Advanced Static Control
CONSULTING

Client **January 14, 2015**
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Objective

To evaluate the electrical resistance properties of the submitted ESD garments based on the ESD Association's test method ANSI/ESD STM 2.1-2013.

Materials Submitted for Test

Transforming Technologies submitted three samples of their ESD garment manufactured with the 9010 series fabric for testing. The product specification sheet for the fabric states that it is made of 90% Polyester and 10% carbon.

ANSI/ESD STM 2.1 requires that all garment materials tested be cleaned a minimum of three times prior to the start of the testing. All three samples submitted for testing were washed 100 times.

Executive Summary

The garments submitted for testing meet all of ANSI/ESD S20.20-2014's resistance requirements for a Groundable Static Control Garment System even after being washed beyond the required three wash cycles.

ANSI/ESD STM2.1 – Garments

ANSI/ESD STM2.1-2013 provides test methods for evaluating the electrical resistance of static control garments. ANSI/ESD S20.20-2014 defines the required limits for Static Control Garments that are to be used in an ESD control program where ESD sensitive devices are handled.

All testing was conducted in an environmental chamber set at 22^0 C and 12% relative humidity. The samples were conditioned for 48 hours prior to testing. The resistance measurements, required by the test method, were made on the supplied samples. At the completion of the low humidity testing the samples were conditioned in an environment set at 22^0 C and 50% relative humidity for 48 hours. At the completion of the conditioning period the resistance measurements were repeated.

A Prostat PRS-801 Resistance System was used for all measurements. This resistance meter meets the "Resistance Measuring Meter" requirements of ANSI/ESD STM2.1-2013.

An ESD garment as defined by ANSI/ESD S20.20-2014 must fall into one of the following categories:

- Static Control Garment – point to point resistance of less than $1.0x10^{11}$ ohms
- Groundable Static Control Garment – point to groundable point resistance of less than $1.0x10^{9}$ ohms
- Groundable Static Control Garment System – meets all of the requirements of a Static Control Garment and a Groundable Static Control Garment. In addition the resistance from the body contact point to the garment's groundable point must be less than $3.5x10^{7}$ ohms.

General Test Procedure

1. Specimens were washed and preconditioned prior to testing. All tests were conducted in the conditioned environment.
2. The voltage and sense leads of the Prostat PRS-801 were each attached to a five pound, 2.5 inch diameter conductive rubber electrode.
3. For the point to groundable point measurements and the Body Contact Point to groundable point measurements only one five pound weight was used. The meter's sensing lead was connected to the garment's groundable point with an alligator clip. Figures 1 and 2 show the basic test setup and garment construction.

