STATIC DECAY METER

Model 406D

Operating Manual

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IMPORTANT
SAFETY INSTRUCTIONS
(Equipment containing HV)

The equipment described in this Manual is designed and manufactured to operate within defined design limits. Any misuse may result in electric shock or fire. To prevent the equipment from being damaged, the following rules should be observed for installation, use and maintenance. Read the following safety instructions before operating the instrument. Retain these instructions in a safe place for future reference.

POWER

POWER CORD: Use only the power cord specified for this equipment and certified for the country of use. If the power (mains) plug is replaced, follow the wiring connections specified for the country of use. When installing or removing the power plug **hold the plug, not the cord.**

The power cord provided is equipped with a **3-prong grounded plug (a plug with a third grounding pin).** This is both a safety feature to avoid electrical shock and a requirement for correct equipment operation. If the outlet to be used does not accommodate the 3-prong plug, either change the outlet or use a grounding adapter.

FUSES: Replace fuses only with those having the required current rating, voltage and specified type such as normal blow, time delay, etc. **DO NOT** use makeshift fuses or short the fuse holder. This could cause a shock or fire hazard or severely damage the instrument.

POWER LINE VOLTAGE (MAINS): If the line (mains) voltage is changed or isolated by an autotransformer the common terminal **must** be connected to the ground (earth) terminal of the power source.

OPERATION

CAUTION

Equipment designed to simulate a high voltage electrostatic discharge such as the Series 900 ESD Simulators and the Model 4046 Static Decay Meter utilize voltages up to 30kV. The basic nature of an ESD event will result in electromagnetic radiation in addition to the high level, short duration current pulse. **Therefore, personnel with a heart pacemaker must not operate the instrument or be in the vicinity while it is being used.**

DO NOT OPERATE WITH COVERS OR PANELS REMOVED. **Voltages inside the equipment consist of line (mains) that can be anywhere from** 100-240VAC, 50/60Hz **and in some equipment, voltages as high a** 30kV**. In addition, equipment may contain capacitors up to** 0.035 µF charged to 30kV and capacitors up to 0.5 µF charged up 6kV. Capacitors can retain a charge even if the equipment is turned off.

DO NOT OPERATE WITH SUSPECTED EQUIPMENT FAILURES. If any odor or smoke becomes apparent turn off the equipment and unplug it immediately. Failure to do so may result in electrical shock, fire or permanent damage to the equipment. Contact the factory for further instructions.

DO NOT OPERATE IN WET/DAMP CONDITIONS: If water or other liquid penetrates the equipment, unplug the power cord and contact the factory for further instructions. Continuous use in this case may result in electrical shock, fire or permanent damage to the equipment.

DO NOT OPERATE IN HIGH HUMIDITY: Operating the equipment in high humidity conditions will cause deteriation in performance, system failure, or present a shock or fire hazard. Contact the factory for further instructions.

DO NOT OPERATE IN AREAS WITH HEAVY DUST: Operating the equipment in high dust conditions will cause deteriation in performance, system failure, or present a shock or fire hazard. Contact the factory for further instructions.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE: Operating the equipment in the presence of flammable gases or fumes **constitutes a definite safety hazard**. For equipment designed to operate in such environments the proper safety devices must be used such as dry air or inert gas purge, intrinsic safe barriers and/or explosion-proof enclosures.

DONOT USE IN ANY MANNER NOT SPECIFIED OR APPROVED BY THE MANUFACTURER: Unapproved use may result in damage to the equipment or present an electrical shock or fire hazard.

MAINTENANCE and SERVICE

CLEANING: **Keep surfaces clean and free from dust or other contaminants. Such contaminants can have an adverse affect on system performance or result in electrical shock or fire. To clean use a damp cloth. Let dry before use.** Do not use detergent, alcohol or antistatic cleaner as these products may have an adverse affect on system performance.

SERVICE: Do not attempt to repair or service the instrument yourself unless instructed by the factory to do so. **Opening or removing the covers may expose you to high voltages, charged capacitors, electric shock and other hazards. If service or repair is required, contact the factory.**

1.0 INTRODUCTION

Electrostatics is the oldest form of electrical phenomena known, but it is probably the least understood and the hardest to control. With the advent of synthetic materials in just about everything we wear or use, and the advancement of technology where even the slightest over stress will destroy or damage equipment, the effects of undesirable static charges are felt every day. The inherent non-conductivity of most synthetics, especially under dry conditions, causes the accumulation of static charge during processing and handling. This charge buildup, if present in an explosive atmosphere, could cause a spark discharge resulting in explosion. If the charge buildup is present near sensitive electronic components or equipment, it could cause product failure, or promote the accumulation of dust or dirt, which could prove detrimental during further processing. At the consumer level, a static charge buildup can be an annoyance, or at worst, can prevent a product from performing as intended.

There are several ways to determine the effectiveness of static protective material. One effective test method is the Static Decay test described in Mil Std 3010, Method 4046, "Antistatic Properties of Materials". This method measures of the ability of a material, when grounded, to dissipate a known charge that has been induced or applied onto the surface of a material. A copy of the Test Method can be found in Appendix A.

Two of the most common requirements are found in the National Fire Protection Association (NFPA) Code 99, "Standard For The Use Of Inhalation Anesthetics" (1973), paragraph 466 ("Antistatic Accessories and Testing") and Military Specifications Mil-PRF-81705D, "Barrier Materials, Flexible, Electrostatic Free, Heat Sealable". NFPA 99 is the test standard used for products used in the hospital operating room and for products used in hazardous environments (referenced in NFPA 77 "Static Electricity"). Mil-PRF-81705C is the primary specification used for static protective materials for use in the military. Fed-TM-191A, Method 5931 specifies the static decay test for static control fabrics. The Electronics Industry Association (EIA) Standard EIA 541 and the Electrostatic Discharge Association Standard ANSI/ESD S 541 also reference static decay for qualifying material for use as electronics packaging. In addition, other military standards reference Mil-PRF-81705D for qualifying specific material types.

The Model 406D Static Decay Meter is a completely integrated system for measuring the electrostatic characteristics of materials in accordance with Method 4046. The Model 406D is the latest version of the ETS 406 series of static decay measuring equipment that now incorporates both manual and automatic testing modes. This equipment is used as the test standard for qualifying material per Mil-PRF-81705D.

The Model 406D can be used as a laboratory instrument for analyzing the electrostatic characteristics of existing materials, the effectiveness of antistatic additives and sprays, and the development of new static-protective materials; or as a quality control instrument for monitoring the electrostatic characteristics of production per established specifications.

Many different electrode configurations are available which enable the user to test any reasonable size or shape material. Standard Magnetic Electrodes are for film and fabric samples, Clamp Electrodes are for sheet, foam and any type of sample up to one (1) inch thick, plus optional I.C. Tube Electrodes for non-destructive testing of I.C. shipping tubes, and Loose Fill Electrodes for testing loose fill chips. In addition, custom electrodes and test cages can be designed to meet any special customer requirement.

2.0 EQUIPMENT DESCRIPTION

2.1 General

The Model 406D Static Decay Meter shown in Figure 2.1-1 is designed to test the static dissipative characteristics of material by measuring the time required for a charged test sample to discharge to a known, predetermined cutoff level. Three (3) manually selected cutoff thresholds at 50%, 10% and 1% (referred in earlier specifications as 0%) of full charge are provided. Samples are charged by an adjustable 0 to ±5kV high voltage power supply.

Figure 2.1-1: Model 406D Static Decay Meter

Sample testing may be performed either manually or automatically. In the Manual Mode, the operator must manually calibrate the unit periodically by compensating for thermal drift, and by adjusting the full-scale sample charge point. Further, the operator manually steps the unit through the test sequence by operating the unit's mode select buttons. In the Automatic Mode, the operator selects the number of tests to be performed (up to 9) and the time between each test, sets the full scale sample charge point once, then initiates automatic testing.

During each test cycle in the Automatic Mode, thermal drift is measured by the unit's Auto-Zero subsystem and is automatically compensated for. The system monitors the sample charge and, when the proper level is reached, automatically starts the discharge and decay time measurement cycle. When the cutoff point is reached, the unit steps to the Test Over state and displays the decay time measurement on a four digit LED numeric readout. The test result is displayed until the interval time (approximately 1-25 seconds) selected by the operator has lapsed, then, the unit automatically starts another test sequence including Auto-Zero. Upon reaching the number of pre-selected test cycles, the unit completes the last test, goes to **TEST OVER** and continuously displays the last decay time measurement and the number of tests performed.

Front panel indicator lights indicate the cutoff threshold selected, operating state and on/off status of the high voltage. The sample is contained in a special Faraday Cage, which includes a patented Electrostatic Sensor (ETS Patent No. 3824454) that enables the system to make a true electrostatic (non-contact) measurement of the charge on the sample. A fail-safe interlock system is employed which automatically discharges the test sample and/or prevents charging of the test sample when the Faraday Cage hood is raised. The safety interlock system also prevents the sample from being charged if the cage is not properly connected to the Control Unit. The unit may be switched to operate from either 100, 110, 220 or 240 VAC, 50-60 Hz.

2.2 Controls

All controls for operation of the Static Decay Meter are located on the front panel of the unit. Four types of controls are used: two position (latching) push button switches, momentary push button switches, rotary controls and a ten (10) position rotary switch. The state of the **POWER ON/OFF** switch and **MAN/AUTO** switch are indicated by panel markings above and/or below each switch. The state in the DOWN position (button latched in) is marked BELOW each switch. When the **POWER ON/OFF** button is UP, the power is OFF. When the **MAN/AUTO** button is UP, the unit is in the **MANUAL** mode.

2.2.1 Main AC POWER ON/OFF

This self-latching (push-on-push off) switch controls the AC power input to the unit. When placed in the down position, the AC power will be **ON** and the front panel indicators will be illuminated.

