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RMV TESTING SERVICES

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Subject: ESD Smock Evaluation

RMV Testing is in receipt of your ESD Garments, which will be evaluated per ANSI/ESD STM-2.1-1997 **"for the Protection of Electrostatic Susceptible Items- Garments."** The garment material was subjected to ANSI/ESD STM11.11-2001 for Surface Resistance measurements at 73^0F +/-5^0 @ 12% RH +/-3% RH after 48-72 hours of preconditioning. In addition, an attenuation examination of the garment was made to the AMD protocol to determine the effective field suppression of a smock. A tribocharge generation test was employed to determine voltages that could be generated from the garment. Finally, the garment was subjected to a modification of EIA S541-1988, Appendix F, for static decay.

SURFACE RESISTANCE TESTS:

Resistance Testing may be the most important test that one can conduct in evaluating materials. In 1993, the ESD Association adopted the test method ANSI/EOS/ESD S.11.11-1993 to replace an older test method that tested D-C conductance on insulators. ASTM D-257 required hand pressure along two fixed rails. In addition, dependant upon the instrumentation, the voltage output from the rails could be in excess of 500 volts.

Today's test method, ANSI/ESD STM11.11-2001, involves a concentric ring fixture that utilizes five measured pounds of weight on the specimen. This test is conducted on an insulative surface for testing after preconditioning in the environmental chamber from 48-72 hours. A Keithley 617 (Serial Number 483502 and calibrated on 10/09/03) lab grade surface resistance meter was used in conjunction with a Prostat PRF 911 Concentric Ring fixture (Serial Number 8271992, calibrated on 10/09/03) and a NFPA 5-lb weight. **Figure 2** below demonstrates the test method.

Figure 1

Table 1 ANSI/ESD STM11.11-2001 [72 Hours @ 6.7%RH at 70.5 deg F] Results in ohms

Outside Position 1	Outside Position 2	Outside Position 3	Inside Position 4	Inside Position 5	Inside Position 6
7.6E+05	6.6E+05	7.4E+05	8.0E+05	6.7E+05	7.3E+05

The results were favorable in this examination.

POINT-TO-POINT RESISTANCE:

Using electrodes in accordance with ANSI/ESD STM 4.1-1997, two NFPA 5-lb weights were used to evaluate the sleeve-to-sleeve (**Figure 2A**) characteristics and panel-to-panel measurements (**Figure 2B**). A target range of 1.0E+06 ohms to 1.0 E+09 ohms is desired. Values less than 1.0 E+05 ohms may be considered an electrical hazard. Said product is evaluated on an insulative test bed. A Prostat 801 Meter (Serial Number: 6990056 calibrated on 7/9/03) was used for this evaluation series.

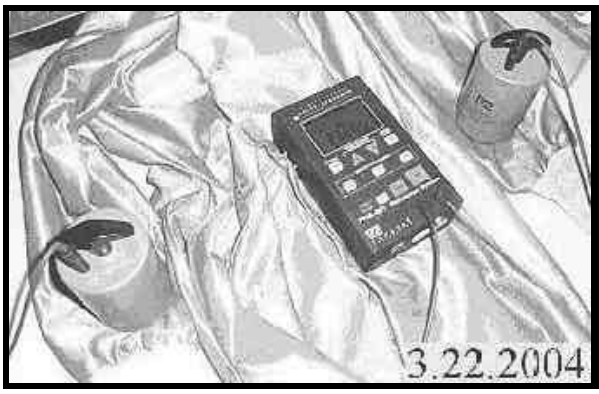

Figure 2A

Figure 2B

Table 2 ANSI/ESD STM2.1-1997 [72 Hours @ 6.7%RH at 70.5 deg F] Results in ohms

Sleeve to Sleeve	Sleeve to Sleeve	Sleeve to Sleeve	Panel to Panel	Panel to Panel	Panel to Panel
9.8E+06	8.9E+06	9.2E+06	9.5E+06	9.6E+06	9.5E+06

In this phase, the clip-to-clip measurements were taken (**Figure 3**) to determine the quality of joining the cuffs to the garment' s sleeves. **Table 3** lists the results, which were favorable.

