STATIC ELIMINATION IN THE WORKPLACE

Static electricity is excess electrical charge residing on the surface of a material. In industry, it is usually caused by the contact and subsequent separation of two materials when at least one of them is non-conductive. The improved strength of many non-conductive materials allows them to be thinner and lighter, a requirement for microminiaturization. Lightweight materials are more susceptible to the effects of static, and processing them at higher speeds increases the amount of static produced. The resultant problems are often quite visible. Some of the more obvious are: erratic action of products during processing; dust attraction; static sparks causing areas where explosive fumes are present; and the destruction or deterioration of semi-conductive elements. Many methods of solving static problems are available.

STATIC PROTECTION SYSTEMS INTRODUCTION

It appears that the common element throughout the typical manufacturing plant is the protection of people from the generation of static charges. Likewise, companies attempt to protect tables and floor areas where people work (and can generate or transmit static charges), as well as to provide ESD safe containers and packaging.

The overall approach to providing static protection in the manufacturing environment should be to institute system-wide procedures to keep everyone and everything at the same electrical potential. In doing so, a potential difference significant enough to destroy or degrade a sensitive component will never be created across the leads of a sensitive IC. Thus, it is important to provide a means for rapid charge dissipation, as well as avoid static electrical charge generation.

CONDUCTIVE MATERIALS

Conductive materials in the form of textiles, sheet, foam, and fabricated garments are gaining acceptance as products suitable for protecting delicate devices from static charge during electronic fabrication, assembly, and packaging. These materials can be carbon black-filled, high- and low-density polyethylene, polypropylene, and polyvinyl chloride; open cell, carbon-impregnated urethane foam; and metallized nylon fabric. In addition, new colloidal film technology has been developed, resulting in amino resin laminate work surfaces, Faraday shielding, clear DIP tubes, and colloidal film, floor wax finishes. The materials are being used in worker garments, wrist straps, work station accessories, tote boxes and trays, shielding screens, shielding bags, and packaging materials for in-process use, and for shipping. Their purpose is to discharge static charges to ground at controlled, low-energy levels.

FLOOR SURFACE CONTROL TECHNIQUES

Floor surfaces are subject to charge generation by virtue of the movement of people and material handling equipment; this includes hand carts, pallet trucks, and trays. The following are generally desired characteristics of an ESD surface:

- Ability to discharge a static charge rapidly from work station personnel.
- Low propensity to generate a charge on personnel who walk across the floor, or carts which travel on the floor.
- Clean, high gloss, hard surface with excellent durability for foot traffic.
- A cleanable, noncurling surface to prevent walkers from tripping.

A brief industry survey revealed that the typical working floor surfaces used in ESD safe areas were: vinyl asbestos tile with or without floor wax; conductive vinyl tile; conductive (carbon impregnated) floor mats; multilayer conductive floor mats; and antistatic (soap- or oil-filled) floor mats.

ESD precautions on floor surfaces generally vary greatly from company to company, as well as within departments of the same company. The largest use of ESD-safe floor materials is in the assembly area, where conductive tile and mats are frequently utilized. Although conventional static control conductive mats and tile provide for rapid static discharge, they are substantial charge generators for walking personnel. "Antistatic" topical treatments and "antistatic wax" are of no value in this application. The complete ideal properties for ESD floor surfaces are achieved only by use of a colloidal film finish which not only dissipates a static charge, but also prevents static charge generation.

WORK SURFACES/BENCH TOPS

In an overall static control system, effective work surfaces are often felt to be secondary in importance, after the use of wrist straps. The purpose of the protective work surface is to drain static charges out of the operator's work area before they can interact with static sensitive devices. Therefore, the work surfaces must be conductive to electrical charges and properly grounded. Judging from available literature and reports, the following characteristics are deemed important:

- *Surface Resistivity.* The electrical resistivity of the surface of the material should be approximately 10 ohms/square.
- *Zero Voltage Suppression.* The conductive work surface should be able to discharge a conductive container when it is placed on its surface.
- *Long Life in Actual Application.* Some of the softer portable mats have been reported to tear, shred, or slough particles during normal use, as a result of wear and abrasion. These should be avoided.
- *Chemical Resistance.* Work bench surfaces should be resistant to most common solvent cleaners such as trichloroethane, MEK, and other similar materials.