2.2.2 MAN/AUTO Mode Select

This self-latching switch, when in the **AUTO** (down) position puts the unit in the **AUTO** mode. In this mode, the **AUTO** mode numeric indicator will be illuminated.

2.2.3 Adjustment Controls

2.2.3.1 **ZERO**

This control is functional in the **MANUAL** mode only. It is used to set the **SAMPLE CHARGE** meter reading to zero when the system is in the **ZERO/STANDBY** mode. Since the accuracy of the decay time measurement is highly dependent on the initial setting of the zero point, it should be set as accurately as possible and re-checked prior to each test run.

2.2.3.2 **FULL SCALE**

This control is used to adjust the **SAMPLE CHARGE** meter to full scale (a reading of ±5kV) when the system is in the **MANUAL** mode and the operate state has been set to **CHARGE**.

2.2.4 Operate Controls

The unit has four operating states related to sample decay time measurement. Three of the four states, **ZERO/STANDBY**, **CHARGE** and **TEST** are operator controlled while the fourth state, **TEST OVER** is automatically programmed by the unit at the end of each decay time test.

2.2.4.1 **ZERO/STBY**

This momentary push button switch, when activated, places the unit in the **ZERO/STANDBY** state. In this state, the High Voltage Power Supply is turned **ON**, the electrostatic sensor shutter in the Faraday Cage is closed, and the sensitivity of the **SAMPLE CHARGE** meter is increased to allow the meter to be accurately set to zero in the **MANUAL** mode. Further, when depressed, the **ZERO/STBY** button causes the **DECAY TIME** and **AUTO** mode indicators to reset to zero.

In the **AUTO MODE**, depressing the **ZERO/STBY** button will stop the automatic test sequence and reset the **DECAY TIME** and **AUTO** mode counters to zero.

2.2.4.1 **CHG**

This momentary push button switch, when activated, places the unit in the **CHARGE** state. In this state, the High Voltage Power Supply is **ON**, and the shutter in the sensor head of the Electrostatic Voltmeter is open, allowing the **SAMPLE CHARGE** meter to read the charge on the sample.

In the **Manual** mode, the unit will remain in the **CHARGE** state until the operator starts the test by pushing the **TEST** button. In the **AUTO** mode, if the **SAMPLE CHARGE** meter has been previously adjusted to read 5kV (as required for automatic operation), the unit will step to the **CHARGE** state when the **CHG** button is depressed and then will automatically step to the **TEST** state when the sample voltage reaches 95% of full charge. In this mode, the automatic test sequence will be repeated automatically with the unit stepping from **CHARGE** to **TEST** to **TEST OVER** and then back to **CHARGE** for the number of test cycles selected by the **AUTO MODE TESTS** switch.

2.2.4.3 **TEST**

This momentary push button switch, when depressed, steps the system from the **CHARGE** state to the **TEST** state. Here, the shutter in the sensor of the Electrostatic Voltmeter is open, the High Voltage Power Supply is turned off, the discharge relay is closed, causing the charge on the sample to start to decrease, and the **DECAY TIME** counter is activated allowing the sample decay time to be measured. In the **AUTO MODE**, the **TEST** button is not used since the unit will automatically step to the **TEST** state after the **CHARGE** button is depressed.

2.2.5 High Voltage Control

2.2.5.1.High Voltage **ADJUST**

This control is used to set the Charging Voltage level. It is continuously variable and enables the charging voltage to be set to any level from 0 to ±5 kV. When in either **ZERO/STBY** or **CHG**, the high voltage level set by the **ADJUST** control is indicated by the reading on the **CHARGING VOLTAGE** meter.

2.2.5.2 High Voltage Polarity (**+** or **-**) and **ON/OFF** select controls

This group of three interlocked, self-latching push buttons turns the High Voltage Power Supply **ON** or **OFF** and determines the polarity. The polarity buttons are dual function since they select the polarity of the charging voltage and turn the High Voltage Power Supply on. The HVPS is turned off by depressing the center **OFF** button. Since these three buttons are interlocked, depressing any one button will release the one that was previously depressed. Further, only one button should be depressed at a time.

2.2.6 CUTOFF Threshold Selection

2.2.6.1 Discharge **CUTOFF** select buttons

This group of three interlocked, self-latching buttons selects the decay time measurement **CUTOFF** threshold. Three cutoff thresholds are provided: 50% (Half Life), 10% (per NFPA 99), and 1% (per Mil-PRF-81705D, and EIA and ESD 541). These buttons are interlocked; hence, depressing any one button will release the one that had been previously depressed. Only one button should be depressed at a time. If more than one button is depressed, an error will result in the decay time measurement due to the programming of a non-standard cutoff threshold. For those applications where testing to CECC 00015 Section 8.2 is required, the 50% cutoff is replaced by a 5% cutoff threshold and the full scale **SAMPLE CHARGE** meter reading is changed to 1 kV.

2.2.7 AUTO MODE

These controls provide for programming the unit in the **AUTO** mode and are functional only when the **AUTO/MAN** button is in the **AUTO** (down) position.

2.2.7.1. **TESTS**

This 10-position rotary switch selects the number of tests to be conducted. It should be set when the system is in the **ZERO/STBY** state prior to the start of the automatic test sequence. If the switch is set to zero, the unit will not go into the **TEST** mode when the **CHG** button is depressed, but will remain in either **TEST OVER** or **ZERO/STBY**.

2.2.7.2. **INTERVAL**

This continuously variable control is used to select the time interval between the completion of one test and the start of the next (time sample is grounded). The interval time may be set to any value from about 1 second, when the control is in the **MIN** position, to about 25 seconds, when the control is in the **MAX** position. When the pointer on the **INTERVAL** knob is set to **5**, the interval will be about 5 seconds, a convenient interval time for most testing. During the interval time, the **DECAY TIME** display will hold and display the decay time of the last test and the **AUTO** mode counter will display the number of the test run just completed.

2.3 Displays and Meters

Three types of indicators are used in the unit. Analog meters indicate voltage and charge levels, multicolored point source LED indicators display test status, cutoff threshold and high voltage presence information, and a LED numeric readout displays the decay time and the **AUTO** mode test sequence number.

2.3.1 Meters

2.3.1.1 **SAMPLE CHARGE** Meter

This analog meter is part of the Electrostatic Voltmeter sub-system in the Static Decay Meter. It indicates the true relative charge level on the test sample. The zero (center scale) position is used in the **MAN** mode to calibrate the system for offsets and thermal drift that can occur. The ±5kV points on the **SAMPLE CHARGE** meter scale are used to calibrate the system to the full charge level on the test sample. The meter also provides the operator with information about the presence or absence of initial static charges on the test sample.

2.3.1.2.**CHARGING VOLTAG**E Meter

This analog meter provides an indication of the high voltage output level of the charging Voltage Power Supply. It is used in conjunction with the High Voltage **ADJUST** control to set the **CHARGING VOLTAGE** output level. It is calibrated to read directly in kV.

2.3.2 Indicators

2.3.2.1.**CUTOFF %**

This group of three LED indicators provides the operator with a display of the **CUTOFF** threshold that has been selected. The indication will agree with the **CUTOFF** button that is depressed.

2.3.2.2.**OPERATE**

This group of 4 indicators provides the operator with information about the sequence state the unit is in. They operate in both the **MAN** and **AUTO** modes.

In the **MAN** mode the **ZERO/STBY**, **CHG** and **TEST** indicators will display the **TEST** state selected by the operator via the **OPERATE** buttons. The **TEST OVER** indicator will be illuminated automatically when a test has been completed and the **CUTOFF** threshold reached.

In the **AUTO** mode, only the **ZERO/STBY** and **CHG** indicators are controlled by the operator depressing the corresponding **OPERATE** buttons. The **TEST** and **TEST OVER** indicators will be automatically illuminated at the appropriate time during the **AUTO** mode test sequence.

2.3.2.3.**HV ON**

This indicator will be illuminated when the High Voltage Power Supply is ON and its output is in excess of about 150 Volts. It is intended to provide the operator with information regarding the presence or absence of high voltage within the unit.

2.3.3 Numeric Readouts

2.3.3.1.**DECAY TIME** Readouts

This 4-digit LED display indicates the **DECAY TIME** test result when the unit is in the **TEST OVER** state. It is reset to zero when either the **ZERO/STBY** or **CHG** button is depressed. It will also be reset to zero when the **MAN/AUTO** button is activated or when the power is initially turned on. The readout can display a maximum **DECAY TIME** of 99.99 seconds with a resolution of .01 second.

2.3.3.2.**AUTO** Mode Indicator

This single digit LED display indicates the number of test cycles (1-9) that have been completed and is only illuminated in the **AUTO** mode. It is advanced by one count each time the unit goes into the **TEST** state automatically. When the **AUTO** mode indicator displays the same number as set on the **TESTS** selector, the unit will have completed the test run and will then go to, and stay in, the **TEST OVER** state. It is reset to zero when either the **ZERO/STBY** or **CHG** button is depressed. It is also set to zero when the **AUTO** button is depressed or the power is initially turned on.

2.4 Rear Panel

The rear panel of the Model 406D is shown in Figure 2.4-1 and contains all the input and output connections for the system. **Starting with Serial #877 a universal switching power supplies that operates from 90-260VAC, 50/60Hz is used. It is not necessary to change the voltage settings or fuse in the Power module. These units incorporate resettable fuses. To reset turn off unit for at least 20 seconds, then turn back on. If the system still does not operate contact ETS at 215-887-2196 for service.**

Figure 2.4-1: Rear Panel (Ser# 877 forward)

2.4.1 Voltage Select Module (<u>NOTE:</u> For Serial# 876 and all prior units)

All instruments with Serial #876 or below were equipped with a **LINE VOLTAGE SELECT** module that enables the user to select the correct line voltage. These voltages are 100, 120, 220 and 240 VAC, 50/60Hz.

