Static Protection Wrist Straps and Grounding Cords

In the battle against static, the static control wrist strap can be the most important weapon

In the first three parts to this series, we've discussed static protection in general and, more specifically, the portable static-protective field service kits and static-shielding packaging.

This month we turn to the two critical components of any static protective work station or kit-wrist straps and ground cords. We'll discuss how they work, the construction, advantages and disadvantages to various types on the market and some safety considerations.

The design

The greatest potential source of static electricity damage, particularly in a field service environment, is the human body. Therefore, the single most important tool a technician can use to prevent static damage is a good quality, effective wrist strap, properly fitted and grounded.

The concept of controlling static electricity build-up on the human body by means of a conductive wrist strap is really straightforward. Because the human body is a conductor of electricity, any static charge on it can be removed by connecting any part of the body to ground. The two components of a standard conductive wrist strap, the wrist band and ground cord, accomplish this.

Obviously, a technician could dissipate the static charge on the body at any given moment by simply reaching out and touching a known ground. However, this procedure is really not adequate static prevention because it isn't permanent. As soon as contact with that ground is broken, even the simplest body movements can immediately regenerate charges on the body because of capacitive changes relative to ground. Uncontrolled, these capacitively generated voltages can reach several hundred volts or more. A grounded wrist strap is the only effective way to ensure that any charge is dissipated as quickly as it develops.

The conductive band contacts the wearer's skin, and the ground cord snapped to the band (and, therefore, to the wearer) connects it to some ground point. Because the snap on the band is designed to swivel easily, and because most ground cords are coiled and expandable, this wrist strap design allows the wearer a great deal of mobility and freedom of movement.

Types of wrist bands

The earliest wrist bands were constructed of strips of carbon-filled plastic wrapped around the wrist and fastened by a hook-and-loop fabric closure mechanism. The entire band was conductive, inside and out. Some bands are still made this way today. There are others of similar design in which the band is a nonconductive plastic or fabric, and a layer or strip of conductive plastic, or even just a metal tab, is added to the inside of the material to make contact with the skin.

This basic design has several shortcomings. First, these plastic bands, whether conductive or nonconductive, are generally stiff and uncomfortable. The edges of the plastic tend to cut into the wrist's skin. Models with a band that is conductive on the inside and outside may pose a safety hazard for the wearer if the band were to contact a live circuit. Those that use a band that is nonconductive on the outside with only a small conductive contact pad on the inside do not offer 360¡ contact with the wrist, and therefore the static-draining capabilities may be intermittent.

Also, although the hook-and-loop style of closure mechanism offers adjustability, bands that use this system are difficult to put on, and allow the wearer to arbitrarily adjust them too loosely to make effective contact with the skin.

Another type of wrist band is the ball and chain bracelet type. The band is made of chain material similar to pull chains sometimes found on lamps. Because this type of band is metal, it may present the same electrical safety hazard as the conductive bands described before. This chain bracelet design also has two other problems. Because it is designed to hang loosely around the wrist, there is the possibility of the bracelet snagging on other objects around the work site. Also, the electrical continuity of this link design has been shown to be intermittent as the chain shifts with normal wrist movements.

Yet another design is the metal watch band type. An expandable, metal-link watch band is fitted with a metal plate/male snap in place of the watch mechanism. Because the links and this plate are all metal, the band will serve as a static control wrist band by simply connecting it to ground with a standard ground cord. The only drawbacks to this design are the highly conductive metal exterior of the band and the link construction, which is uncomfortable for some wearers because it snags and pulls the hairs on the wrist. (Note: Newer models have a plastic coating over the outside of the metal links.)

The greatest innovation in wrist band design came in the woven fabric band. In this design, conductive fibers are interwoven into the band's fabric on the inside nearest the skin, leaving only nonconductive fabric on the outside of the band, which avoids the electrical safety hazard present in conductive bands.

