

**NOT MEASUREMENT
SENSITIVE**

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**DEPARTMENT OF DEFENSE
HANDBOOK**

**ELECTROSTATIC DISCHARGE
PROTECTIVE PACKAGING**



**This handbook is for guidance only.
Do not cite this document as a requirement.**

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FOREWORD

1. This handbook is approved for use by all Departments and Agencies of the Department of Defense (DoD).
2. Military packaging has experienced many changes in the packaging of electrical devices. Many of the new electronic parts and devices are highly susceptible to damage from static electricity, even at levels that can be neither seen nor felt. Electrostatic Discharge (ESD) affects many components such as transistors, resistors, integrated circuits, and many types of semiconductor devices. Static charge can degrade or destroy electronic devices during shipping, handling, and installation. Often it takes only a small charge to cause this damage. In fact, nearly half of today's new semiconductors, with their denser geometries, have a static sensitivity of 100 volts or less. This means that almost any moving object can generate a dangerous charge in an unprotected environment. A spark discharge resulting from the accumulation of electrostatic charges does not necessarily destroy a device or cause a circuit in which it is used to become nonfunctional. The device can be permanently damaged, yet performs its intended function. Additional exposures to these spark discharges or using the device in a circuit can further damage and degrade it until failure occurs. This is known as a latent failure and can seriously affect a system's reliability.
3. It is essential that everyone involved in the acquisition, handling, transporting, and storing of Electrostatic Discharge Sensitive (ESDS) items be concerned about ESD. All ESDS items should be packaged, shipped, and stored in ESD protective materials, including condition code F returns (economically repairable materiel which requires repair, reconditioning, or overhaul).
4. Reducing damage to ESDS items begins with understanding the problem. This handbook is intended to provide guidelines on precautionary measures for reducing failures as they relate specifically to packaging and handling of ESDS items.
5. Comments, suggestions, or questions on this document should be addressed to Chief, Logistics Support Activity, Packaging, Storage, and Containerization Center, ATTN: AMXLS-AT, Tobyhanna, PA 18466-5097 or emailed to logsapt@logsa.army.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <http://assist.daps.dla.mil>.

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1. SCOPE

1.1 Scope. This handbook provides detailed guidance for DoD personnel who use, handle, package, or store Electrostatic Discharge Sensitive (ESDS) items. It is designed to promote the use of standardized packaging materials as well as promote an understanding of the Electrostatic Discharge (ESD) threat through all levels of maintenance and supply. **This handbook is for guidance only and cannot be cited as a requirement.**

1.2 Application. This handbook is applicable to all DoD personnel involved in assembly, handling, packaging, and storing of ESDS items.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed below are not necessarily all of the documents referenced herein, but are those needed to understand the information provided by this handbook.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein.

FEDERAL SPECIFICATIONS

- PPP-B-1672 - Boxes, Shipping, Reusable With Cushioning
- PPP-C-795 - Cushioning Material, Packaging (Flexible Closed Cell Plastic Film, for Long Distribution Cycles)
- PPP-C-1797 - Cushioning Material, Resilient, Low Density, Unicellular, Polypropylene Foam

COMMERCIAL ITEM DESCRIPTIONS

- A-A-3129 - Cushioning Material, Flexible Open Cell Plastic Film (for Packaging Applications)
- A-A-59135 - Packaging Material, Sheet
- A-A-59136 - Cushioning Material, Packaging, Closed Cell Foam Plank

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DEPARTMENT OF DEFENSE SPECIFICATIONS

- MIL-DTL-117 - Bags, Heat-Sealable
- MIL-PRF-55182 - Resistors, Fixed, Film, Nonestablished Reliability, Established Reliability, and Space Level, General Specification for
- MIL-PRF-55342 - Resistors, Chip, Fixed, Film, Nonestablished Reliability, Established Reliability, Space Level, General Specification for
- MIL-PRF-81705 - Barrier Materials, Flexible, Electrostatic Protective, Heat-Sealable
- MIL-DTL-81997 - Pouches, Cushioned, Flexible, Electrostatic-Protective, Transparent
- MIL-PRF-83401 - Resistor Networks, Fixed, Film, and Capacitor-Resistor Networks, Ceramic Capacitor and Fixed Film Resistors, General Specification for
- MIL-PRF-87893 - Workstation, Electrostatic Discharge (ESD) Control

DEPARTMENT OF DEFENSE STANDARDS

- MIL-STD-129 - Standard Practice for Military Marking for Shipment and Storage
- MIL-STD-1686 - Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
- MIL-STD-2073-1 - Standard Practice for Military Packaging

DEPARTMENT OF DEFENSE HANDBOOKS

- MIL-HDBK-263 - Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) (Metric)

(Copies of these documents are available online at <http://assist.daps.dla.mil> or <http://assist.daps.dla.mil/quicksearch/> or from the Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

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2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
ELECTRONIC INDUSTRIES ALLIANCE (EIA)
ELECTROSTATIC DISCHARGE (ESD) ASSOCIATION

- | | | |
|-----------------|---|--|
| ANSI/EIA 625 | - | Requirements for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices |
| ANSI/ESD S20.20 | - | Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) |
| ANSI/ESD S541 | - | Packaging Materials for ESD Sensitive Items |

(Copies of ANSI documents are available online at www.ansi.org or from the American National Standards Institute, 25 West 43rd Street, New York, NY 10036, telephone (212) 642-4900, facsimile (212) 398-0023.)

(Copies of EIA documents are available online at www.eia.org or from the Electronic Industries Alliance, 2500 Wilson Boulevard, Arlington, VA 22201, telephone (703) 907-7500.)

(Copies of ESD documents are available online at www.esda.org or from the Electrostatic Discharge Association, 7900 Turin Road, Building 3, Rome, NY 13440-2069, telephone (315) 339-6937, facsimile (315) 339-6793.)

ASTM INTERNATIONAL

- | | | |
|-------------------------|---|---|
| ASTM D 996 | - | Standard Terminology of Packaging and Distribution Environments |
| ASTM D 1974 | - | Standard Practice for Methods of Closing, Sealing, and Reinforcing Fiberboard Boxes |
| ASTM D 5118/
D 5118M | - | Standard Practice for Fabrication of Fiberboard Shipping Boxes |
| ASTM D 5330/
D 5330M | - | Standard Specification for Pressure-Sensitive Tape for Packaging, Filament-Reinforced |
| ASTM D 5445 | - | Standard Practice for Pictorial Markings for Handling of Goods |

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ASTM INTERNATIONAL (Continued)

ASTM D 5486/ - Standard Specification for Pressure-Sensitive Tape
D 5486M for Packaging, Box Closure, and Sealing

(Copies of ASTM International standards are available at www.astm.org or from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, telephone (610) 832-9585, facsimile (610) 832-9555.)

3. DEFINITIONS

3.1 Definitions. General definitions of terms unique to this standard are listed below. Definitions of other terms commonly used in the packaging community may be found in ASTM D 996.

3.2 Antistatic. Refers to the property of a material that inhibits triboelectric charge generation effects.

3.3 Antistatic fast pack. Reusable container with antistatic cushioning and the word “antistatic” printed on both ends.

3.4 Antistatic tote tray. Conductive containers ideal for static-free storage, kitting, and in-process handling and transporting of static-sensitive assemblies or devices.

3.5 Conformal coatings. Liquid materials applied directly to Printed Circuit Boards (PCBs) and electronic components during final manufacture. Once hardened they will provide physical, electrical, and environmental protection.

3.6 Conductive. Materials defined as being either surface or volume conductive. Such materials may be either metal or impregnated with metal, carbon particles, or other conductive ingredients or whose surface has been treated with such materials through a process of lacquering, plating, metallizing, or printing.

3.7 Electrostatic discharge (ESD). A transfer of electrostatic charge between bodies at different electrostatic potential caused by direct contact or induced by an electrostatic field.

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3.8 Electrostatic discharge (ESD) grounding point system. A designated connection, location, or assembly used on an ESD protective material or device that is intended to accommodate electrical connection from the device to an ESD ground.

3.9 Electrostatic discharge (ESD) protective material. Packaging materials having the capabilities to limit the accumulation of electrostatic charges by safely dissipating electrostatic charges, or by shielding parts from the effects of external electrostatic charges.

3.10 Electrostatic discharge (ESD) protective packaging. ESD damage occurs when an accumulation of static electricity generated by the relative motion or separation of materials is released to another object. Packaging items with ESD protective materials tends to minimize the chance of triboelectric charge damage to sensitive items.

3.11 Electrostatic Discharge Sensitive (ESDS) items. Electronic items which are susceptible to damage or degradation as a result of an electrostatic discharge event.

