THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**BAGHOUSE FILTRATION PRODUCTS**		
APPLICATION:	**CONTROL OF $PM_{2.5}$ EMISSIONS BY BAGHOUSE FILTRATION PRODUCTS**		
TECHNOLOGY NAME:	**L3650**		
COMPANY:	**W. L. Gore & Associates, Inc.**		
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The U.S. Environmental Protection Agency (EPA) has created the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by accelerating the acceptance and use of improved and cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the design, distribution, financing, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations; stakeholder groups, which consist of buyers, vendor organizations, permitters, and other interested parties; and with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

The Air Pollution Control Technology (APCT) Verification Center is operated by RTI International (RTI), in cooperation with EPA's National Risk Management Research Laboratory. The APCT Verification Center evaluates the performance of baghouse filtration products (BFPs) used primarily to

control $PM_{2.5}$ emissions (particles 2.5 μm and smaller in aerodynamic diameter). This verification statement summarizes the test results for W. L. Gore & Associates, Inc.'s filter fabric L3650.

VERIFICATION TEST DESCRIPTION

All tests were performed in accordance with the APCT *Generic Verification Protocol for Baghouse Filtration Products*, available at http://etv.rti.org/apct/pdf/baghouseprotocol.pdf. The protocol is based on and describes modifications to the equipment and procedures described in Verein Deutscher Ingenieure (VDI 3926, Part 2), *Testing of Filter Media for Cleanable Filters under Operational Conditions*, December 1994. The VDI document is available from Beuth Verlag GmbH, 10772 Berlin, Germany. The protocol also includes requirements for quality management, quality assurance, procedures for product selection, auditing of the test laboratories, and test reporting format.

Outlet particle concentrations from a test fabric were measured with an impactor equipped with appropriate substrates to filter and measure $PM_{2.5}$ within the dust flow. Outlet particle concentrations were determined by weighing the mass increase of dust collected in each impactor filter stage and dividing by the gas volumetric flow through the impactor.

Particle size was measured while injecting the test dust into the air upstream of the baghouse filter sample. The test dust was dispersed into the flow using a brush-type dust feeder. The particle size distributions in the air were determined both upstream and downstream of the test filter fabric to provide accurate results for penetration through the test filter of $PM_{2.5}$. All tests were performed using a constant 18.4 ± 3.6 g/dscm (8.0 ± 1.6 gr/dscf) loading rate, a 120 ± 6.0 m/h (6.6 ± 0.3 fpm) filtration velocity [identical to gas-to-cloth ratio (G/C*)], and aluminum oxide test dust with a measured mass mean aerodynamic diameter maximum of 1.5 μm (average of three impactor runs). All baghouse filtration products are tested in their initial (i.e., clean) condition.

Each of the three test runs consisted of the following segments:

- Conditioning period – 10,000 rapid-pulse cleaning cycles,
- Recovery period – 30 normal-pulse cleaning cycles,
- Performance test period – 6-hour filter fabric test period with impactor.

VERIFIED TECHNOLOGY DESCRIPTION

The W. L. Gore & Associates, Inc. company provided the following information about their product. The L3650 is a GORE membrane/fiberglass fabric laminate with a weight of 22 oz/yd^2 (746 g/m^2). Figure 1 is a photograph of the fabric. Sample material was received as nine 46 x 91 cm (18 x 36 in.) swatches marked with the manufacturer's model number, year, and month of manufacture, and cake side. Three of the swatches were selected at random for preparing three test specimens 150 mm (5.9 in.) in diameter.

VERIFICATION OF PERFORMANCE

Verification testing of the W. L. Gore & Associates, Inc., L3650 filter fabric was performed during October 18–25, 2005, for standard test conditions at the test facility of ETS, Incorporated, 1401 Municipal Road, Roanoke, VA 24012. Test conditions are listed in Table 1. The overall test results summarized in Table 2 are the averages of three individual tests.

*Filtration velocity and gas-to-cloth ratio are used interchangeably and are defined as the gas flow rate divided by the surface area of the cloth.

Figure 1. Photograph of W. L. Gore & Associates, Inc.'s L3650 filter fabric

Table 1. Test Conditions for Baghouse Filtration Products Brand/Model: W. L. Gore & Associates, Inc.'s L3650

Test parameter	**Value**
Dust concentration	18.4 ± 3.6 g/dscm (8.0 ± 1.6 gr/dscf)
Filtration velocity (G/C)	120 ± 6 m/h (6.6 ± 0.3 fpm)
Pressure loss before cleaning	1,000 ± 12 Pa (4 ± 0.05 in. w.g.)
Tank pressure	0.5 ± 0.03 MPa (75 ± 5 psi)
Valve opening time	50 ± 5 ms
Air temperature	25 ± 2 °C (78 ± 4 °F)
Relative humidity	50 ± 10 %
Total raw gas stream flow rate	5.8 ± 0.3 m^3/h (3.4 ± 0.2 cfm)
Sample gas stream flow rate	1.13 ± 0.06 m^3/h (0.67 ± 0.03 cfm)
Number of filtration cycles	
• During conditioning period	10,000 cycles
• During recovery period	30 cycles
Performance test duration	6 h ± 1 s

Table 2. Baghouse Filtration Product Three-run Average Test Results for W. L. Gore & Associates, Inc.'s Fabric L3650

Verification parameter	At verification test conditions
Outlet particle concentration at standard conditions[a]	
$PM_{2.5}$, g/dscm	<0.000002
(gr/dscf)	(<0.000007)
Total mass, g/dscm[b]	<0.000002
(gr/dscf)	(<0.000007)
Average residual pressure drop, cm w.g. (in. w.g.)	2.45 (0.96)
Initial residual pressure drop, cm w.g. (in. w.g.)	2.36 (0.93)
Residual pressure drop increase, cm w.g. (in. w.g.)	0.18 (0.07)
Filtration cycle time, s	251
Mass gain of test sample filter, g (gr)	0.09 (1.39)
Number of cleaning cycles	87

NA = Not applicable – values shown are for three tests.

[a] Standard conditions: 101.3 kPa (14.7 psia) and 20 °C (68 °F). One or more of the impactor substrate weight changes for these results were near the reproducibility of the balance.

[b] Total mass includes the mass of $PM_{2.5}$ and larger particles that passed through the fabric.

The APCT Verification Center quality assurance officer has reviewed the test results and the quality control data and has concluded that the data quality objectives given in the generic verification protocol and test/QA plan have been attained.

This verification statement addresses five aspects of filter fabric performance: filter outlet $PM_{2.5}$ concentration, filter outlet total mass concentration, pressure drop (ΔP), filtration cycle time, and mass gain on the filter fabric. Users may wish to consider other performance parameters such as temperature, service life, and cost when selecting a filter fabric for their application.

In accordance with the generic verification protocol, this verification statement is applicable to filter media manufactured between the signature date of the verification statement and 3 years thereafter.

Signed by Sally Gutierrez	*7/28/06*	*Signed by Andrew R. Trenholm*	*7/20/06*
Sally Gutierrez	Date	Andrew R. Trenholm	Date
Director		Director	
National Risk Management Research Laboratory		APCT Verification Center	
Office of Research and Development		RTI International	
United States Environmental Protection Agency			

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