testing; Top Row Right: for Water Spray Testing; Bottom Row: Water Spray Injection (spray wand moved back and forth across scoop inlet)]

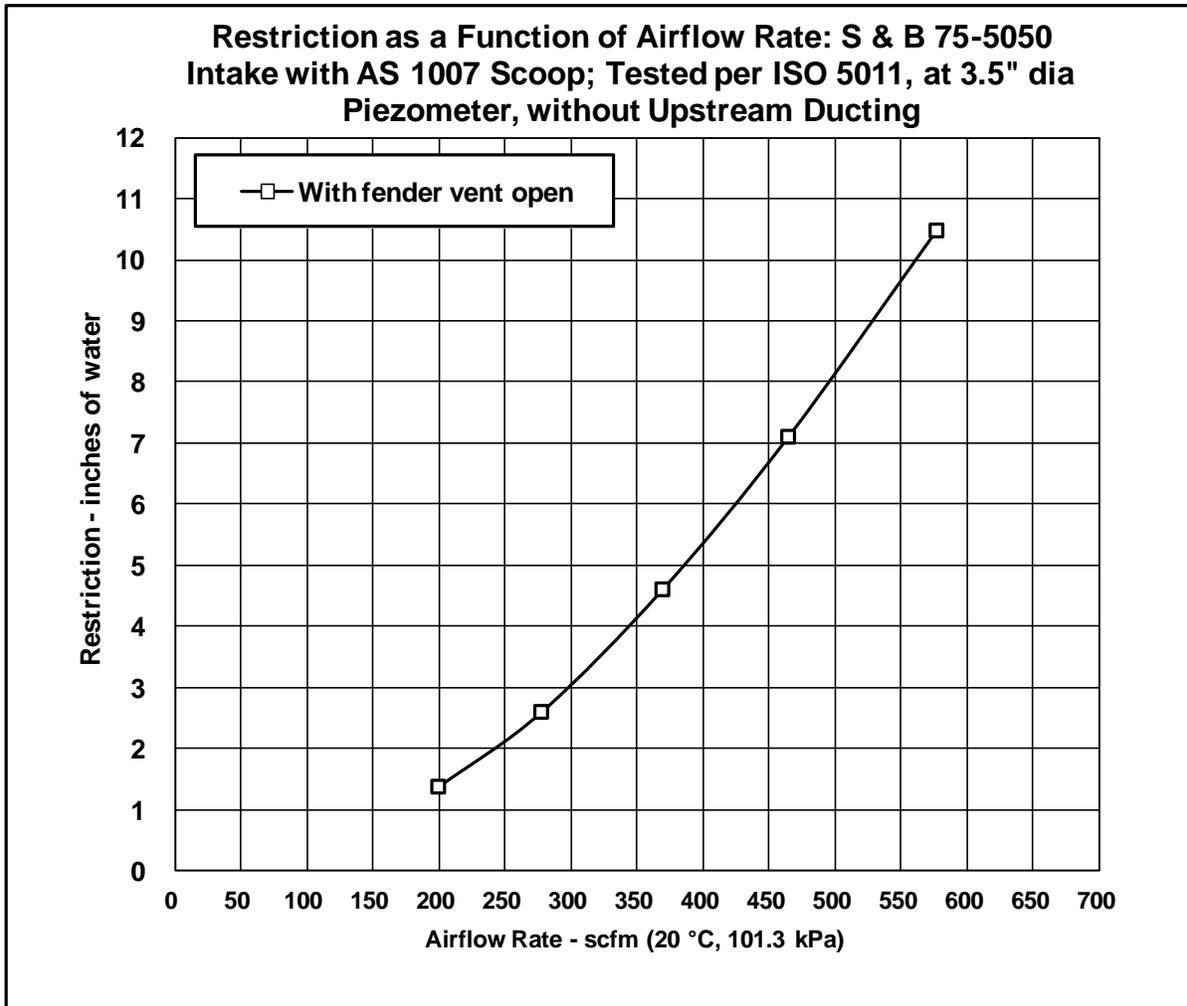


Figure 2

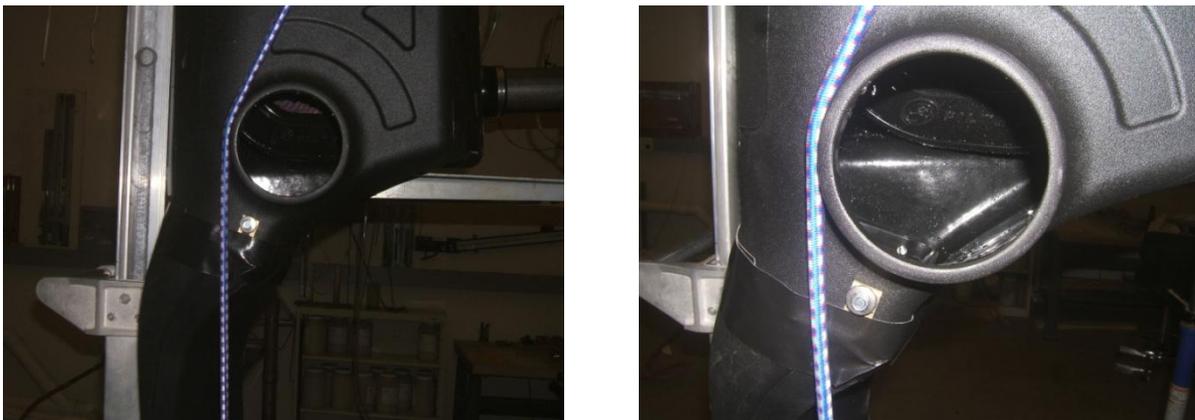


Figure 3. Some General Photographs during and after Testing (Test 2; 75-5050 Intake with AS-1007 Scoop)