3.12 Electrostatic discharge sensitive (ESDS) labels. All unit packs, intermediate and exterior containers of ESDS devices (or other electronic items that are alone or are part of assemblies) that are susceptible to damage from ESD should be marked with an approved ESDS device attention label.

3.13 Intermediate pack. A wrap, box, or bundle that contains two or more unit packs of identical items.

3.14 Ionization. The process by which a neutral atom or molecule acquires a positive or negative charge.

3.15 Ionizer. A device which is designated to generate positive and/or negative ions. In an ESD workstation, it is designed to neutralize or eliminate an electrostatic field that could be hazardous to the handling or packing of ESDS items.

3.16 Monitor (charge plate). An instrument used to measure the charge neutralization properties of ionization equipment.

3.17 Static dissipative. A material which will rapidly dissipate electrostatic charges over its surface or volume, having a resistivity range between conductive and insulative.

3.18 Static electricity. Electrical charge at rest. The electrical charge is due to the transfer of electrons within a body or from one body to another.

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3.19 Static safe area. Any area that is capable of limiting or controlling static charge on people and conductive/nonconductive materials.

3.20 Static shielding. Containers or packages capable of protecting from static discharges as well as static fields.

3.21 Triboelectric effect. The generation of static electricity caused by rubbing two substances together or by the contact and separation of two materials.

3.22 Unit pack. The first tie, wrap, or container applied to a single item or a quantity thereof or to a group of items of a single stock number, preserved or unpreserved, which constitutes a complete or identifiable package.

3.23 Worksite. Area identified, constructed, and equipped with an ESD workstation(s) and materials for trained personnel to handle ESDS items. Each worksite will be adequately and properly identified and marked as an ESD worksite.

3.24 Workstation. Area centrally located within the worksite, containing a workbench and materials to handle ESDS items.

4. GENERAL GUIDANCE

4.1 Generation of electrostatic charges. Electrostatic charges are generated by the contact and separation of the surfaces of two materials, with at least one being nonconductive. Friction caused by rubbing materials together tends to increase the amount of accumulated electrostatic charges. A familiar example of ESD is the spark that occurs by walking across a carpet and touching a metal doorknob. The contact and separation of shoes and carpet generate an electrostatic charge that is induced on a person's body, which is sufficiently conductive due to salty moisture on the body's surface. Since the doorknob is metal and highly conductive, a spark occurs when the hand is brought close to the doorknob, assuming the electrostatic charges are great enough.

4.1.1 Dry and moist materials. Separating dry materials generates greater electrostatic charges than moist materials because the moistness is sufficiently conductive and helps to dissipate the charge. For this reason, ESD effects are more noticeable in the winter since heating systems reduce moisture on the surfaces of furniture and other objects. Any circumstance that results in a low relative humidity will permit a greater accumulation of electrostatic charges.

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4.1.2 Static charge. A static charge is an excess or a deficiency of electrons on a surface. An excess of electrons produces a negatively charged surface and a deficiency of electrons produces a positively charged surface. Table I gives examples of common materials that charge positively, or negatively when separated from each other. Materials that charge positively lose their loosely bound surface electrons and materials that charge negatively, attract and maintain those electrons. Table II shows typical electrostatic voltages that occur during normal workday activities, and table IV lists typical electrostatic charge sources.

4.2 ESD damage. As shown in table II, activities such as walking, working at a bench, and handling common materials can generate thousands of volts of static electricity. If a spark discharge occurs from an accumulation of electrostatic voltage, electronic components, PCB components, and other electronic assemblies can be destroyed or damaged. Spark discharges cannot be felt if the electrostatic voltage is less than the threshold level for that particular individual. This threshold level is usually within the range of 2,500 to 4,000 volts of electrostatic charge.

4.3 Description of an integrated circuit. Since the advent of the integrated circuit, electronic components have become smaller and their functional capabilities have become greater. A microprocessor, the core element in a microcomputer, is less than one-half of a cubic inch in volume. Because of the micro-miniature size of the functional components in an integrated circuit, they are much more susceptible to ESD damage than their earlier, significantly larger counterparts. Table III provides the relative ranges for possible damage.

4.3.1 Damage by spark discharge. Considering the threshold levels at which most people can feel a spark discharge from electrostatic voltage, it is easy to understand how electronic parts can unknowingly be damaged during handling. If it is not immediately destroyed, the damaged part may not cause a functional system failure until after it reaches the user.

4.3.2 Microscope view. Figure 1 is a Scanning Electron Microscope view of a capacitor on a microchip of a high performance operational amplifier that has been damaged by ESD. Figure 1 shows the capacitor magnified at two different ranges with the damaged areas indicated by arrows. The ESD damage resulted in a 400-ohm path from the capacitor to ground, causing a malfunction in the amplifier.

4.4 Identification/acquisition. Items identified as ESDS will be protected from the very beginning of the acquisition process to final disposal. Specific control programs involved with item design, test, inspection, manufacture and maintenance are contained in MIL-STD-1686 as implemented by MIL-HDBK-263.

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4.4.1 Special protective devices. The requirements for the use of special protective devices prior to packaging, as with shunting bars, clips, or non-corrosive conductive foams for protection, is the responsibility of the Government activity involved in item acquisition. MIL-HDBK-263 and MIL-PRF-87893 provides further guidance in this area.

4.5 U.S. Air Force. U.S. Air Force activities have been instructed to utilize ANSI/ESD S20.20 instead of MIL-STD-1686 and ANSI/ESD S541 instead of MIL-HDBK-263.

5. DETAILED GUIDANCE

5.1 Identifying ESDS items. Due to the tremendous volume of electronic parts presently used by the military and the methods needed to accomplish the task, identifying parts that are ESDS is essential. ESDS items are categorized as follows:

a. The FEDLOG Army Master Data File (AMDF) Response for National Stock Numbers (NSNs) contains a data field identified as “ESDC” (Electrostatic Discharge Code). This is a one character alpha code (for example, A, B, C, or D) that indicates whether an item is susceptible to ESD or electromagnetic interference damage. If there is not a code in this field, do not assume that item is not ESDS. All owners of ESDS items have not entered a code in this FEDLOG AMDF data field.

b. If the letters “GX” are displayed in the MOP (Method of Preservation) field in an NSNs FEDLOG AMDF Packaging Data Response File, it is an ESDS item (see MIL-STD-2073-1, Appendix J, table J.1a, Specialized preservation codes).

c. All printed circuit cards and wiring boards with mounted ESDS components.

d. All parts with Federal Supply Class (FSC) 5962.

e. The U.S. Army Aviation and Missile Command has identified FSCs 5955, Oscillators and Piezoelectric Crystals, 5963, Electronic Modules, and 7042, Mini and Microcomputer Control Devices as ESDS items.

f. The Defense Electronic Supply Center has identified specific resistors and semiconductors listed below as ESDS items.

(1) FSC 5905 resistors:

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- (a) Film resistors conforming to MIL-PRF-55182.
- (b) Resistor chips conforming to MIL-PRF-55342.
- (c) Resistor networks conforming to MIL-PRF-83401.
- (2) FSC 5961 semiconductor devices:
 - (a) Microwave diodes.
 - (b) Insulated gate field effect transistors (Metal Oxide Semiconductor Field Effect Transistors (MOSFET)).
 - (c) Junction field effect transistors.
 - (d) Silicon-controlled rectifiers.
 - (e) Hybrid semiconductors.
 - (f) Small signal Schottky diodes.
 - (g) Semiconductor devices, not otherwise named, which operate at a frequency above one gigahertz.

g. A number 3, used to specify a Type Cargo Code (TCC), can be found in the FEDLOG AMDF Freight Data Response File. In this data file, TCC is a one character alpha/numeric code used for all shipments via water to identify the type of cargo included within the shipping unit. The number 3, used in this field, identifies ESDS items, for example, materiel subject to damage caused by ESD.

