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ELECTROSTATIC PROPENSITY OF GARMENTS MADE OF NOMEX WITH ONE PERCENT METAL FIBERS COMPARED WITH FLAMEPROOF COTTON

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TECHNICAL SUPPORT DIRECTORATE
DOVER, NEW JERSEY

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
Garments which are worn by munitions handlers have a tendency to accumulate high electrostatic voltages depending on garment material, type of shoes worn, humidity, temperature, and composition of flooring. This test study compared garments made of flameproof cotton with garments made of two types of material woven from Nomex with 1% metal fibers. Electrostatic charge was measured using two methods: Hand discharge to an electrometer and a static meter gun held at 5, 15.25, and 30.5 cm (2, 6, and 12 in.).

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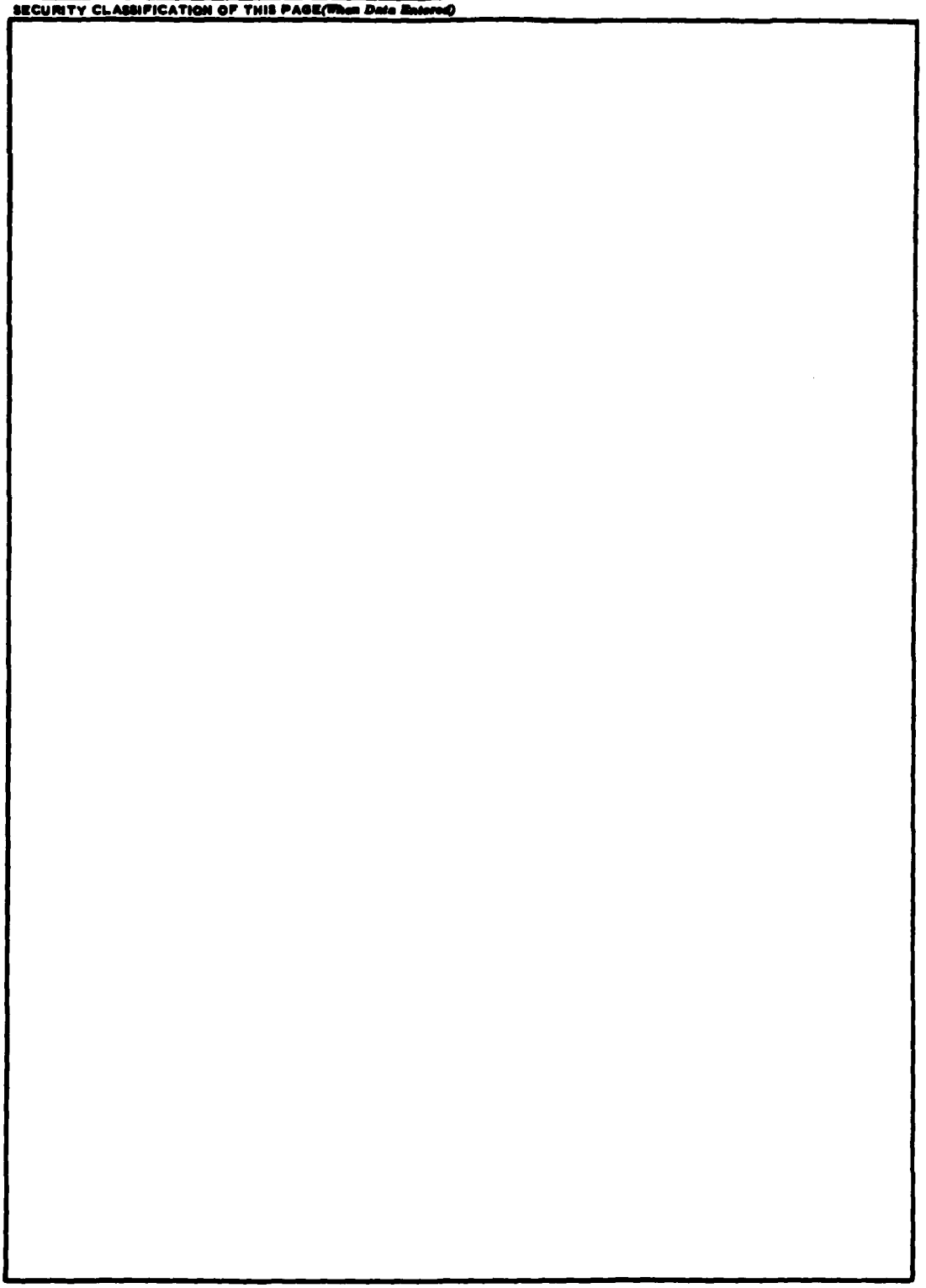

SUMMARY

Tests were performed to compare electrostatic charge developed on garments made of flameproof cotton with two types of material containing Nomex with metal fibers [Riegelstat F4X and Nomex with 1% stainless steel (Nomex SS)]. The data show:

1. Riegelstat F4X and Nomex SS were comparable to flameproof cotton in propensity to generate static charge. Nomex SS coveralls can be substituted for cotton coveralls now worn by explosive handlers.

2. Electrostatic voltages are negligible if Nomex SS or flameproof cotton coveralls are worn with conductive shoes and the floor is grounded.

3. Very high voltages can be generated which can prove hazardous if the explosives handler wears insulated shoes or the floor is insulated.

4. Generated electrostatic voltage levels are greater at lower humidities for test conditions of insulated shoes and/or insulated floor.

5. Static charge-generating propensity of Riegelstat F4X and of Nomex SS, after washing, was not conclusively determined.

CONTENTS

INTRODUCTION

A study was initiated to compare the static charges generated by cotton garments and by garments manufactured from two types of material containing Nomex with 1% metal fibers:

1. Ninety-nine percent Nomex and 1% Brumsmet fiber, manufactured by Riegel Textile Corporation (hereinafter referred to as Riegelstat F4X).

2. Ninety-nine percent Nomex and 1% stainless steel fibers (hereinafter referred to as Nomex SS).

The test plan included a general discussion on electrostatic charging, methods of measurements, and types of systems that could cause an electrostatic problem (app A).

The test plan also specified an evaluation of fabric surface resistance measurements that could be reliably used to observe the propensity of a garment to generate an electronic charge and its ability to dissipate that charge.

Tests were performed specifically to determine how Nomex with metal fibers (Riegelstat F4X and Nomex SS) compared with cotton, if either or both were an improvement over cotton, and if either or both could replace cotton fabric used in garments worn by explosive handlers and visitors to explosive areas. The following garments were tested:

1. Coat, Workrite Uniform Company, Riegelstat F4X

2. Coverall, Worklon Company, Nomex SS

3. Standard stock cotton coveralls

    a. New without flameproofing

    b. New with flameproofing

    c. Old with flameproofing

Tests were performed in an atmospherically controlled chamber at 19% relative humidity, 21°C (70°F) and at 37% to 40% relative humidity, 24°C (75°F).

When the test subject wore conductive shoes, the static charge was minimal and, therefore, fewer tests were required. When the test subject wore insulated shoes, a minimum of three and a maximum of five readings were taken for each test:

1. Walking on copper plate

2. Walking on asbestos tile

3. Sliding about a plastic covered metal chair and then arising from it.

4. Sliding about on both a grounded and ungrounded metal chair and then arising from it.

5. Walking on conductive linoleum.

To record electrostatic propensity, the test subject, while standing on a conductive sheet (copper or conductive linoleum), grasped the probe of an electrometer with the fingers of his right hand. Electrostatic voltage measurements were taken while the subject wore both insulated spark-proof shoes and conductive shoes, with and without conductive sheet grounded. Sixteen separate tests were made on each garment; each test was performed three to five times, resulting in 48 to 80 separate readings for each relative humidity. The number of readings were again doubled because the copper measurement plate was either grounded or insulated.

The capacitance-to-ground of the test subject was measured with conductive and insulated spark-proof shoes. The following capacitance were recorded:

Capacitance (picofarads)	Conditions
120	Insulated shoes, copper measurement plate grounded
120	insulated shoes, copper measurement plate not grounded (insulated)
4600	conductive shoes, copper measurement plate grounded
3770	conductive shoes, copper measurement plate not grounded (insulated)

The energy available from hand discharge, dependent on the charge induced and the capacitance of the subject's body, can be calculated by

$$E = \frac{1}{2} CV^2 \text{ joules}$$

where E is the energy in joules, C is the capacitance in farads, and V is the maximum voltage as read on the electrometer.

Using representative values, a man wearing insulated shoes and charged to 10,000 volts has stored 60,000 ergs as electrical energy; whereas, if he were wearing conductive shoes which allow an electrostatic voltage of 100 volts, he has only stored 200 ergs of energy.

The ability of the human body to retain charge is determined by its leakage time constant which is the body's capacitance times its leakage resistance. The leakage resistance of the test subject from hand through shoes to ground was measured and found to be as follows:

1. With insulated shoes: 4×10^{11} ohms

2. With conductive shoes: 500,000 ohms

With conductive shoes, the leakage time constant is:

$$t = RC = 5 \times 10^5 \times 4600 \times 10^{-12} = 2.3 \text{ milliseconds}$$

Similarly, with insulated spark-proof shoes, the leakage time constant is 48 seconds.

The human body's discharge time constant is determined by the product of the body's capacitance in series with 5,000 ohms plus the external discharge resistance. Assuming a man is wearing insulated shoes and discharging into a low resistance, his discharge time constant is 0.6 microseconds.

TEST PROCEDURE

Measurement of Electrostatic Discharge from Hand

The test subject, attired in a Riegelstat F4X, Nomex SS or cotton garment, flameproof treated or untreated, performed body

movements simulating work conditions. The garments were first conditioned by being hung overnight in a test chamber at the desired temperature and relative humidity. After performing selected body movement, the test subject walked on a copper measurement plate and touched an electrometer probe. The body voltage was indicated on a Keithley 610B voltmeter and the maximum value was recorded. The body movements for which tests were performed were as follows:

1. Subject sliding about on a vinyl simulated leather covered metal chair and then arising from it.

2. Subject sliding about on a metal chair and then arising from it.

3. Subject walking on a metal plate.

4. Subject walking on asbestos tile.

The above tests were performed under the following conditions:

1. Relative humidity: 37-40%; temperature 24-26°C (75-79°F)

2. Relative humidity: 19%; temperature 21°C (70°F)

3. Metal plate: grounded and ungrounded

4. Metal chair: grounded and ungrounded

5. Footwear: conductive and insulated, spark-proof shoes

6. Clothing worn under the test garments: polyester knit trousers, combination polyester/cotton shirt, nylon or dacron socks and polyester tie.

When the subject wore insulated shoes, three to five tests were performed for each operation.

Appendix B delineates the raw data documented in testing of the following garments:

1. Coats, Riegelstat F4X, Workrite Uniform Company (Items 1, 2, 3 and A of app B)

2. Coveralls, Nomex SS, Worklon Company (Item B)

3. Coveralls, cotton, new, non-flameproof (Item C)

4. Coveralls, cotton, new, flameproof (Item D)

5. Coveralls, cotton, old, flameproof (Item E)

6. Coveralls, cotton, new, non-flameproof (Item F)

7. Coveralls, Nomex SS, Worklon Company (Item G)

After the above garments were tested, first at 40% and then at 19% relative humidities, they were washed ten times, using a standard washing procedure. Flameproof treatment was applied to the cotton garments after each washing. The Nomex-plus-metal-fiber garments received no flameproofing. Two garments (unwashed) were used as controls to compare electrostatic discharge with those garments washed.

Electrical Surface Resistance of Garment Fabric

Surface resistance measurements were made prior to the first washing and after the tenth. Three types of resistance measurements were made: voltage current type using a Keithley 610B Electrometer, resistance type using a Keithley 610B Electrometer, and a Simpson Voltmeter (VOM) which was used whenever the Keithley 610B Electrometer was overloaded due to Kiegelstat's low surface resistance. Figure 1 shows the test setup for the voltage/current method. Tests were performed on samples of specific size as determined by the dimensions of the concentric-ring electrodes. Based on the dimensions of the concentric-ring electrodes, ohms/square can be obtained by multiplying the resistance obtained by the constant 15.5.