Figure 3

Table 3 ANSI/ESD STM2.1-1997 [48 Hours @ 14.7 %RH at 71.5 deg F] Results in ohms

Clip to Clip 1	Clip to Clip 2	Clip to Clip 3	Clip to Clip 4	Clip to Clip 5	Clip to Clip 6
3.8E+06	3.4E+06	3.3 E+06	4.1E+06	3.5E+06	4.3E+06

Note: The hanger served as an insulator and the clips were fastened to a chain by means of Teflon ties.

Another resistance examination was to measure the point-to-point resistance between ground snaps to a groundable point. This examination employs one alligator clip to a ground snap while the other lead is connected to the grounding point of an ESD workstation. **Table 4** illustrates the results.

Table 4 ANSI/ESD STM2.1-1997 [48 Hours @ 14.7 %RH at 71.5 deg F] Results in ohms

Position 1	Position 2
9.9E+06	9.9E+06

The results were favorable in this examination.

STATIC DECAY:

The garment was subjected to 52 hours preconditioning at 14.8% RH. Passing constitutes a static decay of less than 2.0 seconds from +/-1000 volts to +/-100 volts. The garment was hung from an insulative hanger and the sleeves were isolated from ground by using the resistance clips. One alligator clip was fastened to a Charge Plate while another lead was affixed to the garment. When the plate was charged to +/-1000 volts, a grounded lead was pressed against the garment to determine the rate of decay. The results are illustrated in **Figure 5** and **Table 5** (Charge Plate 156A/1 Serial Number: 694, Calibration 8/5/2003),

