AD-A126 111 EVALUATION OF IN-PACKAGE PERFORMANCE OF ANTISTATIC MATERIALS(U) DARCOM PACKAGING STORAGE AND CONTAINERIZATION CENTER TOBYHANNA PA R MCGILL ET AL. NOV 80 1/1

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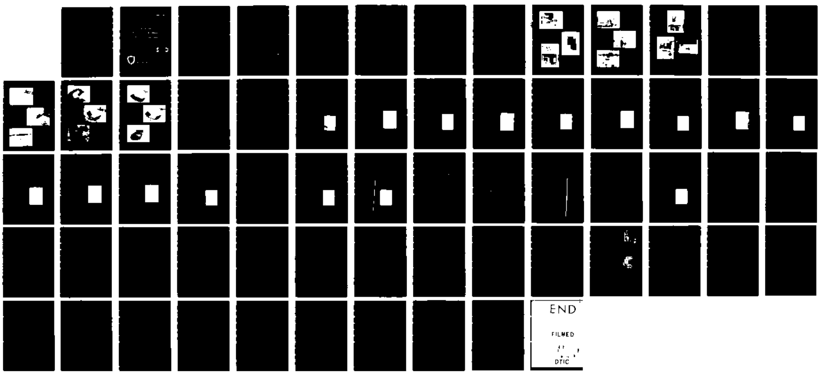

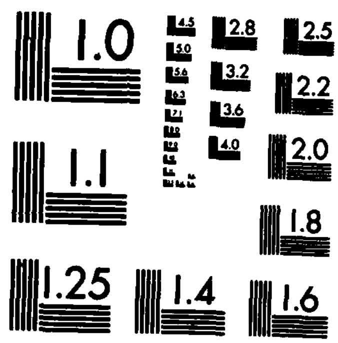


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

PROJECT REPORT

DARCOM LS-8-80

NOVEMBER 1980



# EVALUATION OF IN-PACKAGE PERFORMANCE OF ANTISTATIC MATERIALS

(PHASE I)

THE CONTENTS OF THIS REPORT HAVE BEEN REVIEWED AND APPROVED BY HQDARCOM



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ABSTRACT

This project originated as the result of three major concerns by the DARCOM Packaging, Storage, and Containerization Center (DARCOMPSCC). These were: (1) recognized deficiencies in current test methods and material specifications regarding static charge propensity of packaging materials, (2) responsibility of DARCOMPSCC in connection with lead service testing where static sensitive components are being packaged, and (3) actual experience by the Naval Sea Systems Command involving failures of low-voltage printed circuit boards (PCB).

Accomplishment of the project required the initial development of an "in-package performance" test procedure so that realistic simulations of transit, storage, and handling conditions could be achieved as a determinant of the reasons for the Navy-experienced failures. The failures had been occurring despite the use of intimate wraps of static-free cushioning material within desiccated sealed bags.

Successful establishment of the new procedure showed that static charge buildup was possible within the Navy's packs. It further showed that compliance with current specifications involved with electrostatic materials does not guarantee safety from electrostatic hazards always present in the distribution cycle. Where packaging materials do not benefit from the availability of direct grounding paths, some of the current common materials produced results equivalent or better than some of those claimed to be static free.

A packaging procedure is recommended for Navy's immediate use involving the use of opaque black conductive polyolefin in an intimate bag configuration enclosing low-voltage PCBs and cushioning protection utilizing transparent pink hexagonal shaped material, and negating the use of desiccant unless absolutely necessary.

This project was the initial phase of a two-part project; the second phase to address additional static-free materials, singly and in combination; and, the achievement of further refinements in the "in-package performance" procedure encompassing conditioning and more precise static voltage measurement using pack resonance concepts and variable humidity levels.

CONTENTS

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# EVALUATIONS OF IN-PACKAGE PERFORMANCE OF ANTISTATIC MATERIALS - PHASE I

Project Report DARCOM LS-8-80

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## 1. Introduction.

a. For the past several years, DARCOMPSCC has been concerned with the appropriateness of test methods for determining the in-package performance of static-sensitive components and the required associated packaging materials. These fears were prompted by two developments which have occurred simultaneously over a previous minimum 10-year period. The first has been the greatly accelerated usage of plastics in all forms for packaging; the second being the steadily increasing complexity and miniaturization of solid state electronic components. Regarding the latter, generally, the smaller the part, the less power it can dissipate, the thinner the insulating layers, and the more susceptible it is to static degradation. This sensitivity can produce immediate destruction of the component (whether alone or assembled into circuits) or it can allow damage which is not detectable until a later time when failure eventually occurs. Static-sensitive components include MOS, CMOS, FET, junctions, bi-polar and microwave diodes, and thick film precision resistors. The static charge itself may be produced by in-transit vibration which causes movement of both the item and intimately applied packaging materials both within unit packs and from outside sources. Static sources include the full range of the newer plastic packaging materials as well as packaging, handling, and user personnel associated with the life cycle of military components. Even the older, more common packaging materials (i.e., barriers, wraps, cushioning, and tapes) cannot be excluded as a potential static source.

b. Over this corresponding period of time, a number of specifications were either newly developed or modified in an attempt to offer static-free packaging materials which would serve as barriers against both the creation and the passage of static discharge to sensitive packaged components. In support of these documents, requirements and tests were developed geared primarily to the evaluation of flat samples of the questionable material. Unfortunately, such testing, although well-meaning, offered the user a false sense of security. This testing was intended to measure the speed with which an applied static charge on a material dissipates through an excellent ground path. In other words, the test charge was either perfectly held or perfectly freed. Between the two conditions, the time is measured as decay time and is considered the final indicator of static-free performance. Such a perfect set of conditions obviously does not exist within a package. Instead, various leakage paths are in evidence based on the combinations of materials inherent in the packaging method. In-package test methods therefore should be considered as a second and important supplemental step in determining the true effects of static charge on packaged components.

c. Aside from the previous realization of a need for static charge test methods improvement, this project was prompted essentially in response to the Naval Sea Systems Command regarding observed failures in shipments of low-voltage printed circuit boards. This damage was occurring despite the prescribed use of static-free packaging materials. Complete background in connection with this problem is referenced in this report as appendix A. The major objectives of this project were therefore established to:

(1) Evaluate specific Navy packaging methods currently prescribed for the problem PCBs.

(2) In accomplishing (1) above, develop a new test procedure which would improve reliability in simulating in-package performance.

(3) Determine the effect of desiccant in packaging methods dealing with static-sensitive components.

(4) Recommend appropriate changes to documents containing requirements for various static-free materials.

d. To accomplish the above, new concepts in test apparatus and systems had to be established to simulate transit and storage conditions. This project does not address the potential corrosive hazards which may exist with certain of the specially treated or constructed static-free materials.

e. There is certainly a wealth of information available identifying the hazards of static discharge. Such static awareness is fine where it culminates in remedial action against these effects. This has been accomplished effectively in areas of manufacturing of sensitive components. This project, however, based on its in-package emphasis, had to address essentially untried principles, since remedial actions were not available for the critical path from packager to user where components are electrically "floating" with varying degrees of isolation. Discussion within this project report will therefore intentionally refrain from unnecessary repetition of very technical data available from many different sources. Analysis of component damage through the use of electron microscopes does not assist this project in the quest for causes of in-transit and storage deficiencies.

## 2. Discussion.

a. Preliminary. It is only necessary to realize that the generation of static charges can be attributed to contact (rubbing) between a variety of dissimilar surfaces. This has resulted in observations in the form of the triboelectric series. This series lists various materials which exhibit different degrees or tendencies in retaining positive or negative static charges. Those materials which are furthest apart in the series generate the greater static charge. Most of the newer plastics, to include laminates, have a high propensity to negative charge; whereas human hair tends to be highly positive. Thus, as most of us have observed, rubbing of most plastics on the body will cause the hair to stand up on the skin. In actuality, a person walking across a carpet can generate from 10,000 to 40,000 volts. Walking across vinyl tile can generate 4,000 to 15,000 volts. The variables in these cases, of course, are the degree of rubbing or scuffing during walking, the relative humidity, composition of the shoes, and the kind of clothes worn. A relationship can be directly established in considering such buildup in packaging through transit vibration, materials in intimate contact, humidity levels within sealed barriers, and the kind of container utilized. Corona discharge[1] is another important factor in static charge propensity discussion. This effect results when a charge is dissipated through the air to a receptor. Relating this to our example of walking across a carpet, it can be recalled by most of us as the zap which occurs when our hand nears a doorknob. Without actually touching the knob, we felt the discharge and, in fact, could actually see it under darkened conditions. Again, a relationship exists where a package is exposed to a static discharge occurring in close proximity to the outer portion of the container, pouch, or bag. Essentially, these relationships established the testing methods which were adopted for this project. During the course of these tests, it is necessary to understand that 30-50 volts are sufficient to damage certain components. As stated previously, much data are available in this area and this voltage level is accepted for purposes of this project based on consensus opinions of manufacturers. However, voltages actually obtained through application of the two test methods in this report should only be considered in a comparative manner for determination of static charge propensity.

b. Test preparation. The instrumentation, environmental conditions, and simulated package configurations were based entirely on the considerations in a. above as well as the specific concerns cited by the Navy. Four variables were chosen as those which would be closely controlled. These were temperature, humidity, vibration, and standard outer pack materials. In the case of the latter, some materials changes were made to detect the overall effect of such changes. Figure 1 identifies the total setup to include the environmental chamber. Figures 2 and 3 provide more detailed views of the recording means used in the tests to follow. It should be noted that appendix B identifies the total listing of instrumentation and associated materials with specific references to individual components.

(1) Environmental. Within the standard temperature/vibration facility (ref 13, app B), steps were taken to also control humidity at low levels to insure an atmosphere conducive to testing for static charge propensity. This was effectively achieved with both static and dynamic dehumidification. Statically, 560 units of desiccant were placed in a "bed" isolated from the vibration table surface (see ref 14, app B, and fig 4). Dynamically, inlet and outlet portions of a dehumidifier (ref 11, app B) were channeled through an access port of the chamber. Using this technique, and following an approximate

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[1]For purposes of this report, corona discharge does not involve methods of air ionization; but only the presence of a static charge voltage detected in the vicinity of a high voltage plate.

Figure 1. Complete environmental and instrumentation setup.

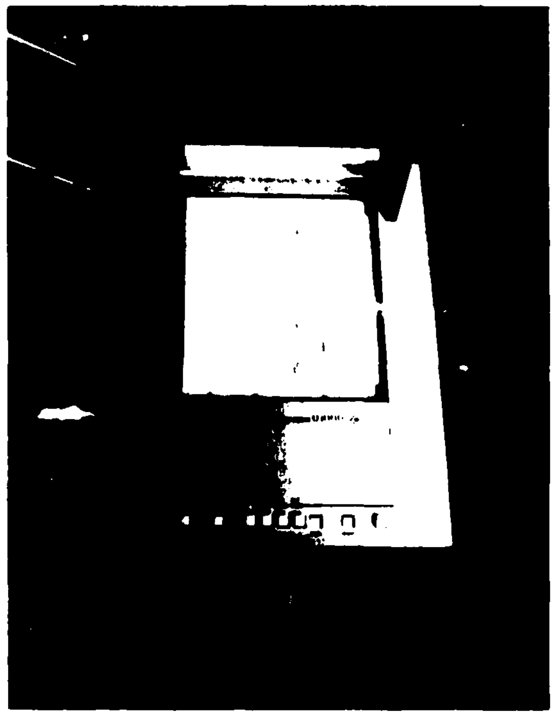


Figure 2. Chart recorder for static charge buildup during vibration.

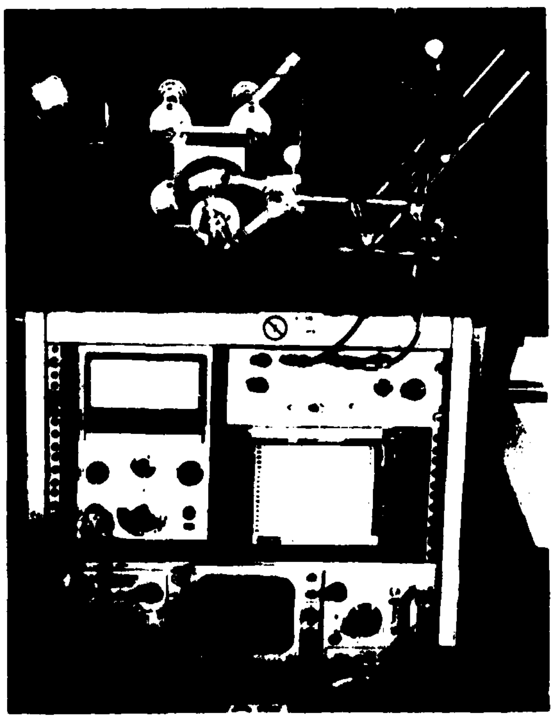


Figure 3. Console for all types of static charge testing.

Figure 4. Desiccant bed and dynamic dehumidification system (note arrow).

Figure 5. Humidity indicator showing between 15 and 20% RH.

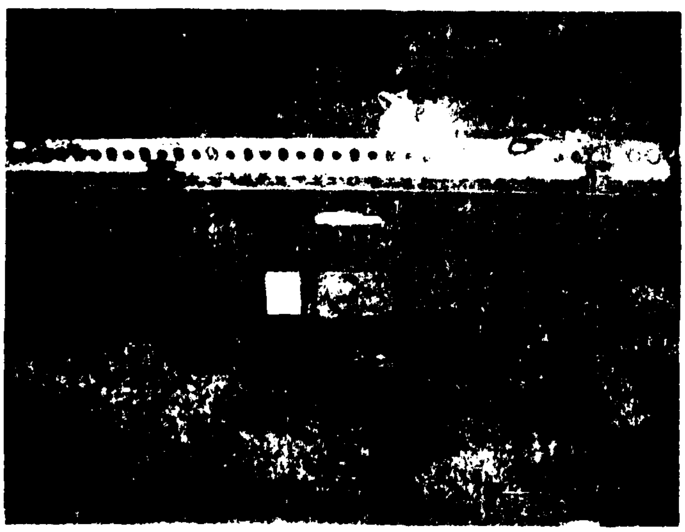


Figure 6. General view of test facility showing pack, hold-down for vibration, and area for specimen conditioning.

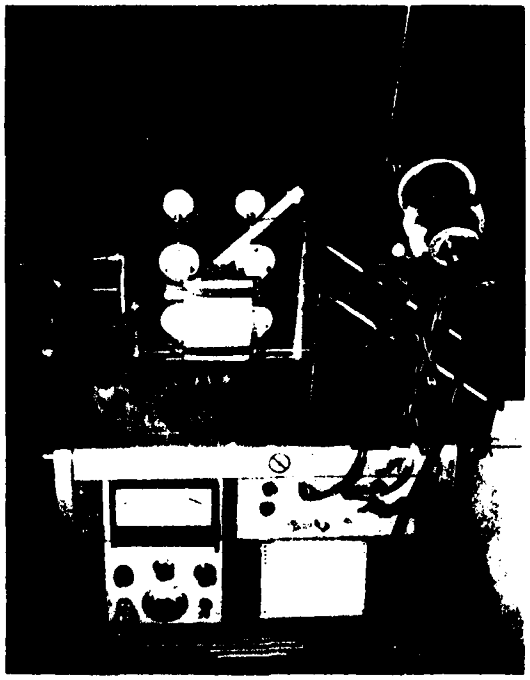


Figure 7. Portion of instrumentation for testing in accordance with Method 4046 and as high voltage switch for testing packs.