The variable-voltage power supply is adjusted to any value up to 1,000 volts, taking care not to overload the current meter, a Keithley 610B Electrometer. Resistance is calculated by:

$$R = \frac{E}{I}$$

where E = power supply voltage (volts)
and I = current measured with the electrostatic voltage meter (amperes)

With a Keithley 610B Electrometer, resistance can also be measured directly. The power supply is not used in this mode.

When Nomex SS was tested, the test voltage caused a decrease in resistance, allowing current magnitudes to flow beyond the range

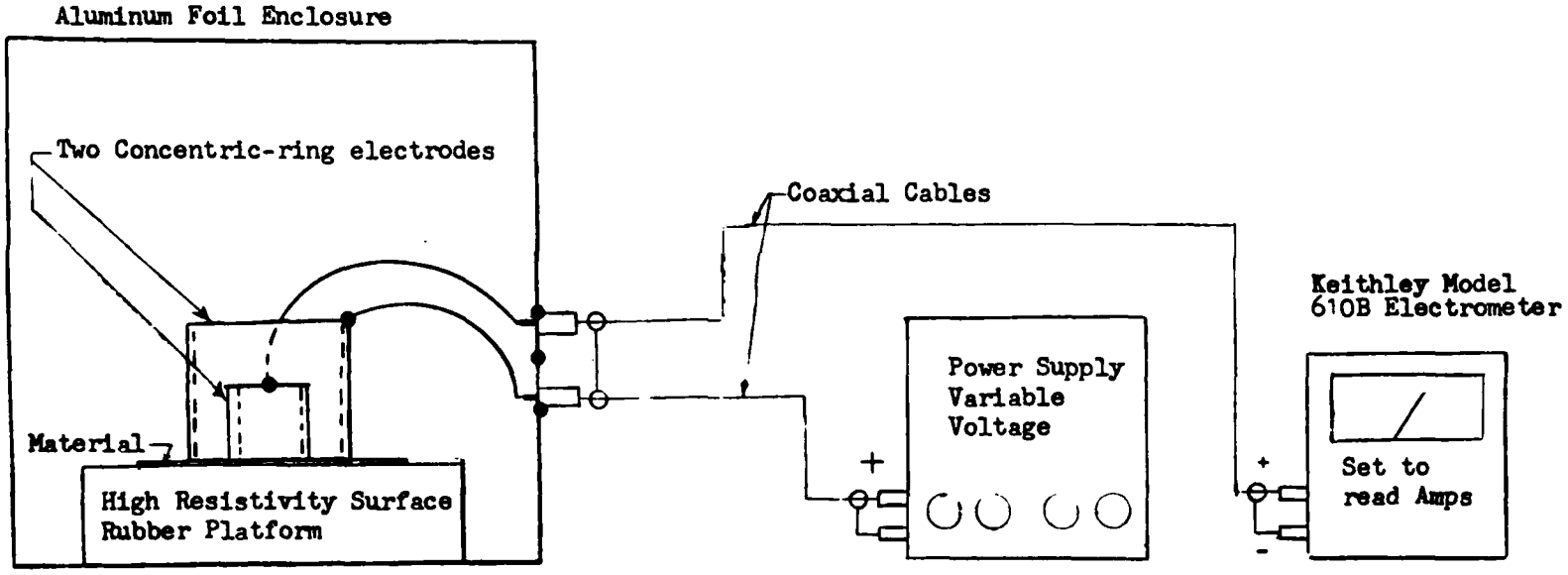

Figure 1. Voltage/current method of testing for surface resistance

of the Keithley 610B Electrometer. Therefore, an ohmmeter reading was made first of the material's resistance as received (app C).

Since Nomex with metal fibers developed low surface resistance after being washed ten times, an ohmmeter was used to obtain additional information.

Test Subject Capacitance

Capacitance during the electrostatic propensity tests was measured while the test subject was wearing both conductive and insulated shoes and standing on a copper plate (app D). The copper plate was either grounded or ungrounded to conform with the test requirement. The values of capacitance thus obtained made it possible to calculate energy stored on the test subject and to clarify the static charge phenomenon. The capacitance was obtained with the test subject's holding the capacitance measurement terminal of the General Radio Type 1650A Impedance Bridge while an operator adjusted its settings.

Test Subject Resistance to Ground

The resistance of the test subject to ground was obtained by his grasping the test probe of the Keithley 610B Electrometer. Resistance measurements were obtained using the voltage/current and the resistance method (app E). The resistance method was exclusively used for conductive shoes and only with the mesurement plate grounded. For insulated shoes, the measurement plate was either grounded or ungrounded (insulated). With the voltage/current method, resistance is calculated by

$$R = \frac{V}{I}$$

Static Meter Gun Measurements

A static meter gun was held close to, but not touching, the garment being measured for electrostatic charge accumulation. Electric charge was not lost from the garment. The static meter was calibrated for distances of 5, 15.25, and 30.5 cm (2, 6, and 12 in.) away from the garment. Meter gun readings were made of the electrostatic potential on the garment's back, front, and coverall cuffs or polyester trouser cuffs (when coat rather than coverall was worn). The purpose of these tests was to measure the maximum electrostatic potential accumulation on each garment and compare the results with voltage measurements obtained with the electrometer. Repetitive tests were performed with the test subject's wearing either insulated or conductive shoes with the different types of garments, as was specified in the test plan.

Test equipment is listed in appendix F.

DISCUSSION

Comparison of Nomex Containing 1% Metal Fibers with Cotton

Nomex, a synthetic material manufactured by duPont Corporation, has superior properties of flame resistance compared with cotton. Garments of Nomex used by explosive handlers have the additional advantages of uniformity and reliability of flameproof properties as compared with flameproof-treated cotton garments. The superior wearability of Nomex over cotton significantly offsets increased cost.

Since Nomex is a synthetic material, it tends to generate static charge in use. For applications where it is important to minimize static charge, 1% metal fibers are woven into the material. Two such materials are evaluated in this report for comparison of static charge propensity as compared with cotton; one is Riegelstat F4X and the other is Nomex SS.

No attempt was made in this test program to generate the maximum possible static charge. Rather, the emphasis was to evaluate the comparative static-charge-generating propensity of the materials being evaluated over a range of test conditions considered realistic for the intended use of the garments. The total raw data that was generated is found in appendix B.

When the test subject wore conductive shoes rather than insulated shoes, the monitored static charges were considerably lower. However, even when the test subject wore conductive shoes, knee-length coat and polyester knit pants, the gun-type static meter registered voltages as high as 5,000 on the trouser cuffs. This was localized phenomenon and was present despite the fact that the data monitored with a hand on the electrometer probe indicated 160 volts (app B). Gun measurements on the coat were zero. For this same coat, when the test subject wore insulated shoes, his body voltage was nearly 9,000 volts; gun readings on the garment were as high as 8,000 volts; and gun readings on the trouser legs were as high as 10,000 volts. Similar measurements made with coveralls that did not allow the pant legs to be exposed had very low gun voltage readings (app B).

These data indicate the necessity of explosive handlers' wearing conductive shoes; also that static charge dissipative coveralls be worn in lieu of knee-length work coats which allow trouser legs to be exposed. If these protective measures are taken, clothing worn under the coveralls (that by themselves have static-charge-generating propensity) will not generate static charge voltages on the outside surface of the coveralls, thus averting static charge hazard for explosive handlers.

Whether the conductive plate is grounded or ungrounded, the static charge measured is the same (app G). The reason for this is the high capacitance-to-ground of the ungrounded plate. Had steps been taken to move the plate farther from ground (provide better isolation), the capacitance-to-ground would have been less and the voltage measured would have been greater. Similarly, measurements made with the test subject's standing on asbestos floor tile would have indicated greater voltages. These tests showed that conductive linoleum of the type normally used on table tops was equivalent to a metal plate for similar test conditions. A man arising from a metal chair generated considerable static charge independent of whether the chair was grounded or not. The test conditions that generated maximum voltage were those of a man sliding about on a plastic chair while wearing insulated shoes. Therefore, these are the conditions used for discussing the relative merits of the different garments, although the relative voltage levels measured amongst the test garments remain the same for the other test conditions.

Voltages monitored for the various test samples at 19% relative humidity, measured with the electrometer, are shown in app H. These data show that Nomex fabrics woven with metal fibers (both Riegelsat F4X and Nomex SS) are slightly superior to the untreated cotton; other data found in appendix B show that the untreated cotton generates up to 12,000 volts. Cotton with flameproofing is slightly superior to the others, with the older cotton garment being best. Data on similar tests at 35 to 39% relative humidity are presented in appendix B which also shows all voltage levels to be reduced approximately one order of magnitude due to the increased humidity. The average voltage levels for all of the Nomex-plus-metal-fiber materials is approximately equal to the average value of the cotton without flameproofing. However, the cotton with flameproofing is decidedly superior at the higher levels of humidity.

Elecrostatic hand discharge voltage test data on test garments before washing and after 10 washings are shown in appendix H. The cotton garments were treated with flameproofing chemicals after each washing as is the normal custom. The object of this effort

was to determine whether the desirable properties of garments made from Nomex with metal fibers deteriorated after extensive washing. The cotton garments were used as a control.

The cotton garments without flameproofing decreased considerably in static-charge-generating propensity (app H). This is consistent with previous test data for cotton garments with added flameproofing chemicals as compared with new untreated cotton garments. The voltage level measured for the Nomex-with-metal-fiber garments also decreased dramatically following washing. These results for the Nomex with metal fibers were not considered consistent with theory. The expectation was that the static charge propensity of the Nomex with metal fibers was expected to remain the same at best and, if there were mechanical deterioration of the metal fibers, the voltage levels were expected to increase. It is suspected that the decrease in voltage levels occurred during handling in the laundry room by inadvertent contamination from the flameproofing used for the cotton. These data, therefore, do not provide the required information concerning the effect of many washings of the Nomex with metal fibers.

Carefully controlled, standard wash tests are recommended to evaluate possible change in static charge propensity of Nomex with metal fibers. To avoid postponing use of this material, spot checks should be performed on a man wearing a garment of this material, after each actual use, and after extended washings to assure that physical deterioration due to washing has not created a static charge problem.

The techniques for monitoring electrostatic voltages as presented in this report, do not record possible transient voltage levels that could be considerably higher than the steady state levels monitored. If these high level voltages exist under certain circumstances, they should be ascertained inasmuch as dangerous detonation of explosives, presently unpredictable, could occur.

One could represent a condition where a man, sitting in a chair and wearing conductive shoes, could generate a high voltage. However, on arising from the chair and stepping on a conductive floor, he could decrease the voltage to a safe level. Under these circumstances, if the man touched a detonator as he was arising from the chair (while at his peak voltage level), he could deliver sufficient voltage and energy to fire the detonator. The charging time constant is much less than the discharge time constant. This phenomenon might explain the reason for some explosions, the causes of which are presently unknown. Therefore, transient-type tests to evaluate this effect are recommended.

Relative Resistivity Measurements of the Garment Fabrics

Relative resistivity measurements recorded on the various garment materials are presented in appendix C. These data do not allow one to predict the static charge propensity of Nomex with metal fibers as compared to cotton. Although the Nomex with metal fibers showed very low relative resistivity as compared to cotton, the static charge generated was comparable. The reason for this apparent discrepancy is believed to be the inhomogeneity of the Nomex-with-metal-fiber material because a low percentage of metal fibers may not completely neutralize the charge generated in the high resistance Nomex threads, but yet show low resistance in direct readings. It is possible, however, to develop a relationship for a homogeneous material, such as pure cotton, between resistivity and static charge-generating propensity, although additional work is required to make this relationship more definitive.

CONCLUSIONS

1. At relative humidity levels of 19% to 39%, an explosives handler, standing on a conductive floor, will generate the same static charge voltage levels when wearing coveralls made of Nomex SS as he would if he were wearing flameproof-treated coveralls.