Operator Comfort. The laboratory work surface should provide a clean area to avoid particles or fibers which might injure the operator, and it should be visually pleasing.

A brief survey of the industry revealed that a typical work surface or bench top used in an ESD safe area included hard surface laminates of an amino resin construction; portable multilayer vinyl mats; portable conductive black polyethylene mats; and fiberglass reinforcement of plastic products.

The soft portable static control mats made of conductive black polyethylene or single and multilayer vinyl mats are all acceptable as ESD-safe work surfaces. However, differences do appear in hard-surface static control materials. The amino resin laminate possesses acceptable static control properties; however, conventional formicas with conductive backings have high voltage suppression, and are therefore not suitable. Static elimination laminates with conductive fibers or "hairs" showed a wide range of surface properties, including many non-conductive areas. Additionally, these "hairs" create dead shorts. Skin irritation developed, however, in only one of the hard surfaces, the fiberglass-reinforced plastic sheet.

ESD-SAFE MATERIAL HANDLING SYSTEMS

ESD protective tote boxes, parts bins, and trays are also an important part of the complete static control system. Non-conductive material handling containers are frequently used in manufacturing areas and may be a significant source of static electrical charges. In addition to being significant charge generators, since the plastic is an insulator, removal of these charges is nearly impossible. Therefore, the replacement of non-conductive tote boxes, parts bins, and trays with conductive items is recommended.

Material handling containers should be electrically conductive so that a nearby charged object does not induce a voltage across the leads of the static-sensitive device inside the container. Also, such containers should provide an electrical path to ground so that the charged container may be discharged.

Important characteristics of these static control systems are:

Containers should be electrically conductive to provide a path to ground for all electrical charges.

Conductive containers should include covers, such that induced electrical charges will not be present on the interior of the box. This property is called a Faraday Cage effect and enables the container to protect static-sensitive devices from external electrical fields.

Uniformity of electrical properties.

Structural strength.

The use of conductive containers for static-sensitive devices has become relatively common in the electronics industry. Antistatic products which were soap-or oil-filled plastics were utilized because the slippery surface prevented or reduced static charge generation. However, such materials are true insulators and cannot provide a Faraday Cage to shield the contents from external charges or electrical fields. Also, such antistatic properties were not permanent.

STATIC ELIMINATION EQUIPMENT

Static eliminators include a broad range of devices for neutralizing non-conductive materials by producing a region of ionized air through which the charged material can pass. Ionized air contains free positively and negatively charged particles which are attracted to oppositely charged surfaces of the material, thus neutralizing the charge. The three basic types of static eliminators are induction, radioactive, and electrical. Induction static bars consist of a row of grounded metallic points or tufts, placed as close as possible to the moving material without touching it. Induction bars are inexpensive, work well when charges in the material are very high, and when it is not necessary to remove all of the charge.

Radioactive static bars employ a coating of radioactive substance, such as Polonium or Americium, facing toward the material to be discharged at a distance of about one inch. They work well on materials which are not too highly charged and moving at only moderate speeds.

Electrical static bars have a series of points maintained at high voltage but usually capacitively coupled to the voltage source so that they are shock-free even when touched. A small power unit energizes the electrical bars which are placed about one inch from the moving material. They are excellent ionizers capable of completely neutralizing large quantities of charges, even at relatively high speeds of travel. In addition to static bars, which can be straight for neutralizing sheets and webs, or circular for surrounding tubes or cylindrical objects, static eliminators are available in other forms. They are built into compressed air nozzles or guns for simultaneous cleaning and neutralizing, thus preventing reattraction of the dust. They are built into shaped parts in the ionized air. Other area static eliminators have a grid of static bars (usually supplied in 2-foot x 2-foot modules) through which laminar air can be passed to keep the work area of a clean bench or clean room static free.

STATIC ELECTRICITY METERS

Static electricity meters aid in the proper positioning of static elimination equipment. Effectiveness of static elimination equipment can be analyzed, and materials can be tested to determine charge acceptance and rate of discharge.

Static electricity meters detect and measure voltage of field strength associated with static charges. Readings are taken by pointing the instrument probe at the device or material being checked. Types of static electricity meters range from compact, pocket-sized units to highly sensitive, sophisticated units. Various probes, indicators, output devices and recorders are available with different meter types.

This article was written for ITEM 85 *by George R. Berbeco, President, Charleswater Products, Inc., West Newton, MA.*