Electro-Tech Systems, Inc. (ETS) Test Report
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MATERIAL EVALUATION REPORT

STATIC DECAY AND SURFACE RESISTIVITY TESTING OF MAT SAMPLES

EVOLUTION SORBENT PRODUCTS, LLC

MAY 13, 2016

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Static Decay and Surface Resistivity
Testing of Mat Samples
Evolution Sorbent Products LLC
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GENERAL

Electrostatic characterization tests were performed by the ETS Testing Laboratory on samples submitted by ESP under Purchase Order Number 6696. One material type (six samples) was tested on both sides for static decay and surface resistivity compliance.

TEST CONDITIONS

Date of Test:	5/5/16
Humidity:	50.2% RH
Temperature:	74°F
Conditioning Time:	50 Hours

TEST APPARATUS

HUMIDITY CONTROL

An ETS Series 5000 Controller and 5500 Chamber provide the controlled environment to condition and test the samples at the specified relative humidity. The system is capable of controlling the humidity to within 1% of the desired level with an accuracy of ±2% RH and is calibrated to standards traceable to NIST.

STATIC DECAY

An ETS Model 406 Static Decay Meter is used to perform the static decay measurements. A System Test Module (STM) is used to verify the calibration of the Static Decay Meter.

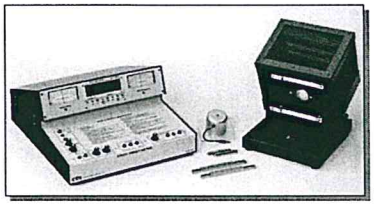
SURFACE RESISTIVITY

Surface resistivity measurements of planer material are performed using a Dr. Thiedig Milli-TO-2 or an ETS Model 863/6487 Wide Range Resistance Meter in conjunction with an ETS Model 803B Surface/Volume Resistivity Probe. An ETS Model 809B Calibration Check Fixture is used to verify the calibration of the resistance test set-up.

TEST METHODS

The following test methods and specifications were used in the evaluation of the test material:

STATIC DECAY



Static decay testing is based on the test method described in Mil-Std-3010C, Method 4046 "Electrostatic Properties of Materials". This test method requires a 3.5 x 5.5 inch test specimen be placed between a pair of electrodes electrically connected together and be conductively charged to both plus and minus 5000 volts. After the sample has accepted the applied charge, the charging voltage is removed, the electrodes are grounded and the time for the charge to bleed down to a specified cutoff level is measured. This test can be modified to evaluate different sample sizes and configurations. Most military and electronic industry specifications require decay time to be measured to the 1% (50 volt) cutoff level (previously designated as 0%). Applications referenced to NFPA (National Fire Protection Association) specifications require the decay time to be measured to the 10% (500 volt) cutoff level.

CALIBRATION CHECK

Prior to static decay evaluation, a system check is performed on the Static Decay Meter using the System Test Module (STM). The STM is placed into the Faraday Test Cage in lieu of a test specimen. It produces a known decay time when plus and minus 5kV is applied. This test checks both the accuracy of the decay time measurement and the balance in decay times between positive and negative charging voltage polarities.

INITIAL CHARGE AND ACCEPTED CHARGE

Material that is static dissipative or conductive will have no measurable static charge on the surface and will be able to conduct the 5kV charging voltage across the surface when applied. A sample that has a measurable initial charge prior to applying the charging voltage indicates that the sample is either insulative or contains both insulative and dissipative characteristics on the surface.

The magnitude of the initial charge is listed in the *IC Volts* column of the data sheet. Generally, a material that has both an initial charge and accepts the applied 5kV will not have a measurable decay time if the cutoff selected is below the level of the initial charge. However, material with an initial charge, a very long or no charge/decay characteristics can be evaluated by noting the amount of charge conducted across the surface of the test material after applying 5kV for one minute. The greater the charge accepted after one minute, the more dissipative the material. This value is listed in the *AC Volts* column of the data sheet. No readings are recorded under *Decay Time*.