5.2 Packaging of ESDS items. In all cases, the first contacting layer (with bare item) of the selected protective material will be static dissipative and not conductive. Such a layer may be in the form of a homogeneous single film or cushion thickness, or a multi-layered structure either as a flat film or cushioning pad as in a pouch configuration. Shielding will be required to protect against the effects of static discharge. This protection is normally available in materials through the use of conductive layers attained by carbon loading metallization or other manufacturing techniques as provided by MIL-PRF-81705. Selection of the appropriate preservation materials will be based on the nature of the item and prescribed packaging data. MIL-STD-2073-1 identifies

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procedures for the packaging of ESDS items with the specialized preservation code GX in table J.Ia, and marking requirements via a special marking code, 39, found in table J.X. Unpreserved ESDS items should be handled only at an ESD protective workstation by trained personnel (see Appendix C), who can effectively employ the protective materials and equipment provided. Only antistatic preservation materials will be used to form the unit pack. Preserve and pack ESDS items using the following procedures (see figure 2):

a. Wrap the item in material conforming to MIL-PRF-81705, type II or type III, or cushion the item in material conforming to A-A-3129, type I, grade B, or PPP-C-795, class 2, or A-A-59135, class 1, grade B, or PPP-C-1797, type II, to prevent bag puncture. Reclosable cushioned pouches conforming to MIL-P-81997, type I or II, may be used in lieu of initial wrap or cushioning.

b. Place the wrapped or cushioned item in a bag meeting the criteria specified in MIL-DTL-117, type I, class F, style 1, made from material conforming to MIL-PRF-81705, type I, class 1 or 2. The bag should be made of one piece of material folded in half and heat sealed on three sides. This becomes the unit pack holding the ESDS item and can now be handled as you would any non-ESDS item.

c. Place an ESDS device unit pack label (see figure 3) on the unit pack as illustrated in figure 4. In the absence of NSNs, local purchase procedures should be followed when ordering this unit pack sensitive electronic device label. Should this label be temporarily unavailable, unit packs may be marked on two opposing sides with the ESDS device symbol and the statement: "DO NOT OPEN - EXCEPT AT APPROVED FIELD FORCE PROTECTIVE WORKSTATION" or "DO NOT OPEN - EXCEPT AT APPROVED STATIC- FREE WORKSTATION."

d. Most ESDS items (for example, circuit cards, resistors, semiconductors) can utilize 1 of the 12 reusable PPP-B-1672, type II, style D, folding convoluted "fast packs," which are the only fast packs authorized for ESDS items (see figure 4). ESDS items that will not fit into 1 of the 12 authorized fast packs will be packed according to prescribed packaging instructions, or into ASTM D 5118/D 5118M fiberboard containers. Allow for antistatic cushioning, measure for desired size fiberboard container and refer to the recommended fiberboard most frequently used container list (see latest revision of MIL-STD-2073-1). The listed sizes may be requisitioned through normal supply channels. If box-making equipment is available, containers should be fabricated in accordance with ASTM D 5118/D 5118M. After closure of carton that was accomplished in accordance with ASTM D 1974, apply a sensitive intermediate, or exterior electronic device caution label on the appropriate container (see figures 3 and 4). Label and mark according to MIL-STD-129.

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5.3 Transporting before final unit pack. If the unit pack needs to be opened for any purpose, it should be opened at an ESD-controlled workstation (see figure 5). If the item needs to be transported to several areas before it is converted to a unit pack (for example, from receiving inspection, to repair and test, to inspection, then to final unit pack), use the following procedures:

- a. Wrap, cushion, or pouch the item in accordance with paragraph 5.2.
- b. Place the wrapped or cushioned item in an open bag conforming to MIL-DTL-117, type I, class F, style 1.
- c. Fold the open edge over and place a rubber band around the bag to hold the flap down. Common adhesive tape should not be used, since it can generate an electrostatic charge when removed from the roll, or the bag. Antistatic adhesive tape can be used to hold the flap down.
- d. Transport the item by using a covered antistatic tote tray, or by placing the item in an antistatic type II, style D (folding convoluted), fast pack, PPP-B-1672. Protecting items in this manner ensures that the item is first placed in an antistatic environment and then transported.

5.4 Condition code F materiel. All reparable ESDS items should be rendered the level of packaging that would prevent further deterioration of the item. Returned condition code F materiel should be given the same applicable packaging referenced on the preceding pages beginning with paragraph 5.2, for example, condition code A, repaired, or newly procured ESDS items.

5.5 ESD protective packaging materials. Materials with known NSNs are included in appendix B. The list may not be all-inclusive because of the rapid technological changes which affect items available from supply sources.

5.6 The ESD protective worksite. An ESD worksite containing a workstation will require a minimum floor area of 150 square feet. It is recommended that the workstation occupy approximately 70 square feet and be centrally located within this site. The outer perimeter will be identified as a restricted area for trained personnel to handle ESDS items. This work area will be visibly marked, with overhead sign(s): "Caution – ESD Workstation." Figure 5 is a sketch of an ESD-controlled workstation, with items that are crucial in handling ESDS parts safely. The ionizer is a precautionary device that, within its effective area of control, will aid in removing electrostatic discharges from nonconductive surfaces such as the surface of an inadvertently placed Styrofoam cup. Heel straps and a static dissipative floor mat are also included with the essential worksite

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items. Heat-sealing equipment should be located adjacent to the workbench so that the wrist strap remains attached while heat-sealing bags. The tabletop and floor mat ground wires should each go to ground directly (see figure 5, item 6). To prevent the possibility of shocks from high-voltage sources, wrist straps for use at ESD-controlled workstations contain a protective resistor (usually one megohm). Grounding points should be constantly checked for proper grounding.

5.7 Precautions. Observe two basic rules: Handle all ESDS items at a static-safeguarded worksite and transport all ESDS items in static protective containers or packages. Adhere to the following precautions when using an ESD-controlled workstation.

a. When protective apparel is worn it should be frequently checked, especially after cleaning, by scanning personnel with an electrostatic field meter to monitor for damaging ESD voltages.

b. Be sure to attach the wrist strap (mandatory) and heel straps (if used) before handling any ESDS items.

c. Avoid the presence of any non-antistatic or insulative material on or near the worksite such as Styrofoam cups, common plastic or masking tape, common wrapping or barrier materials (for example, bubble pack, or plain poly) cigarette packs, and synthetic materials (for example, rayon, orlon, or plastics of any type) or any other non-job insulating materials.

d. Do not store or use magnetic material near the worksite.

e. Do not perform stretch- or shrink-wrapping operations within the ESD-controlled work area.

f. If more than one ESD-controlled workstation is located in the same area, do not connect the tabletops or floor mats grounding points in series; individually ground each one.

g. Do not use waxes, polishes, or similar material on the floor mat or tabletop. They may deposit an insulating layer of residue reducing or eliminating the effectiveness of the floor mat or tabletop. For the same reason, the use of topical antistatic spray is not recommended on packaging materials.

h. Sweep dust and dirt from the tabletop and floor mat as often as needed to prevent any accumulation which will also insulate them and make them ineffective.

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i. Perform continuity checks of all ground wires weekly (or as directed by manufacturer or command requirements) to ensure that the proper grounding is maintained. A log of grounding point system checks should be maintained for documenting when checks were performed. The log should be available for reviews by supervisors and Quality Assurance personnel. (See MIL-STD-1686 and ANSI/EIA 625).

j. Check wrist straps daily to ensure that the protective resistor (usually one megohm) is still in the circuit and that personnel are properly grounded. If the wrist strap resistance is less than 250K ohms, or indicates an open circuit, do not use it.

k. Antistatic pouches should be used for technical manuals, drawings, work instructions, etc., rather than plain plastic pouches, if they are used at all.

5.8 Typical ESD-controlled workstation. Figure 5 shows a typical ESD-controlled workstation (the heat-sealing equipment is not shown). Indicated on the figure are key ESD-control components that comprise a workstation. Figure 6 depicts several close-up examples of these components.

5.9 ESD workstation conductive material. The term “conductive” is often used in reference to ESD protective tabletops, floor mats, and chairs, but this term is a misnomer. They are not conductive as are common metals (for example, copper, aluminum, etc.), but are classified between metal conductors and insulators of electricity such as ceramic, dry paper, and mica. The resistance characteristics of static dissipative table tops, floor mats, and chairs prevent the possibility of a spark discharge or high current flow. They allow an electrostatic charge to be safely dissipated across the surface to the ground.

5.10 ESD field service kit. ESD protection is required where formal workstations are not practical (that is, remote locations such as shelters and vans). ESD control field service kits provide the next most effective means of preventing ESD damage. Their primary use is in support of personnel who remove ESDS items from service or who place them in operation during which time items are outside of prescribed packaging. Kits are available which allow protection for ESDS items at the ultimate user level (see appendix A). Figure 7 reflects a typical kit as described in Appendix A. It is noted that these static dissipative mats with accessories are not a substitute for a complete ESD protective workstation. The kit is a field expedient and contains only the minimum requirements for ESD-control. This supplemental handling procedure for repair type ESDS items is the only interim technique where the reuse of ESD preservation material is encouraged.

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6. NOTES

6.1 Intended use. This handbook provides guidance on procedures, materials, and practices that can be used to protect and extend the service life of ESD sensitive items. Information is provided on how to receive, handle, pack, mark, and ship ESD items.