The line voltage is normally preset at the factory. When set to 220-240VAC a **"220 VOLT"** label is prominently displayed on the unit. However, if the Model 406D line voltage (Mains) must be changed by the user, follow the procedure below:

The line cord supplied utilizes the standard IEC international appliance connector that enables the user to locally obtain a cord set with the correct power line plug. Before plugging the unit in, check to see that the correct line voltage has been set.

Before attempting to change voltage settings, disconnect the power cord. For 100 and 120 Volt operation a 3/4 Amp, 250 VAC, 3AG Slo Blo fuse is used. Remove the cover of the **POWER/FUSE** unit using a small blade screwdriver or similar tool. Remove the VOLTAGE SELECTOR CARD and move the INDICATOR pin so that it lines up with the desired voltage designation on the cover. To change the fuse(s), loosen the Phillips head screw 2 turns, remove the fuse block by sliding up, then away from the Phillips screw. Change fuses. (**Note**: for some European installations, 2 fuses may be required; otherwise, a dummy fuse is used in the Neutral [lower] holder.) Insert the FUSE BLOCK and slide back onto the Phillips screw and pedestal. Tighten the Phillips screw and replace the cover. Reinstall the COVER assembly into the Housing. For 220/240 Volt operation, a 3/4 Amp, 250 VAC, 3AG Slo Blo fuse is also used.

2.4.2 Recorder Output

The **RECORDER OUTPUT** enables the instrument to be connected to a high-speed chart recorder (preferred recording device) or an oscilloscope using a standard BNC cable to display the decay time curve. This output is the same signal that drives the **SAMPLE CHARGE** meter. **NOTE**: The double pulse generated when the **TEST** state is activated will affect the scope trigger. A storage oscilloscope must be used in the single shot mode and the time base adjusted so the actual discharge waveform will be displayed which begins with the second pulse. The first pulse is the sensor self zero that is activated when the decay measurements begins. The output level is an inverted ±10 Volt analog signal corresponding to the **SAMPLE CHARGE** meter reading. A –10V signal corresponds to a +5kV reading on the **SAMPLE CHARGE** meter and conversely a +10V signal corresponds to a –5kV reading.

2.5 Faraday Test Cage

The Faraday Test Cage is designed to hold the test sample and shield it from any outside electrostatic interference. The standard magnetic electrodes are designed to hold film or fabric samples magnetically. While the Clamp Electrodes are used to hold sheet, foam, and samples up to one inch thick, optional I.C. Tube Electrodes for non-destructive testing of I.C. Shipping Tubes, Loose Fill Electrodes for testing loose fill chips, and Ring Electrodes for non-destructive testing of bottles, cups and canisters are available.

2.6 System Test Module

2.6.1 STM-2

The **STM-2** System Test Module performs in a manner similar to an actual test sample. It contains only resistors and utilizes the capacitance of the electrode assembly to determine decay time. It performs the same function as the previous **STM-1.** It can be used in all prior Model 406 Static Decay Meters.

The **STM-2** can be used to set the full scale of the **SAMPLE CHARGE** meter.

2.6.2 STM-1 (<u>NOTE:</u> Supplied with all 406 Models up to Serial #877)

The System Test Module (**STM-1**) supplied with each Model 406D Static Decay Meter prior to Serial # 877 enables the user to check its operation against a stable, repeatable standard. The **STM-1** uses electronic components (resistors and capacitors) to simulate a test sample with a known and repeatable decay time that is relatively independent of room temperature and moisture conditions. When using the **STM-1** the **FULL SCALE ADJUST** control must be set to the **STM-1** position to achieve a full scale reading on the **SAMPLE CHARGE** meter and then returned to the **NORM** setting to test samples.

3.0 OPERATION

3.1 Initial Set Up

1. Before connecting the Static Decay Meter to the AC line, the four cables from the Faraday Cage must be connected to the Control Unit as shown in Figure 3.1-1.

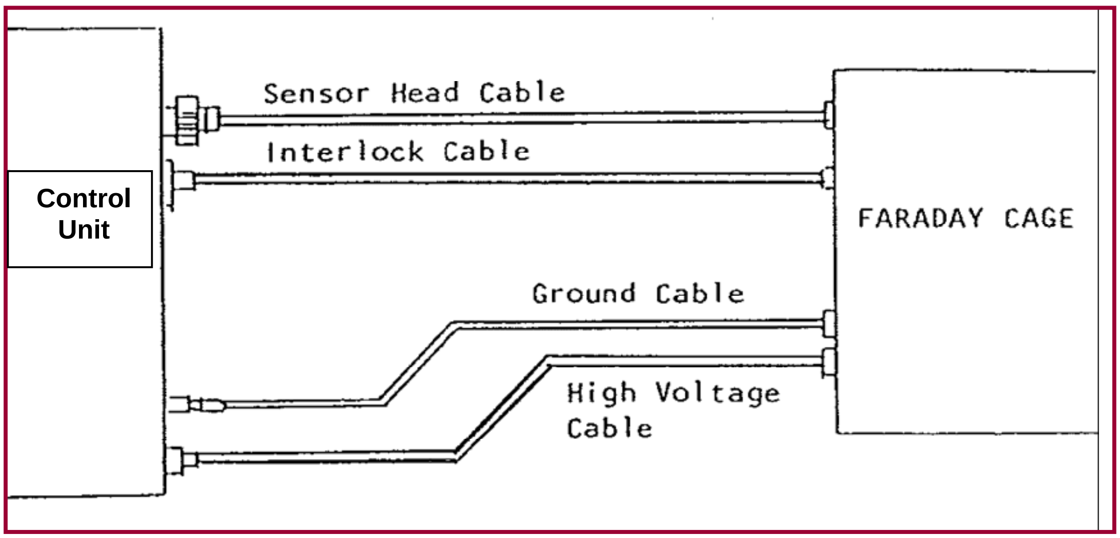


Figure 3.1-1: Faraday Cage – Control Unit Interconnect

2. Recheck all cable connections to make sure that they are tight. Set the following controls to the positions indicated:

POWER:	**OFF** (button up)
MAN/AUTO:	**MAN** (button up)
HIGH VOLTAGE:	**OFF** (center button down)
HIGH VOLTAGE ADJUST:	Fully counter clockwise

3. Connect the Control Unit to the AC line by plugging its AC cord into a properly grounded AC outlet (Mains).

4. Lift the hinged cover of the Faraday Cage and place the **STM** Module between the electrodes of the sample holder as shown in Figure 3.1-2. Return the cover to its operate position (cover down). [**Note:** If using an

STM-1**, insert the banana plug fully into the banana jack. The **STM-2** does not incorporate a plug.]

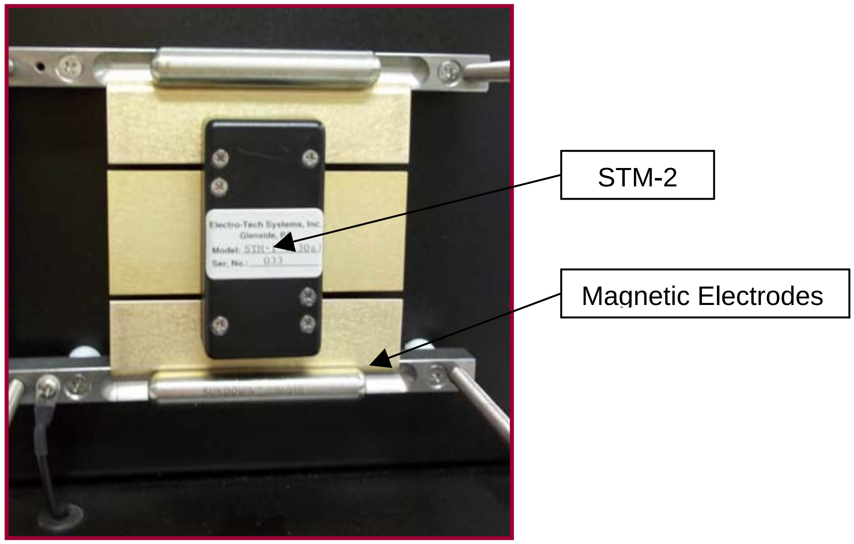


Figure 3.2-1: System Test Module in the Faraday Cage

NOTE: The unit employs a safety interlock system which will prevent high voltages from being impressed on the test sample unless the Faraday Cage cover is positioned in the operate (cover down) position. As an added precaution, it is highly recommended that the **HIGH VOLTAGE OFF** button be depressed (High Voltage will be turned off) whenever the Faraday Cage cover is lifted. Voltages in excess of ±5000 Volts are generated by the Control Unit and are transferred to the test sample area during normal operation of the system. Caution should always be exercised when working with high voltage. The recommended operating procedures should be adhered to all times. Further, no attempt should be made to modify the equipment or tamper with the interlock system in any way.

NOTE: **<u>For systems with Serial # 877 and higher disregard this section</u>.** Unless specifically requested the unit is set for 115 VAC operation. If operation from another line (Mains) voltage is required, the **VOLTAGE SELECT** switch on the rear of the control unit must be set to the appropriate voltage and the fuse changed to that indicated on the rear panel. Refer to Section 5.0 for conversion instructions.

3.2 MANUAL Mode

1. After the **STM** or the test sample has been secured and the Faraday Cage cover returned to it's operate position (cover down) check the control panel to insure that all controls have been set as indicated in paragraph 2 of Section 3.1. Turn Power on by depressing the **POWER** button. It should latch in the down position and the center display area should be illuminated. Allow the unit to warm up for approximately 15 minutes prior to testing.

2. Select the **CUTOFF** level desired by depressing the appropriate button. Refer to Table 3.1 for **CUTOFF** levels and test specifications.