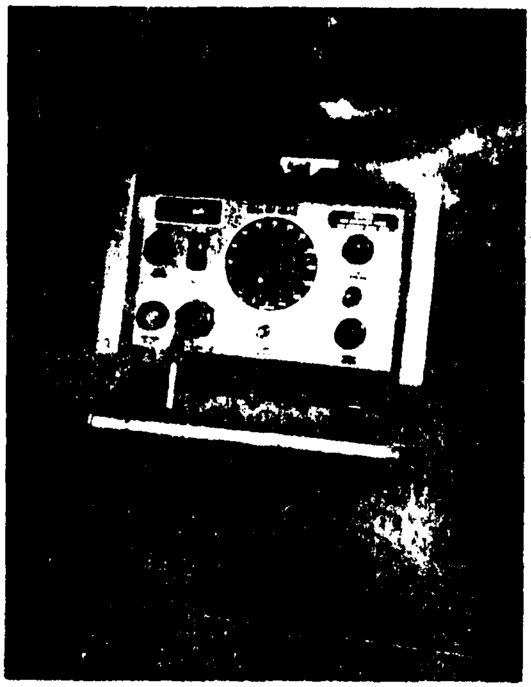


Figure 8. High voltage source, 50,000 volts maximum.

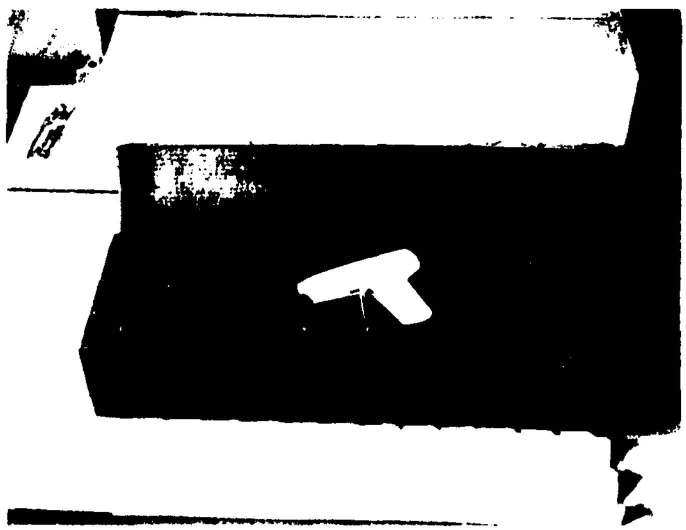


Figure 9. Hand-held static gun, 10,000 volts maximum.

2 days of chamber operation, a relative humidity (RH) was achieved ranging from 15 to 20 percent. With this humidity level and a constant vibration/temperature parameter of 28 Hz/100° F., excellent conditioning means were available. Figure 5 shows a typical RH reading (ref 9, app B). More accurate readings were maintained using an electronic hygrometer (ref 10, app B). Vibration was remotely controlled at the chart recorder and was imposed at designated times during the total test procedure. Figure 6 provides a general view of the relationship and placement of the tested packs within the environmental facility.

(2) Static charge sources. Aside from the anticipated buildup of stati charge caused by vibration conditioning (triboelectric), means were availat for simulating corona discharge. Figure 7 shows a standard electrostatic t chamber identical to the requirements referenced in Method 4046 of FTMS 1. For purposes of this project, the facility was used as a high voltage switch in connection with a dielectric tester (ref 5, app B, and fig 8). A hand-held static gun was used to neutralize package static charge conditions prior to vibration imposition (ref 5, app B, and fig 9).

(3) Static charge sensor. The most effective means for sensing the presence of static charge within packs was determined after many trials using specially constructed capacitive sensors, i.e., conductive plates separated by teflon insulators. The problem was that such a configuration does not simulate, in this case, a printed circuit board with its inherent variety of component shapes and characteristics. For these reasons, actual printed circuit boards were used and wired such that the boards themselves detected static charge voltages. The PCB sensor selected for use is shown in figure 10. The output was connected through shielded cable to the input of the electrometer (ref 2, app B) which in turn provided the output to the chart recorder (ref 1, app B). Output was also provided to a storage oscilloscope; this presentation was used primarily for corona discharge observations (ref 3, app B). Also, for this latter discharge test, a 4-inch by 6-inch plate was isolated from the tested packs (fig 11). This plate was made from standard 1/16-inch thick circuit board material with copper facing. A high voltage lead was soldered to the center of the outside plate face and attached to the static switching chamber (fig 12).

c. Tested materials. To insure initially that only one variable exists during subsequent materials testing, a standard fast pack was chosen as the outer pack. This pack, identified as NSN 8115-00-101-7647, was of appropriate dimension for containing the PCB sensor. Also, the convoluted polyurethane offered opportunity for reduced effects which might be anticipated due to different tested material thicknesses causing tightness of the total pack. The standard fiberboard used was W5c. Later testing, however, addressed the use of conductive corrugated fiberboard as a replacement sleeve for the standard (fig 13). Where feasible, all tested materials were sealed as bags enclosing the sensor. Figures 14 through 17 show representative preparations for testing a variety of these materials. Also tested were polystyrene and polyethylene foams as substitutes for the convoluted polyurethane. Figure 18 shows the required configuration for these tests. For ease of materials referencing, appendix C provides complete descriptions of the tested materials. Direct mentioning of manufacturer's trade names serves no useful purpose for this project since the primary intent is to be able to differentiate between material structures which have been developed to provide antistatic properties. Where materials have exhibited prior compliance to specifications, this reference is further indicated.

d. <u>Test method</u>. The adopted method for actual testing includes a number of precautions which were taken so that final results for the various materials could be used for valid comparisons. The Navy's concern for the effects of desiccated PCB packs was accounted for through the controlled humidity chamber. This simulated the humidity condition which could be anticipated within sealed bags. Other checks included the consistent placement of the bagged sensor for each test sequence, and the use of several runs to verify the "footprint" of each material combination. The method itself has already been identified through discussion in b and c above. However, the complete sequence of steps for vibration conditioning and data recording are identified as follows:

(1) [illegible] pack using selected materials for test.

(2) Vibration condition the pack for 5 minutes, with sensor ungrounded to electrometer.

(3) Ground sensor to [illegible]meter; select scale for test sequence to follow.

[illegible] ground and check for neutrality of pack using the [illegible] condition if [illegible] using the static gun. Once [illegible] 5 additional minutes with sensor grounded to electrometer.

[illegible] vibration, remove ground from sensor and operate chart [illegible] convenient plot length of 240 mm was selected). Monitor [illegible]

(6) [illegible] charge bleedoff, if any, for an approximate [illegible]

(7) [illegible] chart.

[illegible] tester at a setting of 10,000 volts; [illegible] sensor.

[illegible] rating on the correct scales or using the chart [illegible] tested), switch the 10,000 volt charge to the high-[illegible]

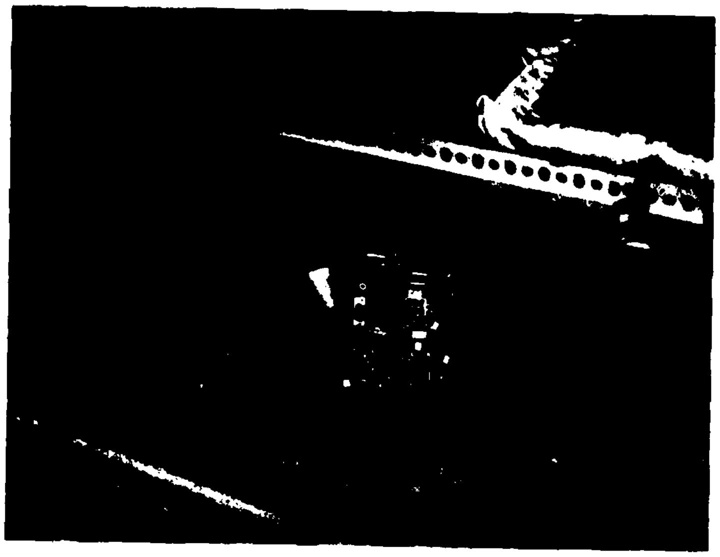
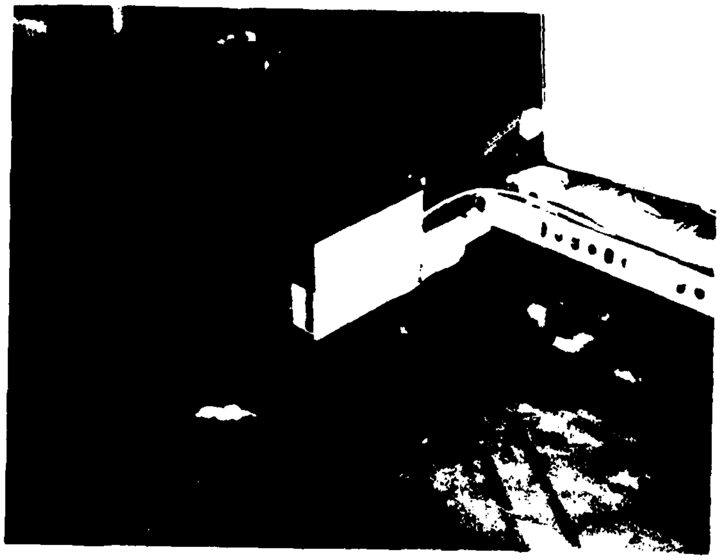


Figure 10. Actual circuit board used as electrometer sensor.

Figure 11. A detail view of the high-voltage charge plate.



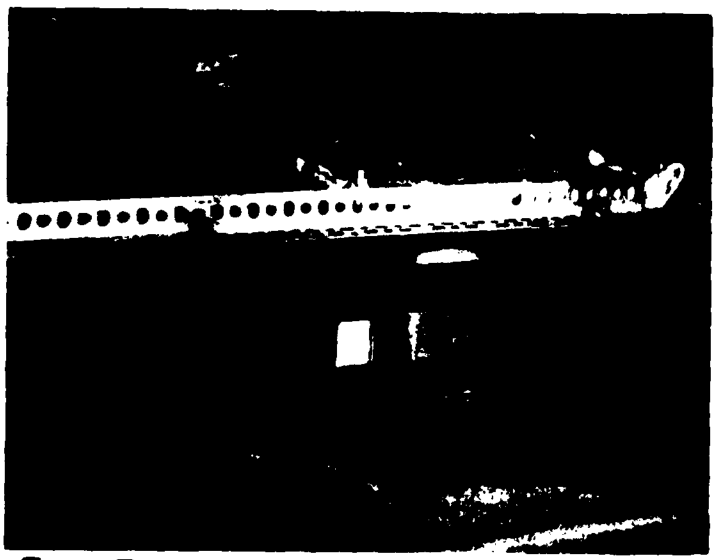


Figure 12. View showing the relationship of charge plate to the tested packs (plate maintained 3/8 of an inch from sleeve outer surface.

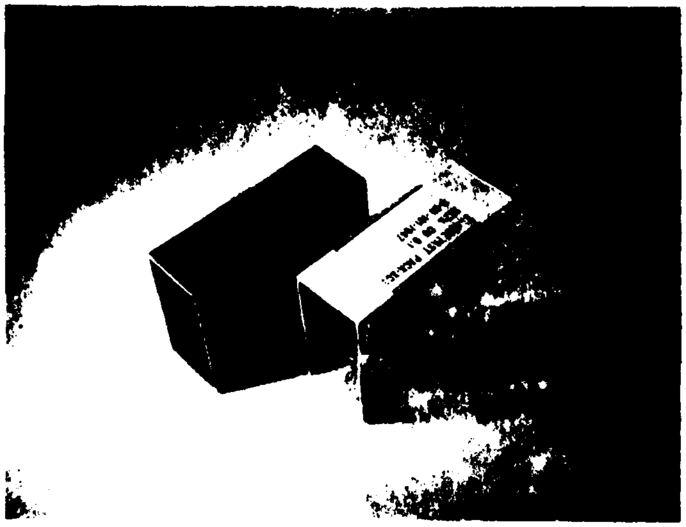
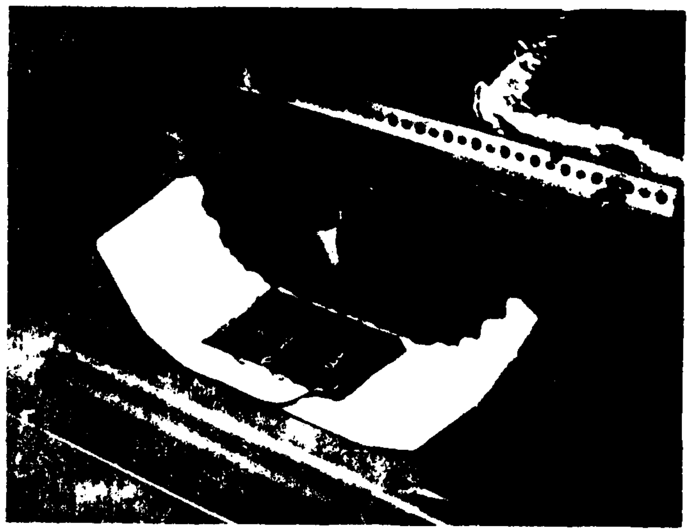


Figure 13. Two different materials used as fast pack sleeves during testing; the first, conductive fiberboard; the second, a standard W5c fiberboard.

Figure 14. Sensor sealed in conductive bag and placed in convoluted polyurethane foam insert as part of a fast pack container.



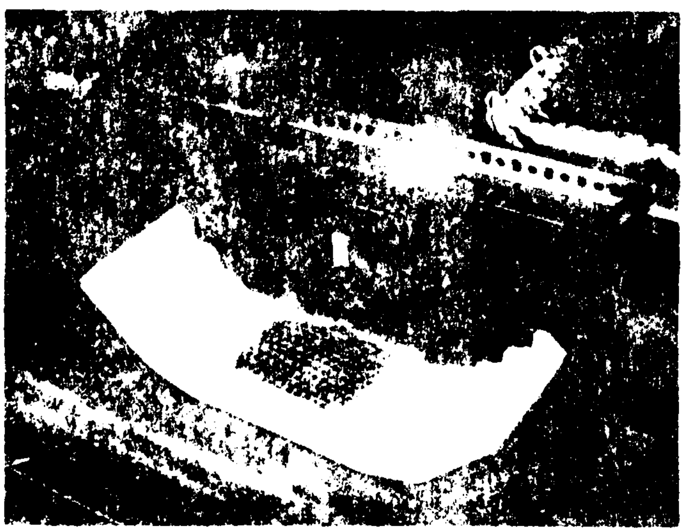


Figure 15. Sensor sealed in tested antistatic cushioned bag.

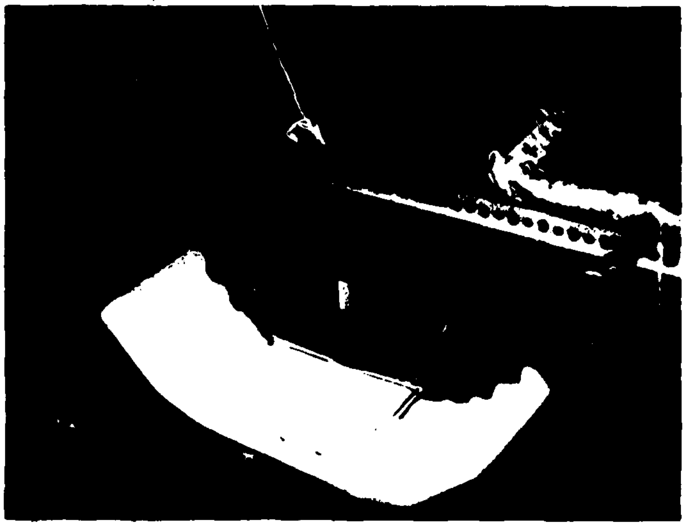


Figure 16. Sensor sealed in common barrier bag material.