6.2 Subject term (key word) listing.

- ESD protective material
- ESD protective worksite
- ESD protective workstation

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

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TABLE I. Common materials that generate triboelectric effect.

Positive (+)	Human hands Asbestos Animal fur Glass Mica Human hair Nylon Wool Fur Lead Silk
Increasing (+)	Aluminum Paper Cotton Steel Wood Amber Sealing wax
Increasing (-)	Hard rubber Nickel, copper Brass, silver Gold, platinum Sulfur Acetate rayon Polyester Celluloid Orlon Saran Polyurethane Polyethylene Polypropylene Polyvinyl Chloride
Negative (-)	Silicon Teflon

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TABLE II. Typical electrostatic voltages.

Means of static generation	Measured voltages	
	10% to 20% RH	65% to 90% RH
Walking across carpet	35,000	1,500
Walking over vinyl floor	12,000	250
Worker at bench	6,000	100
Vinyl envelopes for work instructions	7,000	600
Common poly bag picked up from bench	20,000	1,200
Work chair padded with polyurethane foam	18,000	1,500

TABLE III. Sensitivity ranges.

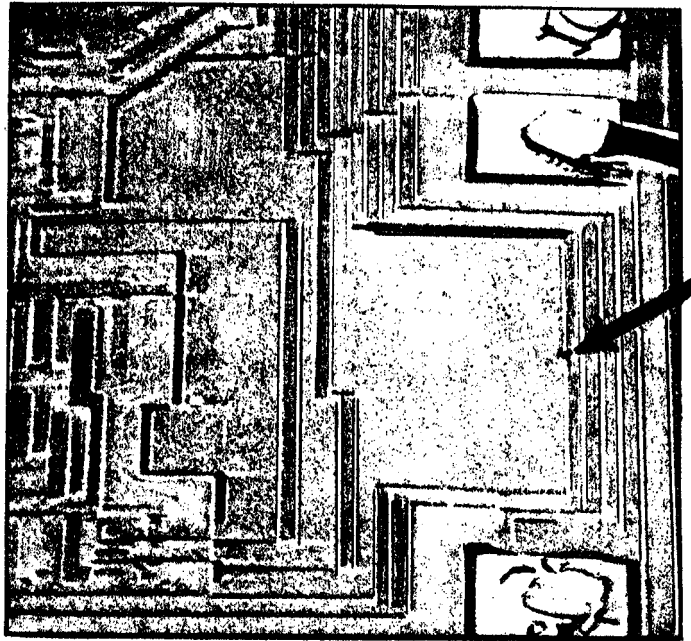
Component	Volts
Transistors	30-7,000
Operational amplifiers (modules)	200-2,500
Diodes	300-2,500
Film resistors	300-3,000
Low-power, integrated circuit logic	500-2,500
Silicon controller rectifier	700-1,000

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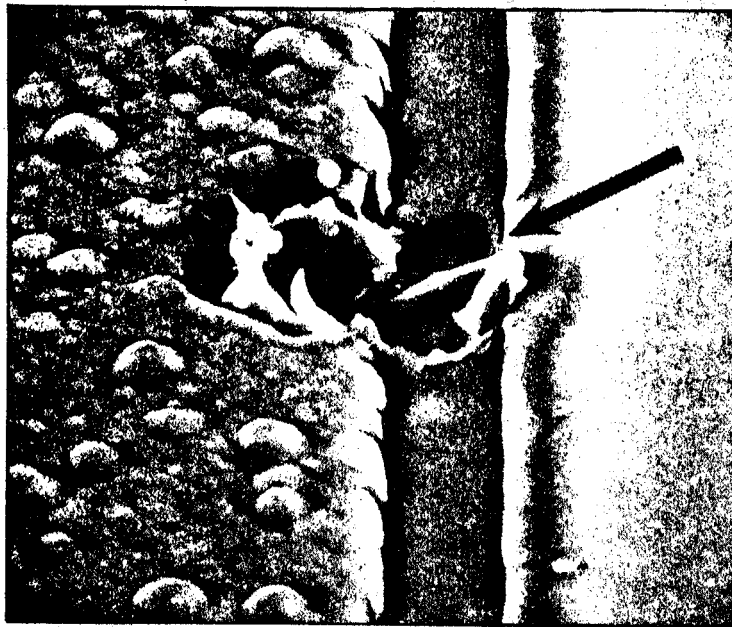
TABLE IV. Typical electrostatic charge sources.

Object or process	Common materials or activities
Work surfaces:	Waxed, painted or varnished surfaces Vinyl or plastics
Floors:	Sealed concrete Waxed, finished wood Rugs Vinyl tile or sheeting
Clothes:	Clean room apparel Animal hair-based garments Nonconductive shoes
Chairs:	Finished wood Foam cushions Vinyl, fiberglass Plastic casters
Packaging and handling:	Plastics (bags, wraps, envelopes, labels, stretch and shrink films, tapes Bubble pack, foam, loose fills plastic trays, pallets, tote boxes, vials, parts, bins, containers
Assembly, cleaning, test, and repair areas:	Spray cleaners Plastic solder suckers Solder irons with ungrounded tips Cleaning or drying by fluid or evaporation Heat guns and blowers Sandblasters Electrostatic copiers

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Failure site indicates surface damage to capacitor (175 magnification).



Closer view indicates "punch-through" due to ESD (4,300 magnification).

FIGURE 1. Magnified views of ESD caused failure of high-performance operational amplifier.

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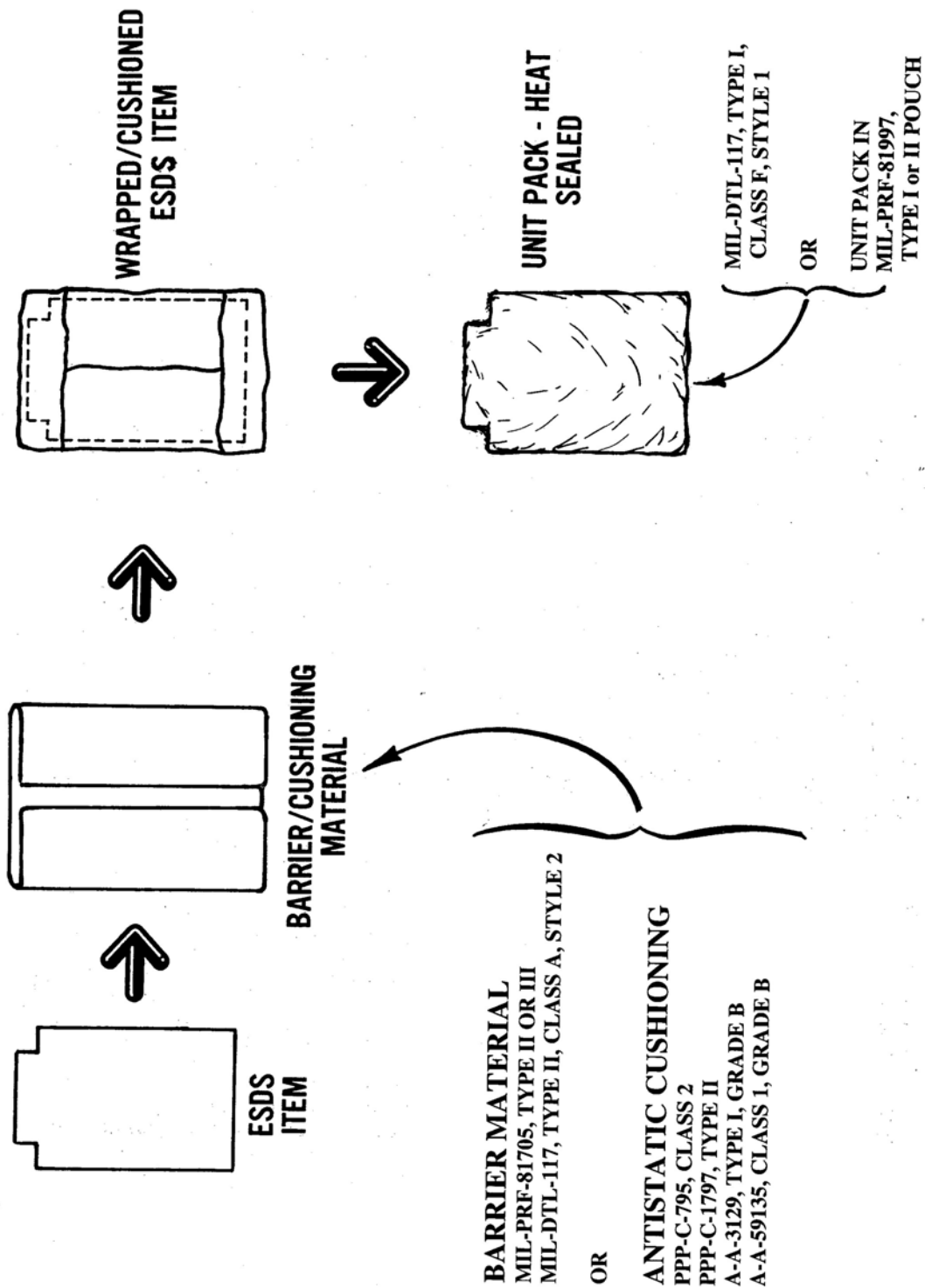


FIGURE 2. ESDS item preservation.