Table 3.1
Cutoff Levels and Applicable Specifications

CUTOFF THRESHOLD	CUTOFF VOLTAGE*	APPLICABLE SPECIFICATION
50%	2500	Half Life
10%	500	NFPA Code 99
1%	50	Mil-PRF-81705C, EIA & ESDA 541

***** Nominal value. Actual cutoff is the percentage selected by the **CUTTOFF** selector. Ex: Accepted voltage is 4.5kV, cutoff is 450V.

3. With the unit in **ZERO/STBY**, set the **SAMPLE CHARGE** meter to zero by adjusting the **ZERO** calibrate control.

4. With the High Voltage **OFF**, depress the **CHG** button and check the reading of the **SAMPLE CHARGE** meter. It should still read precisely zero. If there is movement of the **SAMPLE CHARGE** meter needle (approx 250V), the test sample may have an initial charge. Refer to Section 4.0 for additional information on test samples with an initial charge. Select the desired polarity of the charging voltage by depressing either the **CHARGING VOLTAGE +** or **-** polarity button.

5. Rotate the High Voltage **ADJUST** control clockwise to set the charging voltage to the desired level. ±5kV is the most commonly used test voltage and the system has been calibrated for testing at this level. The charging voltage level will be indicated on the **CHARGING VOLTAGE** meter, and the **HI VOLTAGE ON** indicator will be illuminated. For those systems modified to meet CECC 00015 requirements, the 1kV test voltage will produce a full scale reading on the **SAMPLE CHARGE** meter.

   NOTE: There is an approximate 2 second delay after a polarity button has been depressed before the **CHARGING VOLTAGE** meter will read. This is normal. It allows the previously selected voltage to bleed down to zero before switching to the opposite polarity.

6. Calibrate the **SAMPLE CHARGE** meter to either **+** or **-** 5kV (full scale setting) using the **STM-2,** or if supplied with a **STM-1,** a piece of foil or a known sample with good dissipative characteristics having the same shape as the samples being tested. For example, bubble material. After this full-scale calibration the **FULL SCALE ADJUST** control **must not be changed** during the test run.

7. Depress the **TEST** button to start the Decay Time measurement. The electrostatic sensor shutter will close momentarily, then open to start the decay time measurement. The HVPS will automatically turn off as indicated by the **CHARGING VOLTAGE** meter reading dropping to zero and the **HIGH VOLTAGE ON** indicator turning off.

   NOTE: If the **TEST** button is not depressed within approximately 3 minutes after the **CHARGE** button is depressed, the unit will automatically switch back to the **ZERO/STBY** state. To resume the test sequence, if this occurs, depress **CHG.** This function also limits the Static Decay Meter ability to measure decay times longer than this time out.

8. When the **CUTOFF** threshold selected is reached, the unit will automatically switch to the **TEST OVER** state, the Sensor Head Shutter will close, and the Decay Time measurement, in seconds, will be displayed on the **DECAY TIME** readout. The unit will remain in the **TEST OVER** state until the **ZERO/STBY** or **CHG** button is depressed.

9. To repeat the test measurement, depress the **CHG** button and, when the **SAMPLE CHARGE** meter reads full scale, depress **TEST**. For the greatest accuracy,, it is recommended that the zero calibration point be checked between decay time measurements and the **ZERO** control adjusted if necessary. As noted earlier, calibration of the zero point is always done with the system in **ZERO/STANDBY**.

   NOTE: For additional information on sample testing, please refer to **Section 4.0 "Testing Hints and Other Tests".**

3.3 AUTO Mode

In this mode, the Model 406D Static Decay Meter will conduct up to 9 measurement cycles automatically, including automatic zero calibration. This mode cannot be used with samples that have an initial or a residual charge.

3.3.1 Initial Set Up

Follow the procedures outlined in Section 3.1.

3.3.2 Full Scale Calibration

With the unit in **MANUAL** and **ZERO/STANDBY**, zero the **SAMPLE CHARGE** meter by adjusting the **ZERO** control. Select the **CHARGING VOLTAGE** polarity by depressing either the **+** or **-** button.

Wait approximately 2 seconds, then set the **CHARGING VOLTAGE** meter to either **+** or **-** 5kV using the **HIGH VOLTAGE ADJUST** Control. Depress the **CHG** button and adjust the **FULL SCALE** calibrate control so that the **SAMPLE CHARGE** meter reads ±5kV. Unless this adjustment is properly made **before** the **AUTO** mode is selected, the Automatic Mode may not function properly. The **FULL SCALE ADJUST** knob should point approximately to the **NORM** position. For non-planar material, other settings will apply to achieve a full scale reading.

3.3.3 Sample Testing

After the unit has been calibrated, select the **AUTO** mode by depressing the **AUTO/MAN** button. The button will latch in the down position, the **SAMPLE CHARGE** meter will read zero, the unit will return to the **ZERO/STBY** state and the **AUTO** mode readout will be illuminated and display zero.

1. Select the Cutoff level by depressing the appropriate **CUTOFF** button.

2. Select the number of test cycles desired by setting the **AUTO** mode **TESTS** selector to the appropriate number (1-9). The selector should be set such that the number desired is opposite the pointer on the panel above the selector. Set the **AUTO** mode **INTERVAL** control so that its pointer faces the number 5 on the panel. This will ground the sample for a 5 second interval between test cycles. If more time is required, rotate the knob clockwise toward **MAX**. In a similar way, the interval time may be reduced by rotating this control counterclockwise toward **MIN**. The range of the interval time is from approximately 1-25 seconds.

3. Start the **AUTO** mode test cycle by depressing the **CHG** button momentarily. The unit will step to the **CHARGE** state, the electrostatic sensor shutter will open and the **SAMPLE CHARGE** meter will indicate the sample charge. When the sample charge reaches ±4.75kV (95% of full voltage), the unit will automatically step to the **TEST** state. For samples with a high conductivity (short time constant), the unit will step from **CHARGE** to **TEST** so rapidly that the analog **SAMPLE CHARGE** meter will lag the actual measurement cycle. This is normal.

   In the **TEST** state, the Decay Time readout will be counting and the **SAMPLE CHARGE** meter reading will be decreasing toward zero. The **CHARGING VOLTAGE** meter will read zero, the **HIGH VOLTAGE ON** light will turn off, and the **AUTO** mode readout will increase by one count.

   When the voltage on the test sample decays to the pre-selected cutoff level, the unit automatically steps to the **TEST OVER** state and the **DECAY TIME** readout will display the test sample decay time measurement in seconds. The unit will remain in the **TEST OVER** state until the interval time has lapsed. At the end of this time, the unit will step automatically back to the **CHARGE** state and the test sequence (**CHARGE, TEST, TEST OVER**) will be repeated. The **DECAY TIME** readout will automatically reset to zero each time the unit returns to **CHARGE**.

   Testing will continue until the **AUTO** mode readout reaches the same count as was set with the **AUTO** mode **TESTS** selector. When this occurs, the unit will complete the last test and will go to **TEST OVER** without stepping back to **CHARGE**. Nothing further will occur unless the **ZERO/STANDBY** or the **CHARGE** button is depressed. To repeat or reset the entire test run, momentarily depress the **CHARGE** button. This action will reset the **DECAY TIME** and **AUTO** mode readouts to zero and will re-start the test.

4. To terminate a test before the full number of tests is completed, depress the **ZERO/STBY** button. The **DECAY TIME** and **AUTO** mode

readouts will reset to zero and the unit will remain in **ZERO/STANDBY** until the **CHARGE** button is depressed.

5. When testing of a sample has been completed, the High Voltage Power Supply should be turned off by depressing the **HIGH VOLTAGE OFF** button. When this is done, the **CHARGING VOLTAGE** meter will indicate zero and the **HIGH VOLTAGE ON** light will turn off. The HVPS should be turned **OFF** whenever a sample is being installed in, or removed from, the Faraday Cage or when the unit is on but tests are not being conducted.

6. Faraday Cage Safety Interlock System - The Model 406D contains a Safety Interlock System which is designed to prevent the Control Unit from producing a high voltage output under certain conditions. The Interlock System operates automatically whenever the cover of the Faraday Cage is raised by preventing the Control Unit from producing a high voltage output at the **HIGH VOLTAGE** output connector. The Interlock System, when activated, does not turn off the High Voltage Power Supply in the Control Unit, thus, ±5kV may still be present within the Control Unit when the Faraday Cage cover is up. It causes the CHARGE relay to open and the GROUND relay to close.

   It should be emphasized again that the Interlock System is a safety feature and should not be used as a High Voltage **ON/OFF** switch. The **HIGH VOLTAGE OFF** button should be depressed whenever the Faraday Cage cover is lifted or when tests are not being conducted.

3.3.4 STM System Performance Check

To check the performance of the Model 406D Static Decay Meter, the **STM** System Test Module is mounted in the Faraday Cage in place of a normal test sample.

3.3.4.1 **STM-1 (Systems prior to Serial #878)**

For the **STM-1** the banana plug is inserted into the calibration jack on the base of the Faraday Cage as shown in Figure 3.2-1. It is important to insure that the banana plug is fully seated in the jack. The calibration check may be performed in either the **MANUAL** or the **AUTOMATIC** mode. Select the appropriate test mode and follow the test procedure outlined in Section 3.2 for the **MANUAL** mode or Section 3.3 for the **AUTOMATIC** mode. In either mode, the **CUTOFF** threshold should be set to 10% to obtain the proper calibrated mode decay time reading. When setting the **SAMPLE CHARGE** meter to full scale in the **CHARGE** state (5.0kV), <u>it will be necessary to turn the **FULL SCALE ADJUST CONTROL** to the **STM-1** position.</u> If a 5.0kV reading cannot be obtained, loosen the thumbscrew securing the electrostatic sensor in the test cage and either push it in slightly or rotate it so the viewing port is lined up in the 12:00 o'clock position until a full scale reading on the **SAMPLE CHARGE** meter is obtained. Retighten the screw. If the sensor viewing port is already in the 12:00 o'clock position, make sure **NOT** to rotate it since this will reduce the signal level. At the conclusion of the system test, return the **FULL SCALE ADJUST** control back to the **NORM** position. Calibrate the full scale using a 3x5" (80x127mm) foil stretched between the electrodes. If the sample is not flat, make sure it is static dissipative and adjust the **FULL SCALE ADJUST** for a full scale reading. If the sample is not static dissipative either wrap a specimen in foil or coat it with a topical antistat to obtain the proper reading. Once this calibration has been completed, **DO NOT TOUCH THE FULL SCALE ADJUST** control.