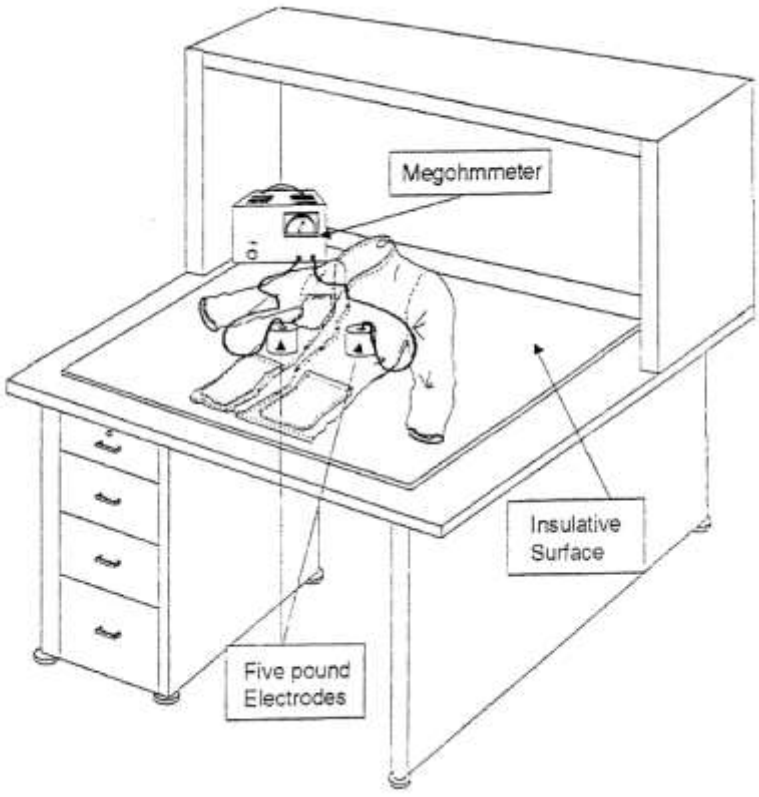

Figure 1 – Resistance Point to Point

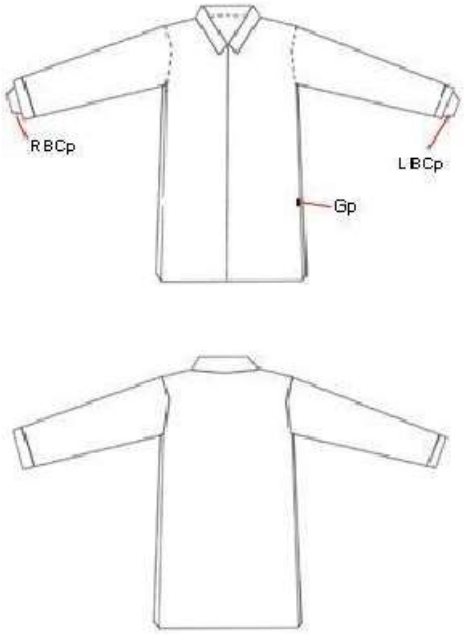

Figure 2 – Garment Construction

Data Calculations

The minimum, maximum and average resistance values for the garments tested were calculated.

The following key explains the short forms used in the data calculation tables:

Key:
LS - Left Sleeve
LFP - Left Front Panel
BP - Back Panel
RFP - Right Front Panel
RS - Right Sleeve
BCP – Body Contact Point
Cuff Only
Gp – Groundable Point

Low Relative Humidity Data

		Resistance Ohms		
Test Type	**Test Location**	**Garment 1**	**Garment 2**	**Garment 3**
Point to Point Resistance	RS to RS	3.40E+05	5.90E+05	5.10E+05
	RS to RFP	2.90E+06	7.40E+06	3.80E+06
	RS to LFP	9.80E+06	6.10E+06	4.70E+06
	RS to BP	8.30E+06	3.20E+06	5.20E+06
	RS to LS	1.70E+07	1.30E+07	5.50E+06
	RS to LBCP	7.20E+06	1.00E+07	5.30E+06
	RBCP to LBCP	3.80E+06	5.30E+06	3.30E+06
Resistance to Groundable Point	RS to Gp	1.90E+07	1.00E+07	4.90E+06
	RFP to Gp	4.50E+06	6.60E+06	4.70E+06
	LFP to Gp	2.70E+06	1.30E+06	5.70E+06
	BP to Gp	2.00E+06	4.60E+06	9.70E+06
	LS to Gp	1.00E+06	1.00E+06	1.10E+06
Body Contact Point	RBCP to Gp	7.40E+06	6.40E+06	2.20E+07
	LBCP to Gp	3.30E+05	3.00E+05	1.60E+06
Other	Right Cuff only	9.60E+04	3.20E+04	7.20E+04
	Left Cuff only	7.30E+04	5.30E+04	5.10E+04
Minimum	3.20E+04			
Maximum	2.20E+07			
Average	5.01E+06			

Moderate Relative Humidity Data

		Resistance Ohms		
Test Type	**Test Location**	**Garment 1**	**Garment 2**	**Sample 3**
Point to Point Resistance	RS to RS	1.10E+06	3.70E+05	6.60E+05
	RS to RFP	7.80E+06	4.50E+06	6.30E+06
	RS to LFP	7.10E+06	1.00E+07	9.30E+06
	RS to BP	1.10E+07	1.10E+07	6.20E+06
	RS to LS	8.90E+06	1.00E+07	2.10E+07
	RS to LBCP	9.50E+06	1.00E+07	1.20E+07
	RBCP to LBCP	5.10E+06	9.10E+06	9.70E+06
Resistance to Groundable Point	RS to Gp	1.10E+07	5.60E+06	8.50E+06
	RFP to Gp	9.00E+06	8.10E+06	1.10E+07
	LFP to Gp	5.00E+06	3.80E+06	4.30E+06
	BP to Gp	5.00E+06	4.50E+06	7.00E+06
	LS to Gp	7.40E+05	1.00E+06	9.20E+05
Body Contact Point	RBCP to Gp	7.50E+06	1.20E+07	1.80E+07
	LBCP to Gp	9.80E+05	2.40E+06	1.80E+06
Other	Right Cuff only	6.40E+04	6.20E+04	5.40E+04
	Left Cuff only	5.60E+04	7.50E+04	8.80E+04

Minimum	5.40E+04
Maximum	2.10E+07
Average	6.23E+06

System Resistance Test

This final optional resistance test is made with the garment being worn by a person. The resistance was measured from a metal wand held in the person's hand to the end of the wrist strap grounding cord that was attached to the garment's groundable point. This resistance value must be less than 3.5×10^7 ohms if the garment is to be used as part of a groundable static control garment system.

The test on these garments was performed under the following ambient room conditions – 22^0 Celsius and 26% relative humidity.

	Garment 1	Garment 2	Garment 3
System Resistance (Ω)	1.50E+06	1.60E+06	1.60E+06

Conclusion

The three garment samples supplied for testing meet the requirements for all three ESD garment categories defined by ANSI/ESD S20.20-2014 including the Groundable Static Control Garment System which is the most stringent of the garment resistance requirements.

A General Statement Concerning This Report

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Respectfully submitted,

Ronald Gibson
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