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Electrostatic sensitive device caution label.
(unit pack)

NOTE: Preferred color is yellow hand on black triangle per ASTM D 5445, symbol 28.
Size may vary.

NSN	SIZE	OPTIONAL FORMS
7540-01-109-8815	5/8- by 2-inch	88



Electrostatic sensitive device caution label.
(intermediate and exterior packs.)

NSN	SIZE	OPTIONAL FORMS
7540-01-109-8815	2- by 2-inch	87
7540-01-110-4906	4- by 4-inch	87A

FIGURE 3. Electrostatic Sensitive Device Labels.

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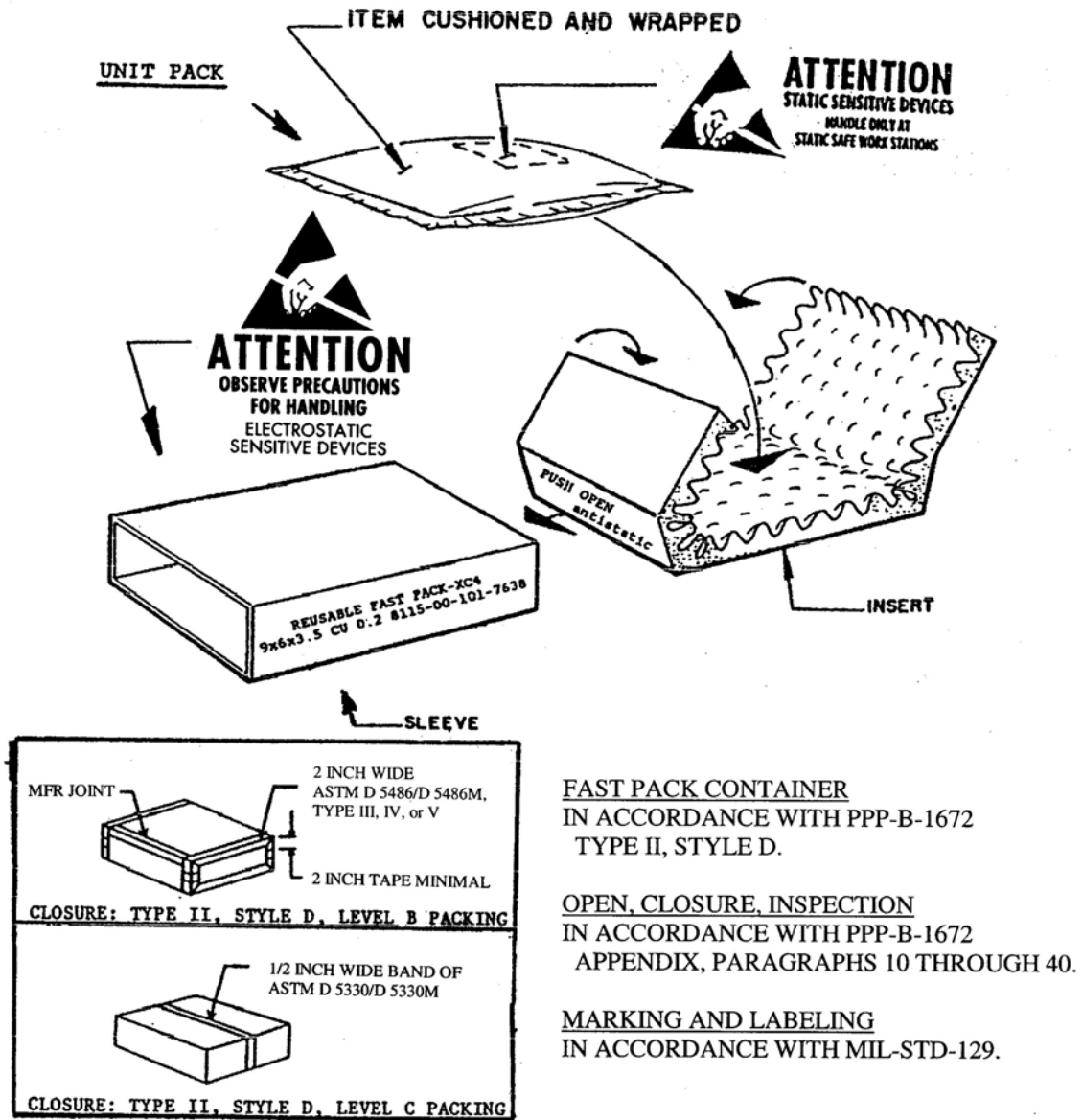


FIGURE 4. Use of PPP-B-1672, Fast Pack.

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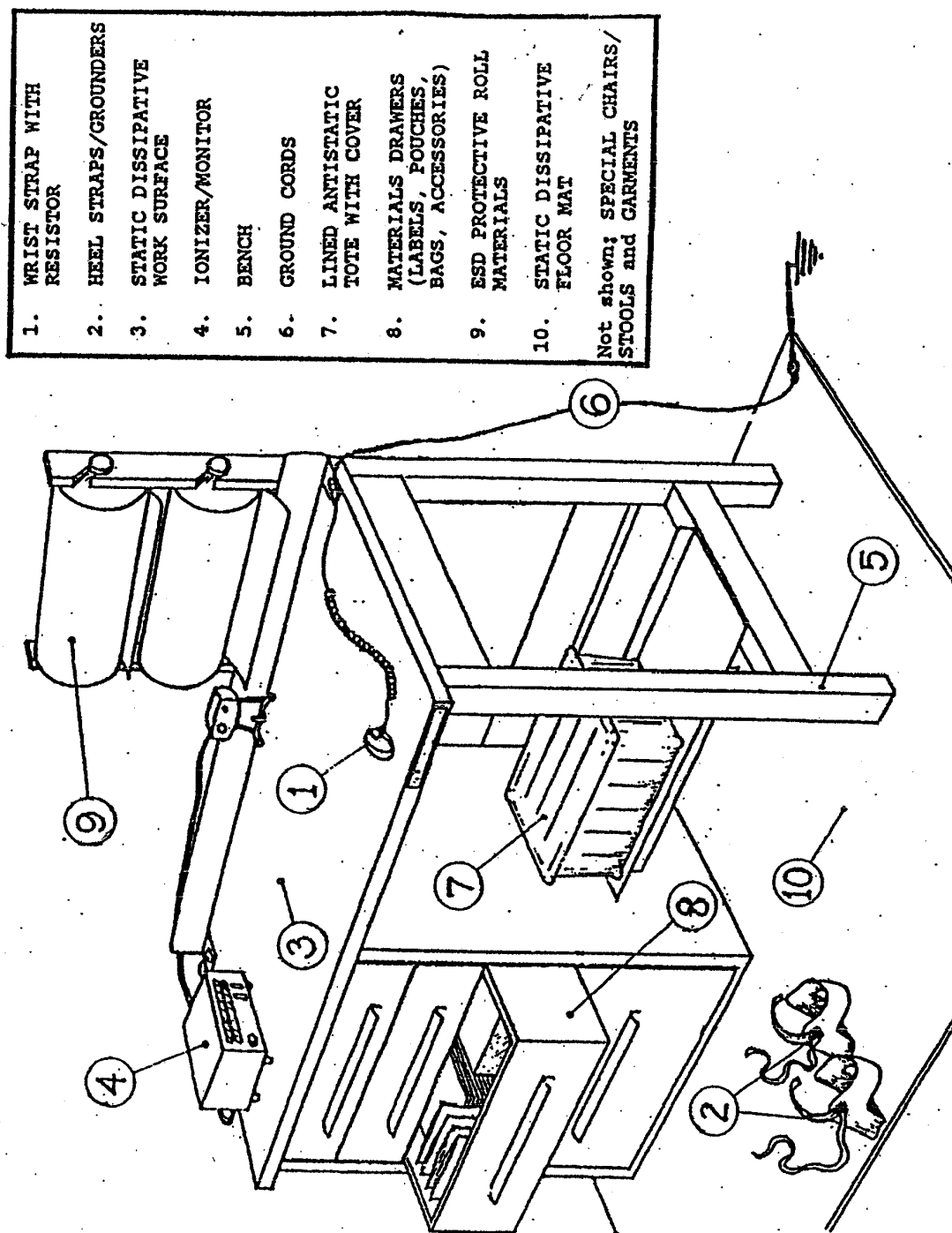
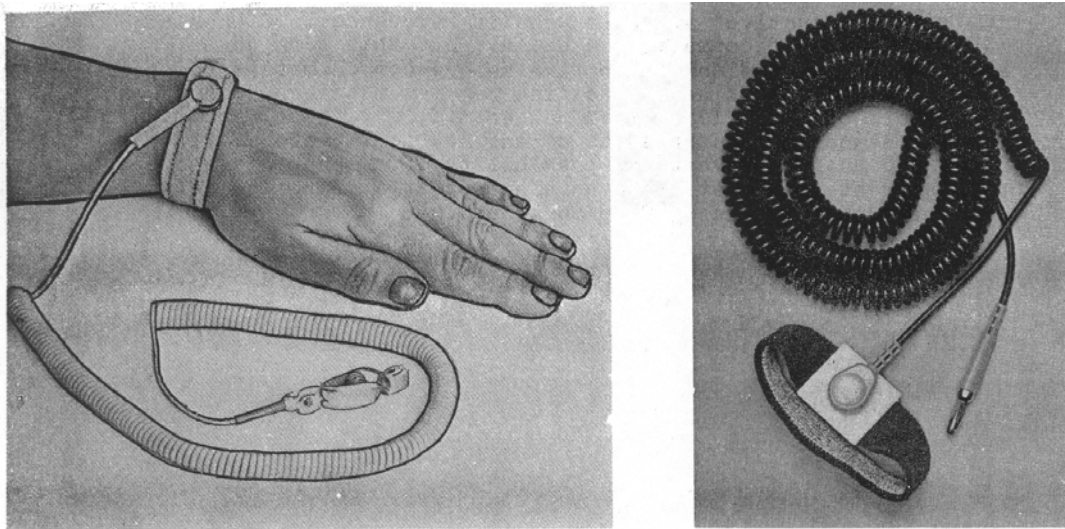