After the **SAMPLE CHARGE** meter has been set contact ETS for **ZERO** and **FULL SCALE**, the test procedure is followed as if a normal sample were being tested. If testing is in the **MAN** mode, depress the **TEST** button to obtain the calibrated **DECAY TIME** reading. If in the **AUTO** mode, momentarily depress the **CHG** button to start the test. In either case, the unit will go through the usual test sequence and will display a **DECAY TIME** reading that should be within ±0.05 seconds of the value indicated on the **STM** System Test Module. Typically, for the **STM-1** the decay time is between 0.20 and 0.30 seconds. The difference between **+** and **–** decay time readings should be no more than 0.02 seconds. If this is the case, refer contact ETS for assistance.

3.3.4.2 **STM-2 (Systems with Serial #878 or higher)**

The **STM-2** does not incorporate the banana plug. Install the **STM-2** directly into the electrodes in the Faraday Cage as shown in Figure 3.2-1. The verification may be performed in either the **MANUAL** or the **AUTOMATIC** mode. Select the appropriate test mode and follow the test procedure outlined in Section 3.2 for the **MANUAL** mode or Section 3.3 for the **AUTOMATIC** mode. In either mode, the **CUTOFF** threshold should be set to 10% to obtain the proper decay time reading. Set the **SAMPLE CHARGE** meter to full scale in the **CHARGE** state (5.0kV). The **FULL SCALE ADJUST** control should be in approximately the 12:00 o'clock position for a full scale reading on the **SAMPLE CHARGE**. At the conclusion of the system test the system is now ready to test a planer sample. If the sample is not flat, make sure it is static dissipative and adjust the **FULL SCALE ADJUST** for a full scale reading. If the sample is not static dissipative either wrap a specimen in foil or coat it with a topical antistat to obtain the proper reading. Once this adjustment has been made, **DO NOT TOUCH THE FULL SCALE ADJUST** control.

After the **SAMPLE CHARGE** meter has been set to **ZERO** and **FULL SCALE**, the test procedure is followed as if a normal sample were being tested. If testing is in the **MAN** mode, depress the **TEST** button to obtain the calibrated **DECAY TIME** reading. If in the **AUTO** mode, momentarily depress the **CHG** button to start the test. In either case, the unit will go through the usual test sequence and will display a **DECAY TIME** reading that should be within ±0.05 seconds of the value indicated on the **STM** System Test Module. If the **DECAY TIME** reading is not within this tolerance, the unit may be out of calibration, or may not be functioning properly. The difference between **+** and **–** decay time readings should be no more than 0.02 seconds. If this is the case, contact ETS for assistance.

For the **STM-2** the decay time is typically between 0.20 and 0.30 seconds when held in place with the magnetic electrodes. Using the clamp electrodes will result in a reading approximately 0.03 seconds lower. This is due to the electrode effect described in Section 4.5. If the **DECAY TIME** reading is not within this tolerance, the unit may be out of calibration, or may not be functioning properly.

3.4 Electrode Configurations

3.4.1 Magnetic Electrodes

Magnetic Electrodes are used to secure film and fabric samples plus the STM-1 to the base electrodes as shown in Figure 3.4-1.

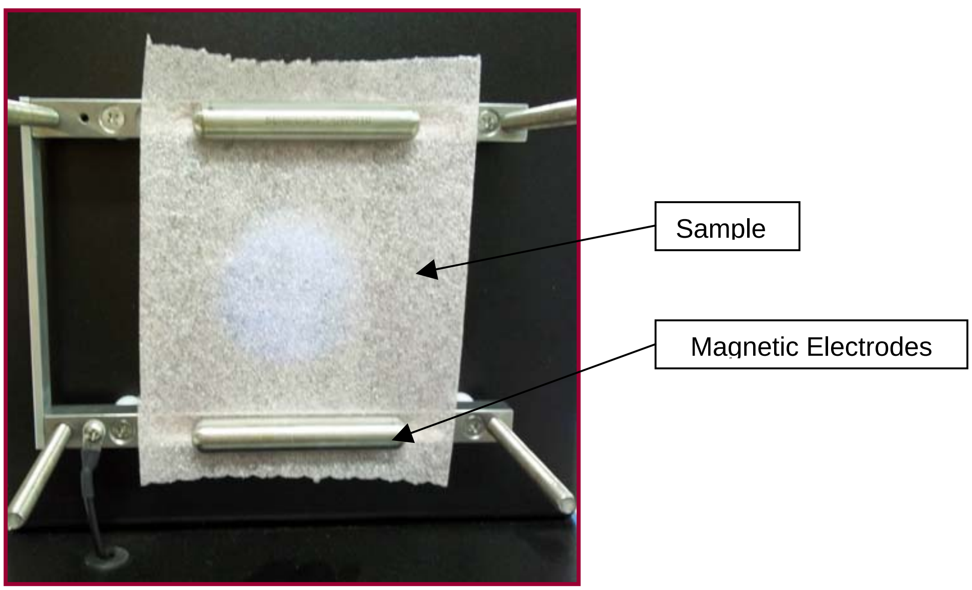


Figure 3.4-1: Magnetic Electrodes

3.4.2 Clamp Electrodes

The Clamp Electrodes shown in Figure 3.4-2 are used to secure samples that are up to one inch thick. Thicker samples can be tested using longer ¼-20 threaded rods.

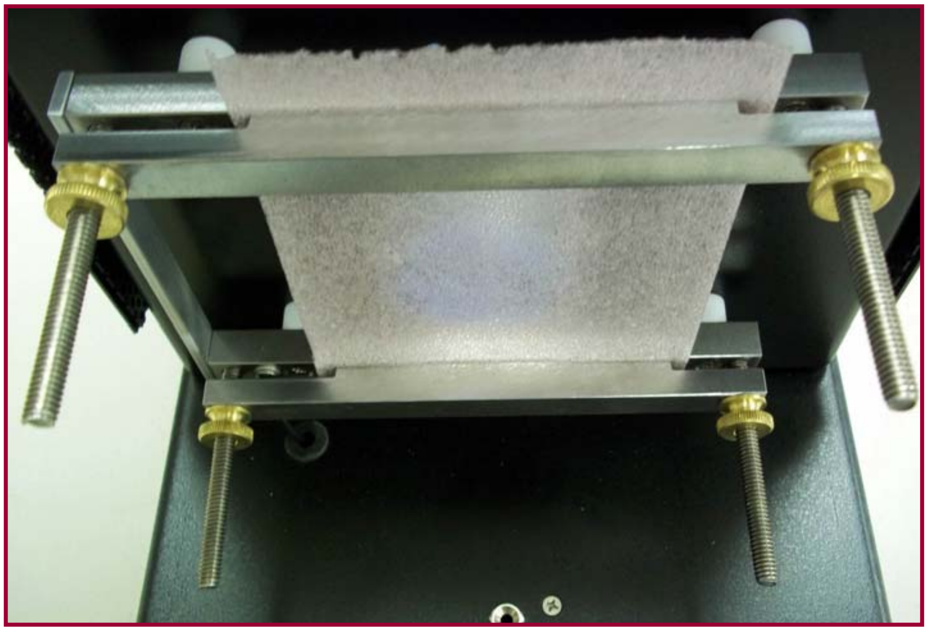


Figure 3.4-2: Clamp Electrodes

3.4.3 Loose Fill Electrodes

Loose Fill Electrodes are used to test loose fill packing chips. Six chips are needed for each test sample array. The chips must be placed over the electrode points and rest on the shoulder as shown in Figure 3.4-3. This is necessary in order to make contact with the outer surface of the chip so that surface treated material will be properly tested.

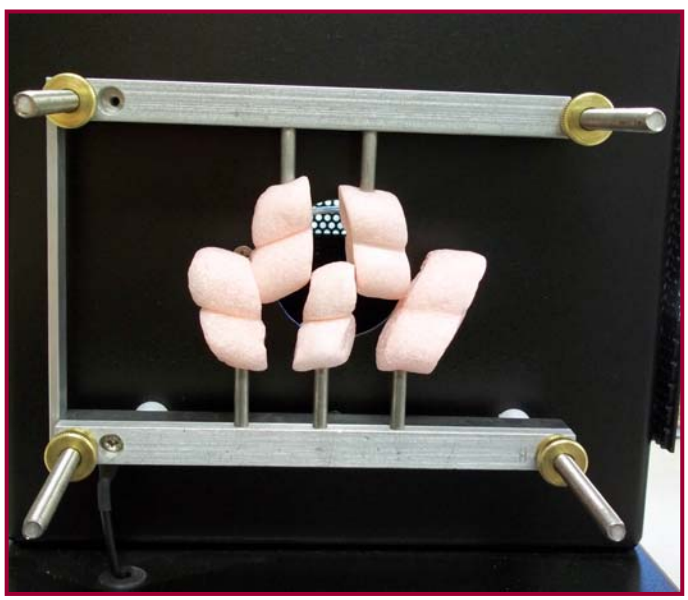


Figure 3.4-3: Loose Fill Electrodes

3.4.4 I.C. Electrodes

When using the I.C. Tube Electrodes, remove the outer clamp electrodes from the fixture. Adjust the tension on the outer I.C. Tube Electrode so that the size tube to be tested slides easily through the roller contacts. To test a tube, place it through the hole located on the side of the cage and slide it through as shown in Figure 3.4-4.