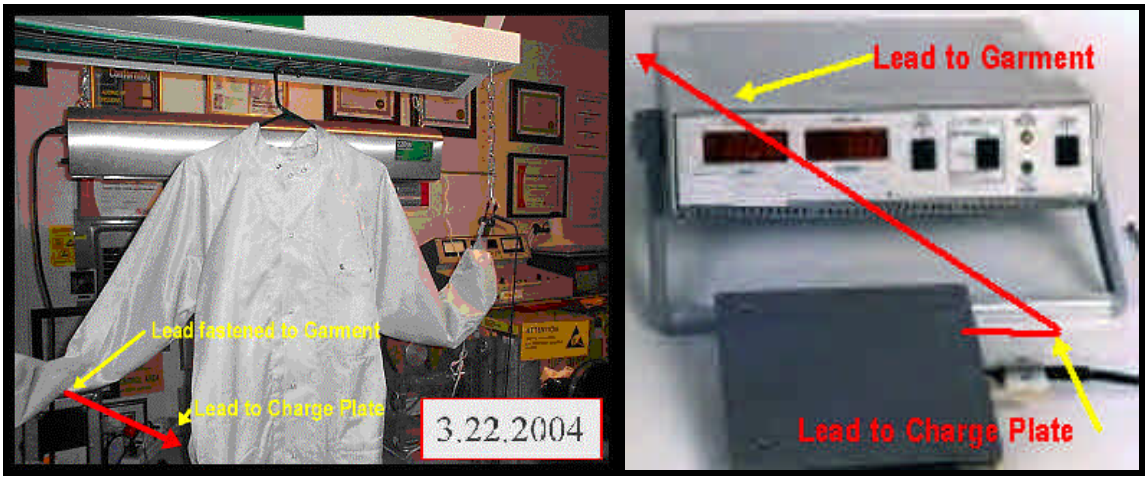

Figure 4

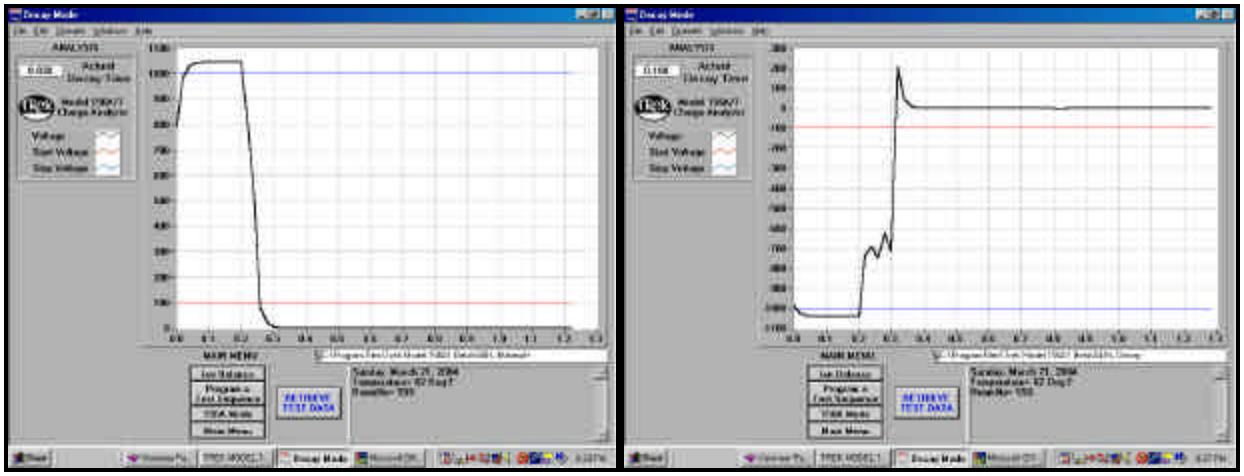

Figure 5

Table 4 Static Decay @ 14.5% RH @ 71.7^{0}F for 49 hours In seconds

+1000 volts to +100 volts	-1000 volts to –100 volts
0.030	0.100

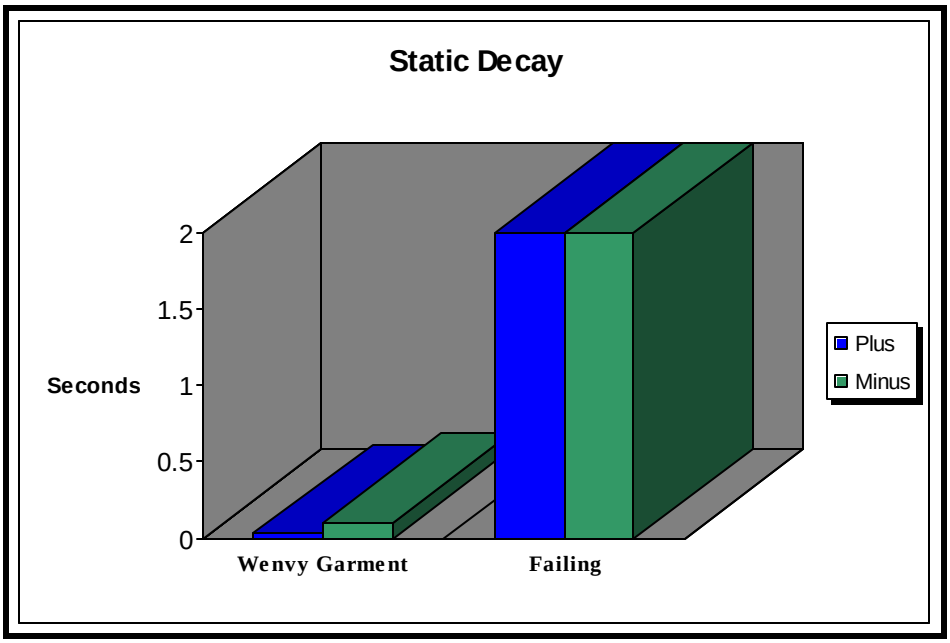

Table 5

Table 5 illustrates the average of results from +/-1000 volts to +/-100 volts. Exceeding the standard upper limit of 2.0 seconds is considered to be failing.

ATTENUATION:

A non-contact voltmeter probe is positioned inside the garment (**Figure 6**) and subjected to the charge generated by a Zerostat Gun. The voltmeter utilized is pictured in **Figure 7** (542-1 Serial Number 075 Calibration 5/3/03).

Figure 6

Figure 7

If the smock performs well, no more than +/-100 volts will penetrate the garment when the snaps are fastened. A good garment will prevent an individual wearing charge generating clothing from transferring a charge to ESD sensitive components by induction.

Figure 8 illustrates the peak voltages generated when the Zerostat Gun (**Figure 9**) is fired into the non-contact voltmeter sensor. **Figure 10** illustrates the peak voltages after the gun is fired into said garment.