2. To minimize static charge voltage buildup, an explosives handler should work on a conductive floor, and should wear conductive shoes and a coverall, rather than a work coat which would expose his pant legs. Under these conditions, garments worn under the coveralls, including underwear, will not adversely affect static charge energy generated by the man to his environment.

3. Observations showed that at the relative humidity levels tested, a man wearing insulated shoes will generate lower electrostatic voltage levels if he is wearing a flameproof-treated cotton garment, rather than an untreated cotton or Nomex-with-metal-fibers garment (either Riegelsat F4X or Nomex SS).

4. Even if a man is wearing conductive shoes and a knee-length work coat made of Nomex with metal fibers, the voltage levels on the portion of his pants exposed beneath his knees could generate dangerous levels of voltage.

5. Data obtained on the performance of Nomex with metal fibers after washing are questionable because of suspected inadvertent contamination. These tests should be rerun.

6. Where test conditions include insulated shoes or insulated floor, static charge voltages induced on garments increase in magnitude when the ambient relative humidity is decreased from 39% to 19%. Relative humidity as low as 5% can exist in a loading area under extreme conditions; tests should be performed at low humidities on both Nomex with metal fibers and on cotton to evaluate potential hazards.

7. Under special circumstances, transient static-charge-induced voltages of very high levels, not recorded with normal measurement techniques, may present a safety hazard.

RECOMMENDATIONS

1. Coveralls made from Nomex with 1% metal fibers may safely be used as uniforms for explosives handlers providing conditions include conductive floor and conductive shoes. Additional elecrostatic tests should be performed on Nomex with metal fibers after washing. In the interim, static charge gun tests should be performed on garments of this material in use after washing.

2. It is not necessary to control the clothing the explosives handler wears under his coveralls providing the conditions described above are met.

3. Additional tests are recommended to evaluate static-charge-induced voltages on both Nomex with metal fibers and on cotton at low temperatures and low relative humidities.

4. Static charge tests should be performed to evaluate the safety hazards from possible large amplitude transient voltages generated during the charging process even where conductive shoes are worn.

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APPENDIX A

TEST PLAN FOR EVALUATION OF ELECTROSTATIC PROPENSITY OF VARIOUS FABRICS

TEST PLAN FOR EVALUATION OF ELECTROSTATIC PROPENSITY OF VARIOUS FABRICS

by

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Evaluation Branch, ID, TSD

MAY 1974

OBJECTIVE

The Evaluation Branch, Instrumentation Division, Technical Support Directorate was requested by Messrs W. Field and B. Perlmutter of Methods Engineering Division and Mr. J. Lippian of the Safety Office, to prepare a test plan to compare the electrostatic properties of various garments to determine if they can be safely worn by explosive handlers and visitors to explosive areas. The following materials are to be tested:

a. Sager Glove Company, shirt, 100% Cotton-Roxel (washable fire retardant treatment)

b. Sager Glove Company, trousers, 100% Cotton-Lynrus (washable fire retardant treatment)

c. Worklon Company, coveralls, 99% Nomex, 1% stainless steel fiber

d. Standard stock cotton coveralls

1. New, with flame proofing

2. New, without flame proofing

3. Old, with flame proofing

e. Workrite Uniform Company, 99% Nomex Aramid, 1% Brunsmet fiber

BACKGROUND

Garments Used in Explosive Environments at Picatinny Arsenal

Cotton has long been recognized as the best material for control of static electricity. This control comes about because of the material's ability to absorb moisture from the air which reduces surface resistivity (the lower the surface resistivity the less the material's propensity for storing charge). It must, however, be recognized that cotton's unique charge dissipation characteristic is associated with the moisture content of the surrounding air; below 35% relative humidity even cotton becomes material to be concerned with in the control of static electricity.

Cotton coveralls used at Picatinny Arsenal are treated with flame proofing material during one phase of the laundering cycle. There have been problems in obtaining consistancy in obtaining flame retardancy in the process. This Arsenal is considering using garments manufactured from Nomex, DuPont's flame retardant nylon. Uniforms of Nomex solve many of problems associated with flame retardant cotton; however, its reported propensity for electrostatic charging renders the material useless in an explosive environment, except where additional anti-static treatment is provided. Riegel Textile Corporation manufactures a fabric sold under the trade name Riegelstat F4X which combines a metal fiber, Brunsmet, with Nomex. This fabric is reported to have properties which compete with cotton as an anti-static fabric.

General Discussion on Static Electricity

Although the field of electrostatics has been known for years, many of the phenomena associated with it are still not understood. This has led many authors to state that electrostatics is both a science and an art.

It is well known that when two different materials are brought in contact and then separated, equal and opposite charges are produced on each material. If one of these charged materials comes in proximity to a conductor, without touching it, free electronics are either attracted toward the charged body or repelled, depending on the polarity of the charging source. If the conductor is isolated from ground while in the presence of the charging body and is then grounded, electrons will either flow from or to earth, depending on the polarity of the charging source. Also, during the process of grounding the conductor a spark discharge often occurs.

The conductor referred to in the previous discussion is very often a human. Charging of the body can occur, for example, during the removal of clothing or when a person rises from a chair. It also occurs when a person walks across an ungrounded floor, especially if non-conductive shoes are worn. If a charged person touches a large object or ground, a spark discharge results. The most obvious danger of a spark discharge is its ability to initiate explosives or volatile gas and air mixtures. It is because of this danger that the control of static charge is of utmost importance in explosive environments.

Control of Static

The common methods used to control the generation and safe dissipation of electrostatic charge, include the use of anti-static materials or finishes, increasing the relative humidity, by ionization or by providing a low resistance path to ground for all items of equipment including flooring and footwear.

Measurement of Static Propensity

There are many schools of thought as regards to the proper way to test for static proneness. Of the many test procedures found in the literature the methods which are most used include the measurement of:

a. Surface resistivity

b. Total charge generated

c. Charge decay rate

The technical manual of The American Association of Textile Chemists and Colorists (AATCC) specifies four different tests for testing for static accumulation. Test Methods AATCC 84-1969 and 76-1969 test respectively for electrical resistivity of yarns and fabrics. Test Method AATCC 15-1969 is a fabric-to-metal cling test. Test Method AATCC 134-1969 is used to measure carpet static (human body potential is measured using an electrostatic voltmeter).

Federal test method Standard 101B, Method 4046 is used to determine the properties of materials in film and sheet form. This procedure utilizes a high voltage power supply and special fixtures to charge and discharge a test specimen. The time required to induce a charge on the surface, the intensity and polarity of the charge, and the time required for complete dissipation of the charge are measured.

A practice that has been followed by this organization is assessing electrostatic problems is to develop a test procedure based on the specific system being evaluated. In this case we are dealing with a clothing-man system. Hence, the procedures developed for the evaluation of various fabrics specified in the Objective will include in addition to evaluation of surface resistivity specific tests that reflect the real system.

PROCEDURE

Surface Resistivity

The measurement of resistivity will be in accordance with the AATCC test method 76-1969.

Three test specimens will be cut from each of the test materials (as received) to be evaluated. Each specimen will be conditioned in a test chamber at three different relative humidity conditions (25, 40 and 65%) at 24°C (75°F) for a period of four hours. The size of each test specimen will be selected to suit the dimensions of the electrodes of the test fixture. Resistance measurements will be made using the Kiethley 610B voltmeter.

The above tests will also be conducted after the test specimens have been washed ten times. The exact laundering process is to be specified. Cotton coveralls are presently laundered in accordance with D/M 21-7-1.1, Operation of Laundry.

Man-Clothing Test

For this test an individual attired in the test garments, will perform specific operations which will evaluate the fabric's static propensity. These operations will include:

a. Person sliding about on a vinyl simulated leather covered metal chair and then rising from it.

b. Person sliding about on a metal chair and then rising from it.

c. Person removing garment; this will be simulated by rubbing test fabrics across the person's back and shoulders.

d. Person walking on conductive surface which is insulated.

The above tests will be conducted under the following conditions:

a. Temperature - 24°C (75°F)

b. Relative humidity - 25 and 50%

c. Floor and Chair - conductive and non-conductive

d. Footwear - conductive and non-conductive

e. Undergarments - cotton, nylon, knit polyester trousers, etc

f. Number of tests - ten for each operation

When the person completes each operation he touches a probe which connects to an electrostatic voltmeter.

TEST REPORT

Resistivity data on each test specimen will be provided. A comparison will be made between the resistivity of each specimen and the body voltage generated during each operation. From the results a material safety criteria will be developed.

APPENDIX B

ELECTROSTATIC PROPENSITY OF GARMENTS

INSTRUMENTATION DATA
TABULATION SHEET

	Tested By	GARMENT TYPE	GARMENT ITEM NO.	Date 1979	Atmosphere C° TEMP	Atmosphere % R.H.	GUN	STATIC CHARGE (Volts) VOLTMETER	TYPE 610B				SHOES INSUL	SHOES COND	SHOES OTHER	FLOOR SURFACE MEAS MADE ON INSUL	FLOOR SURFACE MEAS MADE ON GROUND	FLOOR SURFACE MEAS MADE ON OTHER	RESISTANCE	TYPE OF OPERATION	NOTES ADDITIONAL READINGS (VOLTS)	NOTES BEFORE WASHING TESTS IN 832.08
1	Van Sumeren	Rigid Coat	1	9/6/79	24	39		100	20	135	45		✓			✓				WALKING ON PLATE		
2		Coat						60	130	100	90		✓				✓			WALKING ON PLATE		
3		FUR						550	570	130	450	800	✓			✓				PLASTIC CHAIR		
4								150	220	50	350	670	✓				✓			PLASTIC CHAIR		
5								330	80	50	250		✓			✓				METAL CHAIR, GROUNDED		
6								250	107	90	150		✓				✓			METAL CHAIR, GROUNDED		
7													✓			✓				METAL CHAIR		
8													✓				✓			METAL CHAIR		
9																						
10				9/26				4.7	2	6	1.2	1.0		✓		✓				WALKING ON PLATE	0.9	
11								-.7	-.8	-.6	-.7	-.8		✓			✓			WALKING ON PLATE		
12								5	8.3	-2	7	7.5		✓		✓				PLASTIC CHAIR		
13								-.8	-.8	-.7	-.8	-.7		✓			✓			PLASTIC CHAIR		
14								-.5	-.62	-2.3	-2.6	-2.7		✓		✓				METAL CHAIR, GROUNDED		
15								4	-.7	-.7	-.8	-.7		✓			✓			METAL CHAIR, GROUNDED		
16																✓				METAL CHAIR		
17																	✓			METAL CHAIR		
18																						
19		Rigid Coat	2	9/13	24.5	36		92	38	58	10	37	✓			✓				WALKING ON PLATE		
20		Coat						8	8	33	50	91	✓				✓			WALKING ON PLATE		
21		FUR						300	270	700	400	900	✓			✓				PLASTIC CHAIR	600	
22								150	330	550	600	550	✓				✓			PLASTIC CHAIR	130, 600	
23								490	390	390			✓			✓				METAL CHAIR, GROUNDED		
24								550	275	220			✓				✓			METAL CHAIR, GROUNDED		
25								100	390	580	560	495	✓			✓				METAL CHAIR		
26								190	240	340	480		✓				✓			METAL CHAIR		
27																						
28				9/13	26	36		-11	-9.5					✓		✓				WALKING ON PLATE		
29								-2.5						✓			✓			WALKING ON PLATE		
30								5						✓		✓				PLASTIC CHAIR		
31								-.8	-2.4					✓			✓			PLASTIC CHAIR		
32																✓				METAL CHAIR, GROUNDED		
33																	✓			METAL CHAIR, GROUNDED		
34								-7						✓		✓				METAL CHAIR		
35									-2.4					✓			✓			METAL CHAIR		
36																						
37																						