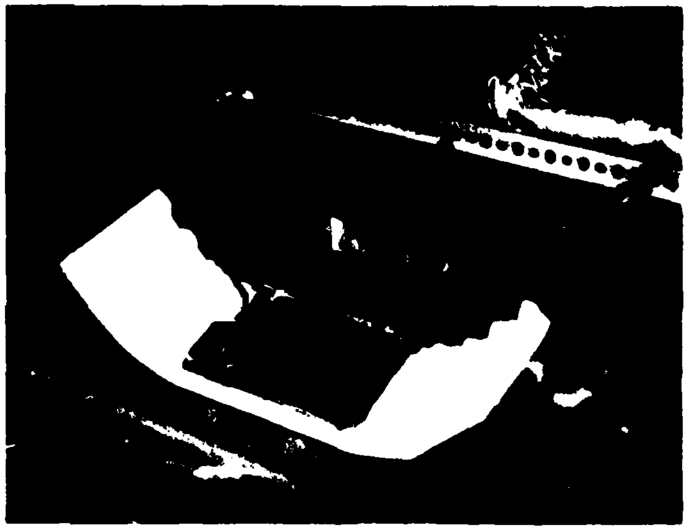
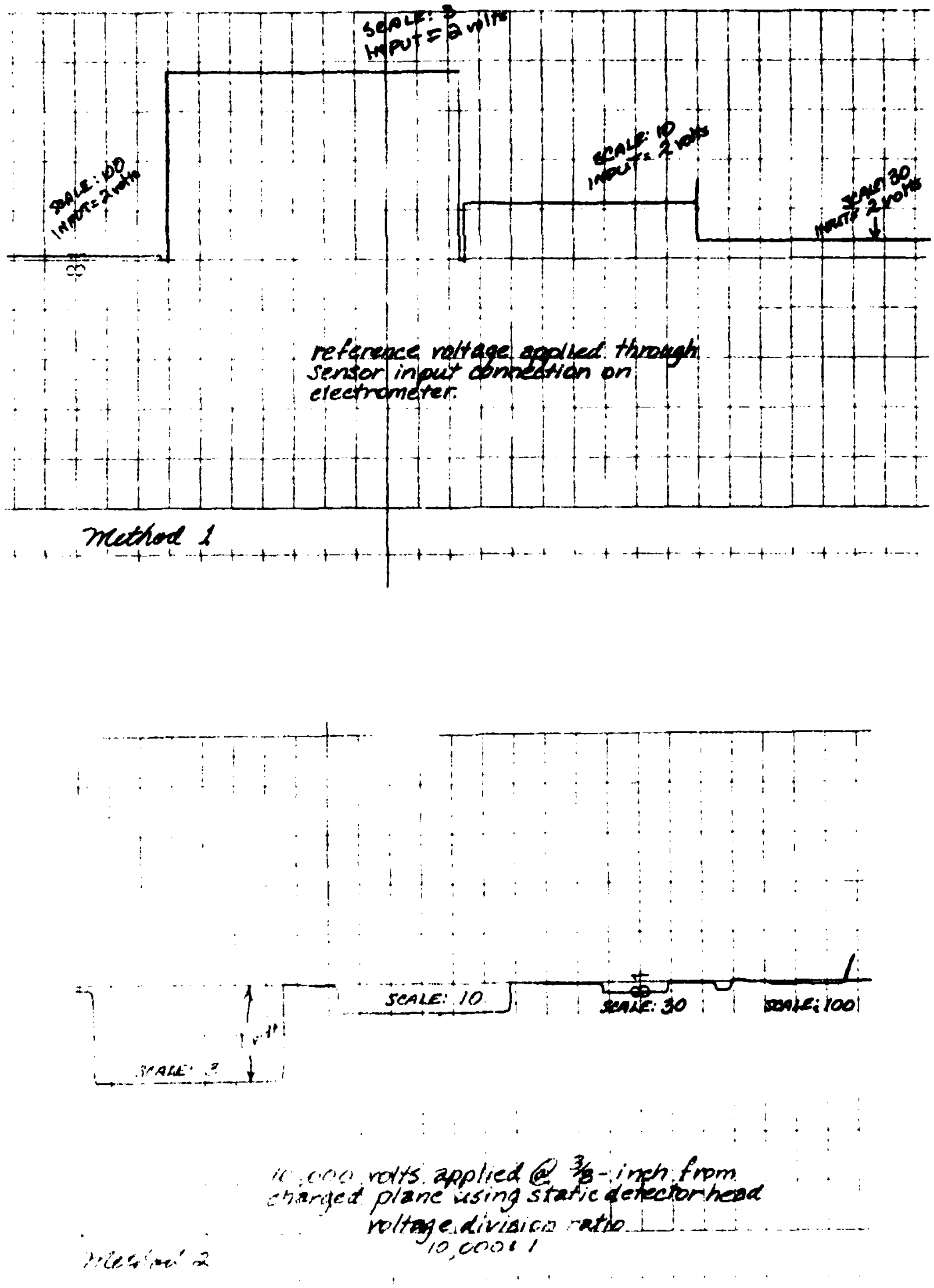


Figure 17. Sensor sealed in experimental metallized material.

Figure 18. Sensor sealed in common cushioning material and placed in polystyrene foam cushion inserts as part of a fast pack. Polyethylene foam also used as substitute.

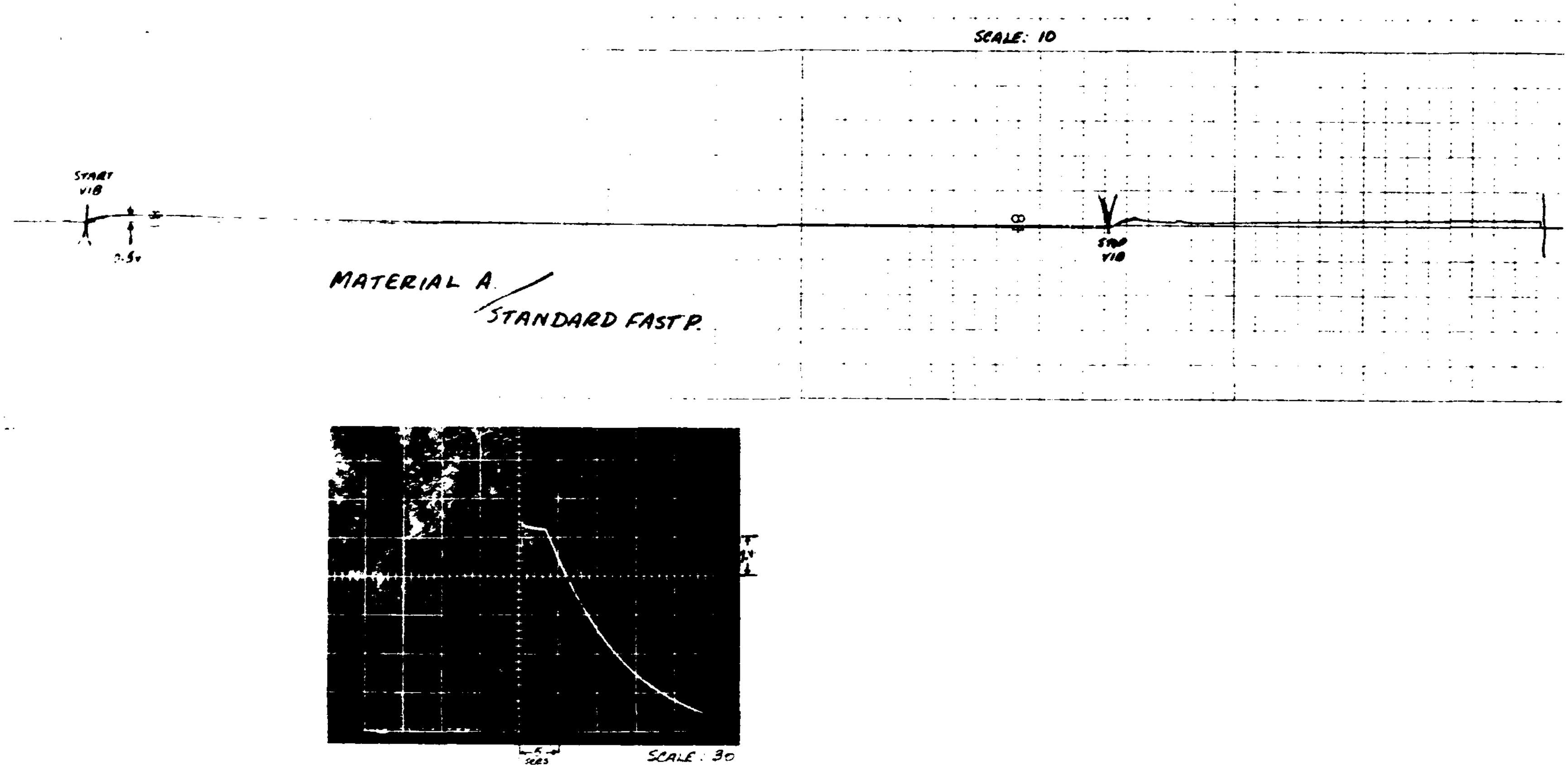



...ure 1?. Voltage reference checks.

(10) Record the voltage magnitude and shape seen by the sensor within the pack.

It should be noted that steps 8, 9, and 10 were conducted in all cases where significant changes were anticipated in the shape of the bleed-off path; i.e., use of conductive outer materials or different cushioning. Figure 19 identifies voltage reference checks using two different methods; one a direct technique using a direct current input voltage and the other an indirect technique using the detector head supplied with the electrometer. It is seen that good correlation exists between the two methods. This proven calibration was used in determination of voltage magnitudes in all of the recorded tests.

e. Test results. Test data were gathered using the method identified in d above. As discussed earlier, various material combinations were tested starting with a single bag material tested in conjunction with a standard fast pack container. Recordings for this sequence are presented as figures 20 through 32. Figure 33 identifies the use of a conductive plastic ribbon grounding strap secured to both surfaces of a special metallized material classified as material F. Figures 34 through 38 represent results obtained from the substitution of polystyrene foam for the standard fast pack polyurethane. Figure 39 uses a polyethylene foam substitute. For figures 40 through 42, convoluted polyurethane is again used while the standard sleeve has been replaced with a conductive fiberboard. Figures 43 through 45 provide static charge buildup effects where various materials are used in intimate contact and surrounding the simulated item. For these readings, selection of material combinations were dependent upon their performance to that time on an individual basis. Thus, conductive fiberboard was again selected as a substitute for the standard. For purposes of this analysis, comparisons are first made within the groups just mentioned. Finally, identical materials within each group are compared. It should be noted that voltage magnitudes are relatively low particularly during static buildup testing. However, these values are useful when used for comparison purposes between materials within each group. Of particular significance is the status of the static charge buildup once the vibration is removed (bleed-off). Since the packs are not perfectly isolated, the assumption would be that a truly static-free material would release an assumed low level of static charge through this imperfect path. In the case of high voltage discharge, this path is quite readily defined due to the higher voltage seen by the sensor.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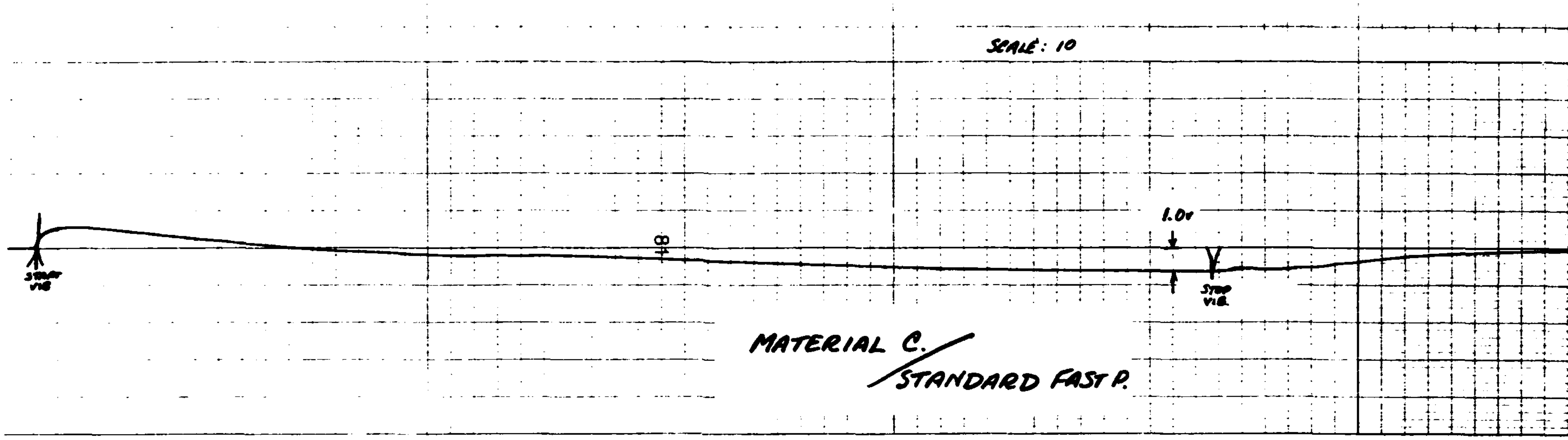
STOP VIB
MATERIAL A / STANDARD FAST P.
SCALE: 30

Figure 20.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1.0v
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MATERIAL C.
STANDARD FAST P.
81

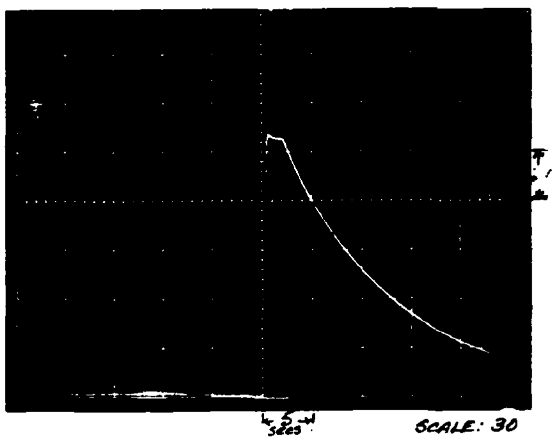

5 secs
SCALE: 30

Figure 21.