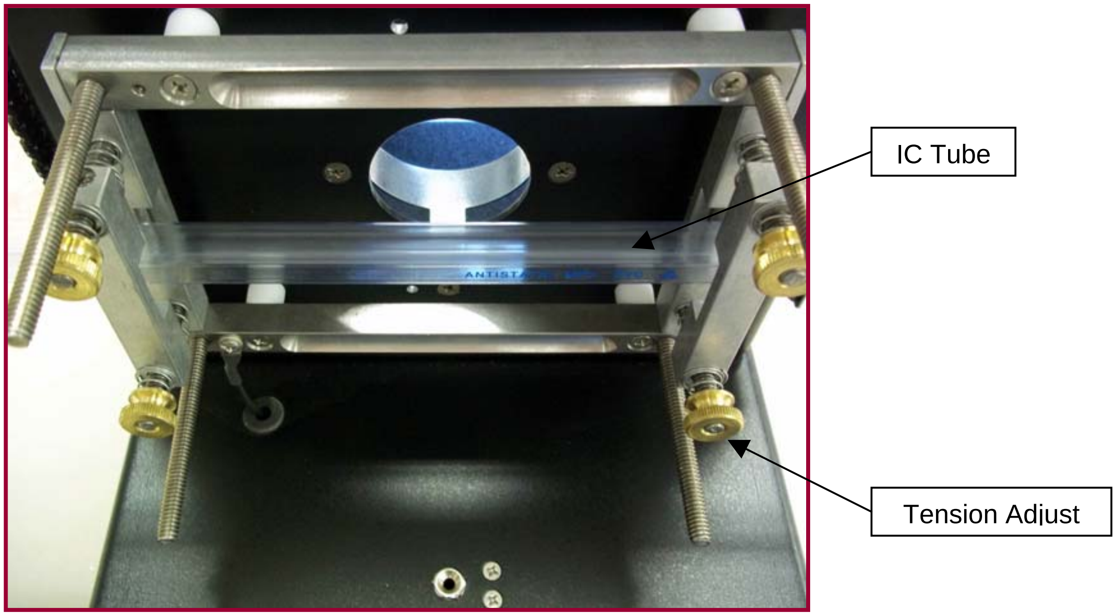


Figure 3.4-4: I.C. Shipping Tube Electrodes

3.4.5 Small Sample Electrodes

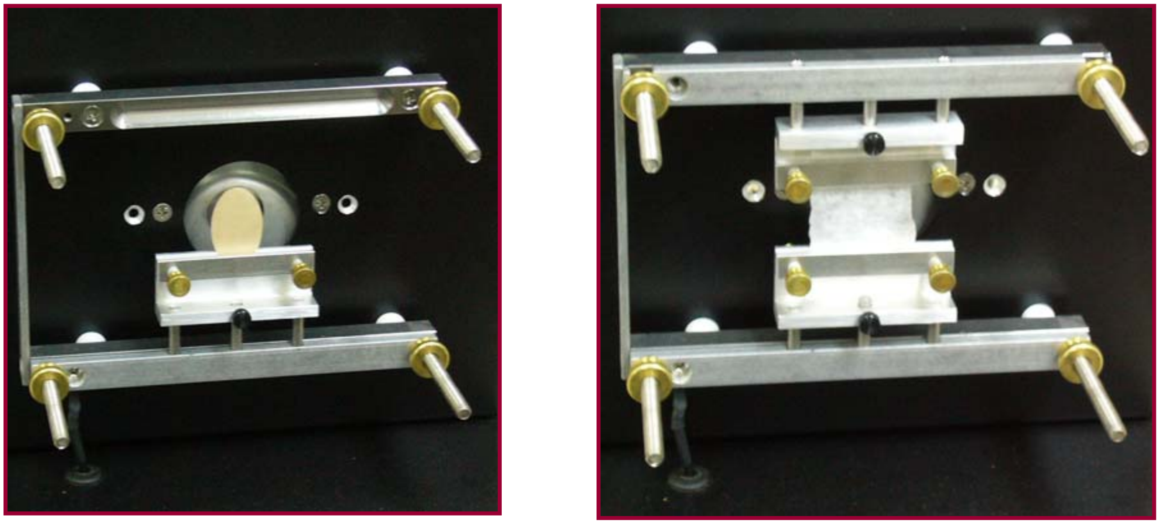
The standard ETS Model 406D Static Decay Meter is designed to test film, fabric and rigid samples having a nominal size of 3" x 5". However, the electrodes can accommodate a sample size down to 4.125" in length. The electrodes are electrically connected together. The dual electrode configuration is required to secure thin films and fabrics. For rigid samples, just the bottom electrode configuration can be used

However, to test undersize samples (<4.125”) a special electrode configuration is required to hold the sample and bring it within view of the sensor. To install, first remove the magnetic or clamp electrodes, if installed. Place the .25” (6mm) slots over the threaded rods and secure with the thumbscrews or wing nuts. If a small rigid sample is being tested then only the bottom electrode needs to be installed If film or fabric samples are to be tested then both upper and lower electrodes are required as shown in Figure 3.4-5a and b respectively. The sample holders each can be adjusted vertically up to 0.5” (12mm). This allows for minimum sample lengths from 2.5” to 3.5”.

These electrodes come with both aluminum and Delrin clamps in case it is desired to isolate the rear of the sample.

Adjust the Full Scale Adjust control as described in Section 5.2, para. 4 and then test in the standard manner. **NOTE:** The field effect using these electrodes will be greater than the nominal 1500V seen with the standard electrodes.

Contact the factory for other special configurations.



a. Rigid Sample b. Fabric Sample

Figure 3.4-5: Small Sample Electrode

3.4.6 Nondestructive Sample Testing

The Nondestructive Static Decay Test Fixture Model 806B shown in Figure 3.4-6 replaces the Faraday Cage. It enables the user to non-destructively test larger objects such as tote boxes, sheet material, work surfaces, molded parts, etc. It can even measure liquids and powders. The electrodes are configured in the same manner as the standard Faraday Cage except instead of clamping the sample to the electrodes the entire electrode assembly is placed onto the test surface. Conductive rubber is used for the point of contact to ensure good contact between the electrodes and the sample.

A high voltage safety switch (in lieu of the Interlock found on the Faraday Cage is provided to disable the high voltage between tests.)

NOTE:

Failure to turn off the high voltage after performing a test may result in a shock hazard. High voltage may remain on the electrodes.

Figure 3.4-6: Nondestructive Static Decay Test Fixture

3.4.6.1 **Installation**

The Model 806B connects directly to the Control Unit of the Model 406D in the same manner as the Faraday Cage. The sensor head is removed from the Faraday Cage by loosing the brass thumbscrew that retains the sensor in the clamp. The sensor is then plugged into the 3 banana plugs located on the top of the Fixture as shown in Figure 3.4-6. The sensor viewing port must be centered in the round opening on the bottom of the Fixture as shown in Figure 3.4-7.

Figure 3.4-7: Sensor alignment

Secure the Sensor cable with the black cable clamp.

Unplug all the cables going to the Control Unit from the Faraday Cage and plug the cables from the Model 806B into the corresponding connectors.

Place the Model 806B on a metal plate and adjust the **FULL SCALE** Adjust until the voltage on the **SAMPLE CHARGE** meter corresponds to the HIGH VOLTAGE being applied.

NOTE

The Model 806B cannot be used to test samples resting on a conductive surface. The sample MUST be placed on an insulated surface that is at least several inches (cm) away from any conductive surfaces. Conductive objects near the test set up will affect the electrostatic field and alter the sample static decay time characteristics.

3.4.6-2 **Sample Testing**

The Model 806B is capable of testing the static decay characteristics of planar material, powders and liquids. Static decay times are specified for a nominal 3x5" (76x127mm). Larger samples of the same material will exhibit longer decay times. This must be taken into account when testing finished product that may have a large area or multiple sides such as a box or bin.

To determine a Pass/Fail criteria first perform a standard static test of the material the product is made from. Then perform the nondestructive test on the product. The ratio of the two decay times will determine the Pass/Fail criteria for the nondestructive test.

To test liquids and powders place the product in a glass or other insulated container that is at least 8x6" (203x153mm) and approximately 1" (25mm) deep. Place the Fixture on the material and perform the test in the normal manner. The electrodes should not penetrate the material by more than approximately ¼" (6mm). The electrodes are stainless steel and the conductive rubber is nickel impregnated silicone rubber.

4.0 Testing Hints and Other Tests

4.1 General

The measurement of electrostatic charge is dependent on several factors, mainly sample characteristics, humidity, and to a much lesser extent, temperature. It is very common for a 10% change in one condition, such as humidity, to cause a significant change in decay rate. It is very important to try to duplicate a set of conditions exactly when attempting to compare measurements. Many times this is not possible, such as when an antistatic additive blossoms to the surface of a material over a period of time. The following are some hints and additional test procedures that will help to understand the many factors affecting electrostatic measurements.

4.2 Free Air Measurement

Measure the electrostatic field with 5kV applied to just the electrodes (no sample in place). This is the free air electrostatic field caused by the charge on the electrodes. It is approximately 1,500-1800 Volts with magnetic electrodes and 2000-2200 Volts with clamp electrodes. Other electrode configurations will result in different voltage levels.

If a sample is inserted the maximum charge measured when 5,000 volts is applied is the free air value. This indicates that the sample is a very good insulator and will not accept any conducted charge.

The charging voltage is applied to the ends of the sample. If the sample has very high insulating properties the electrons will not flow across the sample. However, since the electrons will not flow, the material may have developed a deficiency or an excess of electrons during manufacture or by handling. This condition results in the material having an initial charge associated with it that will not change by conductive charging or by grounding. When the material is rubbed or separated, voltages may be generated by triboelectric charging. The only way to remove this initial charge is to place it in front of an ionizer for several seconds. This will remove the initial charge, but it will not alter it's ability to conduct or dissipate charge.