INVESTIGATION DATA
INVESTIGATION SHEET

	Tested By	GARMENT TYPE	GARMENT ITEM NO.	Date 1974	Atmosphere C° TEMP	Atmosphere % R.H.	GUN	STATIC CHARGE (VOLTS) VOLTMETER TYPE 6108					SHOES INSUL	SHOES COND	SHOES OTHER	FLOOR SURFACE MEAS MADE ON INSUL	FLOOR SURFACE MEAS MADE ON COND	FLOOR SURFACE MEAS MADE ON OTHER	RESISTANCE	TYPE OF OPERATION	NOTES ADDITIONAL READINGS(VOLTS) BEFORE WASHING TESTS IN B3108
1	Van Sawyer	Riegelstat	3	9/23	23.3	37.5		15	20	19			✓			✓				WALKING ON PLATE	
2		Coat						8	34	42	7	5	✓				✓			WALKING ON PLATE	
3		F4X						500	330	1K	845		✓			✓				PLASTIC CHAIR	
4								1K	350	450	930		✓				✓			PLASTIC CHAIR	
5								220	300	390			✓			✓				METAL CHAIR, GROUNDED	
6								550	300	350			✓				✓			METAL CHAIR, GROUNDED	
7								270	300	1K	440		✓			✓				METAL CHAIR	
8								450	180	420	290		✓				✓			METAL CHAIR	
9																					
10				9/18	23.3	35		-.8						✓		✓				WALKING ON PLATE	
11								1.7						✓			✓			WALKING ON PLATE	
12								2.6						✓		✓				PLASTIC CHAIR	
13								-.8						✓			✓			PLASTIC CHAIR	
14																✓				METAL CHAIR, GROUNDED	
15																	✓			METAL CHAIR, GROUNDED	
16								5						✓		✓				METAL CHAIR	
17								-.8						✓			✓			METAL CHAIR	
18																					
19		Riegelstat	A	9/24	23.3	38		-39	46	-5	31		✓			✓				WALKING ON PLATE	
20		Coat						-13	55	48	57		✓				✓			WALKING ON PLATE	
21		F4X						520	650	350	250		✓			✓				PLASTIC CHAIR	
22								520	1K	1.6K	1.3K		✓				✓			PLASTIC CHAIR	
23								50	30	40	130		✓			✓				METAL CHAIR, GROUNDED	
24								180	115	260	210		✓				✓			METAL CHAIR, GROUNDED	
25								130	20	-50	380		✓			✓				METAL CHAIR	
26								440	-110	-30	15	110	✓				✓			METAL CHAIR	
27																					
28				9/24	22.8	39		2.2	2.8	-0.8	1.4			✓		✓				WALKING ON PLATE	
29								-.8	-.8	-.8	-.8			✓			✓			WALKING ON PLATE	
30								11.5	-3	11.5	11.5	-5		✓		✓				PLASTIC CHAIR	
31								-.8	-.8	-.8	-.8			✓			✓			PLASTIC CHAIR	
32								1.7	.9	.6	-1.4			✓		✓				METAL CHAIR, GROUNDED	
33								-.8	-.8	-.8	-.8			✓			✓			METAL CHAIR, GROUNDED	
34								93	-3	-8	-.2			✓		✓				METAL CHAIR	
35								-.8	-.8	-.8	-.8			✓			✓			METAL CHAIR	
36																					
37																					

INSTRUMENTATION DATA

TABULATION SHEET

	Tested By	GARMENT TYPE	ITEM NO.	Date 1974	Atmosphere C° TEMP	% R.H.	GUN	STATIC CHARGE (VOLTS) VOLTMETER		TYPE CICB			SHOES INSUL	SHOES COND	SHOES OTHER	FLOOR SURFACE MEAS MADE ON INSUL	FLOOR SURFACE MEAS MADE ON CCMB	FLOOR SURFACE MEAS MADE ON OTHER	RESISTANCE	TYPE OF OPERATION	NOTES ADDITIONAL READINGS (VOLTS)	NOTES BEFORE WASHING TESTS IN B3208
1	Von Savage	NOMEX 99%	B	9/4/74	22.2	36		-40	17	39	-50	-31	✓			✓				WALKING ON PLATE		
2		COVERALLS						-46	-50	33	30	-16	✓				✓			WALKING ON PLATE		
3		17.5 S.						110	550	300	500		✓			✓				PLASTIC CHAIR		
4		WORNLON						600	750	730	300	1.6K	✓				✓			PLASTIC CHAIR		
5								600	330	100	200		✓			✓				METAL CHAIR		
6								520	600	630	300	250	✓				✓			METAL CHAIR		
7								570	600	680			✓			✓				METAL CHAIR, GROUNDED		
8								550	800	700			✓				✓			METAL CHAIR, GROUNDED		
9																						
10								-1.4						✓		✓				WALKING ON PLATE		
11								-.8						✓			✓			WALKING ON PLATE		
12								1.5						✓		✓				PLASTIC CHAIR		
13								-.6						✓			✓			PLASTIC CHAIR		
14																✓				METAL CHAIR, GROUNDED		
15																	✓			METAL CHAIR, GROUNDED		
16								-3.4						✓		✓				METAL CHAIR		
17								-.7						✓			✓			METAL CHAIR		
18																						
19	Von Savage	Cotton	C	9/4/74	25	37		-38	-14	-19	14	-34	✓			✓				WALKING ON PLATE		
20		COVERALLS		9/4/74				-36	-36	-10	-8	-18	✓				✓			WALKING ON PLATE		
21		NEW, No						400	470	370	580	350	✓			✓				PLASTIC CHAIR	580	
22		FLAME Proof						180	350	1.02k	450	450	✓				✓			PLASTIC CHAIR		
23								650	350	800			✓			✓				METAL CHAIR, GROUNDED		
24								700	1K	1.1K			✓				✓			METAL CHAIR, GROUNDED		
25								680	500	450	150	600	✓			✓				METAL CHAIR		
26								600	600	1.38K	1.9K	500	✓				✓			METAL CHAIR	495	
27																						
28				9/4/74	21	38		3	-1					✓		✓				WALKING ON PLATE		
29								-.8						✓			✓			WALKING ON PLATE		
30								1.9						✓		✓				PLASTIC CHAIR		
31								-.8						✓			✓			PLASTIC CHAIR		
32																✓				METAL CHAIR, GROUNDED		
33																	✓			METAL CHAIR, GROUNDED		
34								-.8						✓		✓				METAL CHAIR		
35								-.8						✓			✓			METAL CHAIR		
36																						

INSTRUMENTATION DATA
TABULATION SHEET

	Tested By	GARMENT TYPE	ITEM NO.	Date 1971	Atmosphere C° TEMP	% R.H.	GUN	STATIC CHARGE (VOLTS) VOLTMETER			TYPE 6108		SHOES UNSUL	CCND	OTHER	FLOOR SURFACE MEAS MADE ON INSUL	CCND	OTHER	RESISTANCE	TYPE OF OPERATION	NOTES Additional Readings (Volts)	BEFORE WASHING TESTS IN B3208
1	VanSumm	COTTON	D	9/14/71	23.3	38		-70	-20	35	80		✓			✓				WALKING ON PLATE		
2		COVERALLS						-70	10	80	100		✓				✓			WALKING ON PLATE		
3		NEW, WITH						-50	-100	-50			✓			✓				PLASTIC CHAIR		
4		FLAME						100	-400	-120	-120	-60	✓				✓			PLASTIC CHAIR		
5		PROOF						20	45	45			✓			✓				METAL CHAIR, GROUNDED		
6								-40	-10	+22	+30	+30	✓				✓			METAL CHAIR, GROUNDED	+32	
7								14	30	5	40		✓			✓				METAL CHAIR		
8								100	75	0			✓				✓			METAL CHAIR		
9																						
10								-2.8						✓		✓				WALKING ON PLATE		
11								-.8						✓			✓			WALKING ON PLATE		
12								3						✓		✓				PLASTIC CHAIR		
13								-.7						✓			✓			PLASTIC CHAIR		
14																✓				METAL CHAIR, GROUNDED		
15																	✓			METAL CHAIR, GROUNDED		
16								.6						✓		✓				METAL CHAIR		
17								-.8						✓			✓			METAL CHAIR		
18																						
19	VanSumm	COTTON	E	9/28/71	24.5	37		30	-25	-36	-5	5	✓			✓				WALKING ON PLATE	57, -61	
20		COVERALLS		9/29/71				-14	-28	-17	10	30	✓				✓			WALKING ON PLATE		
21		OLD, WITH						80	52	120	160	100	✓			✓				PLASTIC CHAIR	50, 140	
22		FLAME						150	94	320	560	400	✓				✓			PLASTIC CHAIR	-140, 390	
23		PROOF						-15	-28	-31	-22		✓			✓				METAL CHAIR, GROUNDED		
24								-100	-30	-40	-60		✓				✓			METAL CHAIR, GROUNDED		
25								130	-8	-8	2	-12	✓			✓				METAL CHAIR	-20	
26								40	-15	-2	-8	-4	✓				✓			METAL CHAIR	-6	
27																						
28					24	38		-13						✓		✓				WALKING ON PLATE		
29								-2.4						✓			✓			WALKING ON PLATE		
30								10						✓		✓				PLASTIC CHAIR		
31								-2.4						✓			✓			PLASTIC CHAIR		
32								-8						✓		✓				METAL CHAIR, GROUNDED		
33								-15						✓			✓			METAL CHAIR, GROUNDED		
34								-7						✓		✓				METAL CHAIR		
35								-2.4						✓			✓			METAL CHAIR		
36																						

INSTRUMENTATION DATA
TABULATION SHEET

	Tested By	GARMENT TYPE	ITEM NO.	DATE 1974	ATMOSPHERE C° TEMP	% RH	GUN TROUSER	GUN GARMENT	STATIC CHARGE (VOLTS) HAND DISCHARGE ELECTROMETER TYPE 610B					SHOES INSUL	SHOES COND	MEAS MADE ON INSUL	MEAS MADE ON COND	TYPE OF OPERATION	NOTES ADDITIONAL READINGS (VOLTS)	NOTES B-FORE WASHING TESTS IN B3109
1	VanSomas	Riegelstat						0	-36	-40	-32	-15	-30	✓		✓		WALKING ON PLATE		
2		Coat F4X	1	9/30	21	19			-30	-120	+50	+50		✓			✓	WALKING ON PLATE		
3		WORKRITE						8K	8K	3K	7.5K	7.5K		✓		✓		PLASTIC CHAIR		
4								8.5K	8.5K	8K	8.5K	3.7K	8K	✓			✓	PLASTIC CHAIR		
5								0		350	300	200		✓		✓		METAL CHAIR, GROUNDED		
6								0		350	430	300		✓			✓	METAL CHAIR, GROUNDED		
7																				
8								0		1.5	1.0	2.0			✓	✓		WALKING ON PLATE		
9								0		-.8	-.8				✓		✓	WALKING ON PLATE		
10										37	70	70	55		✓	✓		PLASTIC CHAIR		
11								0		-.8	-.8				✓		✓	PLASTIC CHAIR		
12										4.0	4.5	11.0	2.0		✓	✓		METAL CHAIR, GROUNDED		
13										-.8	-.8	-.8			✓		✓	METAL CHAIR, GROUNDED		
14																				
15	VanSomas	Riegelstat	2	9/30	21	19		0		40	-18	-14		✓		✓		WALKING ON PLATE		
16		Coat F4X						0		38	30	50		✓			✓	WALKING ON PLATE		
17		WORKRITE						5K	5K	5.5K	6 K	5.2K		✓		✓		PLASTIC CHAIR		
18								2K	2K	2.8K	6K	6K	5.5K	✓			✓	PLASTIC CHAIR		
19								0		500	750	530		✓		✓		METAL CHAIR, GROUNDED		
20								0		530	600	750		✓			✓	METAL CHAIR, GROUNDED		
21																				
22								0		-.8	-1.5	-.8			✓	✓		WALKING ON PLATE		
23								0		100	70	50	60		✓		✓	WALKING ON PLATE		
24								C		-6	3	15	8.5		✓	✓		PLASTIC CHAIR		
25								0		-.8	-.8	-.8			✓		✓	PLASTIC CHAIR		
26								0		10	22	28			✓	✓		METAL CHAIR, GROUNDED		
27								0		-.8	-.8	-.8			✓		✓	METAL CHAIR, GROUNDED		