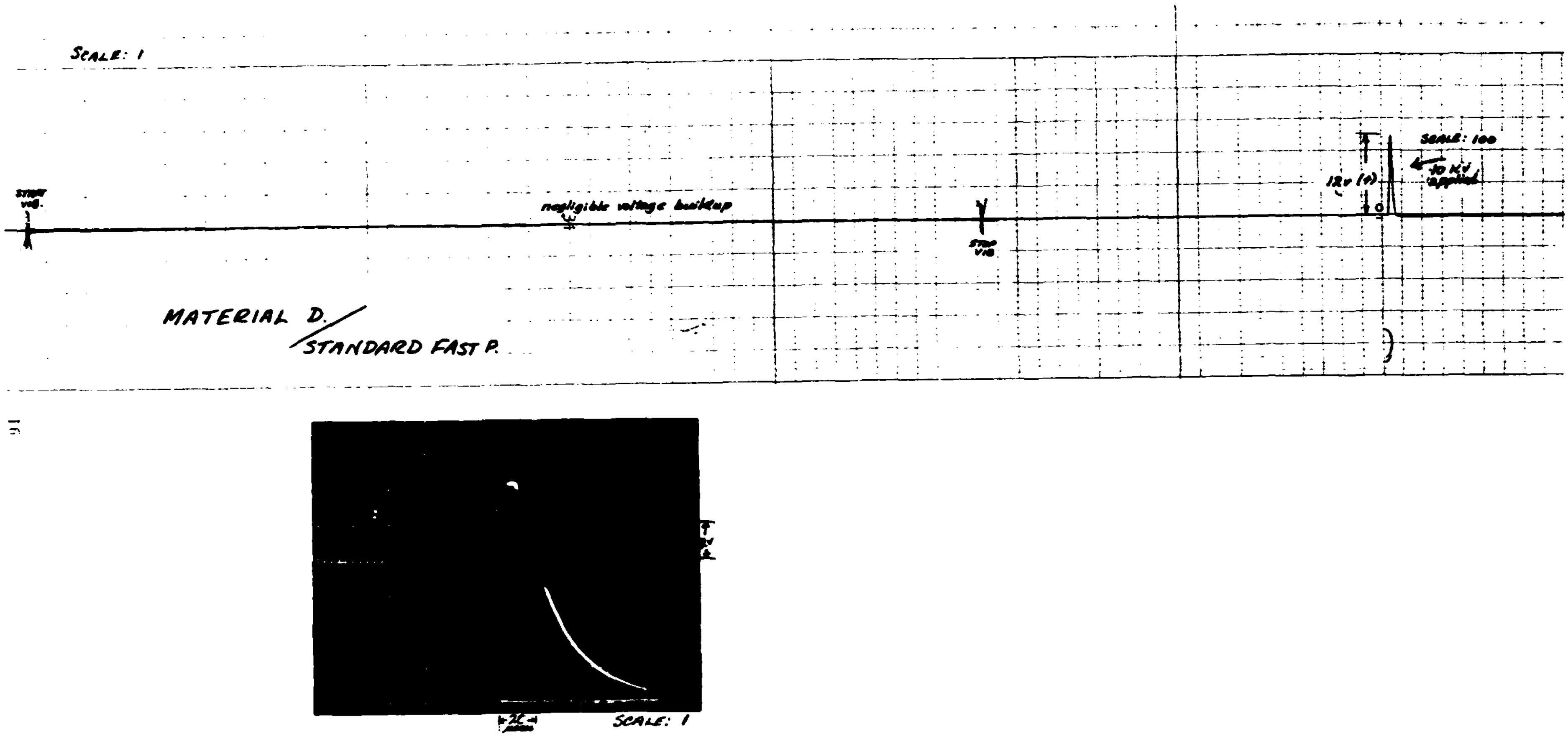
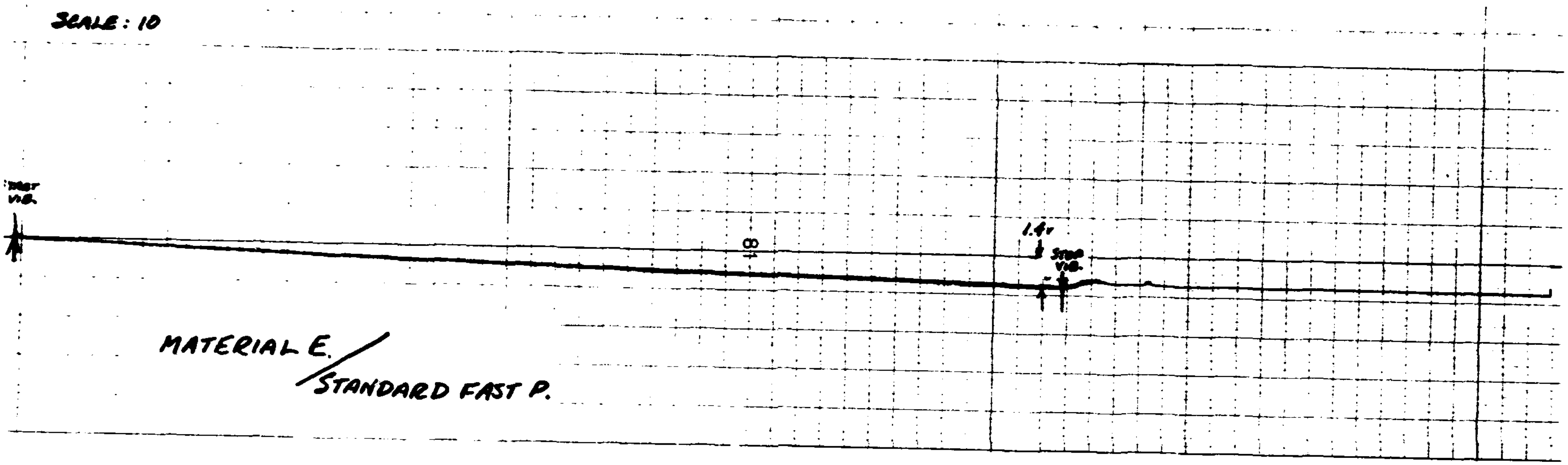

SCALE: 1
START VIB.
negligible voltage buildup
STOP VIB
12v (?)
SCALE: 100
10 Kv applied
MATERIAL D./STANDARD FAST P.
SCALE: 1

Figure 22.



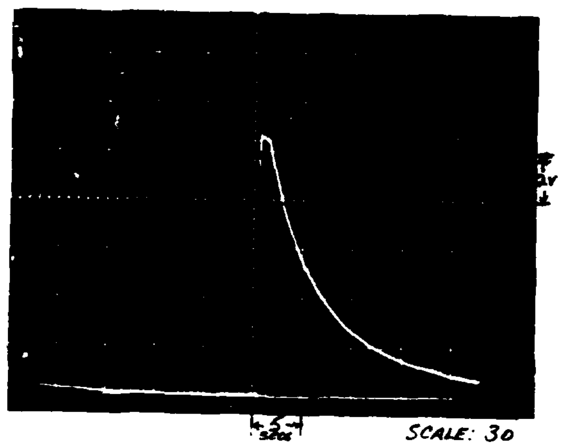




Figure 23.

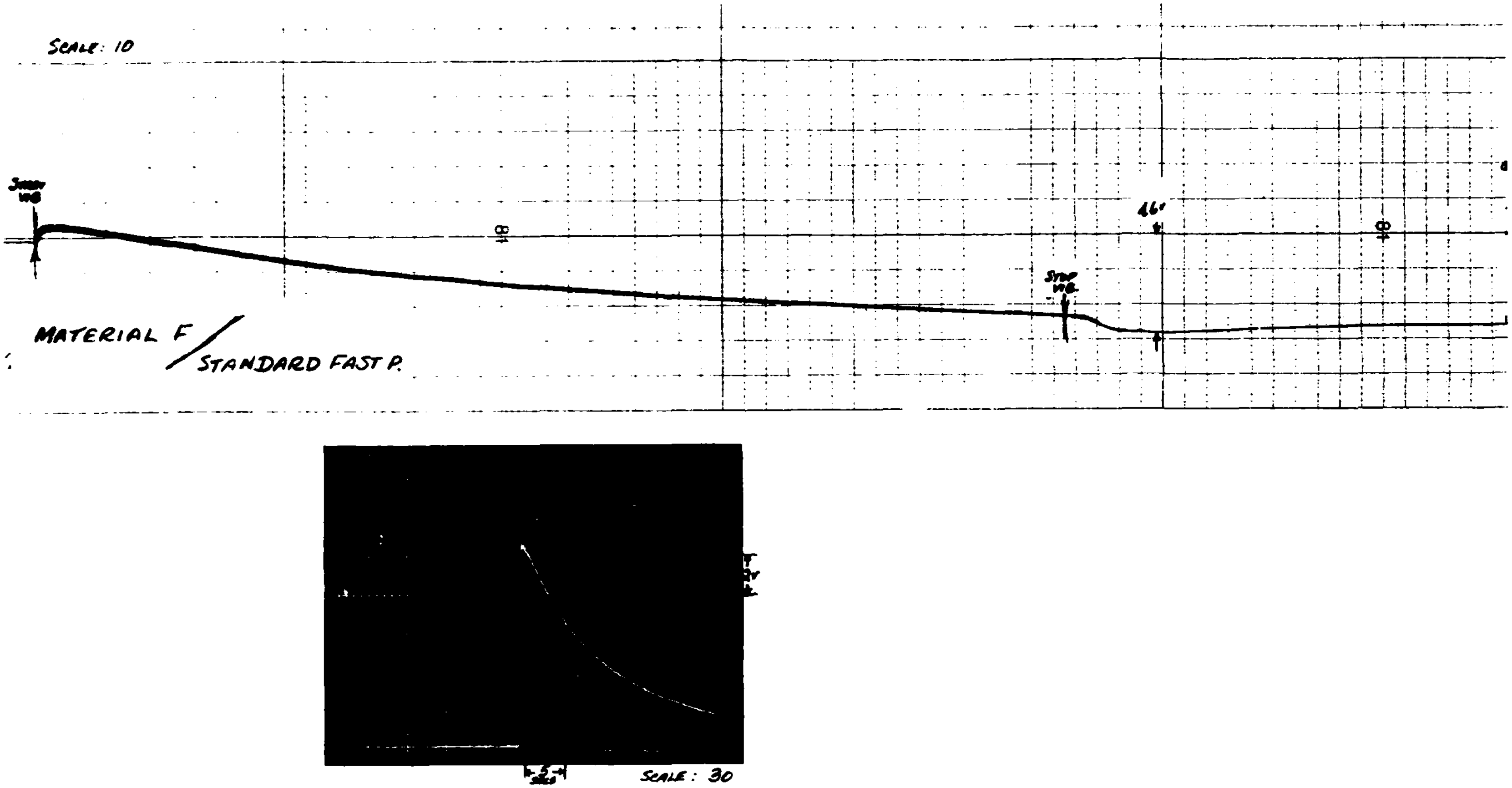
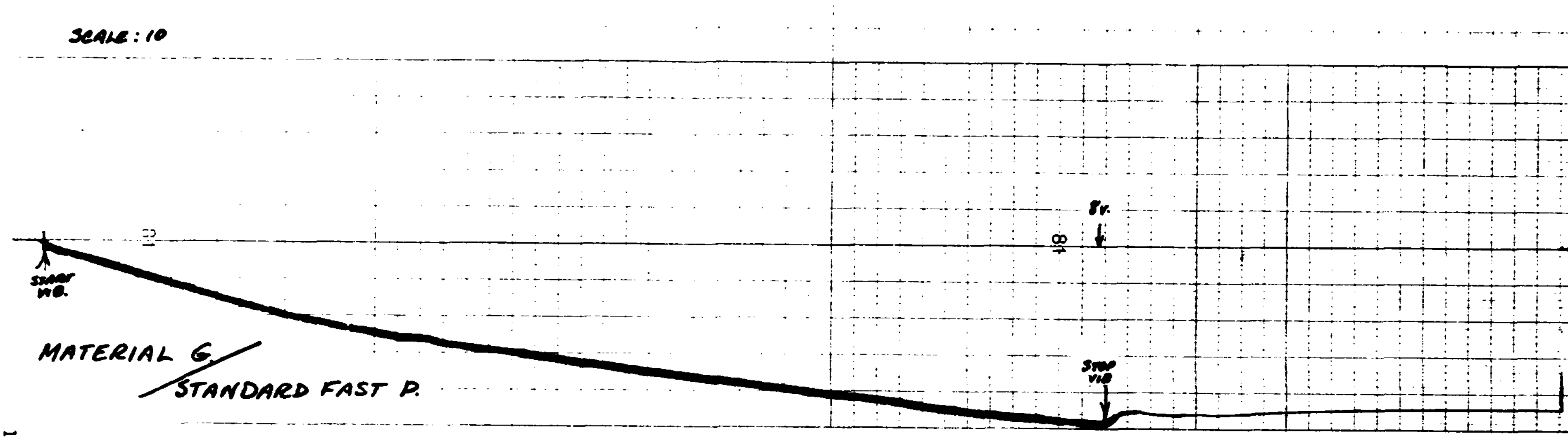



Figure 24.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MATERIAL G
STANDARD FAST P.
8v.
STOP VIB

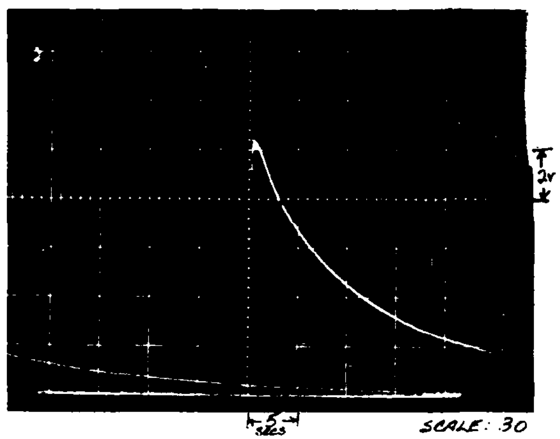
2v
5 secs
SCALE: 30

Figure 25.

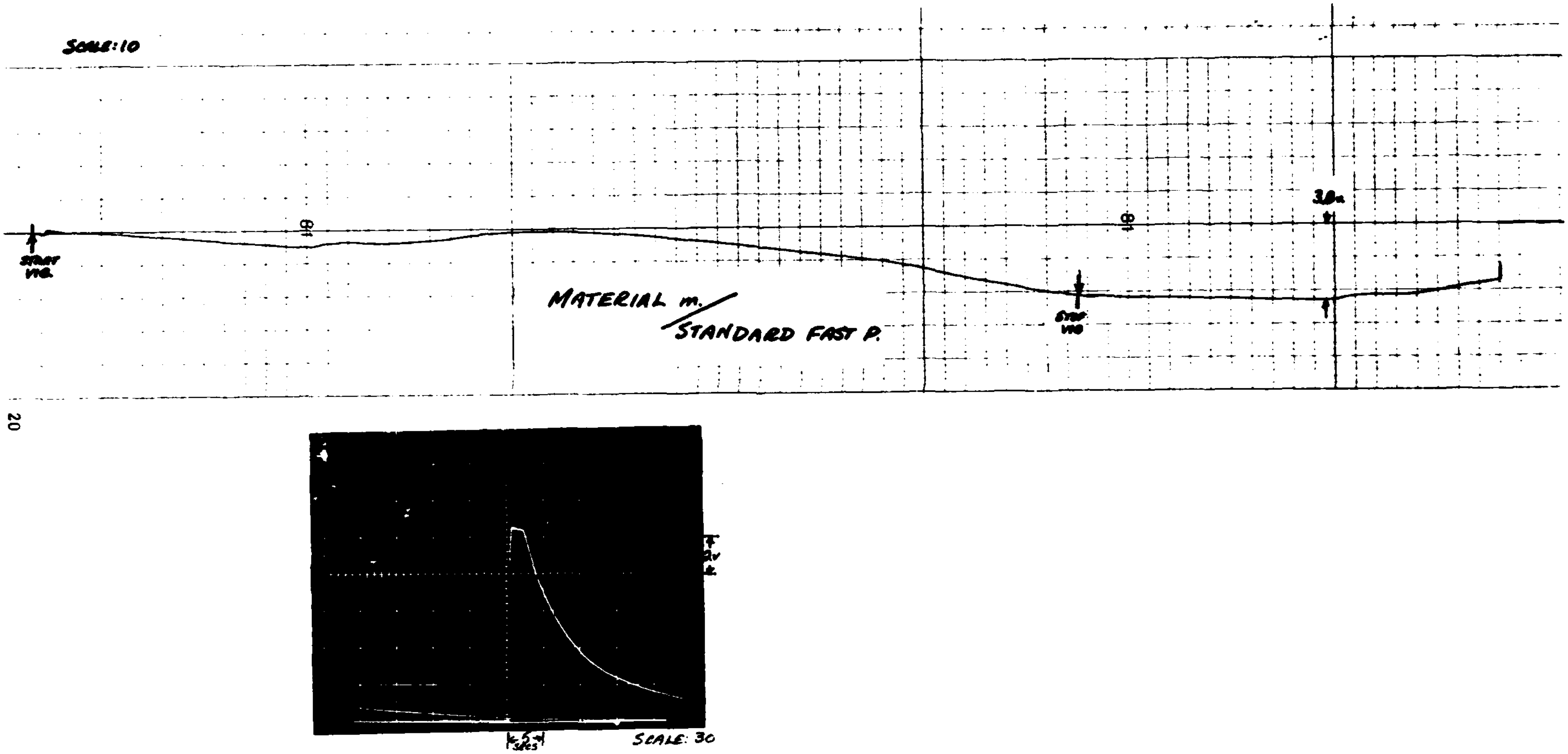
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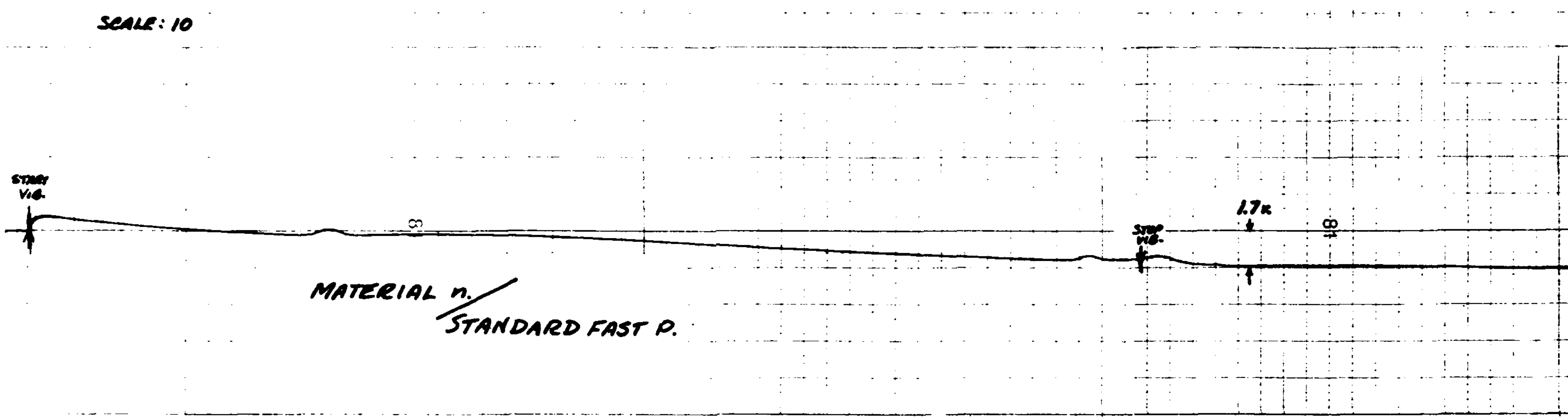
Figure 26.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1.7K