4.3 Effects of Humidity

Chemically treated antistatic materials are dependent on the relative humidity for effectiveness. Both topically treated and internally mixed antistatic materials draw moisture from the atmosphere to produce an electrostatically conductive layer on the surface. Antistatic chemical concentrations may be such that at a modest relative humidity of 50% the sample will exhibit excellent characteristics with very fast decay times (less than 0.1 seconds), but may not exhibit any static dissipative properties at 12% R.H.

Carbon or metal fiber loaded materials are not humidity dependent, but if the loading is too light then the effects of the filler material will be dependent upon humidity.

4.4 Insulative Materials

An insulative material (one defined as having a surface resistivity greater than or equal to $1x10^{12}$ ohms/sq.) does not permit electrons to flow easily across the surface. However, electrons can be removed or added triboelectrically to produce a positive or negative charge on the material. When this occurs, the sample is said to have an initial charge. This initial charge is detected by the **SAMPLE CHARGE** meter as soon as the sample is placed in the test electrodes. If the entire sample is insulative, then when 5kV is applied the sample will not conduct a charge and when the sample is grounded (depress **TEST** button) the sample will not bleed off the charge. When the 5kV is applied, the **SAMPLE CHARGE** meter will read the algebraic sum of the initial sample charge and the free air value described in Section 4.2.

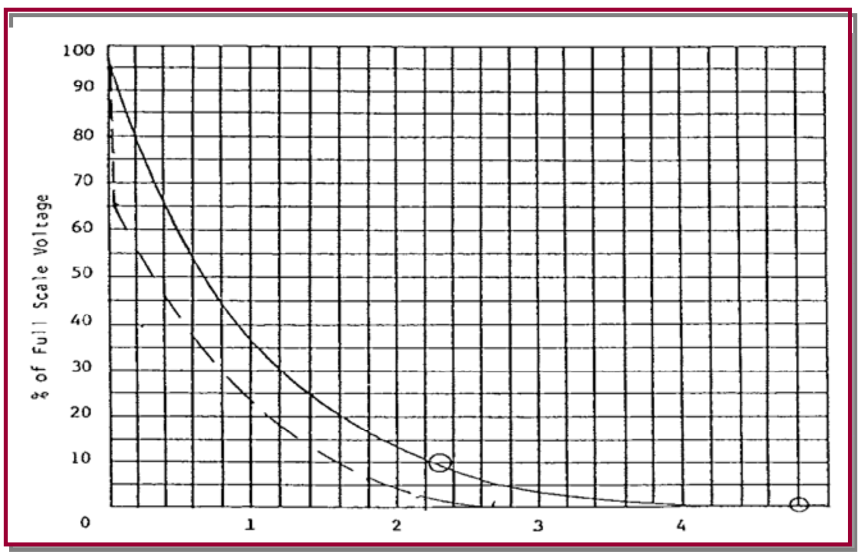
If only a portion of the sample is insulative, then the **SAMPLE CHARGE** meter will read an initial charge (not a calibrated value, however, because the "hot" spot occupies only a portion of the field that is in view of the Electrostatic Voltmeter sensor). When 5kV is applied, the **SAMPLE CHARGE** meter will read the algebraic sum of the initial charge and the applied 5kV. When the **TEST** button is depressed, the sample will bleed off the applied charge and decay down to the initial charge. This evaluation can only be done in the **MANUAL** mode.

Marginally static dissipative materials with very long decay times, and therefore, very long charging times, can be evaluated by measuring the amount of charge the sample accepts over a fixed period of time (e.g. 15 to 60 seconds, using an external timer or watch). The accepted charge in this case is the charge conducted across the sample after the 5kV has been applied (initial charge plus free air value) to the value after the 15-60 second time period. The more charge accepted within the established time period, the better the static dissipative characteristics of the material.

4.5 The Standard Exponential Decay Curve

The System Test Module, **STM-1** will follow the standard exponential decay curve, which is the solid line in Figure 4.5-1. The decay curve is a function of the **STM-1** capacitor plus the capacitance of the electrode configuration and the 400 megOhm resistance in the **STM-1**.

When testing a sample the charge on the sample bleeds through the electrodes to ground via the ground relay. The **STM-2** simulates an actual sample using a 30 gigOhm resistance and the system intrinsic capacitance. Since the electrode resistance is much lower than the sample or **STM-2** resistance, the decay time curve is actually a composite of at least two different exponential decays as shown by the dash line. The field on the electrodes collapses first then the charge on the sample begins to bleed off to ground as shown in the figure. The intrinsic capacitance of the Faraday Test Cage, electrodes and discharge circuit is 50pF. The discharge circuit incorporates a 10 MegOhm resistor that limits the fastest decay time to 1% to 1.25 milliseconds. The relay switching time is approximately 3 milliseconds. This time is approximately one order of magnitude faster than the 10 millisecond resolution of the readout. Samples with non-uniform antistatic treatment will have multiple exponential decay curves with the decay characteristics changing from the fastest decay time curve to the slowest decay time curve.



Time Constant - τ

Figure 4.5-1: Standard and Method 4046 Exponential Decay Curves

4.6 Measuring Laminated Film

The Model 406D is specifically designed to measure the static decay characteristics of homogeneous static dissipative material having a surface resistance between 10^8 and 10^{12} Ohms. Below 10^8 Ohms the decay time is less than the measurement capability of the instrument (minimum time is 2.3msec). This is due to the time required for the internal relays to switch. Above 10^{12} Ohms, the time to charge the material ranges from several seconds to not able to conduct the applied 5kV charge.

Laminated materials such as static shielding film may consist of two or more layers with one layer being conductive. This composite alters the way the static decay time is measured. **When testing this type of material the edges <u>must not touch the electrodes</u>. The samples must be cut oversize (6x6" [150x150mm]) plus the FULL SCALE adjust must be precisely set using a piece of aluminum foil stretched between the electrodes. This control <u>must not be changed during the measurement.</u>** The following are the different types of measurements observed when testing this material:

1. **Conductive layer facing sensor:** The conductive layer will become charged to the full 5kV and when grounded will decay almost instantly to 1% in <1 or 2 msec.

2. **Dissipative or insulative layer facing sensor:** If this layer is dissipative it will charge to the full 5kV and when grounded will have a measurable decay time, usually in the millisecond range. If this layer is insulative the applied charge will be induced onto the surface of the conductive layer and the **SAMPLE CHARGE** meter will indicate a accepted charge that is less than 5kV, typically, around 4.8kV. When grounded, the charge on the conductive layer collapses and the **SAMPLE CHARGE** meter drops instantly to some voltage slightly above the 1% cutoff level, typically, about 1-200V. In this case, the clock will continue to run. **Note:** The amount of accepted charge will decrease and the residual charge will increase as the insulated layer thickness increases.

3. **Triple laminate:** This material will perform in a similar manner as the dissipative or insulated side for the two-layer film described above.

5.0 SYSTEM ADJUSTMENTS

The Model 406D Static Decay Meter, like all precision electronic instruments, should be returned to the factory once a year for calibration. However, due to heavy use or having been moved to another location the instrument may require some minor adjustments in the interim. This section covers adjustment of **FULL SCALE**.

The **FULL SCALE** adjustment is performed externally by adjusting system gain or the distance between sensor and sample.

5.1 SAMPLE CHARGE Meter Zero Adjust

5.1.1 Zero (Mechanical Center Scale Adjustment)

1. Turn the power off and allow the **SC**m zero reading to stabilize for at least 30 seconds.

2. Using a small flat bladed screw driver, set the **SC**m to read precisely zero by adjusting the black mechanical center adjust screw located on the face of the meter at the pivot point of the needle. Make sure the unit is in a horizontal position while making this and the full-scale adjustment that follows.

5.2 Full Scale Adjustment

The Sensor Head has been set at the factory and should not have to be re-adjusted under normal circumstances. Should it be necessary to re-set the spacing of the sensor head, the following procedure should be followed:

1. Mount the **STM-1** or **STM-2** System Test Module in the Faraday Cage.

2. Select the **MAN** mode and adjust the charging voltage to +5.0 kV.

3. Adjust the **SAMPLE CHARGE** meter (**SC**m) for zero using the **ZERO** adjust knob.

4. If using the **STM-1** place the system in **CHARGE** then set the **FULL SCALE ADJUST** control to the **STM-1** position. If using the **STM-2** set the **FULL SCALE ADJUST** control to the **NORM** position. The **SC**m should read +5.0kV. If not, adjust the control slightly to obtain +5kV. If not, loosen the Sensor Head retaining clamp screw and move the sensor forward to increase the **SC**m reading and conversely, rearward to decrease the **SC**m reading. Make certain the sensing part in the Sensor Head is always in the 12 o'clock position and appears centered in the viewing hole in the Faraday Cage. Retighten the retaining clamp screw.

   When testing static dissipative or conductive composite or laminated films use a known good sample to adjust the full scale using the adjust control if the **STM-1** was used for the initial system check. If the **STM-2** was used, this step is not necessary.

   The full scale setting is critical for these types of material. If the charge is conducted onto the material the **SC**m will read the fully applied 5kV. If the charge was induced onto the material, the **SC**m will indicate an accepted voltage level that is several hundred volts less, depending on the thickness of the material. When the decay time is measured, the **SC**m will drop very quickly due the collapse of the electrostatic field on the electrodes and the buried conductive layer leaving a small residual charge that remains on the non-conductive or dissipative outer layer. If this remaining charge is greater than the cut off level the clock will run on. However, if it is less than the cut off level the clock will indicate a very fast decay time (<0.01sec) If the outer layer is dissipative, the **SC**m will drop rapidly then bleed off the remaining charge and the clock will indicate a measurable decay time.

