Humidity and ESD Control

I. INTRODUCTION

The control of electrostatic discharge can easily be implemented by employing basic control practices and principles in conjunction with the proper control products. Establishing an ESD Control program is dependent on the components that need protecting, the specifications of the internal quality control program and both the manufacturer and customer's requirements. What is often overlooked are the inherent environmental conditions and their control, i.e., humidity, temperature, pressure, number of air borne particles and air recirculation. The most significant environmental factor in ESD Control is the relative humidity (RH).

II. EFFECTS OF HUMIDITY

In very dry areas, humidification is desirable because it makes antistatic materials with "sweat layers" function better as well as an overall reduction (not elimination) in triboelectric charging for all materials. Do not let high humidity levels build a false confidence, and beware of corrosion problems with interconnects and other electrical interfaces.

A high relative humidity, over 30% RH, reduces the resistance of most dielectrics resulting in an increase in return current, which is the current that opposes a charge buildup. When an object is undergoing tribocharging in a high humidity environment, the object will reach an equilibrium point where the tribocharging current equals the return current. For objects that undergo charging to a high potential, the primary impact of humidity is to encourage or discourage corona, and effect the rise time of the discharge current.

Normally, the moisture content in the air tends to lower the surface resistance of floors, carpets, table mats, etc., by letting wet particles create a vaguely conductive (or less than 10^{-9} Ohms/square) film over an otherwise insulating surface. If the relative humidity decreases, this favorable phenomenon disappears.

The air itself, being dry, becomes a part of the electrostatic build-up mechanism every time there is an air flow (wind, air conditioning, blower) passing over an insulated surface.

Table I

Tribocharging and Relative Humidity (RH)

(Reference 4)

ACTIVITY (@ 70° F)	**STATIC VOLTAGES**	
	20 % RH	**80% RH**
Walking across vinyl floor	12 kV	250 V
Walking across synthetic carpet	35 kV	1.5 kV
Arising from foam cushion	18 kV	1.5 kV
Picking up polyethylene bag	20 kV	600 V
sliding styrene box on carpet	18 kV	1.5 kV
Removing Mylar tape from PC board	12 kV	1.5 kV
Shrinkable film on PC board	16 kV	3 kV
Triggering vacuum solder remover	8 kV	1 kV
Aerosol circuit freeze spray	15 kV	5 kV

As Table 1 above shows, triboelectric charging persists even at high relative humidity. The fact remains that triboelectric charging becomes troublesome below 20 to 30% relative humidity, as shown by the high voltages attained at 20% RH in the Table 1. According to Koyler ET. Al. [1], Relative humidity values should include an associated temperature because a temperature factor is involved in surface resistivity.

III. MIL-HDBK-263 Standard

Humid air helps to dissipate electrostatic charges by keeping surfaces moist, therefore increasing surface conductivity. Substantial electrostatic voltage levels can accumulate with a decrease in relative humidity, see Table 1 above. However, it is also evident from Table 1 that significant electrostatic voltages can still be generated with relative humidity as high as 90 percent. Relative humidity between 40 percent and 60 percent in ESD protective areas is desirable as long as it does not result in corrosion or in other detrimental effects such as PWB delamination during soldering. Where high relative humidity levels cannot be maintained, ionized air can be used to dissipate electrostatic charges.

MIL-STD-1695 specifically addresses relative humidity levels in the range of 30 - 70 percent in areas where electronic parts and hybrid microcircuits (MIL-STD-1695, bwork areas 5 and 6) are handled or processed. MIL-STD-1695 requires the same level of relative humidity controls for handling and storage areas (MIL-STD-1695, work area 13), except when items are covered or protected.

IV. CONCLUSION

Humidity control does limit the triboelectric charging process, but does not eliminate any of the conventional safeguards; it is strictly a backup or "safety net" measure. Also, humidity control may give personnel a false sense of security and cause a relaxation of operator disciplines, thus lowering overall ESD safety. Humidity control is also expensive and can cause corrosion or other adverse side effects. Humidity control is a backup that should be implemented only after careful consideration of benefits vs. cost and hazards.

Humidification to 30 or 40% relative humidity, minimum, at 70° F, is surely desirable, but drawbacks include (1) expense of facilities for adding water to the air, (2) possible adverse effects such as delamination of polyamide circuit-board laminates or corrosion of metals if the humidity becomes too high, (3) the psychological factor of false confidence inspired in operators and even engineers, and (4) personnel discomfort. An ESD control program should still be employed using conventional grounding, shielding, ionization, and training products and techniques.

V. REFERENCES

1. ESD From A to Z; Electrostatic Control for Electronics, Kolyer, John M.; Watson, Donald E., Van Nostrand Reinhold, New York, NY, 1990
2. Electrostatic Discharge and Electronic Equipment, Boxleitner, Warren, IEEE Press, New York, NY, 1989
3. Electrostatic Discharge; Understand, Simulate and Fix ESD Problems, Mardiguian, Michel, Interference Control Technologies, Inc., Gainesville, VA, 1986
4. "Exploding the Humidity Half-Truth and Other Dangerous Myths", Moss, R., EOS/ESD Technology Magazine, page 10, April 1987
5. Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies and Equipment (excluding electrically initiated explosive devices), MIL-HDBK-263B, Appendix I, section 40.1.17, 1994