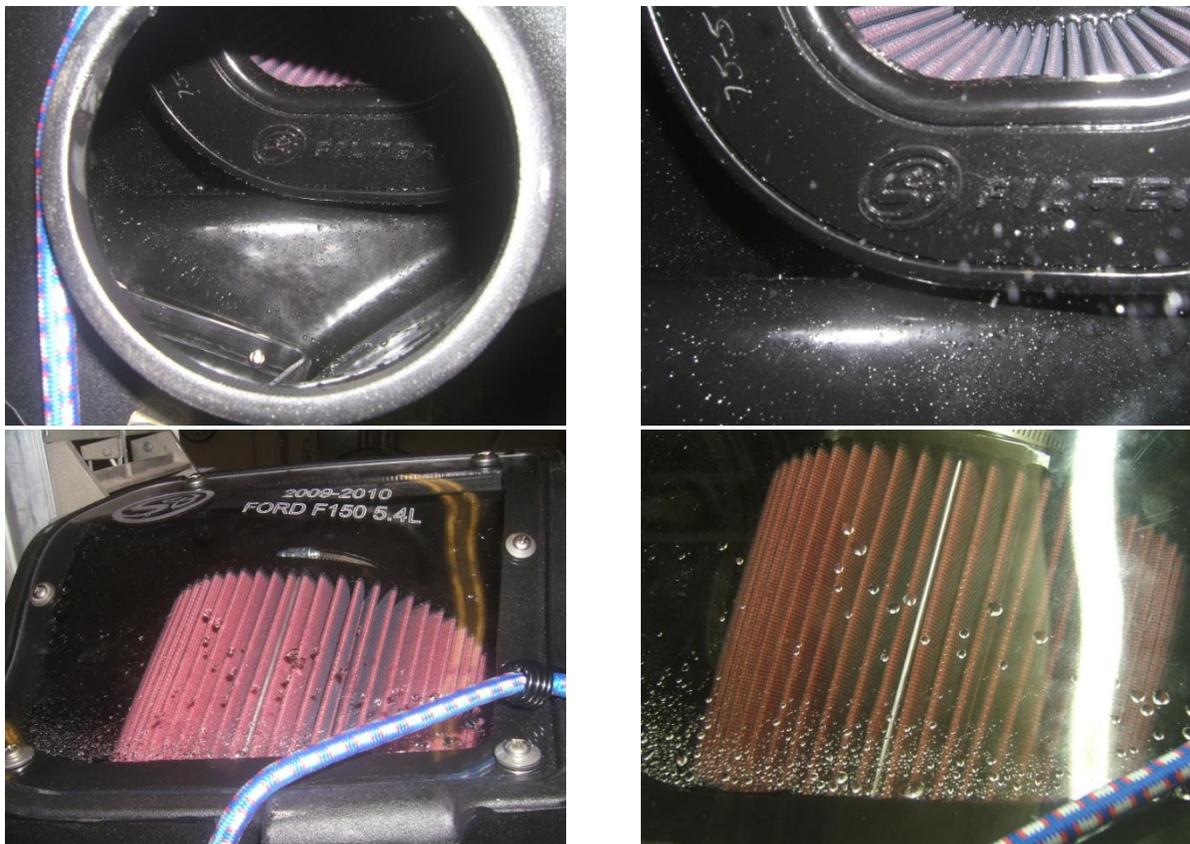


Figure 3. Some General Photographs during and after Testing (Test 2; 75-5050 Intake with AS-1007 Scoop) (Continued)

If you have any questions concerning the test program 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.

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