1/13

6.0 WARRANTY

Electro-Tech Systems, Inc. warrants its equipment, accessories and parts of its manufacture to be and remain free from defects in material and workmanship for a period of one (1) year from date of invoice. ETS will, at its discretion either replace or repair without charge, F.O.B. Glenside, similar equipment or a similar part to replace any equipment or part of its manufacture which, within the above stated time, is proved to have been defective at the time it was sold. All equipment claimed defective must be returned properly identified to the Seller (or presented to one of its agents for inspection). This warranty only applies to equipment operated in accordance with Seller's operating instructions.

Seller's warranty with respect to those parts of the equipment that are purchased from other manufacturers shall be subject only to that manufacturer's warranty.

The Seller's liability hereunder is expressly limited to repairing or replacing any parts of the equipment manufactured by the manufacturer and found to have been defective. The Seller shall not be liable for damage resulting or claimed to result from any cause whatsoever.

This warranty becomes null and void should the equipment, or any part thereof, be abused or modified by the customer of if used in any application other than that for which it was intended. This warranty to replace or repair is the only warranty, either expressed or implied or provided by law, and is in lieu of all other warranties. The Seller denies any other promise, guarantee, or warranty with respect to the equipment or accessories and, in particular, as to its or their suitability for the purposes of the buyer or its or their performance, either quantitatively or qualitatively or as to the products that it may produce. The buyer is expected to expressly waive rights to any warranty other than that stated herein.

ETS must be notified before any equipment is returned for repair. ETS will issue an RMA (Return Material Authorization) number for return of equipment.

Equipment should be shipped prepaid and insured in the original packaging. If the original packaging is not available, the equipment must be packed in a sufficiently large box (or boxes if applicable) of double wall construction with substantial packing around all sides. The RMA number, description of the problem along with the contact name and telephone number must be included in formal paperwork and enclosed with the instrument. Round trip freight and related charges are the owner's responsibility.

WARNING

WOODEN CRATES MUST NOT BE USED. PACKAGING OF DELICATE INSTRUMENTS IN WOODEN CRATES SUBSTANTIALLY INCREASES THE CONTENT'S SUSCEPTIBILITY TO SHOCK DAMAGE. DO NOT PLACE INSTRUMENTS OR ACCESSORIES INSIDE OTHER INSTRUMENTS OR CHAMBERS. ELECTRO-TECH SYSTEMS, INC. WILL NOT ASSUME RESPONSIBILITY FOR ADDITIONAL COST OF REPAIR DUE TO DAMAGE INCURRED DURING SHIPMENT AS A RESULT OF POOR PACKAGING.

APPENDIX A
Method 4046
Electrostatic Properties of Materials

1.0 Scope

1.1 This test is used to determine the electrostatic properties of materials in filmed and sheet form, by measuring the time required to induce a charge on the surface of the material, measure the intensity and polarity of the charge, as well as the time required for complete dissipation of the induced charge.

1.2 This method does not determine the surface, volume or insulation resistivities of the materials.

2.0 Definition

2.1 Electrostatic properties are defined as the ability of a material, when grounded, to dissipate a charge induced on the surface of the material.

3.0 Apparatus

3.1 A metal template, 5 by 3 by 1/8 inches.

3.2 A high voltage source, at least 0 to 5kV, positive and negative.

3.3 An electrometer for measuring volts, amperes and ohms with a full scale reading of 0.01, 0.1, 10 and 100, or an oscilloscope with a response of 1 microsecond per division, or equivalent.

3.4 Electrostatic test chamber

3.5 A single channel, pen type recorder with speeds of 0.5, 1.0, 2.0, 4.0 and 8.0 inches per minute and per second.

3.6 A desiccating chamber for conditioning specimens.

3.7 Two knife blade switches, hooked up so that when one is opened the other will close.

3.8 The equipment shall be assembled as illustrated in Figure 2.

3.9 A chamber or room uniformly maintained at 73° ±3.5° F and 50 ±5 percent relative humidity in which to perform tests.

4.0 Specimens

4.1 Select specimens at random and in sufficient number to represent adequately the variation of the material. A minimum of three specimens per condition are required.

4.2 Each specimen shall be 5 by 3 inches and shall be free of defects such as holes, cracks and tears. If the specimen is coated, the coating shall be continuous.

5.0 Conditioning

5.1 Prior to testing, expose one-third of the specimens for 12 days in an oven uniformly maintained at 160º ±5º F; one-third of the specimens in a horizontal position for 24 hours under a continuous water shower; and one-third of the specimens in an atmosphere uniformly maintained at 73º ±5º F and 50 ±5 percent relative humidity.

5.2 Unless otherwise specified, all specimens shall be placed in the desiccating chamber for a minimum of 24 hours immediately before testing, as specified in section 6.

5.3 Test environment. Perform tests in an atmosphere uniformly maintained at 73º ±3.5º F and a dry condition of less than 15 percent relative humidity. This relative humidity can be obtained by inserting a dish (approximately 4 inches in diameter) containing 50 grams of anhydrous calcium chloride into the test chamber. The anhydrous calcium chloride shall be replaced daily.

6.0 Procedure

6.1 Calibration

6.1.1 Turn on all components and allow to warm up, as noted in the operations manual for the particular item.

6.1.2 Set “multiplier” switch of the electrometer at 10 and the “operate” switch at “zero check”.

6.1.3 Close the ground switch and adjust the high voltage for 5kV output.

6.1.4 Mount a 1/8-by 3-by 5-inch aluminum panel between the electrodes in the test chamber so that the detector head is directly in the center of the panel. Tighten the four wing nuts to secure the panel.

6.1.5 Adjust the speed of the recorder chart at 1 inch minimum, move operate switch to “operate” position and close the high voltage switch to apply 5kV to test panel.

6.1.6 Move multiplier switch until the meter needle reads maximum without exceeding the limits of the meter. Check to see if the charge indicated by the meter is identical to that being recorded on the chart.

6.1.7 Close ground switch to remove the charge. When the meter reaches zero, stop chart and move operate switch on electrometer to “zero check” position.

6.1.8 Repeat this procedure for both positive and negative charges.

6.2 Each specimen shall be mounted vertically between the electrodes and the wing nuts tightened to insure intimate contact between specimen and electrodes.

6.3 Set chart speed at 0.5 inch/second. Turn on the recorder. Turn meter switch to plus or minus, depending on charge to be applied. Move “operate” switch to position and then close charging switch to apply 5kV to test specimen.

6.4 When the meter needle stops rising, indicating the specimen has received its maximum charge, close the ground switch to remove the charge.

6.5 When the needle reaches zero or after ten seconds, whichever comes first, stop recorder and move operate switch to zero.

6.6 Charge each specimen three times for both positive or negative charges, allowing specimen to remain grounded for ten minutes after each charging cycle to remove any residual charge on the specimen.

6.7 Calculate charge decay time by measuring the horizontal distance on the chart from the point where the specimen was grounded to the point where the needle reached zero. With the speed of the chart known, calculate the decay time for each specimen.

7.0 Report

7.1 Report the facts pertinent to the test.

7.1.1 State that the test was conducted in accordance with this procedure or describe any deviations.

7.1.2 Identify the specimen and specific material tested.

7.1.3 Results of test.

7.1.3.1 State the decay time for each specimen for both positive and negative charges, as calculated in 6.7.

7.1.3.2 State that material was tested as received, aged and exposed to shower.

8.0 Notes

8.1 The purpose of this procedure is to evaluate the electrostatic buildup and dissipation properties of packaging materials used to fabricate enclosures primarily for missile components subjected, in a small degree, to direct climatic exposure. The test is particularly applicable to barrier materials especially formulated to prevent the buildup or retention of electrostatic potential under any atmospheric conditions, the objective being to maximize explosive safety and to preclude ignition of stray flammable materials by electrostatic discharge.

APPENDIX B
National Fire Protection Association (NFPA)
Code 99 – Standard for Health Care Facilities (1993):

Paragraph 12-4.1.3.8 Reduction in Electrostatic Hazard

Paragraph 4663 — Antistatic sheeting, film and textiles shall meet the specific requirements of at least one of the following test methods when preconditioned at 50%, ±2% RH at 70º ±3.5ºF for 25 hours or until equilibrium is reached, and tested at 50% ±2%RH at 70º ±3.5ºF.

1. Method 4046 of Federal Test Method Standard 101C. After the specimen has received its maximum charge from the application of 5000 volts, the time for the indicated specimen potential to drop to 10% of its maximum value shall not exceed ½ second.

Note: The static detector head should be of a type that is adequately shielded to minimize responses to potentials on the electrodes and other stray pickup.

Paragraph 4664 — Antistatic items other than sheeting, film and textiles shall be tested in a manner as closely as possible equivalent to that given in 4663.

APPENDIX C
(Applicable sections)

Mil-PRF-81705D, – Barrier Materials, Flexible, Electrostatic Protective, Heat Sealable:

1.0 Scope

1.1 This specification covers opaque and transparent heat sealable, electrostatic free, flexible, barrier materials for the packaging of missiles, explosive powered and electro-sensitive devices, micro-circuits, semiconductors, thin film resistors, and associated airborne components.

Table 1: Electrostatic properties:

The decay rate shall be 2.00 seconds (maximum) re: Paragraph 4.8.3.

4.0 Quality Assurance Provisions

4.8.3. The tests indicated below shall be conducted in accordance with the specified methods of Fed. Test Method Std. 3010, Electrostatic Properties – Method 4046 per Note 7.

Note 7: Preparation of the test specimens shall be as follows:

Five 3 by 5 inch specimens shall be selected from the material to be tested, one from each outside edge and one from the center. Six additional specimens shall be cut from the same areas. Three shall be aged by exposing the specimen to a dry atmosphere at 160° F for 12 consecutive days. The remaining three shall be placed under a shower in a horizontal position for a minimum of 24 hours. All specimens shall then be placed in the drying chamber for 24 hours before testing. Report the average for the five specimens for As Received, Aged and After Shower Exposure to the nearest 0.01 second.