# DVD-55C
# ESD Control for IT and Electronics Service Technicians

*Below is a copy of the narration for DVD-55C. The contents for this script were developed by a review group of industry experts and were based on the best available knowledge at the time of development. The narration may be helpful for translation and technical reference.*



*Introduction*

OVERLY SINCERE VOICE

I just love the challenge of troubleshooting broken machines and identifying the problem. And there's nothing like that feeling of satisfaction that comes when you make the fix and the equipment works again. The customer gets it back with a minimum of down time. Now that's job satisfaction!

NARRATOR

That sounds really good, but there may be something wrong with that picture? What good does it do to fix something when in a short time ESD damage may cause a sensitive component to fail?

ESD is one of those phenomena that you can't see or hear – and sometimes can't even feel. That's because ESD damage can be subtle. The equipment may appear to be fixed, and will even work for a while – then eventually fails because of the previous degradation and weakening by the ESD event.

As you probably know, ESD control is heavily emphasized in the manufacturing environment of electronics assembly. And IPC has produced a number of ESD training products targeted to production operations. In this program we'll be examining why ESD prevention is important to people who work on electronic equipment *after* it's manufactured. This includes the highly skilled technicians who troubleshoot and repair systems in service centers and in the field, as well as the IT professionals who work on computers, servers and routers.

Let's start with the simple question – what is ESD? ESD stands for Electro Static Discharge. ESD is the sudden transfer, or discharge of electricity from one object to another. Lightning discharging from a thundercloud into the earth is an extreme example of electrostatic discharge.

Another example is the electric shock we sometimes feel after walking across a carpet and touching a doorknob.

These examples of ESD -- which we can see and feel -- last for a fraction of a second and contain anywhere from about 2,000 volts – the lowest level most people can feel – to over 25,000 volts. However, even below 2,000 volts there is still enough static electricity to cause static discharge and damage electronic circuits even when we don't feel it.

Under any circumstances – we're generating ESD all the time. And a lot of common objects around us can be sources of static electricity too. In fact, static zaps under 20 volts are capable of damaging, or destroying some of the sensitive electronic components we handle every day.

Before we get into how to prevent ESD damage, let's take a look at the elementary physics of ESD – so we can better understand what we're dealing with. When there is an *imbalance* of electrons on the surface of a material, an *electrical field* is produced. This field can be measured and can influence other objects in the near vicinity.

Whenever two materials, such as nylon and polyester, are brought into contact with each other and are then *separated*, the two materials become electrically charged. The charge is evident in that it may cause the hair on your arm to stand up.

When two corks are charged by these nylon stockings, the corks will repel each other. On the other hand, when one cork is charged by the nylon and the other cork is charged by polyester, the corks will attract each other. In other words, we can see that like charges repel while opposite charges attract.

These charges are referred to as "static" or static electricity. The word static means "at rest" – so we can say the electrical charge is just sitting on the item -- waiting for an opportunity to move.

Creating electrostatic charge by contact and separation of materials is known as *triboelectric charging*. It involves the transfer of electrons between materials. The charge may be positive, negative or neutral. In the atomic model, protons are positive and reside in the nucleus. Electrons are negative and orbit the nucleus.

When the two materials are placed in contact and then separated, negatively charged electrons are transferred from the surface of one material to the surface of the other material. Which material loses electrons and which gains electrons will depend on the nature of the two materials.

The material that loses electrons becomes positively charged, while the material that gains electrons is negatively charged. A charge is neutral when there are an equal number of protons and electrons. An example of a material that is usually positively charged is *nylon*. A material that is usually negatively charged is *polyester*. *Cotton* is an example of a *neutral* material.

Now, let's return to our discussion of ESD. Whenever two objects with different charges come close together, static electricity rapidly moves from one object to another. This rapid movement of the electrical charge changes it from static electricity to ESD.

It is important to understand how certain materials behave with these electrostatic charges. We'll separate them into three categories. The first material we'll talk about is a *conductor*. Conductors are typically some type of metal, like a piece of wire. The term *conductor* means that this material will conduct electricity. It will freely allow the movement of electrons through it. This will enable us to use *grounding* techniques to eliminate charges. *Grounding* means

providing a path for the extra charges to flow into the earth, leaving the material with a neutral charge.