FIGURE 5. Example of ESD protective workstation.

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WRIST STRAP WITH RESISTOR

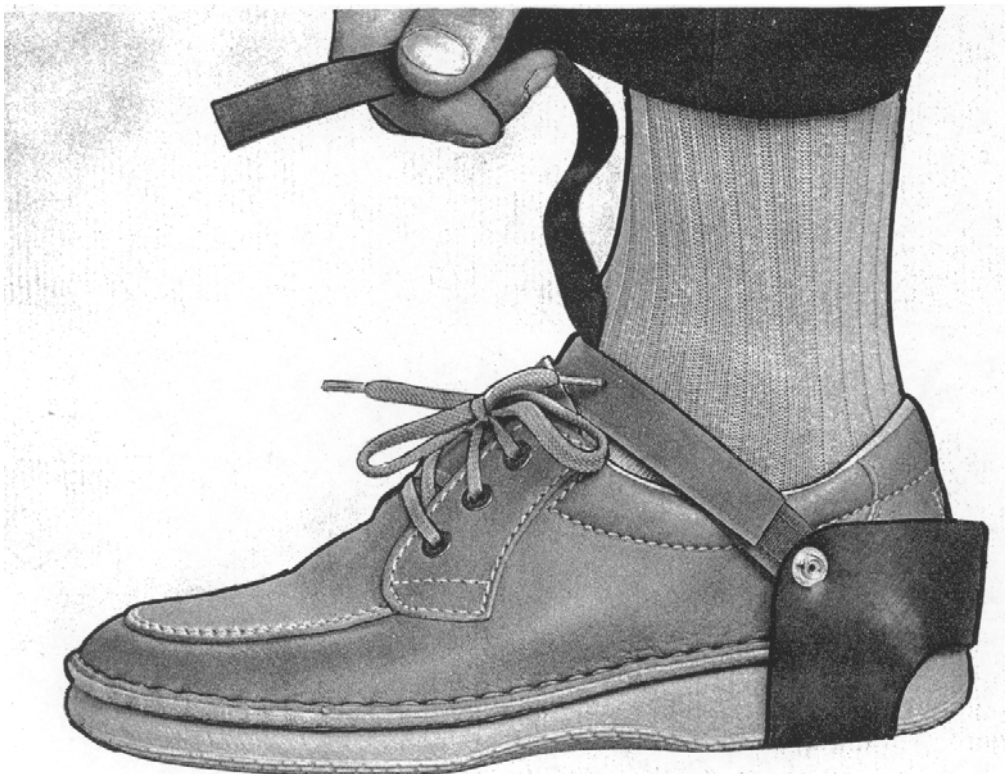


FIGURE 6. ESD protective worksite items.

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FIGURE 7. Typical ESD protective field service kit.

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ELECTROSTATIC DISCHARGE (ESD) FIELD SERVICE KIT AND
WORKSTATION EQUIPMENT

A.1 SCOPE

A.1.1 Scope. This appendix provides information on the ESD field service kit (MIL-PRF-87893, type III), its components, and the basic instructions on how they should be used to handle and protect ESD sensitive items.

A.2 PROCEDURE

A.2.1 ESD protective field service kit instructions. The following steps should be followed when working with ESD protective field service kit instructions.

CAUTION: Only trained personnel should handle unprotected ESDS items. Disconnect all power before handling any item.

STEP 1. Place unfolded work mat on table or floor near work area or service location.

NOTE: Remove all ESD packaging material from pockets (A and B) and place away from mat.

STEP 2. Attach ground cord to mat fastener A or B. Attach bulldog clip to mainframe, chassis, or other bare metal surface near item to be replaced or removed. This surface has to be a part of unit to be replaced or removed, and be a part of unit assembly containing item.

STEP 3. The wrist strap coil containing resistor will be attached to the same mat fastener as the grounded connectors A or B. Adjust wrist strap over wrist against bare skin.

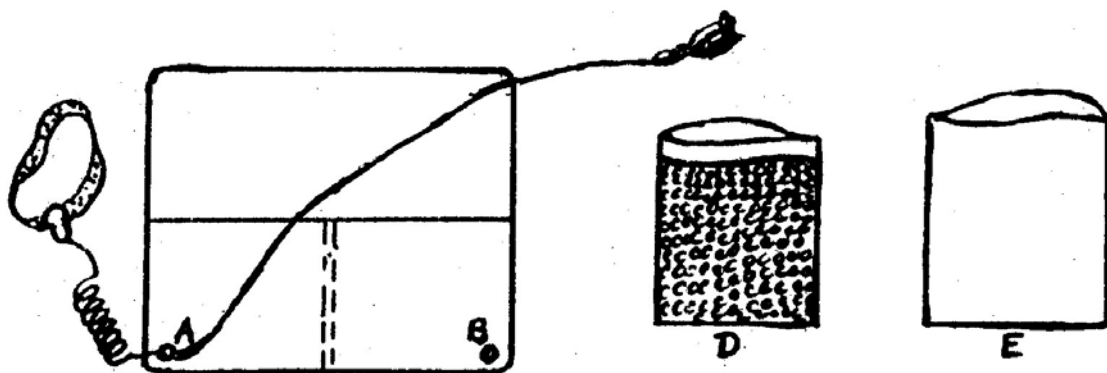


FIGURE A-1. ESD field service kit components.

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STEP 4. Proceed now to remove, replace, or handle the ESDS item only on the mat surface. Keep all other tools or non-ESDS items off the mat.

STEP 5. ESDS items to be returned (for example, condition code F) for repair or otherwise removed from the static dissipating mat should be packaged to prevent any further deterioration (see paragraph 5.2). Place item in antistatic pouch D, made from material conforming to MIL-DTL-81997, type II. Fold over opening and place in shielding bag E, made from material conforming to MIL-PRF-81705, type I. Fold the opening, and place a rubber band over this shielding bag. Do not use adhesive tape. Item can now be handled as you would any other non-ESDS item.

NOTES:

1. Do not disassemble the field service kit until all procedures have been completed.
2. Ground cord and wrist strap cord are usually connected together on the kit's ground snap(s).
3. Follow manufacturers test method and frequency for evaluating the electrical and mechanical characteristics of wrist strap and ground cord.

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TABLE A-I. ESD field service kit and workstation equipment.