INSTRUMENTATION DATA
TABULATION SHEET

	Tested By	GARMENT TYPE	ITEM NO.	DATE 1974	ATMOSPHERE C° TEMP	% RH	STATIC CHARGE (VOLTS) GUN Trouser	GUN Garment	HAND DISCHARGE ELECTROMETER TYPE 610B					SHOES W/St	SHOES COND	MEAS. MADE ON Insul.	MEAS. MADE ON Cond.	TYPE OF OPERATION	NOTES ADDITIONAL READINGS (VOLTS)	NOTES BEFORE WASHING TESTS IN BY'OG
1	Van Sumner	Regulstat	A	10/1	21.1	19	-10K	0	55	100	100	160	95	✓		✓		WALKING ON PLATE		
2		Coat, F4X					-2K	0	-390	+200	65	200	290	✓			✓	WALKING ON PLATE		
3		WORK RITE					-3K	-2K 5K 5K	5.5K	6.5K	7.8K			✓		✓		PLASTIC CHAIR		
4							-1K	9K	8.8K	6.7K	7.3K			✓			✓	PLASTIC CHAIR		
5							-5K	0 .5K	960	1220	1.1K			✓		✓		METAL CHAIR, GROUNDED		
6							-4K	-4K .5K .5K	930	920	930			✓			✓	METAL CHAIR, GROUNDED		
7																				
8							-4K	0	23	-3	-12	2			✓	✓		WALKING ON PLATE		
9							-5K	0	-2	0	0				✓		✓	WALKING ON PLATE		
10							-5K	-9K 0 0	70	120	100	160			✓	✓		PLASTIC CHAIR		
11							-5K	0	-.8	-.8	-.8				✓		✓	PLASTIC CHAIR		
12							-5K	0	20	12	20				✓	✓		METAL CHAIR, GROUNDED		
13							-5K	0	-.8	-.8	-.8				✓		✓	METAL CHAIR, GROUNDED		
14																				
15	Van Sumner	COVERALLS	B	9/30	21.1	19		0	260	80	120	130		✓		✓		WALKING ON PLATE		
16		99% NOMEX						0	-33	28	72	52		✓			✓	WALKING ON PLATE		
17		1% SS						5K	6K	7.2K	7.8K			✓		✓		PLASTIC CHAIR		
18		WORKLON						3K	4K 7.9K	3K	5K			✓			✓	PLASTIC CHAIR		
19								250 500	850	950	1K			✓		✓		METAL CHAIR, GROUNDED		
20								500	950	850	100			✓			✓	METAL CHAIR, GROUNDED		
21																				
22								0	1.6	.8	.8				✓	✓		WALKING ON PLATE		
23								0	-.8	-.8	-.8				✓		✓	WALKING ON PLATE		
24								0	50	98	100	76	97		✓	✓		PLASTIC CHAIR		
25								0	-.8	-.8	-.8				✓		✓	PLASTIC CHAIR		
26								0	19	12	15				✓	✓		METAL CHAIR, GROUNDED		
27								0	-.8	-.8	-.8				✓		✓	METAL CHAIR, GROUNDED		
28																				
29																				
30																				
31																				
32																				
33																				
34																				
35																				
36																				

INSTRUMENTATION DATA
TABULATION SHEET

	Tested By	GARMENT TYPE	ITEM NO.	DATE 1974	ATMOSPHERE °C TEMP	% RH	STATIC CHARGE (VOLTS) GUN TROUSER	GUN GARMENT	HAND DISCHARGE ELECTROMETER TYPE 610B					SHOES INSUL	SHOES COND	MEAS MADE ON INSUL	MEAS MADE ON COND	TYPE OF OPERATION	NOTES ADDITIONAL READINGS (VOLTS)	NOTES BEFORE WASHING TESTS IN B3'09
1	VanSumner	Cotton	C	9/30	21.1	19		0	-200	-550	-1K	-650	-800	✓		✓		WALKING ON PLATE		
2		Coveralls						0	-220	-160	-160			✓			✓	WALKING ON PLATE		
3		New, No						5K	6K	6.7K	8.2K	9K	6.5K	✓		✓		PLASTIC CHAIR		
4		Flame Proof						10K	6K	4.5K	10K	12K		✓			✓	PLASTIC CHAIR		
5								2K	1.8K	3.4K	2.7K	2.6K		✓		✓		METAL CHAIR, GROUNDED		
6								5K	2.5K	4.0K	3.4K	2.8K		✓			✓	METAL CHAIR, GROUNDED		
7																				
8								0	17	.5	1.0	1.8			✓	✓		WALKING ON PLATE		
9								0	-.8	-.8	-.8				✓		✓	WALKING ON PLATE		
10								0	92	110	140	100	180		✓	✓		PLASTIC CHAIR		
11								0	-.8	-.8	-.8				✓		✓	PLASTIC CHAIR		
12								0	61	60	64				✓	✓		METAL CHAIR, GROUNDED		
13								0		-1	-.8	-.8			✓		✓	METAL CHAIR, GROUNDED		
14																				
15	VanSumner	Cotton	D	9/30	21.1	19		0	32	110	100	180	180	✓		✓		WALKING ON PLATE		
16		Coveralls						500	3K	1.1K	1K			✓			✓	WALKING ON PLATE		
17		New, With						5K	5K	6.5K	7K	3.8K	5.7K	✓		✓		PLASTIC CHAIR		
18		Flame Proof						5K	5K	3.7K	5K	5K		✓			✓	PLASTIC CHAIR		
19								0	550	650	550			✓		✓		METAL CHAIR, GROUNDED		
20								0	250	300	450			✓			✓	METAL CHAIR, GROUNDED		
21																				
22								0	.8	10.5	7	3.5			✓	✓		WALKING ON PLATE		
23								0	-.8	-.8	-.8				✓		✓	WALKING ON PLATE		
24								0	45	42	76	98	57		✓	✓		PLASTIC CHAIR		
25								C	-.8	-.8	-.8				✓		✓	PLASTIC CHAIR		
26								0	22	20	25	19			✓	✓		METAL CHAIR, GROUNDED		
27								0	-.8	-.8	-.8				✓		✓	METAL CHAIR, GROUNDED		
28																				
29																				
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INSTRUMENTATION DATA
TABULATION SHEET

	Tested By	GARMENT TYPE	GARMENT ITEM NO	DATE 1971	ATMOSPHERE C° TEMP	ATMOSPHERE % RH	STATIC CHARGE (VOLTS) GUN Trouser	GUN Garment	HAND DISCHARGE ELECTROMETER TYPE 610B				SHOES		MEAS. MADE ON		TYPE OF OPERATION	NOTES ADDITIONAL READINGS (IF ANY)	BEFORE WASHING TESTS IN BATCH
													INSUL	COND	GARMENT	SHOE COND			
1	VanSanten	Cotton	E	10/1	21.1	19	0	0	500	550	140	100	✓		✓		WALKING ON PLATE		
2		Coveralls					0	0	70	100	100		✓			✓	WALKING ON PLATE		
3		Old, With					4K	4K	5K	4.8K	4.2K		✓		✓		PLASTIC CHAIR		
4		Flame Proof					4K	4K	4K	4K	5.2K		✓			✓	PLASTIC CHAIR		
5							0	0	60	380	260		✓		✓		METAL CHAIR, GROUNDED		
6							0	0	600	600	50		✓			✓	METAL CHAIR, GROUNDED		
7																			
8							0	0	5	5	4			✓	✓		WALKING ON PLATE		
9							0	0	0	0	0			✓		✓	WALKING ON PLATE		
10							0	0	100	130	60	65		✓	✓		PLASTIC CHAIR		
11							0	0	0	0	0			✓		✓	PLASTIC CHAIR		
12							0	0	5	9	11			✓	✓		METAL CHAIR, GROUNDED		
13							0	C	-.8	-.8	-.8			✓		✓	METAL CHAIR, GROUNDED		
14																			
15																	WALKING ON PLATE		
16																	WALKING ON PLATE		
17																	PLASTIC CHAIR		
18																	PLASTIC CHAIR		
19																	METAL CHAIR, GROUNDED		
20																	METAL CHAIR, GROUNDED		
21																			
22																	WALKING ON PLATE		
23																	WALKING ON PLATE		
24																	PLASTIC CHAIR		
25																	PLASTIC CHAIR		
26																	METAL CHAIR, GROUNDED		
27																	METAL CHAIR, GROUNDED		
28																			
29																			
30																			
31																			
32																			
33																			
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...STATION DATA

TABULATION SHEET

Tested By	GARMENT TYPE	GARMENT ITEM NO.	DATE 19??	ATMOSPHERIC C°	ATMOSPHERIC %	STATIC CHARGE (VOLTS) GUN Louver	GUN Garment	HAND DISCHARGE ELECTROMETER TYPE 610B			SHOES INSUL	SHOES COND	MEAS MADE ON INSUL	MEAS MADE ON COND	TYPE OF OPERATION	NOTES ADDITIONAL READINGS (VOLTS)	NOTES BEFORE WASH TESTS IN BOLD
				TEMP	RH												
Van Sumner	Regulat	A	10/1	21.1	19						✓		✓		WALKING ON PLATE		
	Coat, F4X										✓			✓	WALKING ON PLATE		
	Work Rite							5K	6.8K	8.3K	8K	✓		✓		PLASTIC CHAIR	PANTS OFF
								5K	6.4K	7.0K	6.5K	✓			✓	PLASTIC CHAIR	↓
								300/200	230	520	450	✓		✓		METAL CHAIR, GROUNDED	
								250	500	520		✓			✓	METAL CHAIR, GROUNDED	
																	PANTS OFF
Van Sumner	COVERALLS	B	10/1	21.1	19	5K		4K	7.5K			✓		✓		PLASTIC CHAIR	↓
	99% NOMEX					4.5K		4.5K	6.9K			✓			✓	PLASTIC CHAIR	
	1% SS					-500	0	90	110				✓	✓		PLASTIC CHAIR	
	WORKLON					0	0	0	0				✓		✓	PLASTIC CHAIR	

I... DENTATION DATA

TABULATION SHEET

SPECIAL TEST - BLACK CONDUCTIVE LINOLEUM

	Tested By	GARMENT TYPE	ITEM NO.	Date 1974	Atmosphere Temp °C	Atmosphere RH	GUN	STATIC CHARGE (VOLTS) VOLTMETER TYPE 610B				SHOES UNSUL	SHOES COND	SHOES OTHER	FLOOR SURFACE MEAS INSUL	FLOOR SURFACE MEAS GROUND COND	FLOOR SURFACE MEAS GROUND OTHER	RESISTANCE	TYPE OF OPERATION TESTS PERFORMED IN BLDG. 1806	NOTES PRIOR TO 10 WASHINGS 83208
1	VanSumeren	Regular	2	10/2	22.8	27		200	100	-220	0	✓			✓				WALKING ON LINOLEUM	All measurements were made on black
2		Coat Eye						250	-340	0		✓				✓			WALKING ON LINOLEUM	conductive linoleum which was either
3								200	-140	60		✓			✓				WALKING ON ASBESTOS FLOOR	grounded or ungrounded (insulated).
4								-130	-240	70		✓				✓			WALKING ON ASBESTOS FLOOR	
5								2.5K	3K	3K		✓			✓				PLASTIC CHAIR	First reading was 9 kV.
6								2.6K	700	-700		✓				✓			PLASTIC CHAIR	
7																				
8																				
9								-12	-3.9				✓		✓				WALKING ON LINOLEUM	
10								.8	-.8				✓			✓			WALKING ON LINOLEUM	
11								-3.1	-4.6				✓		✓				WALKING ON ASBESTOS FLOOR	
12								-2.3	-2.3				✓			✓			WALKING ON ASBESTOS FLOOR	
13								2	7	12			✓		✓				PLASTIC CHAIR	
14								6.5	4.5				✓			✓			PLASTIC CHAIR	
15																				
16																				
17																				
18																				
19	VanSumeren	Cotton	C	10/2	22.8	27		-30	+32	-60	-44		✓		✓				WALKING ON LINOLEUM	
20		Coveralls						-32	+42	-90	-35		✓			✓			WALKING ON LINOLEUM	
21		New No.						-96	65	100	-200		✓		✓				WALKING ON ASBESTOS FLOOR	
22		Flame Proof						-220	-200	-120			✓			✓			WALKING ON ASBESTOS FLOOR	
23								2.5K	2.8K	1.2K			✓		✓				PLASTIC CHAIR	First reading was 5 kV
24								2.5K	1.5K	1.8K			✓			✓			PLASTIC CHAIR	
25																				
26																				
27								-.8	0					✓		✓			WALKING ON LINOLEUM	
28								1	2.5	2				✓		✓			WALKING ON LINOLEUM	
29								-.8	3.2	4.2				✓	✓				WALKING ON ASBESTOS FLOOR	
30								3.7	8	4				✓		✓			WALKING ON ASBESTOS FLOOR	
31								20	42	48				✓	✓				PLASTIC CHAIR	
32								18	15					✓		✓			PLASTIC CHAIR	
33																				
34																				
35																				
36																				
37																				