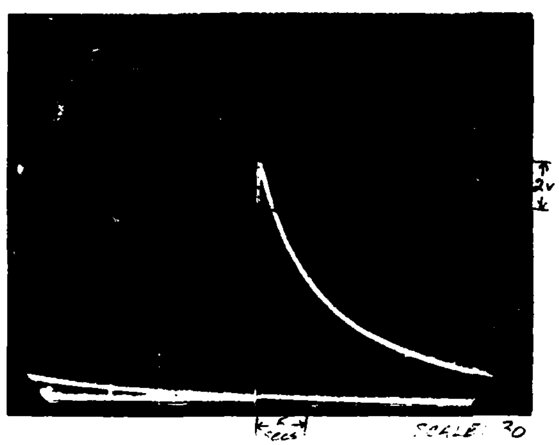
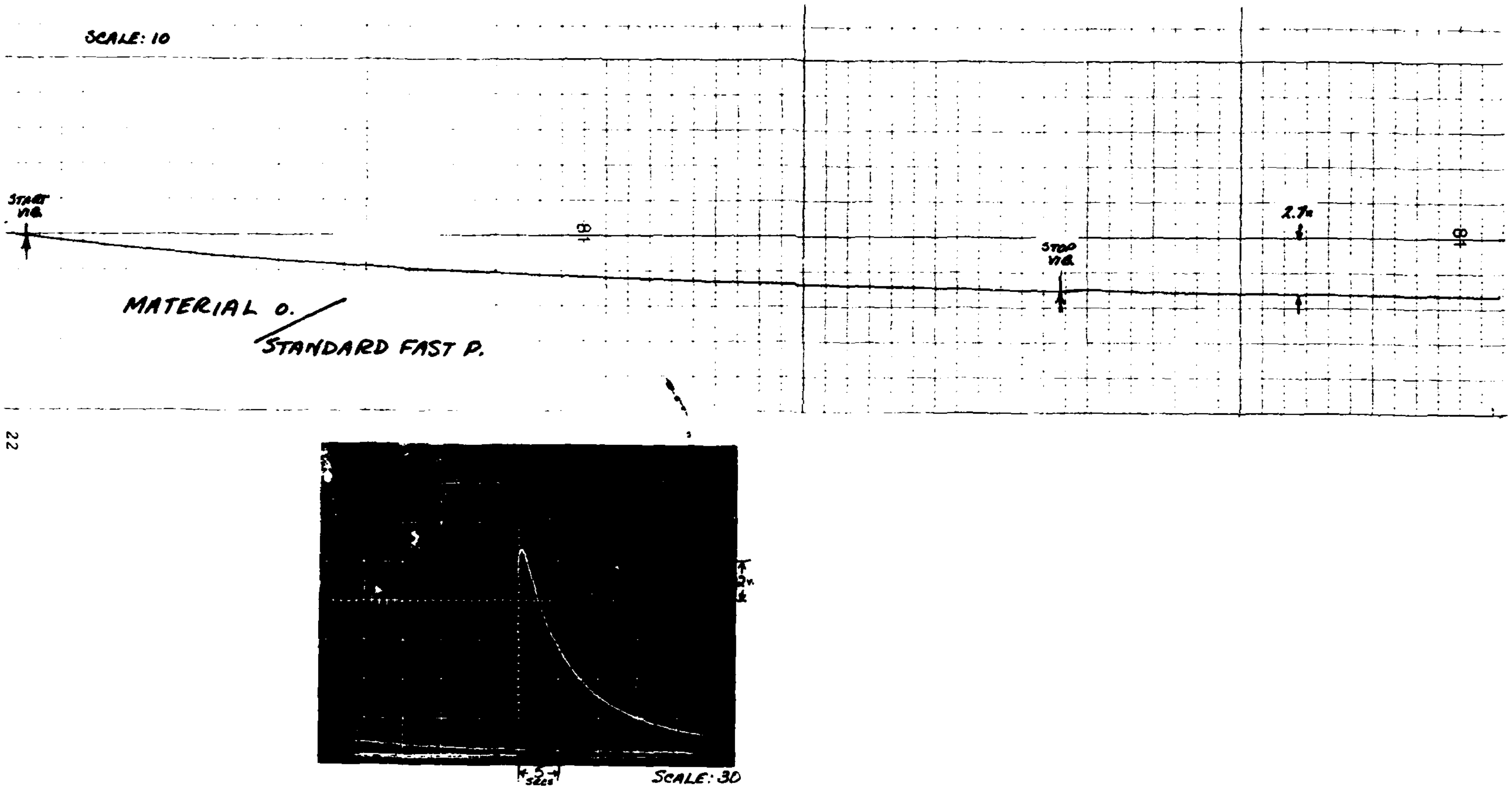

2V
5 SECS

Figure 27.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MATERIAL O./STANDARD FAST P.
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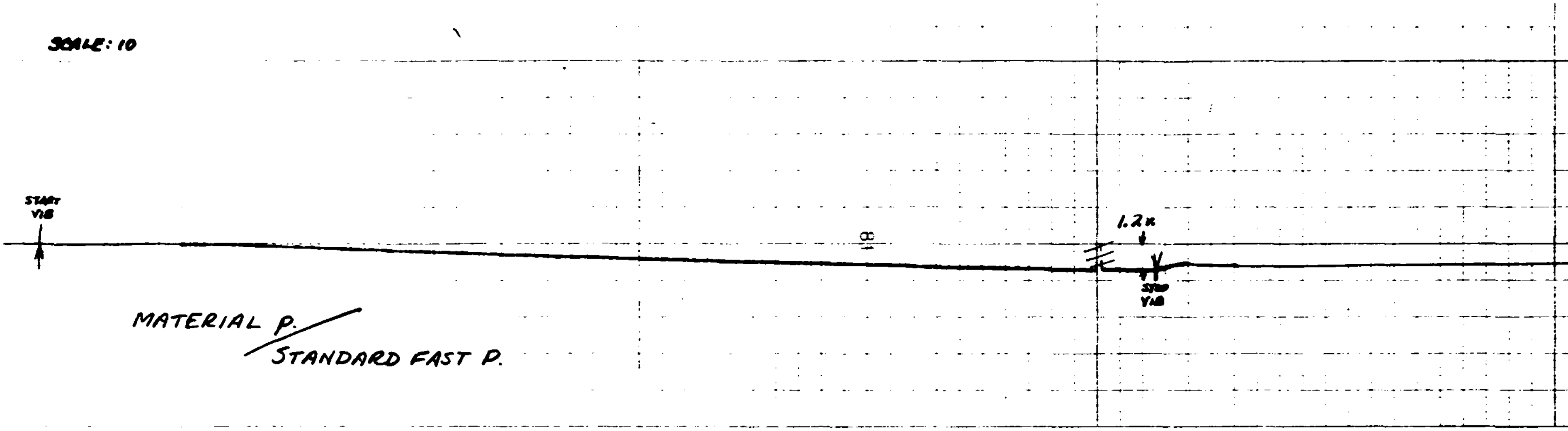
Figure 28.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1.2K
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MATERIAL P.
STANDARD FAST P.

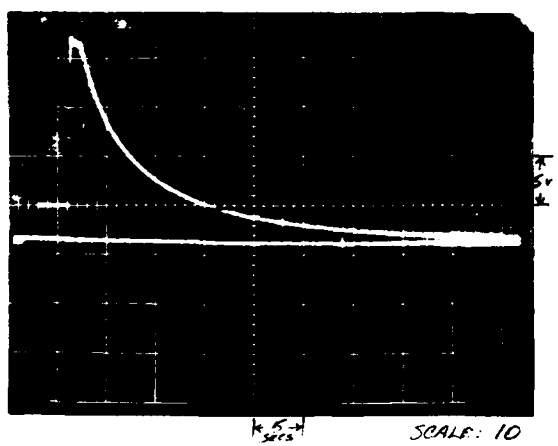
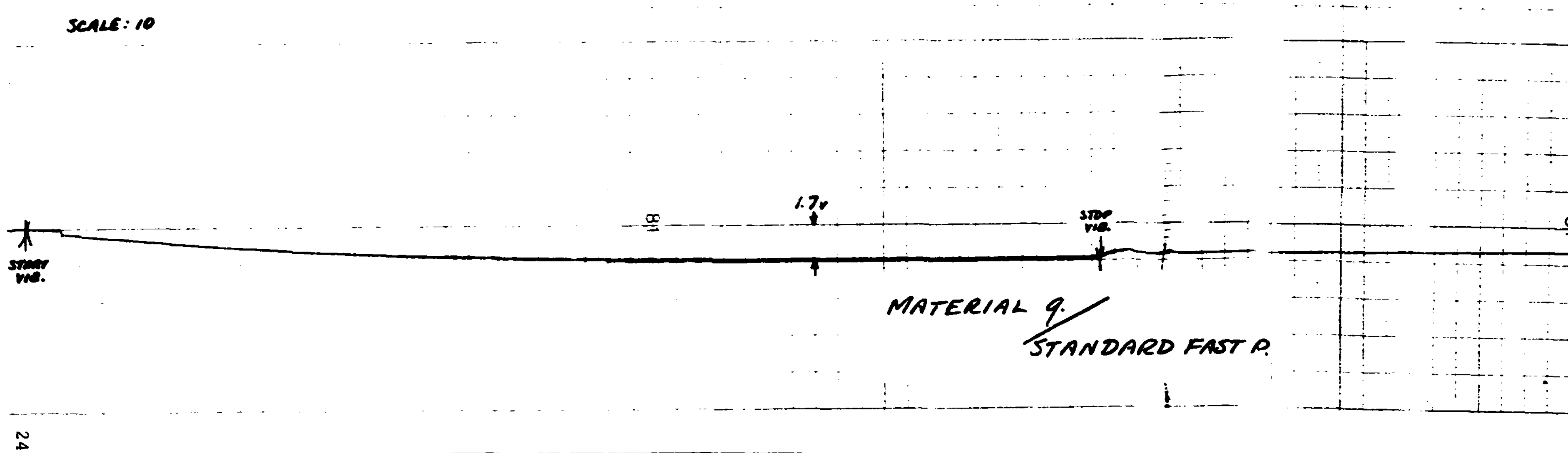

5v
5 secs
SCALE: 10

Figure 29.


SCALE: 10
START VIB.
1.7v
STOP VIB.
MATERIAL 9./STANDARD FAST P.
24

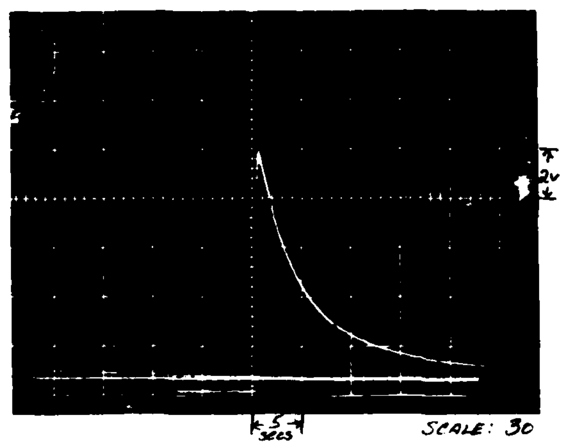
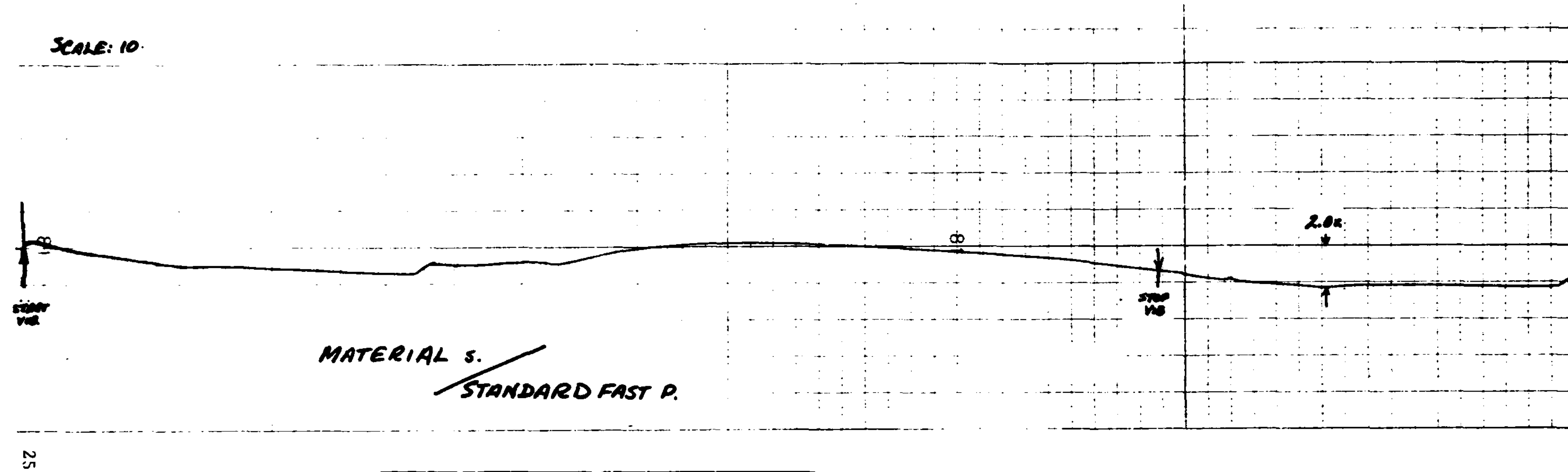

2v
5 secs
SCALE: 30

Figure 30.