DESCRIPTION	National Stock Number
Wrist strap - cable 36 inches in length with a clamp for attaching to material or equipment, with a 250K resistor.	4240-01-063-4880
Workstation – electrostatic control, static dissipative rigid table mat, common point ground system, wrist strap cuff, and wrist strap cord with current limiting resistor; to be used in clean rooms or laminar flow booths where particulate control is necessary, and ESDS items are handled.	4940-01-250-4235
Workstation kit, electrostatic control, static dissipative soft table mat, common point ground system, with adjustable size wrist cuff having a strap cord with current limiting resistor; alligator clip; to be used in all areas other than clean rooms or laminar flow booths where ESDS items are handled.	4940-01-250-4236
Workstation kit – electrostatic control, static dissipative portable work surface, common point ground system, and wrist strap with current limiting resistor; situations where other static control used in work stations are not available includes a small/medium and a large/extra large wrist strap cuff.	4940-01-250-4237
Static floor runner – 4 feet by 40 feet, with 2 each female snaps, 15-foot ground cord; ground cord includes a 1 megohm resistor.	5975-01-209-5753
Mat – electrostatic discharging, 48 inches by 24 inches.	5920-01-269-0444
Field service kit contains 3 each pouch, MIL-DTL-81997, type II; 3 each barrier bags, MIL-PRF-81705, type I; 2 each wrist strap; 1 each ground cord; and 1 each mat, static dissipating.	4940-01-253-5368

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NOTES:

1. Use the FEDLOG, any service (for example, Army has a tank icon), to determine availability (AAC code) and cost of ESD workstation and components. Individual NIIN/NSN data can be reviewed, or do an Interactive Query. Go to the open field for Part Number, and print: "MILW87893", "MIL-W-87893", or MILPRF87893." This is a specification for ESD workstations, MIL-PRF-87893, Workstation, Electrostatic Discharge (ESD) Control. Next, place cursor arrow on "Search" block, bottom right of screen and click. A screen titled, "Part Number Pick List" will appear on monitor screen.

Click cursor on, "Tag All" for Part Numbers available in FEDLOG, bottom left of screen. Go to top of screen and find the Toolbar Icons (below File bar), click cursor on either arrow icon, ◀ or ▶. Clicking cursor on an arrow (◀ ▶) icon will provide data associated with an NSN in the listing of NSNs associated with this specification.

Decide on what data files you want to review on these NSNs. Click cursor on "Data Views" found on the Main Menu bar. Click cursor on "Select Views...F3" and leave the checkmarks on those NSN data fields that will be reviewed (for example, Army Master Data (AMDF Management) Data (AAC, Cost, UI), Reference Number Data, Supplier Data, and Characteristics Data file). The Reference Number Data Response File gives part numbers used by suppliers (CAGE Code) in their supply catalogs, bulletins, advertisements. After pertinent data has been reviewed on an NSN, move cursor arrow to bottom left of screen, point and click on the icon block "Next NSN."

2. There is a Qualified Product List (QPL-87893-01, dated 1 May 1995) for ESD workstation products qualified under the military specification, MIL-PRF-87893. Go to a search browser on a personal computer (PC) and type in <http://assist.daps.dla.mil/quicksearch/>. A screen appears on the PC monitor, "Tell Us What You Want!". At the middle of this page are the words: Document Number (underlined). Type in the numbers "87893". Click PC mouse on "Submit". This action brings up another web page, look for and click PC mouse on "QPL-87893-1". Another web page is displayed. At the top of this page click PC mouse on icon (picture) of a book to the left of the words: "Click here to access document images". Another web page is displayed. Go to the lower left of this page and under "Media", click PC mouse on the small icon stating: "PDF". This action brings you to a QPL document listing of ESD workstation components NSNs and approved U.S. Air Force suppliers.

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ELECTROSTATIC DISCHARGE (ESD) PROTECTIVE MATERIALS

B.1 SCOPE

B.1.1 Scope. This appendix provides National Stock Numbers (NSN) assigned to approved and tested ESD materials. Barrier and cushioning materials meeting ESD protective performance criteria are listed under appropriate Federal and military specifications, and Commercial Item Descriptions (CIDs). The listed NSNs meet the protective criteria set forth in the identified specifications and CIDs. It should be noted that NSNs for these specifications are periodically added, or dropped from the FEDLOG for various acquisition reasons. Therefore, prior to ordering, an NSN's FEDLOG AMDF Acquisition Advice Code (AAC) should be checked to verify if the item is active, and to determine how and under what restrictions the item can be acquired.

B.2 APPLICABLE DOCUMENTS

B.2.1 General. The documents listed below are not necessarily all of the documents referenced herein, but are those needed to understand the information provided by this Appendix.

B.2.2 Government documents.

B.2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein.

FEDERAL SPECIFICATIONS

PPP-C-795 - Cushioning Material, Packaging (Flexible Closed Cell Plastic Film, for Long Distribution Cycles)

COMMERCIAL ITEM DESCRIPTIONS

A-A-3129 - Cushioning Material, Flexible Open Cell Plastic Film
(for Packaging Applications)

A-A-59736 - Boxes, Shipping, Reusable With Cushioning

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DEPARTMENT OF DEFENSE SPECIFICATIONS

- MIL-PRF-81705 - Barrier Materials, Flexible, Electrostatic Protective,
Heat-Sealable
- MIL-DTL-81997 - Pouches, Cushioned, Flexible, Electrostatic-Protective
Transparent
- MIL-PRF-87893 - Workstation, Electrostatic Discharge (ESD) Control

(Copies of these documents are available online at <http://assist.daps.dla.mil> or
<http://assist.daps.dla.mil/quicksearch/> or from the Standardization Document Order Desk,
Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

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TABLE B-I. ESD protective materials.

Description: MIL-PRF-81705, type I (opaque foil)

<u>NSN</u>	<u>SIZE</u>
8135-00-092-3220	3 ft x 600 ft
8135-01-185-6816	3 ft x 150 ft

Description: MIL-PRF-81705, type II (transparent plastic)

<u>NSN</u>	<u>SIZE</u>
8135-01-158-7786	48 in x 48 in
8135-01-163-3486	24 in x 36 in

Description: A-A-3129, type I, style B, class 1, grade B (open-celled without top laminate)

<u>NSN</u>	<u>SIZE</u>
8135-01-057-3607	1/4 in x 48 in x 500 ft
8135-01-088-3845	1/8 in x 48 in x 625 ft
8135-01-088-3846	1/8 in x 24 in x 625 ft
8135-01-088-3848	1/8 in x 6 in x 625 ft

Description: A-A-3129, type I, style B, class 2, grade B (open-celled with a top laminate)

<u>NSN</u>	<u>SIZE</u>
8135-01-087-3602	1 / 4 in x 24 in x 375 ft
8135-01-087-3603	1 / 4 in x 12 in x 375 ft
8135-01-088-3850	1 / 4 in x 48 in x 375 ft

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TABLE B-I. ESD protective materials – Continued.

<u>Description:</u> MIL-DTL-81997, type I (pouch with open-celled material, surrounded by transparent barrier material, plastic, zipper closure)	
<u>NSN</u>	<u>SIZE</u>
8105-01-197-2965	12 in x 12 in
<u>NSN</u>	<u>SIZE</u>
8105-01-197-2966	10 in x 10 in
8105-01-097-7846	10 in x 12 in
8105-01-215-0462	8 in x 8 in
8105-01-216-7804	8 in x 12 in
8105-01-356-6362	3 in x 5 in
8105-01-360-6563	6 in x 6 in
<u>Description:</u> Plastic, single wall bags (fabricated from material referenced to MIL-PRF-81705, type II, closure by heat sealing)	
<u>NSN</u>	<u>SIZE</u>
8105-01-096-9527	5 in x 8 in
8105-01-096-9528	12 in x 18 in
8105-01-097-4507	8 in x 12 in
8105-01-119-8109	18 in x 18 in
8105-01-119-8110	10 in x 24 in
8105-01-120-3370	15 in x 18 in
8105-01-120-3371	14 in x 18 in
8105-01-120-3772	12 in x 16 in
8105-01-120-3373	11 in x 15 in
8105-01-120-3374	10 in x 14 in
8105-01-120-3375	10 in x 12 in
8105-01-120-3376	8 in x 10 in
8105-01-120-3377	8 in x 8 in
8105-01-120-3378	6 in x 10 in
8105-01-120-3379	5 in x 10 in

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TABLE B-I. ESD protective materials – Continued.