INSTRUMENTATION DATA
TABULATION SHEET

	Tested By	GARMENT TYPE	ITEM NO	DATE ATMOSPHERE 1974	C° TEMP	% RH	STATIC CHARGE (VOLTS) GUN TROUSER	GUN GARMENT	HAND DISCHARGE ELECTROMETER TYPE 110B			SHOES INSUL COND	MEASURE ON HANDS	MEASURE ON BODY COND	TYPE OF OPERATION	NOTES ADDITIONAL READINGS (VOLTS)	NOTES AFTER 10 WASHINGS 83206
1	VanSumeren	Rigelstat	1		25.5	27									WALKING ON PLATE		
2		Coat, F4X	"	10/16											WALKING ON PLATE		
3		Workrite	"						2.8K	1.2K	1.25K	✓		✓	PLASTIC CHAIR		
4									700	600	700	✓			PLASTIC CHAIR		
5									210	200	320	✓		✓	METAL CHAIR, GROUNDED		
6			"						120	110	0	✓			METAL CHAIR, GROUNDED		
7																	
8									-2.5	-.2	-1.0		✓	✓	WALKING ON PLATE		
9									-.4	-.4	-.4		✓		WALKING ON PLATE		
10									13	2	3		✓	✓	PLASTIC CHAIR		
11									2	2	5		✓		PLASTIC CHAIR		
12									-4	-5	+4	1	✓	✓	METAL CHAIR, GROUNDED		
13									3	2	-2		✓		METAL CHAIR, GROUNDED		
14																	
15	VanSumeren	Rigelstat	2	10/18	26.7	26.5			70	110	110	✓		✓	WALKING ON PLATE		
16		Coat, F4X							320	200		✓			WALKING ON PLATE		
17		Workrite							630	580	830	✓		✓	PLASTIC CHAIR		
18									500	1.2K	750	✓		✓	PLASTIC CHAIR		
19									-70	100	250	✓		✓	METAL CHAIR, GROUNDED		
20									70	140	110	✓		✓	METAL CHAIR, GROUNDED		
21			"														
22				10/17	26.7	27			2	0	2				WALKING ON PLATE		
23															WALKING ON PLATE		
24									-5	4.5	6				PLASTIC CHAIR		
25									-1	-1	-1	-.7			PLASTIC CHAIR		
26									-.7	-.7	-.7				METAL CHAIR, GROUNDED		
27									-2.2	+1.5	-3A				METAL CHAIR, GROUNDED		
28																	
29																	
30																	
31																	
32																	
33																	
34																	
35																	
36																	
37																	

INSTRUMENTATION DATA
TABULATION SHEET

	Tested By	GARMENT TYPE	ITEM NO	Date 1974	Atmosphere C° Temp	% RH	GUN Trouser	GUN Garment	STATIC CHARGE (VOLTS) HAND DISCHARGE ELECTROMETER TYPE 610B				SHOES INSUL	SHOES COND	MEAS MADE ON INSUL	MEAS MADE ON COND	TYPE OF OPERATION	NOTES ADDITIONAL READINGS (VOLTS)	NOTES AFTER 10 WASHINGS B3208
1	VanSavage	R. egelstat	3	10/18	26.7	25			180	600	520		✓		✓		WALKING ON PLATE		
2		Coat, F4X							430	500	100		✓			✓	WALKING ON PLATE		
3		Workrite							1.4K	1.33K	1.2K		✓		✓		PLASTIC CHAIR		
4									900	1K	900		✓			✓	PLASTIC CHAIR		
5									200	400	500	550	✓		✓		METAL CHAIR, GROUNDED		
6									170	160	400	600	✓			✓	METAL CHAIR, GROUNDED		
7																			
8									-5.5	-1	-4.5			✓	✓		WALKING ON PLATE		
9									-1	-1	-1			✓		✓	WALKING ON PLATE		
10									2.5	4	3	1.5		✓	✓		PLASTIC CHAIR		
11									-.7	-.7	-.7			✓		✓	PLASTIC CHAIR		
12									-5.5	-3	-4			✓	✓		METAL CHAIR, GROUNDED		
13									-2.5	-.8	-.8			✓		✓	METAL CHAIR, GROUNDED		
14																			
15	VanSavage	R. egelstat	A	10/17	26.7	27											WALKING ON PLATE		
16		Coat, F4X															WALKING ON PLATE		
17		Workrite							450	700	400		✓		✓		PLASTIC CHAIR		
18									150	-120	550		✓			✓	PLASTIC CHAIR		
19									230	290	240		✓		✓		METAL CHAIR, GROUNDED		
20									200	130	260		✓			✓	METAL CHAIR, GROUNDED		
21																			
22																	WALKING ON PLATE		
23																	WALKING ON PLATE		
24									8	12	1.5	5.5		✓	✓		PLASTIC CHAIR		
25									-.7	.7	.7			✓		✓	PLASTIC CHAIR		
26									-5.5	-4.2	+3	-6		✓	✓		METAL CHAIR, GROUNDED		
27									-.5	-1	-.5			✓		✓	METAL CHAIR, GROUNDED		
28																			
29																			
30																			
31																			
32																			
33																			
34																			
35																			
36																			
37																			

INSTRUMENTATION DATA
TABULATION SHEET

	Tested By	GARMENT TYPE	ITEM NO	Date 1974	ATMOSPHERE C° TEMP	% RH	STATIC CHARGE (VOLTS) GUN Trouser	GUN Garment	HAND DISCHARGE ELECTROMETER TYPE 6108	SHOES INSUL	SHOES COND	MEAS. MADE ON INSUL	MEAS. MADE ON % COND	TYPE OF OPERATION	NOTES ADDITIONAL READINGS (VOLTS)	NOTES AFTER 10 WASHINGS B3208
1	VanSomeren	99% NOMEX	B	10/17	25.5	29.5								WALKING ON PLATE		
2		1% SS												WALKING ON PLATE		
3		COVERALLS							400 450 350	✓		✓		PLASTIC CHAIR		
4		WORKLOG							-200 750 200	✓			✓	PLASTIC CHAIR	(850, 350	650, 300 OCT 18 25% RH)
5									-170 -120 -200	✓		✓		METAL CHAIR, GROUNDED		
6									-220 -150 -240	✓			✓	METAL CHAIR, GROUNDED		
7																
8														WALKING ON PLATE		
9														WALKING ON PLATE		
10			B						4 5.5 5		✓	✓		PLASTIC CHAIR		
11									-1 -.5 -.5		✓		✓	PLASTIC CHAIR		
12									-5 +1 2		✓	✓		METAL CHAIR, GROUNDED		
13									-.8 -.7 -.7		✓		✓	METAL CHAIR, GROUNDED		
14																
15		COTTON	E	10/17	24.7	30								WALKING ON PLATE		
16		COVERALLS												WALKING ON PLATE		
17		OLD, WITH							470 370 450	✓		✓		PLASTIC CHAIR		
18		FLAMEPROOF							300 350 370	✓			✓	PLASTIC CHAIR		
19									60 155 55	✓		✓		METAL CHAIR, GROUNDED		
20									-10 -10 -10	✓			✓	METAL CHAIR, GROUNDED		
21																
22														WALKING ON PLATE		
23														WALKING ON PLATE		
24									6 6 5		✓	✓		PLASTIC CHAIR		
25									-1 -.6 -.6		✓		✓	PLASTIC CHAIR		
26									-3 1.5 -2.3		✓	✓		METAL CHAIR, GROUNDED		
27									.7 -.6 -.7		✓		✓	METAL CHAIR, GROUNDED		
28																
29																
30																
31																
32																
33																
34																
35																
36																
37																

INSTRUMENTATION DATA
TABULATION SHEET

	Tested By	GARMENT TYPE	GARMENT ITEM NO	DATE 1974	ATMOSPHERE C° TEMP	ATMOSPHERE % RH	STATIC CHARGE (VOLTS) GUN TROUSER	STATIC CHARGE (VOLTS) GUN GARMENT	STATIC CHARGE (VOLTS) HAND DISCHARGE ELECTROMETER TYPE 610B			SHOES MSDR	SHOES LOND	MEAS. MADE ON UNINSL	MEAS. MADE ON INSUL	TYPE OF OPERATION	NOTES ADDITIONAL READINGS (VOLTS)
1	VanSamet	Cotton	F	10/18	26.1	25			500	400		✓		✓		WALKING ON PLATE	CONTROL
2		Coveralls							-70	600	450	✓			✓	WALKING ON PLATE	
3		New, No							2.8K	2.2K	2.2K	✓		✓		PLASTIC CHAIR	
4		Flame Proof							2K	2.2K	-300 ESD	✓			✓	PLASTIC CHAIR	6.5K, 4K, 3.5K oct.18 25% RH)
5		(CONTROL)							1.5K	1.7K	2.1K	✓		✓		METAL CHAIR, GROUNDED	
6									3K	1.8K	1.8K	✓			✓	METAL CHAIR, GROUNDED	
7																	
8									2.2	2.5	3.2		✓	✓		WALKING ON PLATE	
9									-.7	-.7			✓		✓	WALKING ON PLATE	
10									.8	3.7	16 4		✓	✓		PLASTIC CHAIR	
11									-1	-.5	-.3		✓		✓	PLASTIC CHAIR	
12									25	22	20		✓	✓		METAL CHAIR, GROUNDED	
13									-.7	-.7	-.7		✓		✓	METAL CHAIR, GROUNDED	
14																	
15																	
16																WALKING ON PLATE	
17																WALKING ON PLATE	
18																PLASTIC CHAIR	
19																PLASTIC CHAIR	
20																METAL CHAIR, GROUNDED	
21																METAL CHAIR, GROUNDED	
22																	
23																WALKING ON PLATE	
24																WALKING ON PLATE	
25																PLASTIC CHAIR	
26																PLASTIC CHAIR	
27																METAL CHAIR, GROUNDED	
28																METAL CHAIR, GROUNDED	
29																	
30																	
31																	
32																	
33																	
34																	
35																	
36																	
37																	