SCALE: 10
START VIB
MATERIAL S.
STANDARD FAST P.
STOP VIB
2.0K
25

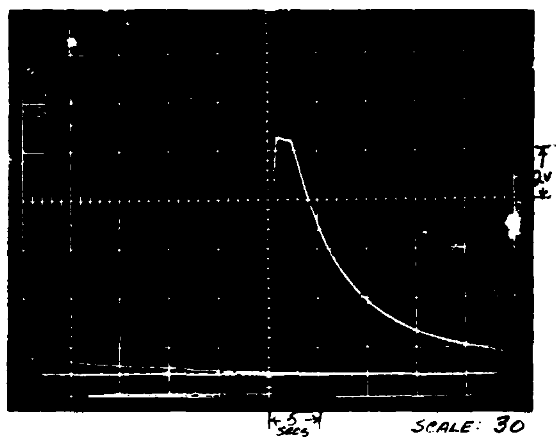
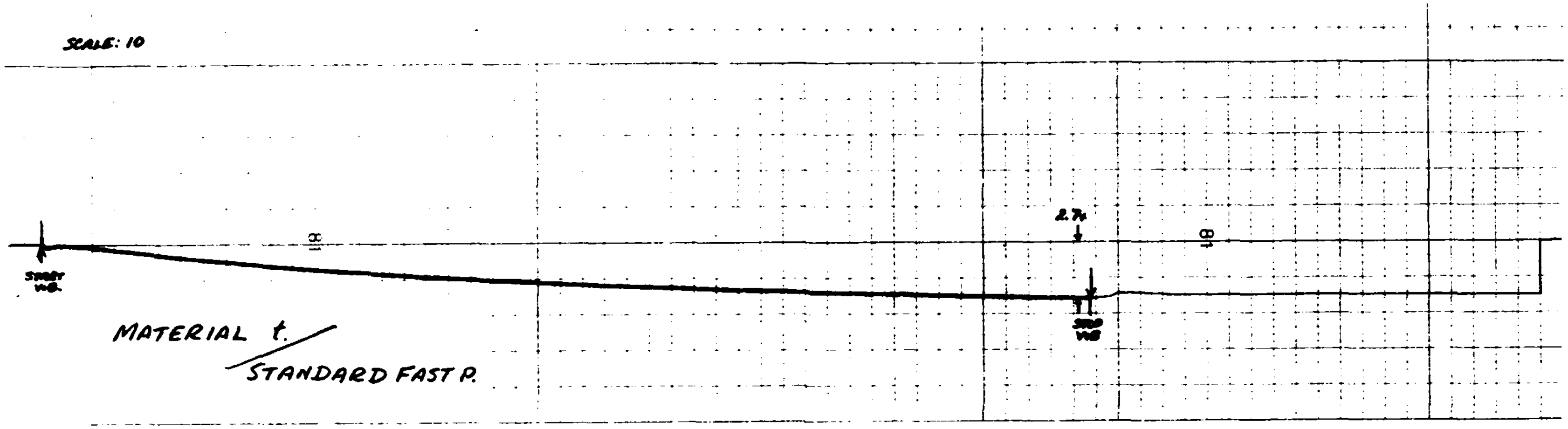

2V
5 SECS
SCALE: 30

Figure 31.



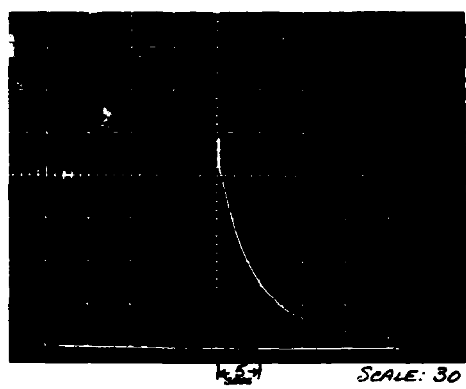




Figure 32.

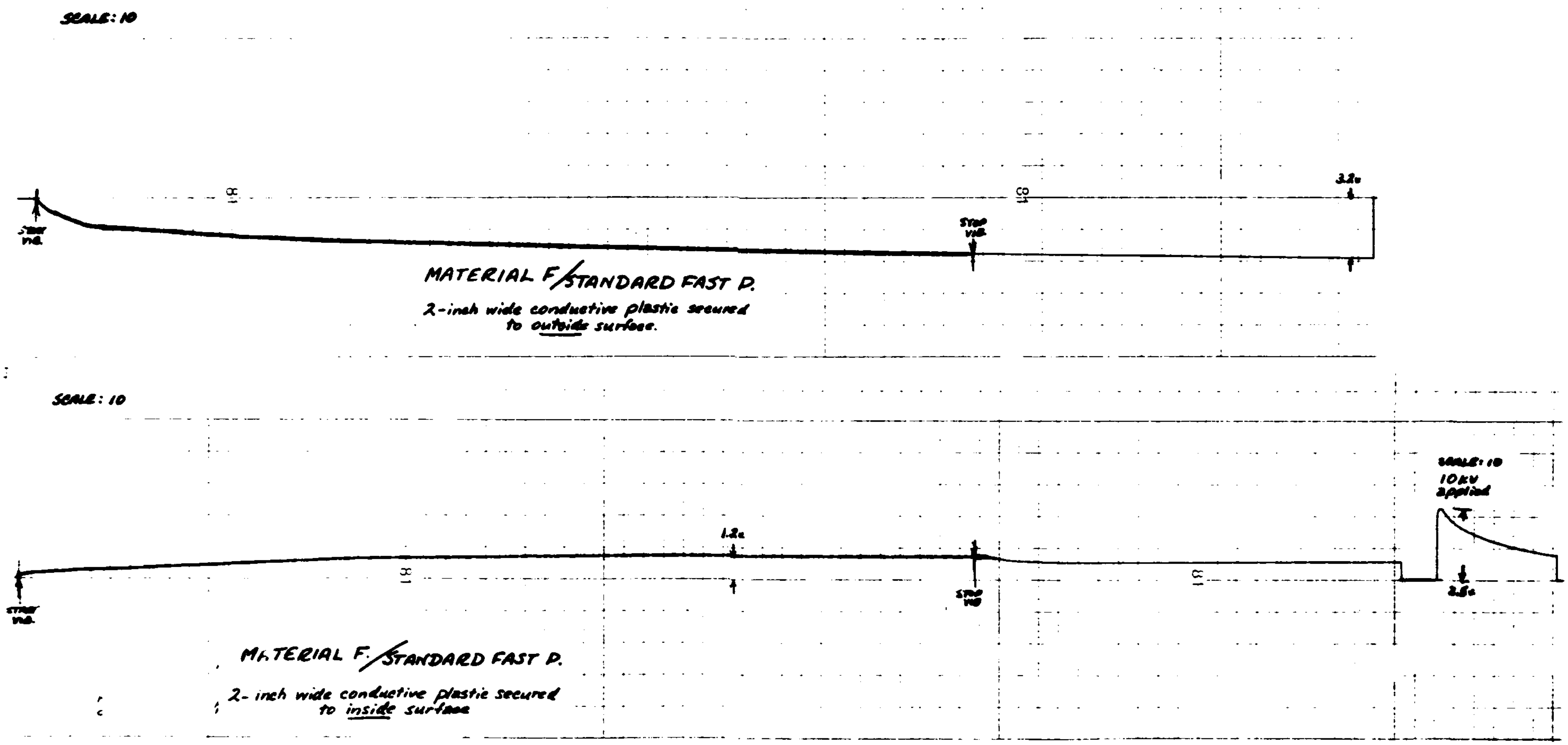

SCALE: 10
3.2v
MATERIAL F/STANDARD FAST D.
2-inch wide conductive plastic secured to outside surface.
SCALE: 10
1.2v
SCALE: 10
10kV applied
MATERIAL F/STANDARD FAST D.
2-inch wide conductive plastic secured to inside surface

Figure 33.

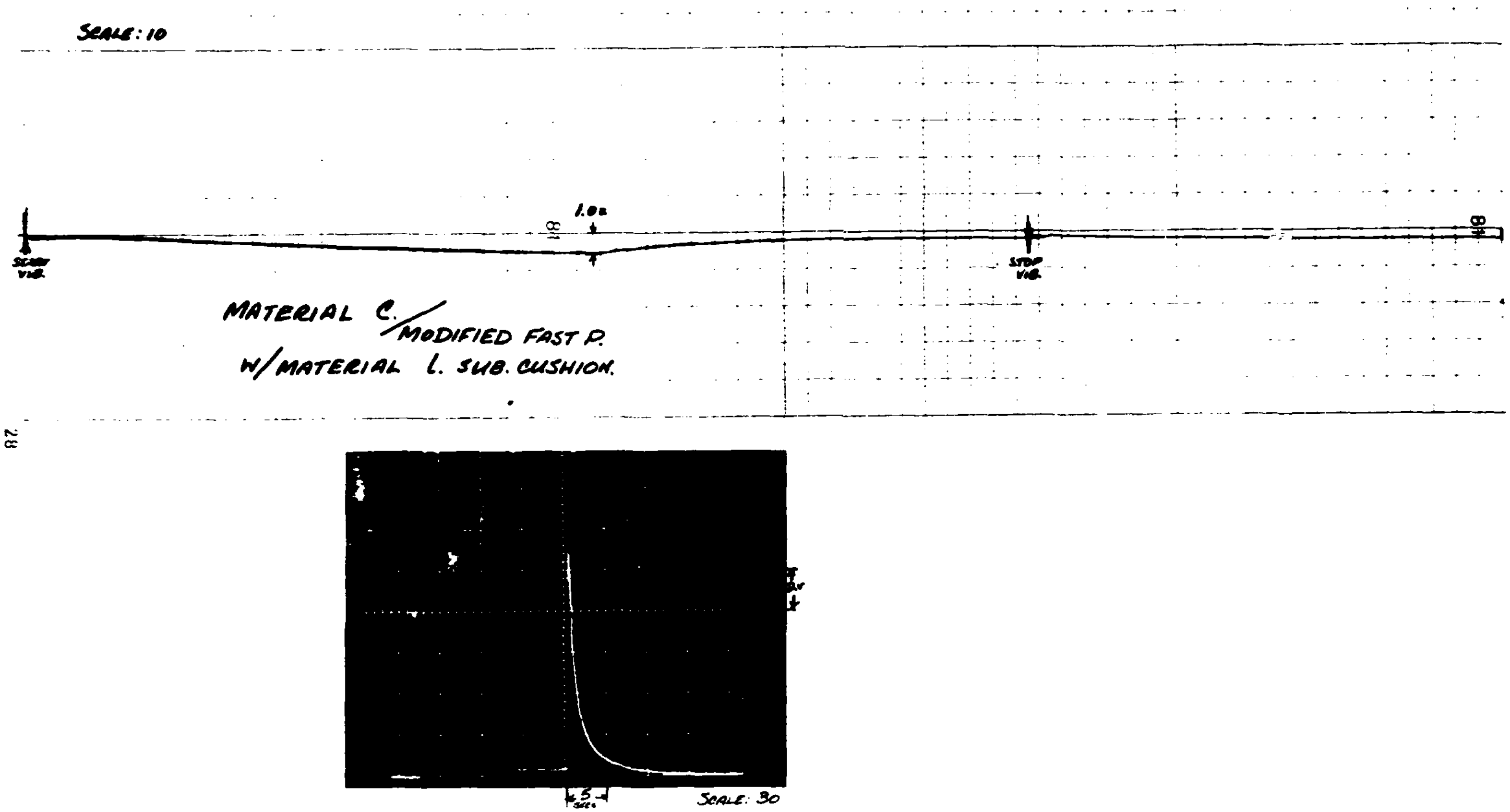
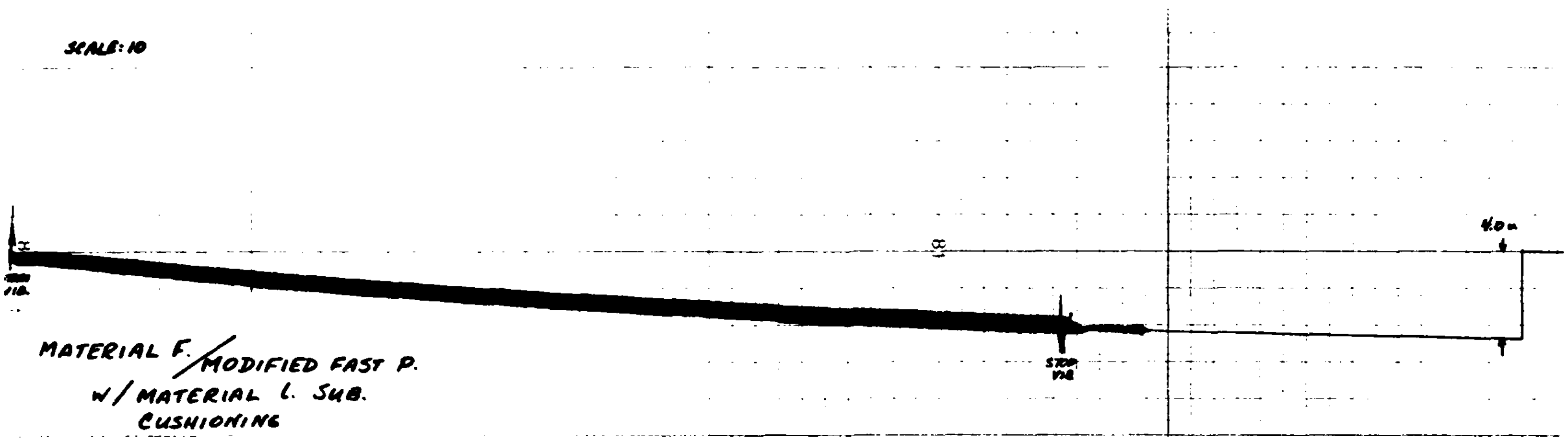

SCALE: 10
1.0 s
START VIB.
STOP VIB.
MATERIAL C/MODIFIED FAST P.
W/MATERIAL L. SUB. CUSHION.
5 SEC
SCALE: 30

Figure 34.


SCALE: 10
MATERIAL F./MODIFIED FAST P.
W/ MATERIAL L. SUB.
CUSHIONING
STOP
4.0 in

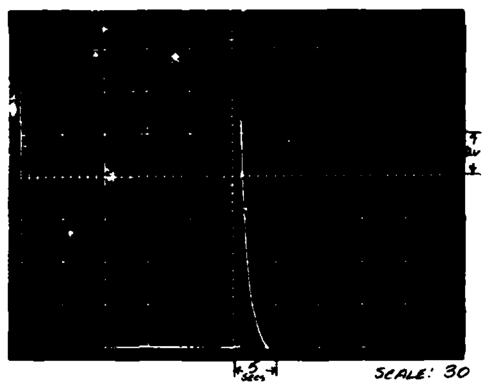

SCALE: 30

Figure 35.