SURFACE RESISTIVITY

Surface resistivity per ASTM-D 257 has generally been the property used to describe the conductive, dissipative or insulative range of static control material. The ETS Series 800 probes conform to the concentric ring design specified. The ratio between the inner and outer electrodes results in a surface resistivity equal to 10X the measured resistance. It should be noted that surface resistivity is expressed in ohms per square, without regard to the size of the square.

Surface resistance per ESD S11.11 is used to evaluate static dissipative material. This resistance is equal to the actual resistance measured with the Model 803B Probe. A test voltage of 10 volts is specified for resistances between 10^4 and 10^6 ohms. A test voltage of 100 volts is required for resistances between 10^6 and 10^{11} ohms. Surface resistance is expressed in ohms. Resistance measurements below or above these values may require different test voltages. Conductive materials (those materials with surface resistances below 10^4 ohms) are measured using either a current source (cs) or voltages equal to or less than 10 volts.

TEST RESULTS

The actual data is contained in the enclosed data sheets.

STATIC DECAY

The samples were charged to ±5kV and the time to dissipate 90% of the charge (10% cutoff) when grounded was measured.

GROUP	**MIN**	**MAX**	**AVERAGE** (Seconds)
A) ESP Anti-Static Sorbent	Less than 0.01	0.03	0.01
a Reverse	0.01	0.04	0.02
No initial charges were recorded and the full 5kV charge was accepted.			

SURFACE RESISTIVITY

GROUP	**MIN**	**MAX**	**AVERAGE** (Ohms/Sq.)
A) ESP Anti-Static Sorbent	2.73×10^9 Ω/sq.	3.90×10^9 Ω/sq.	3.41×10^9 Ω/sq.
a Reverse	2.59×10^9 Ω/sq.	5.30×10^9 Ω/sq.	3.63×10^9 Ω/sq.
Testing was performed using a test voltage of 100 volts.			

CONCLUSIONS

NFPA 99 currently finds acceptable materials that meet *either* the static decay or surface resistivity requirement of the specification.

STATIC DECAY

NFPA 99, which references MIL-STD-3010C (formerly FTM 101C, Method 4046), is commonly referenced for hospitals and hazardous locations. It is also used as a guideline for nonwovens, packaging, filtering, paper, consumer products, cleanrooms and many other applications. The specification requires conditioning at 50% R.H. Acceptable materials have a static decay time of less than 0.50 seconds when measured to the 10% (500 volt) cutoff level.

With average decay times of 0.01 on the top side and 0.02 on the reverse side, group A (ESP Anti-Static Sorbent) met the static decay requirement of the specification.

SURFACE RESISTIVITY

Resistance measurements are used in the static control industry to help categorize materials. Although resistance and resistivity measurements alone cannot tell everything about a material's electrostatic performance, it is a good indicator, can help to establish a baseline, indicate differences between additives or additive levels, show differences within a sample group and characterize the effects of relative humidity on a material's performance. According to industry packaging material specifications such as ESD S.541 (formerly EIA-541) and Mil-PRF-81705E which both utilize test method ASTM-D-257 at 12% RH, a material with surface resistivity measurements less than 1×10^5 ohms/sq. is considered conductive, between 1×10^5 and 1×10^{12} ohms/sq. is considered dissipative and readings above 1×10^{12} ohms/sq. classify the material as insulative.

NFPA 99, which is referenced for this testing also uses test method ASTM-D-257. It has an upper acceptance limit of 1×10^{11} Ω/sq. at 50% RH. Materials with resistivity measurements below this limit are considered acceptable.

With average surface resistivity measurements of 3.41×10^9 ohms/sq. on the top side and 3.63×10^9 ohms/sq. on the reverse side sample group A (ESP Anti-Static Sorbent) exhibited dissipative characteristics and met the requirements of the specification.

Static decay and surface resistivity testing shows the samples met the requirements of both tests and should be acceptable for use in static safe applications referencing this test method.

Note: The data contained in this report has been generated using established industry, DOD, ETS or customer standards. Results and conclusions are based on the specific samples tested on this date under the environmental conditions listed. Ultimately, it is the responsibility of the end user to determine if a material is acceptable for use in a specific application.