DISSIPATION DATA
SULATION SHEET

	Tested By	GARMENT TYPE	ITEM NO.	Date 1974	Atmosphere C° TEMP	R.H.	GUN	STATIC CHARGE (VOLTS) VOLTMETER TYPE 610B					SHOES INSUL	SHOES COND	SHOES OTHER	FLOOR SURFACE MEAS MADE ON INSUL	FLOOR SURFACE MEAS MADE ON COND	FLOOR SURFACE MEAS MADE ON OTHER	RESISTANCE	TYPE OF OPERATION	NOTES ADDITIONAL READINGS(VOLTS)	NOTES AFTER TEN WASHINGS TESTS IN B 3109
1	VAN SANTEN	Regulat	1	230.C	21.1	19		-200	-100	200	200	350	✓				✓			PLASTIC CHAIR	350	
2		Cont FYR																				
3		WORKRITE																				
4																						
5	VAN SANTEN	COVERALLS	B	230C	21.1	19		-200	-300	-100			✓				✓			PLASTIC CHAIR		
6		99% MODACR																				
7		1% SS.																				
8		WORKLON																				
9																						
10	VAN SANTEN	COTTON	F	230C	21.1	19		8K	9K	6K	7.5K		✓				✓			PLASTIC CHAIR		CONTROL
11		COVERALLS																				UNWASHED
12		NOW, NO																				
13		FLAME PROOF																				
14		(CONTROL)																				
15																						
16	VAN SANTEN	COTTON	C	230.C	21.1	19		2.4K	1.9K	1.9K	2.0K		✓				✓			PLASTIC CHAIR		
17		COVERALLS																				
18																						
19																						
20																						
21																						
22	VAN SANTEN	COVERALLS	G	230C	21.1	19		3.5K	2.5K	3K			✓				✓			PLASTIC CHAIR		CONTROL
23		99% MODACR																				UNWASHED
24		1% SS.																				
25		WORKLON																				
26																						
27																						
28																						
29																						
30																						
31																						
32																						
33																						
34																						
35																						
36																						

APPENDIX C

RELATIVE RESISTIVITY OF TEST GARMENTS

INSTRUMENTATION DATA

TABULATION SHEET

MATERIAL OR GARMENT	ITEM NO	24°C PRIOR TO TEN WASHINGS - OHMS 37 TO 40 % RH, 75 °F B3208 VOLT/CURRENT	RESISTANCE	SIMPSON VOM	PRIOR TO TEN WASHINGS 21.1°C 19 % RH, 70°F B7109 OHMS VOLT/CURRENT	RESISTANCE	SIMPSON VOM	AFTER TEN WASHINGS 24 TO 26.7C° 25 % RH, 75 TO 80 F° OHMS B3208 VOLT/CURRENT	RESISTANCE	SIMPSON VOM	NOTES
HIGH RESISTANT RUBBER PLATFORM	—	6 X10[14]			2 X10[14] (1000 VOLTS)			10^{14} (1000 VOLTS)			
Riegelstat Coat F4X	1	*	20K	3K ⊕	*	*	110K	*	*	20 Meg	
Riegelstat Coat F4X	2	1.41 X10[9]	*	20 Meg + 470 ⊕	*	*	170K	*	*	115 +	
Riegelstat Coat F4X	3	*	100K	800 ⊕ 150 ⊕	*	*	130K	*	*	115 +	
Riegelstat Coat F4X	A	*	*	600 ⊕	*	*	110K	*	*	240 +	
NOMEX plus 1% G.S. COVER ALLS	B	*	*	20 Meg	4.175 X10[9] (100 VOLTS)	2.8 X10[11]	>20 Meg	*	47K	20 Meg + 590 ⊕	
COTTON COVERALLS, NEW NO FLAME PROOF	C	1.25 X10[9]			333 X10[12] (1000 VOLTS)			4.3 X10[5] (900 VOLTS)	2.5 X10[8]	5 Meg	
COTTON COVERALLS, NEW WITH FLAME PROOF	D	1.66 X10[6]			2 X10[9] (100 VOLTS)	26 X10[9]		6 X10[5] (100 VOLTS)	7.6 X10[5]	5 Meg	
COTTON COVERALLS, OLD WITH FLAME PROOF	E	134K			1.66 X10[6] (100 VOLTS)			1.28 X10[5] (300 VOLTS)	5.9 X10[5]	5 Meg	

Key: * BEYOND RANGE OF ELECTROMETER

\+ INITIAL READING PRIOR TO CURRENT AND RESISTANCE TESTS

⊕ AFTER CURRENT AND RESISTANCE TESTS

NOTE : THE COTTON COVERALLS WERE TREATED WITH FLAME PROOFING AFTER EACH WASHING

THE RIEGELSTAT SAMPLE PATCHES WERE NOT WASHED

SWUPA-TS Form 1666 Oct 72

APPENDIX D

CAPACITANCE MEASUREMENTS OF TEST SUBJECT

CAPACITANCE MEASUREMENTS OF TEST SUBJECT

1. Insulated Spark Proof Shoes

Capacitance (Picofarads) Measurement Plate was		Test Performed in Building	
Grounded	Ungrounded	3208	3109
110	108	x	-
120	120	-	x
110	110	-	x

2. Conductive Shoes

Capacitance (Picofarads) Measurement Plate was		Test Performed in Building	
Grounded	Ungrounded	3208	3109
1380	-	x	-
1520	-	x	-
4600	3770	-	x
3470	-	-	x

3. Test Subject Capacitance Standing on Asbestos Floor Tile

Capacitance (Picofarads) Shoes		Test Performed in Building
Insulated	Conductive	
100	140	3208

4. Capacitance Measurement Plate

The measurement plate is a copper sheet 91.4 x 244 cm (3 x 8 ft) which lays on, and is insulated from, two sheets of polyethylene. For this test the copper sheet is ungrounded (insulated). Test performed in Bldg. 3109.

C = 12,300 picofarads

5. Capacitance of Test Subject Standing on Polyethylene Sheet

A polyethylene sheet was placed over the copper plate on which test subject stood and a capacitance measurement was taken. Test performed in Bldg. 3208.

C = 1200 picofarads

APPENDIX E

HAND TO GROUND THROUGH SHOE RESISTANCE MEASUREMENT OF TEST SUBJECT

HAND TO GROUND THROUGH SHOE RESISTANCE MEASUREMENT OF TEST SUBJECT

1. Insulated, Spark Proof Shoes

Metal Floor Grounded	Insulated from Ground
4×10^{11} ohms	10^{12} to 10^{13} ohms

2. Conductive Shoes

Metal Floor	
Grounded	Ungrounded
500K ohms 700K ohms 900K ohms	n/a

APPENDIX F

EQUIPMENT

EQUIPMENT

1. Electrical

a. Electrometer, Model 610B, including probe Model 6103A (1000:1) and probe model 6101A (1:1). Manufactured by Keithley Instruments.

b. High Voltage Power Supply Model 240A, manufactured by Keithley Instruments

c. Impedance Bridge, Type No. 1650A, manufactured by General Radio Co.

d. VOM, Simpson Model 260

e. Static Meter, Model CMI-7777, manufactured by Custom Materials, Inc., Chelmsford, Massachusetts

2. Accessories

a. Conductive shoes, Government issue

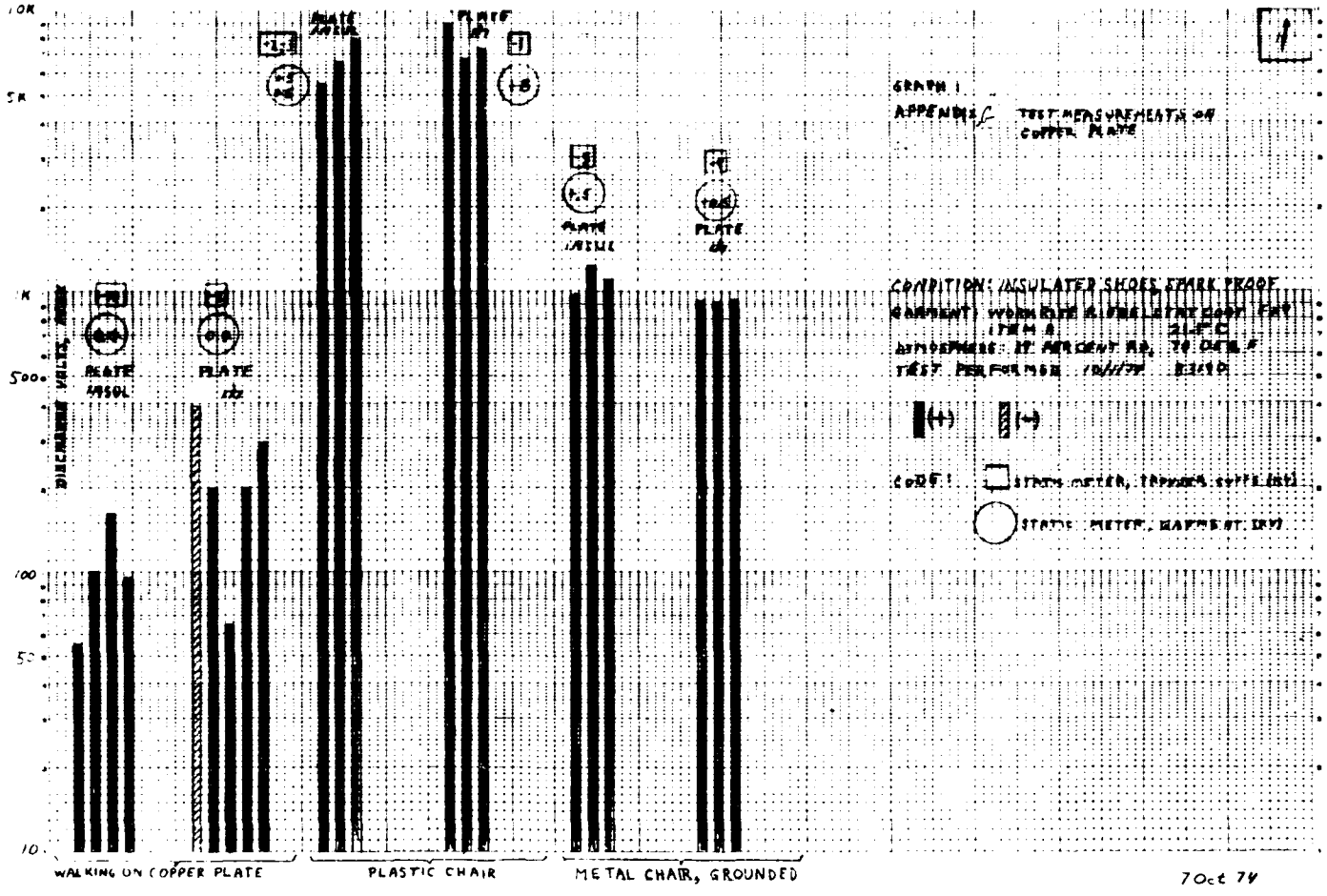
b. Insulated shoes, spark proof, Government issue