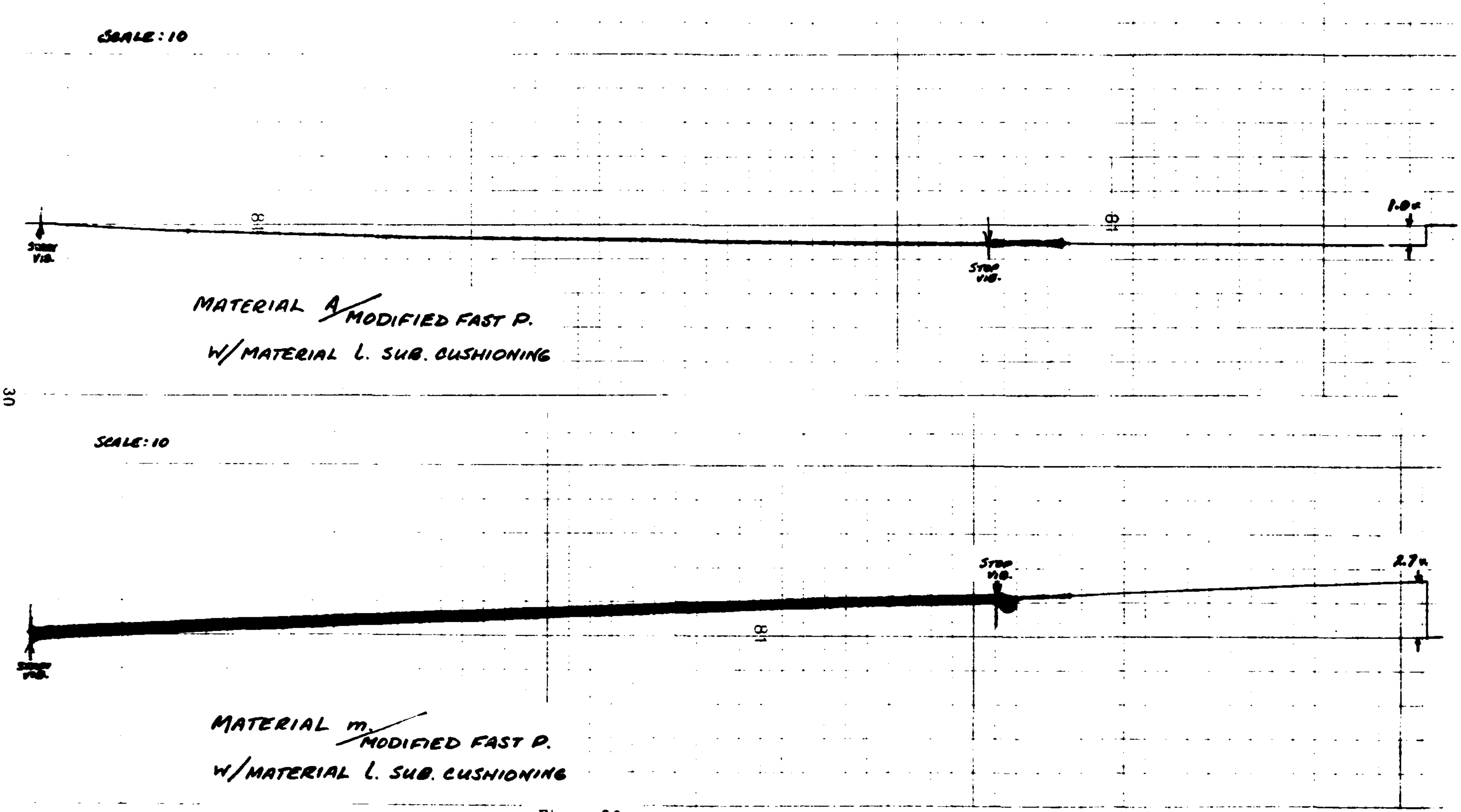

SCALE: 10
START VIB.
STOP VIB.
1.0 u
MATERIAL A/MODIFIED FAST P.
W/MATERIAL L. SUB. CUSHIONING
SCALE: 10
START VIB.
STOP VIB.
2.7 u
MATERIAL m/MODIFIED FAST P.
W/MATERIAL L. SUB. CUSHIONING

Figure 36.

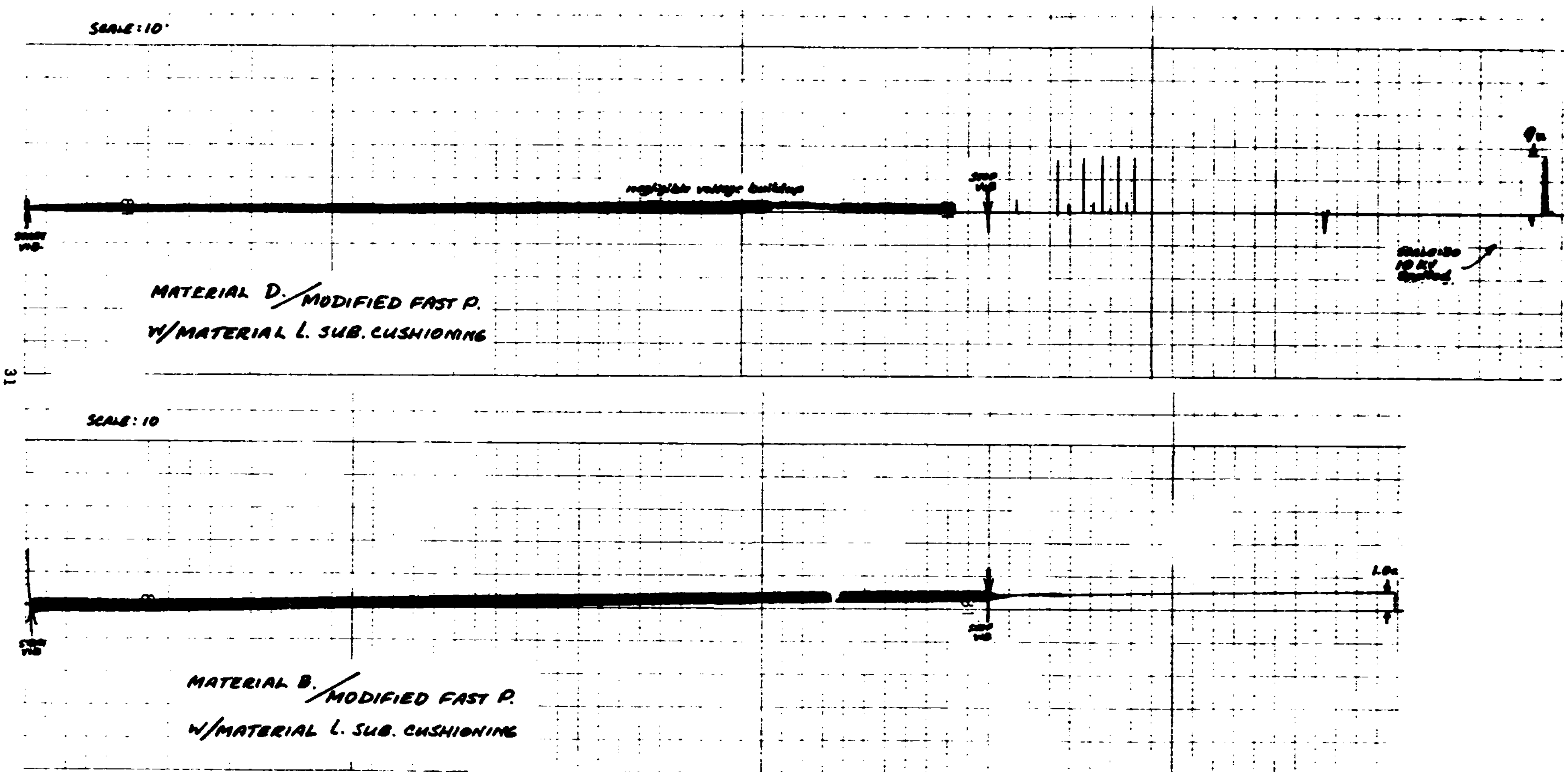

SCALE: 10'
negligible voltage buildup
MATERIAL D./MODIFIED FAST P.
W/MATERIAL L. SUB. CUSHIONING
SCALE: 10
MATERIAL B./MODIFIED FAST P.
W/MATERIAL L. SUB. CUSHIONING

Figure 37.

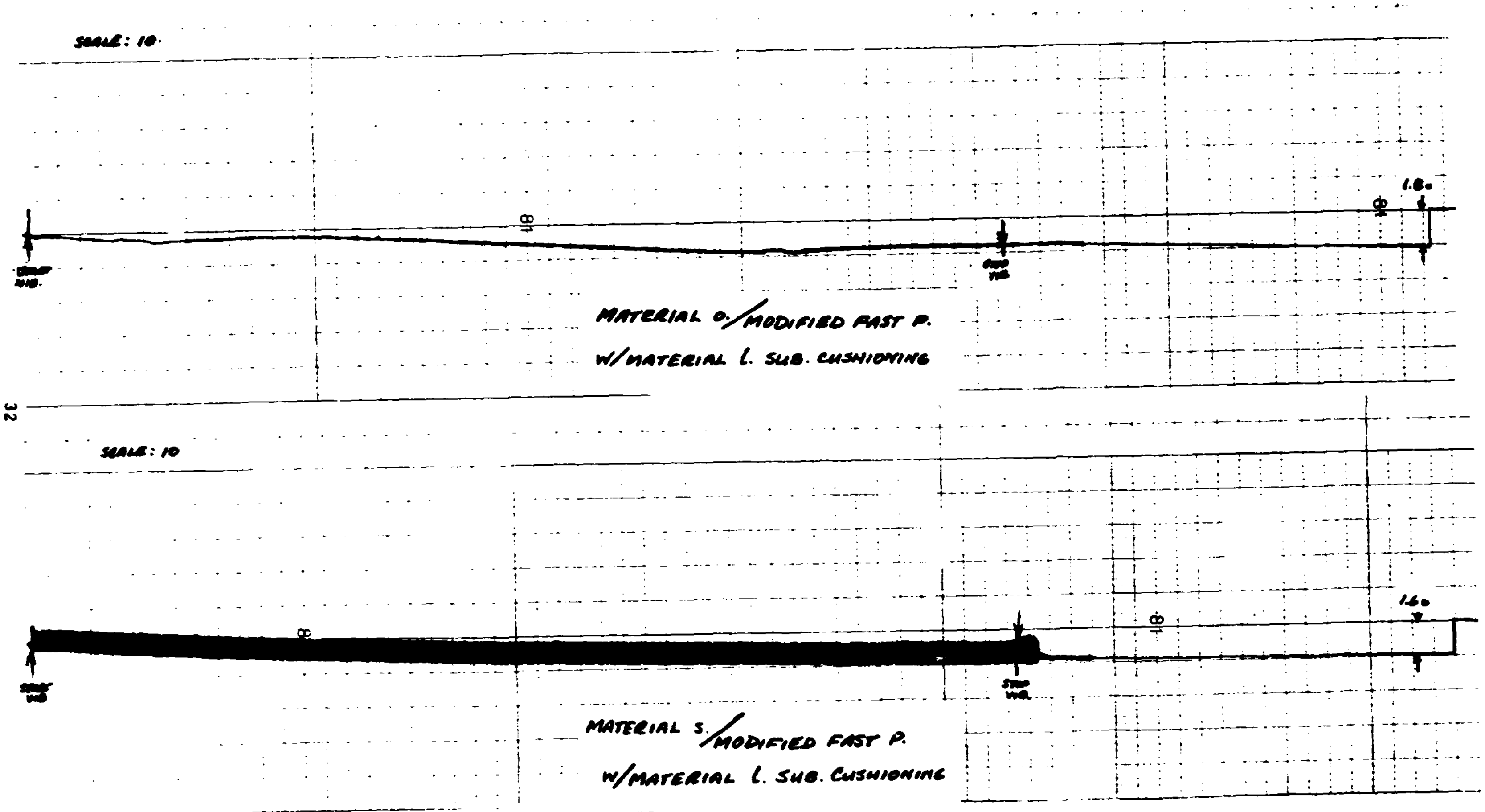

SCALE: 10
81
1.8
MATERIAL O./MODIFIED FAST P.
W/MATERIAL L. SUB. CUSHIONING
SCALE: 10
81
1.6
MATERIAL S./MODIFIED FAST P.
W/MATERIAL L. SUB. CUSHIONING

Figure 38.

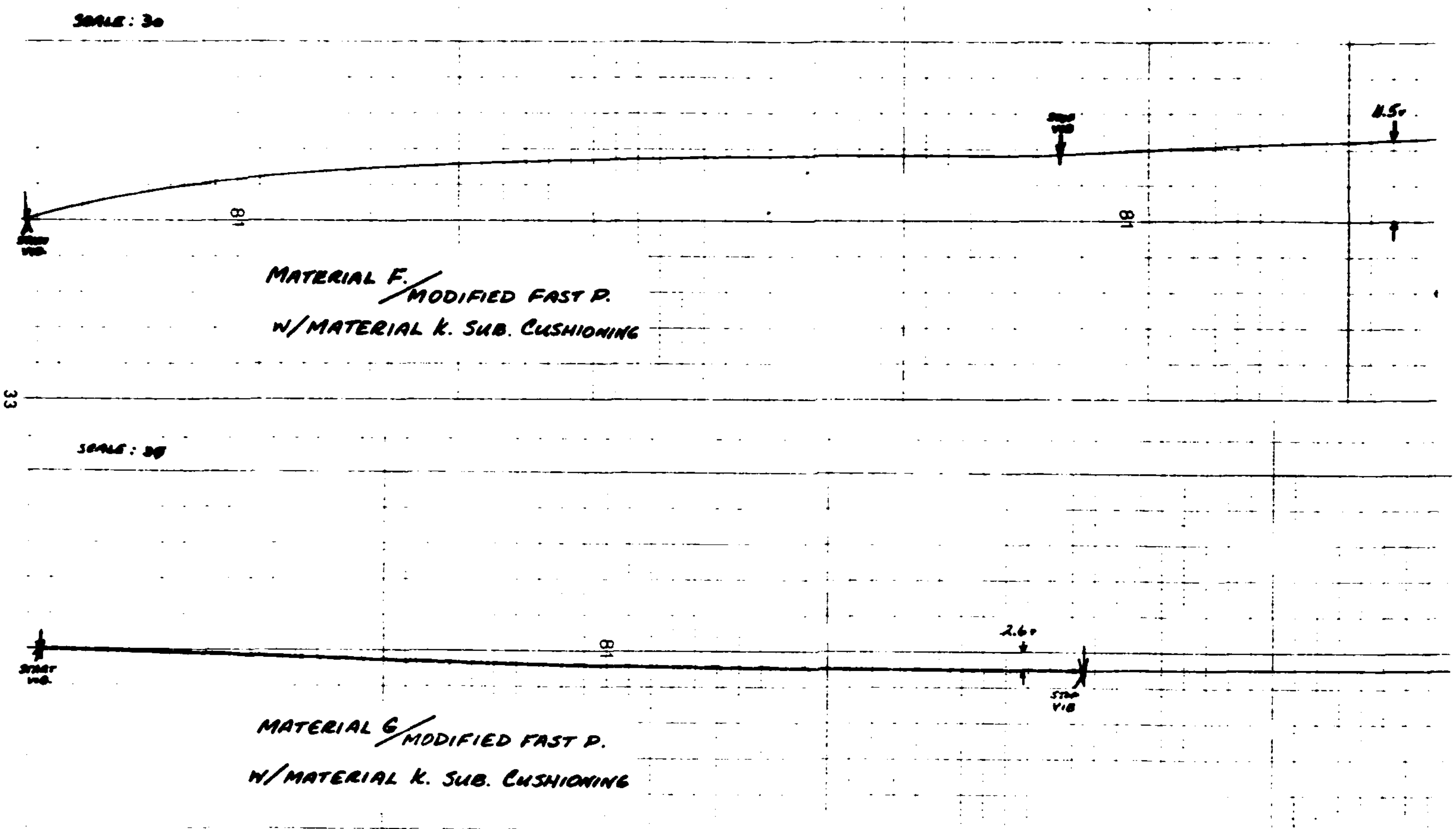
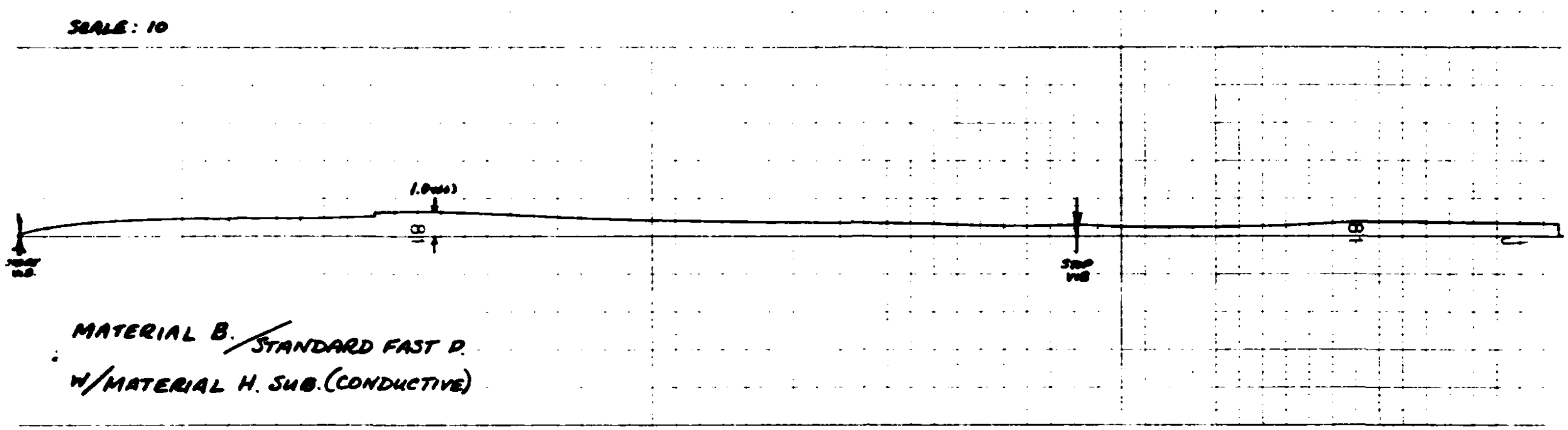

SCALE : 30
11.5
81
81
MATERIAL F./MODIFIED FAST P.
W/MATERIAL K. SUB. CUSHIONING
81
2.6
STOP VIB
MATERIAL G/MODIFIED FAST P.
W/MATERIAL K. SUB. CUSHIONING

Figure 39.