Fabric wrist bands are comfortable and made in several styles: elastic, nonadjustable; elastic, readjustable or one-time adjustable; and nonelastic, readjustable, or one-time adjustable. The elastic nonadjustable type is generally offered in different sizes to accommodate various wrist diameters. The readjustable types are fitted either by means of a hook-and-loop closure or by some other type of clamping mechanism that can be repeatedly opened and closed. The one-time adjustable styles feature a pressure-closing clip that locks the band into a given size.

The greatest innovation in wrist band design came in the woven fabric band.

The fabrics used in these bands can stretch and become dirty (and therefore less conductive) over time, so most of them are able to be washed to recover their shape and remove contaminants. The main advantage of all fabric bands is their comfort. The main disadvantage of the various adjustable types currently on the market is that the wearers may still choose to put them on too loosely to achieve good, consistent static drainage.

Ground cords

At first glance, it would appear there isn't too much to say about ground cords. There are basically only two types, straight cords and coiled, expandable cords. However, there are other features to consider.

Ground cords vary not only in appearance, but also in length, weight, diameter, retractability and terminations. The cords for the first wrist straps were straight and short. However, manufacturers soon learned that this type was much too restrictive, and most switched to a lightweight, coiled design to allow the wearer more freedom while still keeping the cord out of the way.

The terminations on ground cords are also fairly standard. One end generally has a small snap to connect to the wearer's wrist band, and the other end has some means to connect to a ground point. In most cases, this ground connection is accomplished by an alligator clip, either permanently crimped to the cord or slipped over a banana plug molded onto the cord.

The type of conductor used in the ground cords also varies. The oldest cords were simply made of stranded copper wire. However, this type of cord did not stand up too well to constant flexing. More recent construction uses bundles of metal tinsel, which offer excellent strength along with better flexibility.

The most important feature of any ground cord is the strain relief used where the cord enters the termination at each end. While attached to a wrist band, a ground cord is constantly being flexed where it connects to the wrist band snap and to the banana plug/alligator clip. Therefore, the strain relief at these two points should be designed to absorb and spread the stress to avoid premature fracture of the conductor or the connection. Some ground cords have no strain relief incorporated into the design of the snap or banana plug, but the better ones have carefully engineered flexible strain relief that extends the useable life of the cord many times over.

The length, weight and retractability of the coiled ground cords currently on the market are all factors that affect how easy the cords are to use and how much, or little, they interfere with the technician's normal routine. Most manufacturers offer cords in several lengths, generally 5-feet, 6-feet and 10-feet. When relaxed, they are only 1- to 2-feet long. The most widely accepted cords are those that are long enough when extended to allow the technician freedom of movement, springy enough to retract completely even after prolonged and repeated use, and yet lightweight enough not to feel cumbersome to the wearer.

Safety resistors

One of the key points to consider with wrist bands and ground cords is safety. Because the wrist strap concept is based on connecting the wearer to ground, the remote potential of contact with line voltage must be considered. To protect the wearer in such a case, a currentlimiting resistor has been added to the ground cord. (Note: Users should be aware that the resistor in the ground cord will not protect the wearer from an electrical shock if an alternate path to ground is established.)

A value of I MQ was chosen based upon theoretical calculation and experimentation. In case of accidental contact with a hot 120V circuit, a resistor of this value will limit the current experienced by the wearer to a maximum of only 0.1mA, which is even below the threshold of sensation for most people. At the same time, a resistance of 1MQ added to the ground path will still allow almost instantaneous static charge drainage. In fact, adequate charge drainage could be obtained with a total resistance of up to 10MQ between the wearer and ground; the IMQ value was selected primarily for safety.

The wrist band and ground cord system is a safe and extremely efficient means to control static electricity on the body. Choose the wrist strap for your field service organization based upon technical effectiveness, safety, comfort, ease of use and any other factors you deem appropriate. Just be sure your technicians use it. Not doing so could have a negative effect on your P and L.