The second material is called an *insulator*. Insulators *prevent* the flow of electricity. The third material is called partially conductive. Materials that are partially conductive fall somewhere in between conductors and insulators. They are conductors, but not very *good* conductors. For example, static dissipative materials are classed as partially conductive. They will allow grounding techniques to be used, but electrical charges are drained slowly. This is actually a *desired feature* in many cases since draining charges *slowly* minimizes the chance of damaging electronic components.

*People* are one of the biggest causes of ESD. That's because our bodies easily pick up static electricity. In fact, our skin can store relatively large amounts of this electric charge. When you're working on electronic equipment, ESD is one of the most serious problems you'll be facing. If it isn't controlled, the results are higher costs and dissatisfied customers – especially if a product fails at a critical time.

On the other hand, controlling ESD means fewer repairs – so costs can be kept down. This usually leads to increased customer satisfaction and sales – which is a win-win situation for everyone.

***Preventing ESD***

Let's begin this section by discussing packaging and handling considerations. We'll start with *packaging*. All ESD sensitive components and circuit board assemblies come from the manufacturer in *static shielding packaging.*

Whether you're working at an ESD safe technician's bench; troubleshooting a server at a data center; or making a repair in the field – the ESD sensitive components or circuit board assemblies you may be replacing should be kept in the original packaging until used. If a low moisture package needs to be opened to remove some components, it should be resealed with a humidity indicator and a desiccant.

The first rule of proper handling of components and assemblies is to *minimize handling* as much as possible. Also, although you may not know if any of the components are ESD sensitive – it's always best to treat every component as if it is.

When removing components from their packaging, it's critical that you pick the component up by the body – making sure you're not touching the leads. That's because the leads are *conductive,* making them the source of damage if there is an ESD event.

We'll also need to correct any improper practices when handling components. For example, we may get into the habit of sliding a component across a work surface. This movement generates static charges and can damage the component. It's also necessary to set components down -- with the leads *on* a static dissipative surface – which allows any built up charge to discharge slowly.

In terms of circuit board assemblies, it's important to handle them only by the edges – minimizing contact with any conductive surface. Because all the components are connected, an ESD discharge on the board can affect components anywhere in the circuit.

Now, let's take a look at the ways static electricity is generated. We'll begin with static producing materials.

Many common office materials might appear harmless, but they can also cause an ESD event. These materials can generate and hold static charges – thereby creating charged fields. For example, when a charged object, such as these plastic safety glasses, is brought close to an ESD sensitive device, the electric field causes *charge separation* in the ESD sensitive device. If the ESD sensitive device then comes in contact with a conductive item while exposed to the field, the device can be damaged.

The best remedy for this problem is to eliminate all unnecessary non-conductive materials from your bench or around the equipment you'll be working on. Examples include common plastics such as pens and tape dispensers; styrofoam food and beverage containers; vinyl binders, post-it notes and other paper products; bubble wrap; and equipment with plastic housings.

When static generating materials are *necessary* for the job, there are several methods available for reducing the effect these items might have where you're working. For example, applying an anti-static solution to certain types of hand tools and equipment at regular intervals may be helpful.

*Air ionizers* can also help neutralize charges. This machine blows ionized air into the work area to help neutralize any positive or negative charges that accumulate on non-conductive items, or items that are not connected to ground.

Another method of minimizing charge buildup is to operate with controlled humidity – 30% or greater. Dry air tends to make ESD problems even worse.

The way we work can also have an impact on how ESD is controlled. Let's take a look at some static producing activities that are *not* acceptable. Many of these are simply nervous habits that we're not even aware of. Sometimes we get so busy that we leave clutter in our work environment. But this clutter, along with accumulations of dust, can lead to conditions that may cause an ESD nightmare. That's why it's important to perform some housekeeping every day to minimize this potential problem.

We always need to be aware of our movements if we're going to control ESD. Rubbing hands together, raising arms, shifting feet and legs and putting on or taking off clothing around ESD sensitive items can generate charges that may damage components and assemblies. Combing hair is also another *huge* generator of static charge. It may also be important to tie back long hair.

Now, let's discuss *clothing* and ESD. Not paying attention to how you are dressing can create an ESD problem. That's because clothing made out of wool and synthetic materials stores static charges. If this type of clothing comes in contact with sensitive components, ESD damage can occur.