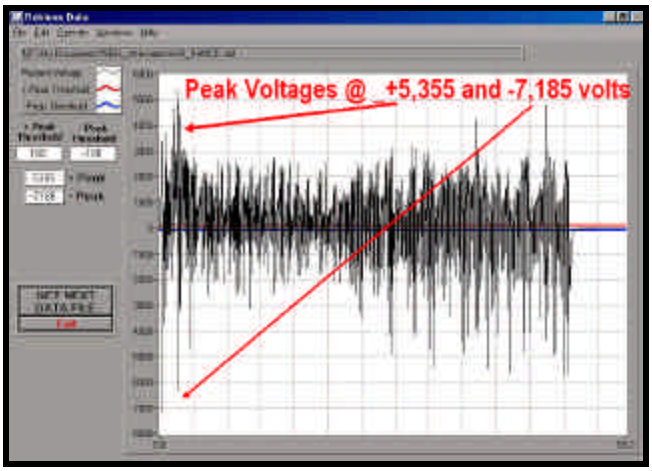

Figure 8

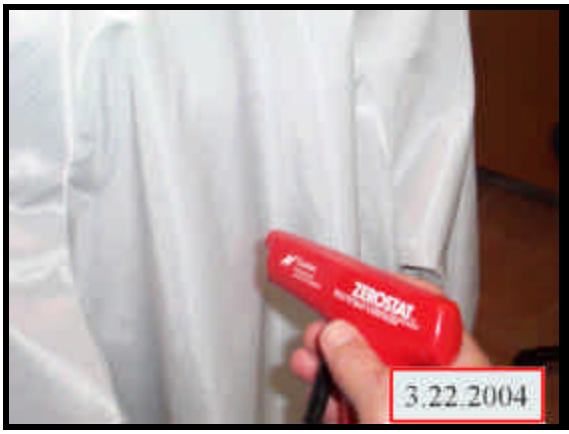

Figure 9

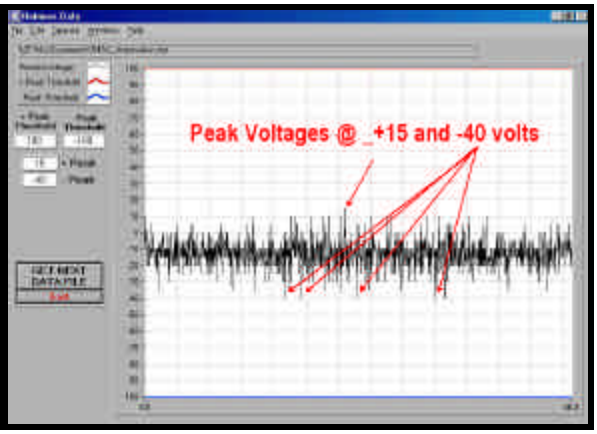

Figure 10

Table 6 Peak Voltages with and without protection of the voltage sensor @ 50% RH

+Peak Voltage without Garment	-Peak Voltage without Garment	+Peak Voltage with Garment	-Peak Voltage with Garment
+5,355	-7,185	+15	-40

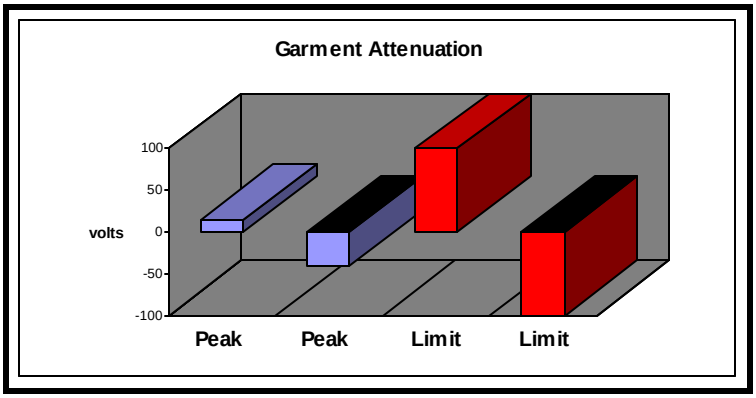

Figure 11

TRIBOCHARGE GENERATION @ 14.5% RH @ 71.7^{0}F for 49 hours:

Said garment was affixed to the charge plate from a grounding snap located near the pocket while insulated from ground. One sleeve is placed upon an insulative surface and pressure is applied with a grounded induction plate (**Figure 11**). When a charged Teflon (**Figure 12**) insulator is rubbed against The garment, any charge seen by a non-contact voltage sensor after removal of smock should be negligible.