<u>Description:</u> Plastic, single wall bags (continued)	
8105-01-120-3380	4 in x 6 in
8105-01-120-3381	4 in x 4 in
8105-01-120-3382	3 in x 5 in
<u>Description:</u> Plastic, single wall bags with zipper closure (fabricated from material referenced to MIL-PRF-81705, type II)	
<u>NSN</u>	<u>SIZE</u>
8105-01-162-2174	6 in x 10 in
8105-01-180-7919	10 in x 12 in
8105-01-181-5534	8 in x 10 in
8105-01-185-2632	24 in x 36 in
8105-01-185-9680	10 in x 16 in
8105-01-217-3773	6 in x 8 in
<u>Description:</u> PPP-C-795, Class 2 (antistatic aircap (bubble), pink tinted)	
<u>NSN</u>	<u>SIZE</u>
8135-01-126-6275	1/8 in x 12 in x 375 ft
8135-01-234-6649	3/16 in x 24 in x 500 ft
8135-01-235-8057	1/2 in x 48 in x 250 ft
<u>Description:</u> MIL-PRF-81705, Opaque, type I, bags	
<u>NSN</u>	<u>SIZE</u>
8105-01-236-0149	8 in x 12 in
8105-01-236-0150	10 in x 14 in
8105-01-236-5944	4 in x 6 in
8105-01-243-6628	20 in x 14 in
8105-01-243-6629	15 in x 25 in

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TABLE B-I. ESD protective materials – Continued.

<u>Description:</u> Fast Pack (PPP-B-1672, type II, style D, exterior dimensions)	
<u>NSN</u>	<u>SIZE</u>
8115-00-101-7638	9 in x 6 in x 3 1/2 in
8115-00-101-7647	9 in x 6 in x 2 1/2 in
8115-00-787-2142	6 in x 5 in x 2 1/2 in
8115-00-787-2146	12 in x 8 in x 2 1/2 in
8115-00-787-2147	6 in x 5 in x 3 1/2 in
8115-00-787-2148	12 in x 8 in x 3 1/2 in
8115-01-019-4084	18 in x 12 in x 3 1/2 in
8115-01-019-4085	18 in x 12 in x 2 1/2 in
8115-01-057-1243	13 in x 13 in x 3 1/2 in
8115-01-057-1244	10 in x 10 in x 3 1/2 in
8115-01-057-1245	16 in x 16 in x 3 1/2 in
8115-01-093-3730	24 in x 16 in x 3 1/2 in
8115-01-449-0898	6 in x 9 in x 4 1/2 in
PPP-B-1672, type II, style D, fast packs are used for ESDS items and have the word “antistatic” printed on both ends.	

NOTES:

1. Acquisition personnel use QPLs to find suppliers for materials that meet performance criteria specified in the specification. Each military or federal specification, referenced in this appendix, should be checked to see if the document has a QPL.
2. To determine if these referenced ESD protective material specifications have additional NSNs, go to the FEDLOG, the Army Interactive Query (Tank icon highlighted). In the data field where an item’s “Part Number” can be entered, type in the relevant military specification, for example, MIL-PRF-87893 (with or without the dashes). If the specification had another document number that was changed during the DoD Standardization Program upheaval in the 1990s, try entering the old military specification document number in the “Part Number” field (for example, MIL-PRF-87893 was known as MIL-W-87893). Type in the old document number.

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TABLE B-I. ESD protective materials – Continued.

After entering either document number, go to the bottom of the left of the new screen, click mouse on the “Tag All” icon, and then go to the tool bar menu line, that is, icon line at the top of the screen with picture of a printer on the extreme left side. Then, go over to the blue right pointing arrowhead. Click on the right pointing arrowhead. A new screen appears providing the first listed NSNs AMDF data. Once this data is reviewed for pertinent information, then look at Characteristics and Reference Number Data Response Files data for each NSN to find out which, if any, military specification the item’s performance characteristics meet; for example, the type, grade, class, style, etc. Once an NSN’s data has been reviewed, go to the bottom of the screen, click on “Next NSN” bar to look at another NSN’s data, if another exists.

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TRAINING

C.1 SCOPE

C.1.1 Scope. This appendix provides information on how to obtain training for the correct procedures and practices to receive, handle, pack, mark, store, and ship ESD sensitive items.

C.2 APPLICABLE DOCUMENTS

C.2.1 General. The documents listed below are not necessarily all of the documents referenced herein, but are those needed to understand the information provided by this Appendix.

C.2.2 Government documents.

C.2.2.1 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein.

DA PAM 350-59 - Army Correspondence Course Catalog

(Copies of DA PAMs are available online at <http://www.atsc.army.mil/accp/catalog.asp> or from the Army Institute for Professional Development (AIPD), U.S. Army Training Support Center (ATSC), Newport News, VA 23628-0001, DSN 826-2169/3335, Commercial (757) 878-2169/3335.)

C.3 ESD COURSES

C.3.1 Sources. Training courses and information for ESD educational programs are available through the following sources:

a. The School of Military Packaging Technology (SMPT) correspondence course, titled, Packaging and Handling of Electrostatic Discharge Sensitive (ESD) Items (Course Number 908 F60). Course enrollment is through the U.S. Army Training Support Center (ATSC), Army Institute for Professional Development (AIPD). Course description and information can be found in DA PAM 350-59, Army Correspondence Course Program Catalog. The ATSC website is as follows: <http://www.atsc.army.mil/accp/catalog.asp>. Download DA PAM 350-59, scroll down to Chapter 2, Section XVII, page 41, dated 1 October 2002.

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b. The SMPT correspondence course titled, Defense Marking for Shipment and Storage (Course Number 908 F32). This course supplements ESDS item packaging procedures with DoD item marking requirements. Course enrollment is also through the ATSC, AIPD, or the following website: <http://www.atsc.army.mil/accp/aipdnew.asp>. The mailing address for ATSC is: Department of the Army, Army Institute for Professional Development, U.S. Army Training Support Center, Newport News, VA 23628-0001.

NOTE: Only questions or comments related to the technical content of the packaging correspondence courses should be discussed with technical experts at the SMPT. Contact SMPT by writing to the Dean, School of Military Packaging Technology, ATTN: ATSL-MPT, Building 360, 360 Lanyard Road, Aberdeen Proving Ground, MD 21005-5001. The school registrar's phone number to obtain points of contact is DSN 298-2008 or commercial (410) 278-2008).

c. The Electrostatic Discharge Association (ESDA) provides for a fee, ESD training and certification courses. Information on their ESD training program can be found at the website <http://www.esda.org> or their training office can be contacted at the following address and phone number: ESD Association, 7900 Turin Road, Building 3, Rome, NY 13440-2069, commercial (315) 339-6937.

C.4 TRAINING AIDS.

C.4.1 Training aids. Video and graphic training aids for local ESD instructional programs can be obtained through the following sources:

a. The Defense Automated Visual Information System/Defense Instructional Technology Information System (DAVIS/ITIS) website contains the searchable listings and descriptions of ESD Audiovisual (AV) productions and Interactive Multimedia Instruction (IMI) products used by the DoD. Following are ESD AV and IMI offerings.

- (1) AV: 602884 - Electrostatic Discharge ESD Control
606761 - Electrostatic Discharge (ESD)
803784 - ESD: The Invisible Threat

- (2) IMI: Electrostatic Discharge Principles and Prevention

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ESD AV and IMI products are available online at <http://dodimagery.afis.osd.mil>. Click on DAVIS/DITIS in the left column 4th link down, and proceed. You may also contact the Joint Audio Visual Information Services Distribution Activity (JVISDA) at OASD(PA)/AFIS-JVISDA, Building 3/Bay 3, 11 Hap Arnold Boulevard, Tobyhanna, PA 18466-5102, DSN 795-7827, commercial (570) 895-7827, or e-mail vibuddy@hq.afis.osd.mil.

b. The ESD Association has videos that are part of its ESD training and auditing program. Contact will need to be made with this association to ascertain their procedures for renting or purchasing ESD videos in their product catalog.

c. Commercial vendors who have ESD training videos, packaging materials, grounding products, static control mat products, monitors, meters, and test equipment are ITW Richmond Technology (<http://www.richmond-technology.com/html/contents.html>), DESCO (<http://www.desco.com>), and Static Specialists Company, Incorporated (<http://www.staticspecialists.com>). These vendors and many other ESD video and product suppliers can be found through the use of any internet search browser, for example, YAHOO, MSN.COM, GOOGLE. The wording to use in the internet search is in quotes: “electrostatic discharge.”

CONCLUDING MATERIAL

Custodians:

Army – SM
Navy – AS
Air Force – 11
DLA – DH

Preparing Activity:

Army – SM

(Project PACK-1118)

Review Activities:

Army – AR, AT, CR, CR3, GL3, MI
Navy – MC, OS, SA, SH, YD
Air Force – 70, 71, 84, 99

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <http://assist.daps.dla.mil>.