One obvious remedy to charge producing clothing is to wear a conductive smock. Conductive smocks not only cover charge producing clothing, but will help drain any charges harmlessly to ground once the smock or technician is grounded. It's important to button the smock so that no part of your clothing shows – and to not roll up the sleeves to the point where you can see the underlying clothing.

If you don't have a smock, it's better to wear clothing made of cotton – a neutral material – to help control ESD. It's also important to avoid wearing loose clothing that drapes down and may come in contact with an ESD sensitive component. Loose clothing is not only an ESD issue, it's

also a *safety* issue. Long loose sleeves can hook an assembly and cause it to drop onto the floor. In addition, your sleeves can get in the way of working, or may even touch a hot soldering iron.

Now let's turn our attention to *personal grounding* – perhaps the most important consideration in ESD control. As we stated earlier, *people* are the main culprits in the destruction of ESD sensitive devices. Let's discuss the equipment that is available to reduce the risk of ESD damage from people. The idea is to drain off charges in a *controlled manner* before they reach an ESD sensitive item.

To do that, all conductive surfaces -- including our bodies -- need to be connected to a *common grounding point*. When a static charge comes into contact with a partially conductive surface, this contact slowly and safely channels the charge away from the ESD sensitive item and neutralizes them into the earth, or ground.

The two types of personal grounding equipment available for working on electronic products are wrist straps and heel straps, also known as shoe grounders. Wrist straps are usually used for seated or stationary operations. When there is a conductive floor, heel straps make it possible to move around without the restriction of the wrist strap cord.

Wrist straps should be worn *snugly* against bare skin. Wrist straps should be attached securely to a ground wire with a current limiting resistor and some form of quick connect / disconnect. It's also important to make sure there's a good fit between the plug and the jack.

Heel straps should be worn so that one end is in contact with your sock, or against your skin inside your sock; and the other end is in contact with the floor. The moisture from your sock or skin aids in completing the electrical connection from your body to ground.

It's also very important to follow your company's policy for *testing* heel straps and wrist straps at regular intervals – and to verify that the testers are properly calibrated. Wearing defective personal grounding equipment will cause ESD problems – and you won't even know it.

With heel straps, you'll need to test each foot separately. That's because testing *both* feet at the same time will not cause a failure in one strap unless both straps fail. While testing wrist straps, it's important to shake your wrist to check for intermittent failures.

The ESD safe technician's bench provides the means for connecting all work surfaces, fixtures, handling equipment, and grounding devices to a common point ground. A static dissipative work surface and a conductive floor or mat also protects against ESD events.

Unfortunately, we don't always have the luxury of this degree of ESD protection. We can't always be at an ESD safe technicians bench – especially when we're engaged in IT applications or when working in the field.

For these situations, it's important to utilize a portable ESD field service kit. The kit typically consists of several connection points for wrist straps; a grounding wire that is usually connected by an alligator clip to an unpainted metal grounding point inside the equipment chassis; and a static dissipative work surface that allows an ESD safe resting place for sensitive components and circuit boards. If you don't have an ESD field service kit, you can use an alligator clip to connect the grounding wire of a wrist strap to an unpainted grounding point inside the equipment chassis.

Let's pretend you have no personal grounding and need to replace a circuit board assembly or a hard drive to fix a problem. You'll want to discharge static electricity from your body by

touching an unpainted metal surface on the equipment. It's important to minimize any movement until you've finished installing the new item and have closed the equipment.

This method of controlling ESD is not recommended. It's safer to hold off on the repair until you have proper personal grounding and have a static dissipative surface to set ESD sensitive items upon. That's because fixing modern electronic systems without ESD protection is like a carpenter working with opaque safety glasses. Of course, this may be possible, but the results might not be pretty. Be smart. Be ESD safe.

This program has presented the ESD control information that's required for troubleshooting and repairing equipment that contains ESD sensitive devices. In section one we explained why ESD is a potential problem -- when working on equipment in service centers, in the field and in IT applications. We also discussed the *physics* of ESD to provide a clear understanding of the phenomenon.

Then we discussed techniques for *preventing* ESD. We described proper packaging and handling; provided tips to avoid generating static electricity; and emphasized the importance of personal grounding and ESD safe work areas.

The satisfaction you feel after fixing malfunctioning equipment will increase significantly when you know you've followed proper ESD prevention procedures. That's because the equipment will be more reliable and likely won't need to be repaired again.