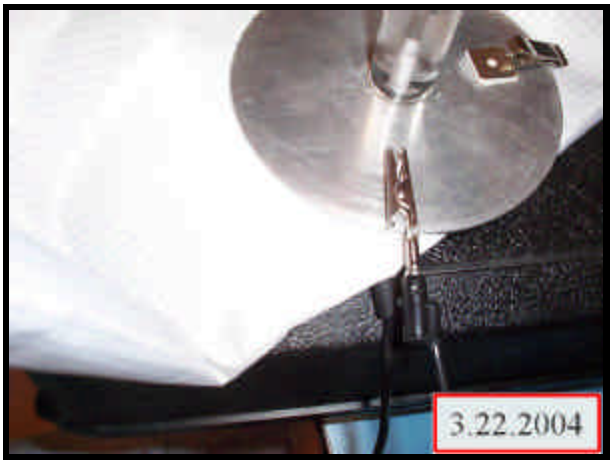

Figure 11

Figure 12

Said garment should drain any voltages generated, while preventing the charge plate from being charged. The results are illustrated in **Figure 13** below.

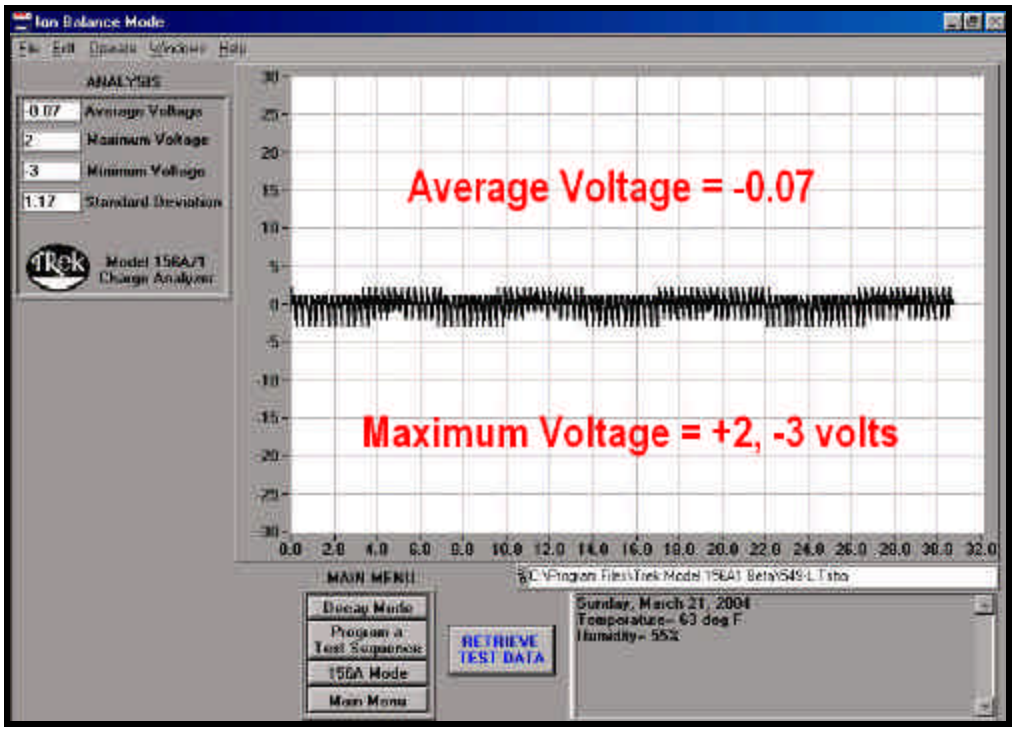

Figure 13

In conclusion, the garment performed well with favorable surface resistance readings, point-to-point resistance using both 5-lb weights and garment clips. Likewise, the resistance from the snaps to a groundable point was within acceptable limits. The garment produced positive static decay readings, encouraging shielding results (attenuation) and low tribocharge generation.

Kind regards,

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P.L. 108-183—The Veterans Benefits Act of 2003, Section 308
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