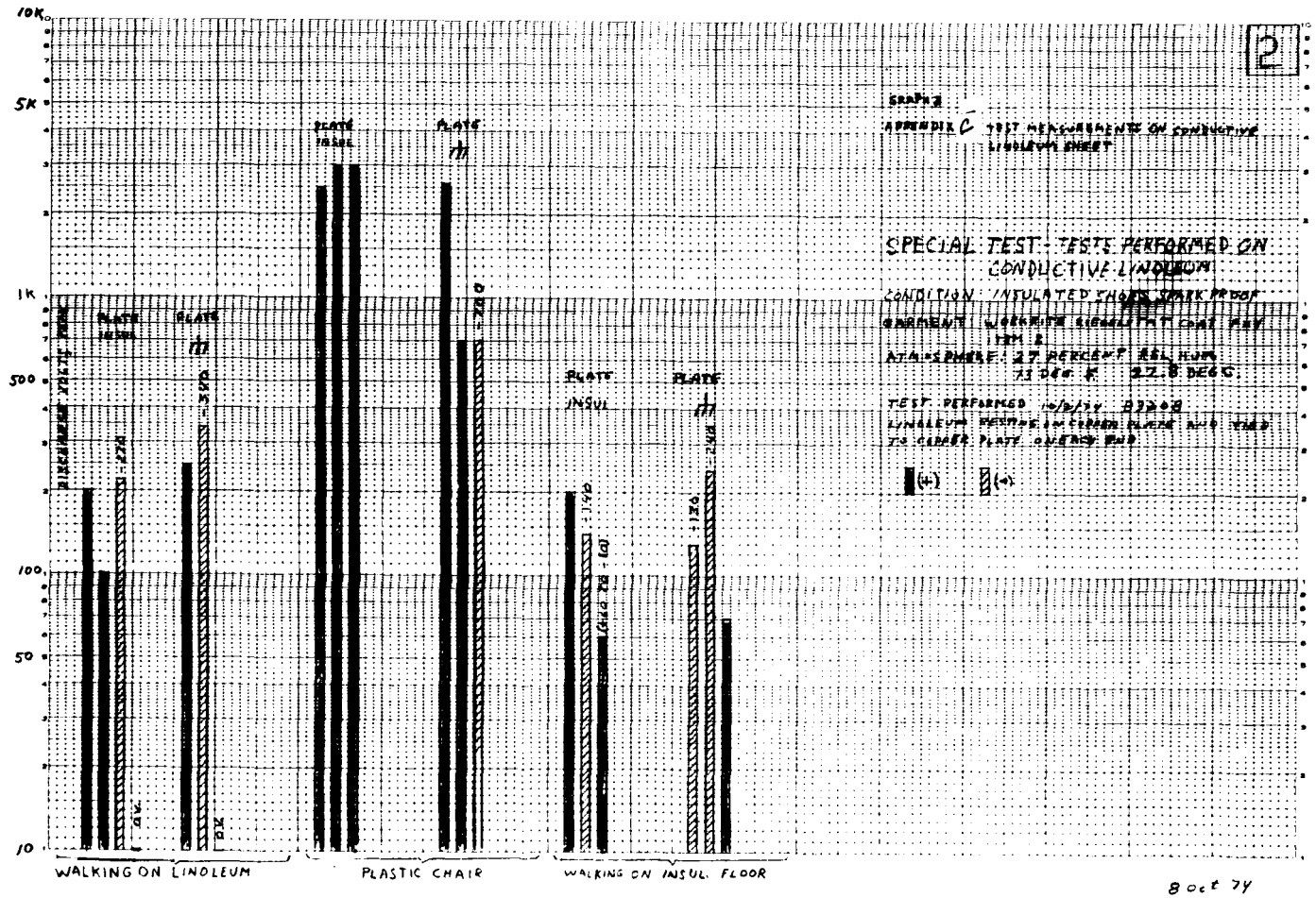
c. Copper plate 8.128 mm (.032 in.) thick, 91.4 x 244 cm (3 x 8 ft)

d. Two each polyethylene sheets 5.08 mm (.020 in.) thick, 122 x 274 cm (4 x 9 ft)

APPENDIX G

ELECTROSTATIC HAND DISCHARGE


10K
5K
1K
500
100
50
10
WALKING ON COPPER PLATE
PLASTIC CHAIR
METAL CHAIR, GROUNDED
GRAPH 1
APPENDIX C
COPPER PLATE
CONDITION: INSULATED SHOES SPARK PROOF
(+)
(-)
7 Oct 74


10K
5K
1K
500
100
50
10
2
GRAPH 2
APPENDIX C TEST MEASUREMENTS ON CONDUCTIVE LINOLEUM SHEET
SPECIAL TEST - TESTS PERFORMED ON CONDUCTIVE LINOLEUM
CONDITION INSULATED SHOES SPARK PROOF
GARMENT WORKING GARMENT ITEM 2
ATMOSPHERE 27 PERCENT REL HUM 23 DEG F 22.8 DEG C
TEST PERFORMED 10/8/74 0730
LINOLEUM MEASURED BETWEEN PLATE AND TIED TO COPPER PLATE OVERLAY END
PLATE INSUL
PLATE
PLATE INSUL
PLATE
PLATE INSUL
PLATE
WALKING ON LINOLEUM
PLASTIC CHAIR
WALKING ON INSUL. FLOOR
8 OCT 74

APPENDIX H

COMPARISON OF ELECTROSTATIC HAND DISCHARGE OF TEST GARMENTS

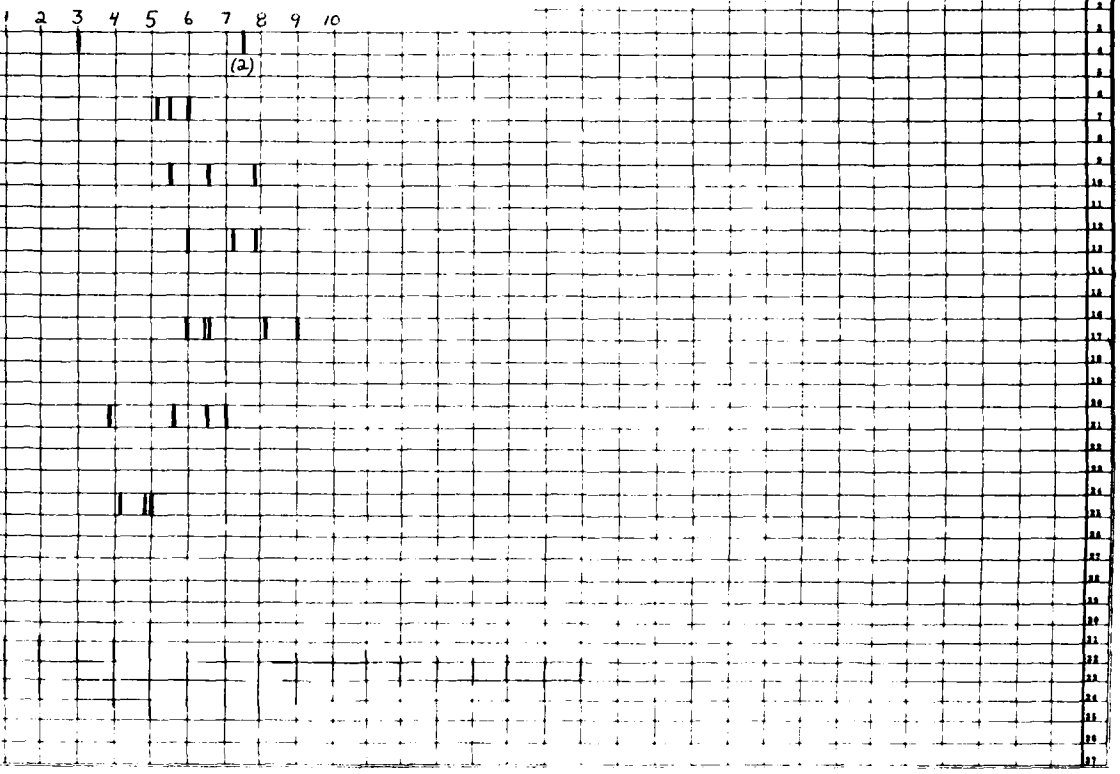
INSTRUMENTATION DATA
TABULATION SHEET

GARMENT 19% RH, 70° F 21.1°C	Item No.
Riegelstat Coat F 4 X, WORKRITE	1
Riegelstat Coat F4X, WORK RITE	2
Riegelstat Coat F4X, WORK RITE	A
COVERALLS, 1 PC SS 99% NOMEX WORK LON	B
COTTON COVERALLS NEW, NO FLAME PROOF	C
COTTON COVERALLS NEW, WITH FLAME PROOF	D
COTTON COVERALLS OLD, WITH FLAME PROOF	E

PLASTIC CHAIR, MEASUREMENT PLATE UNGROUNDED (INSULATED)
PRIOR TO T&N WASHINGS

Tests performed 30 September and 1 October 1974 in Bldg. 3109

DISCHARGE KILOVOLTS, MAX INSULATED SHOES



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INSTRUMENTATION DATA
TABULATION SHEET

24 DEG.C NOM
35 TO 39% RH
75 DEG F (NOM)

PLASTIC CHAIR, MEASUREMENT PLATE UNGROUNDED (INSULATED)
DISCHARGE VOLTS, MAX INSULATED SHOES PRIOR TO TEN WASHINGS
Tests performed 12 September to 26 September 1974 in Bldg. 3206

GARMENT	Item No
Riegelstat Coat	1
F4X, WORK RITE	
Riegelstat Coat	2
F4X, WORK RITE	
Riegelstat Coat	3
F4X, WORK RITE	
Riegelstat Coat	A
F4X, WORKRITE	
COVERALLS 12SS	B
99% NOMEX	
WORKLON	
COTTON COVERALLS	C
NEW, NO FLAME PROOF	
COTTON COVERALLS	D
NEW WITH FLAME	
PROOF	
COTTON COVERALLS	E
OLD, WITH FLAME	
PROOF	

(2)
(2)
5) (3)
(3)

25 50 75 100 200 300 400 500 600 700 800 900 1K 1.1K DISCHARGE VOLTS MAX

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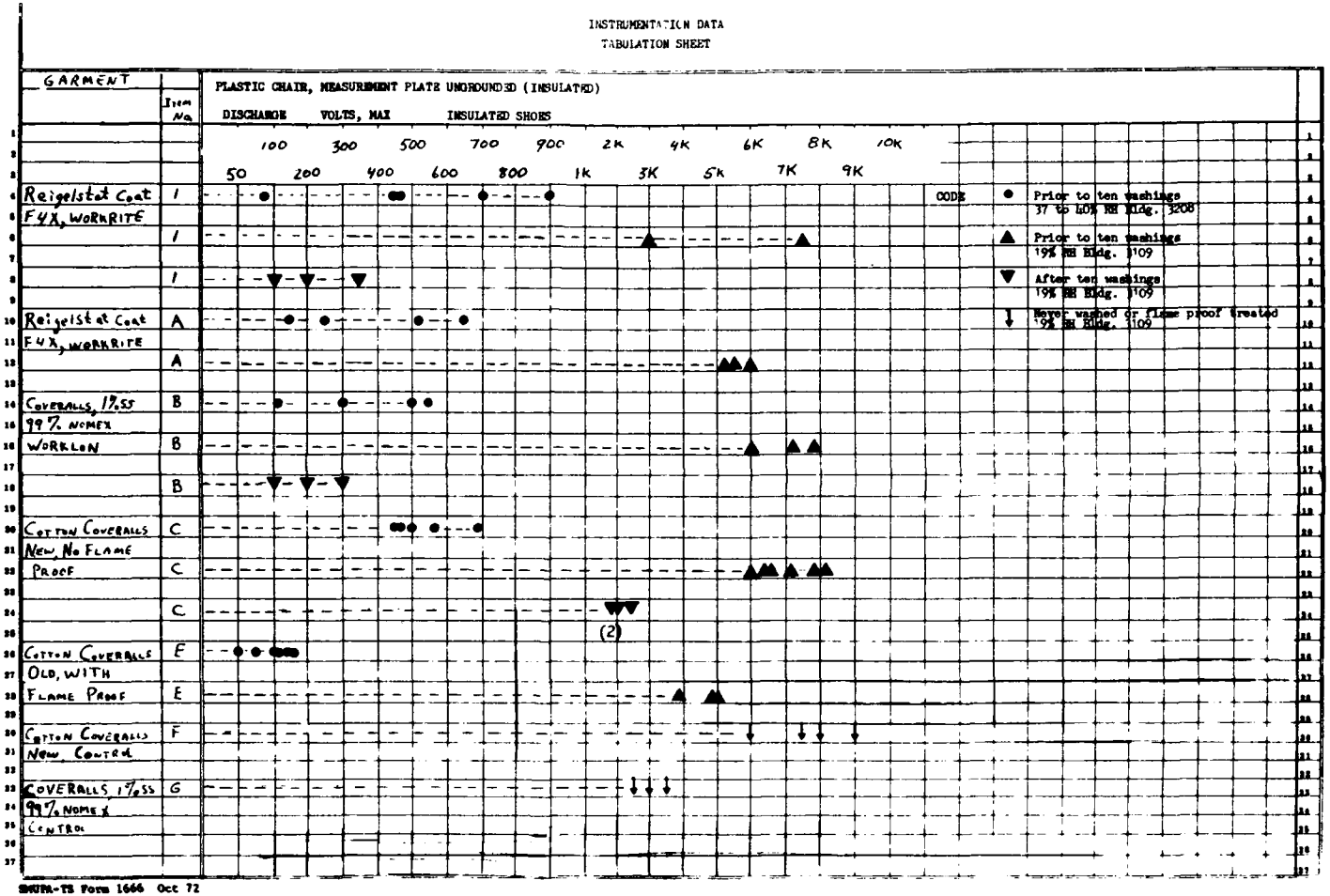
INSTRUMENTATION DATA
TABULATION SHEET



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