SCALE: 10
(1.0mil)
MATERIAL B. / STANDARD FAST D.
W/MATERIAL H. SUB. (CONDUCTIVE)

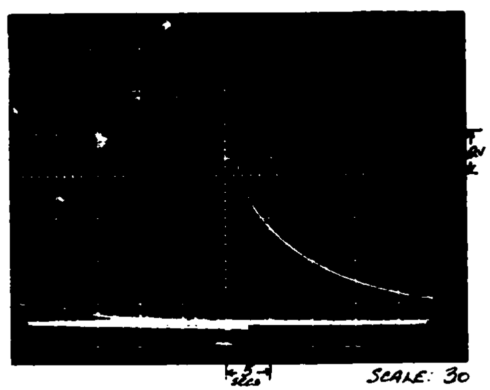

SCALE: 30

Figure 40.

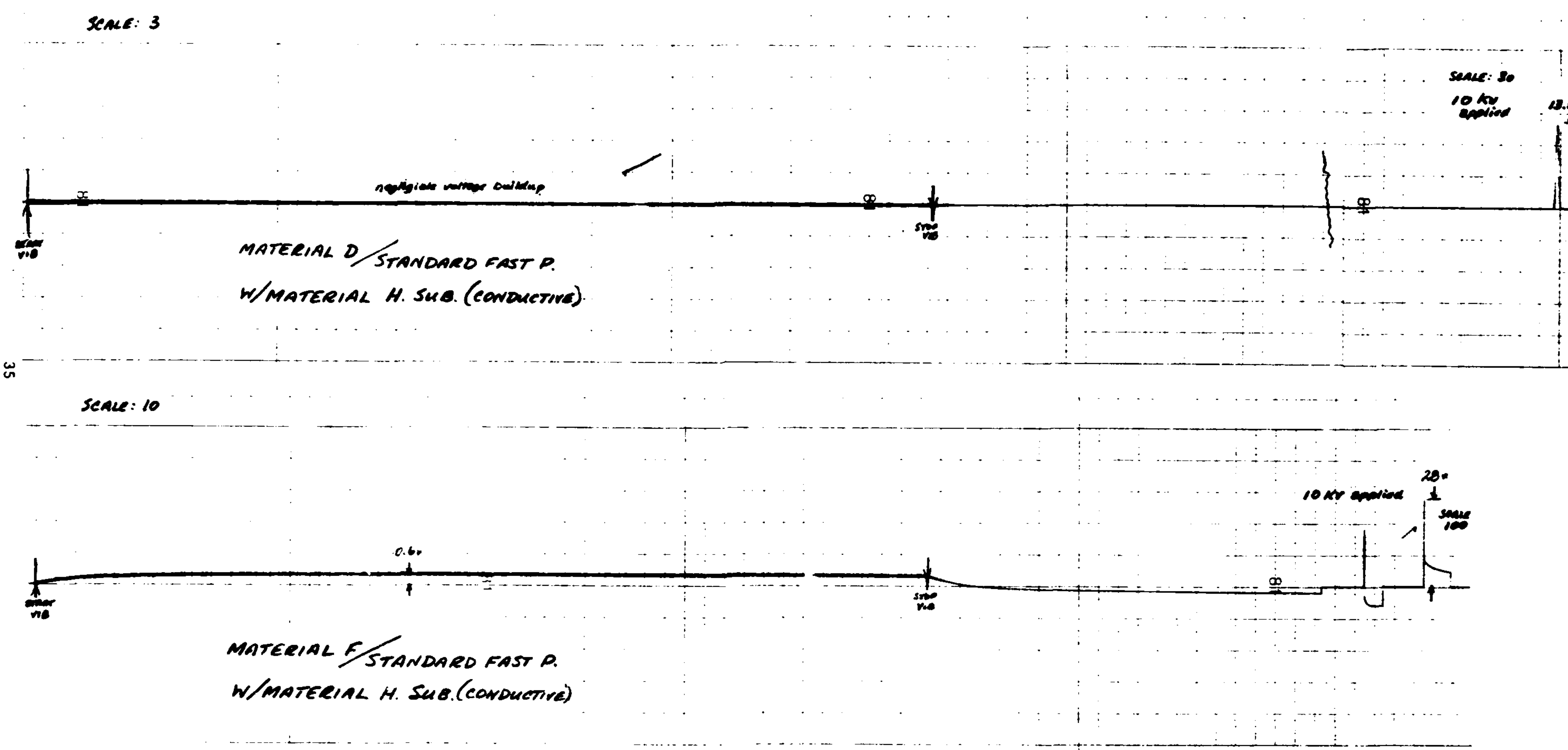

SCALE: 3
SCALE: 30
10 KV Applied
13.6
negligible voltage buildup
START VIB
STOP VIB
MATERIAL D/STANDARD FAST P.
W/MATERIAL H. SUB. (CONDUCTIVE)
SCALE: 10
0.6v
28v
10 KV Applied
SCALE 100
START VIB
STOP VIB
MATERIAL F/STANDARD FAST P.
W/MATERIAL H. SUB. (CONDUCTIVE)

Figure 41.

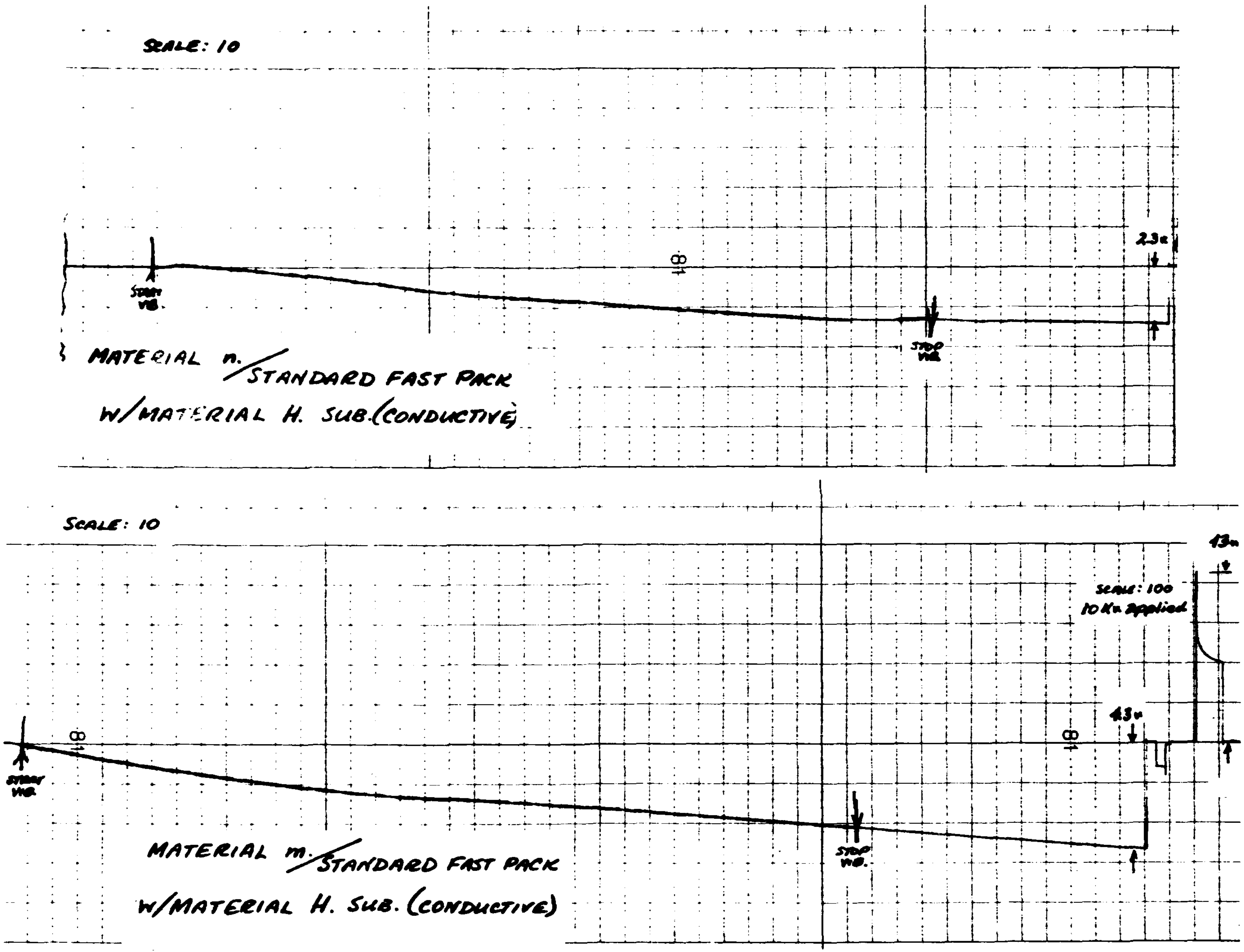

SCALE: 10
23u
START VIB.
STOP VIB.
MATERIAL n./STANDARD FAST PACK
W/MATERIAL H. SUB.(CONDUCTIVE)
SCALE: 10
43u
SCALE: 100
10 Ku Applied
43u
START VIB.
STOP VIB.
MATERIAL m./STANDARD FAST PACK
W/MATERIAL H. SUB. (CONDUCTIVE)

Figure 42.

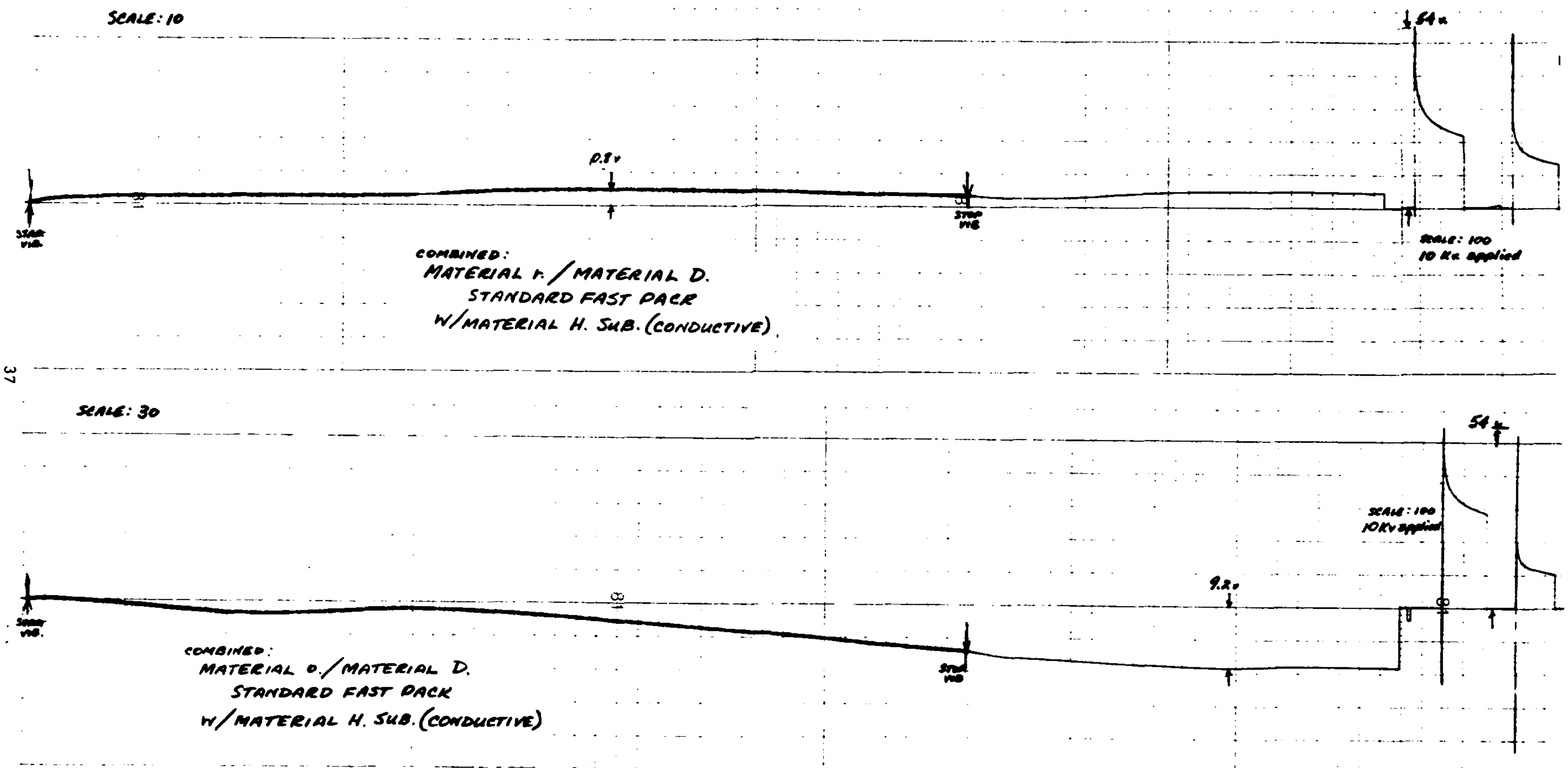

SCALE: 10
54 v
0.8 v
COMBINED:
MATERIAL F./MATERIAL D.
STANDARD FAST PACK
W/MATERIAL H. SUB. (CONDUCTIVE)
SCALE: 100
10 Kv applied
SCALE: 30
54 v
SCALE: 100
10 Kv applied
9.2 v
COMBINED:
MATERIAL O./MATERIAL D.
STANDARD FAST PACK
W/MATERIAL H. SUB. (CONDUCTIVE)

Figure 43.

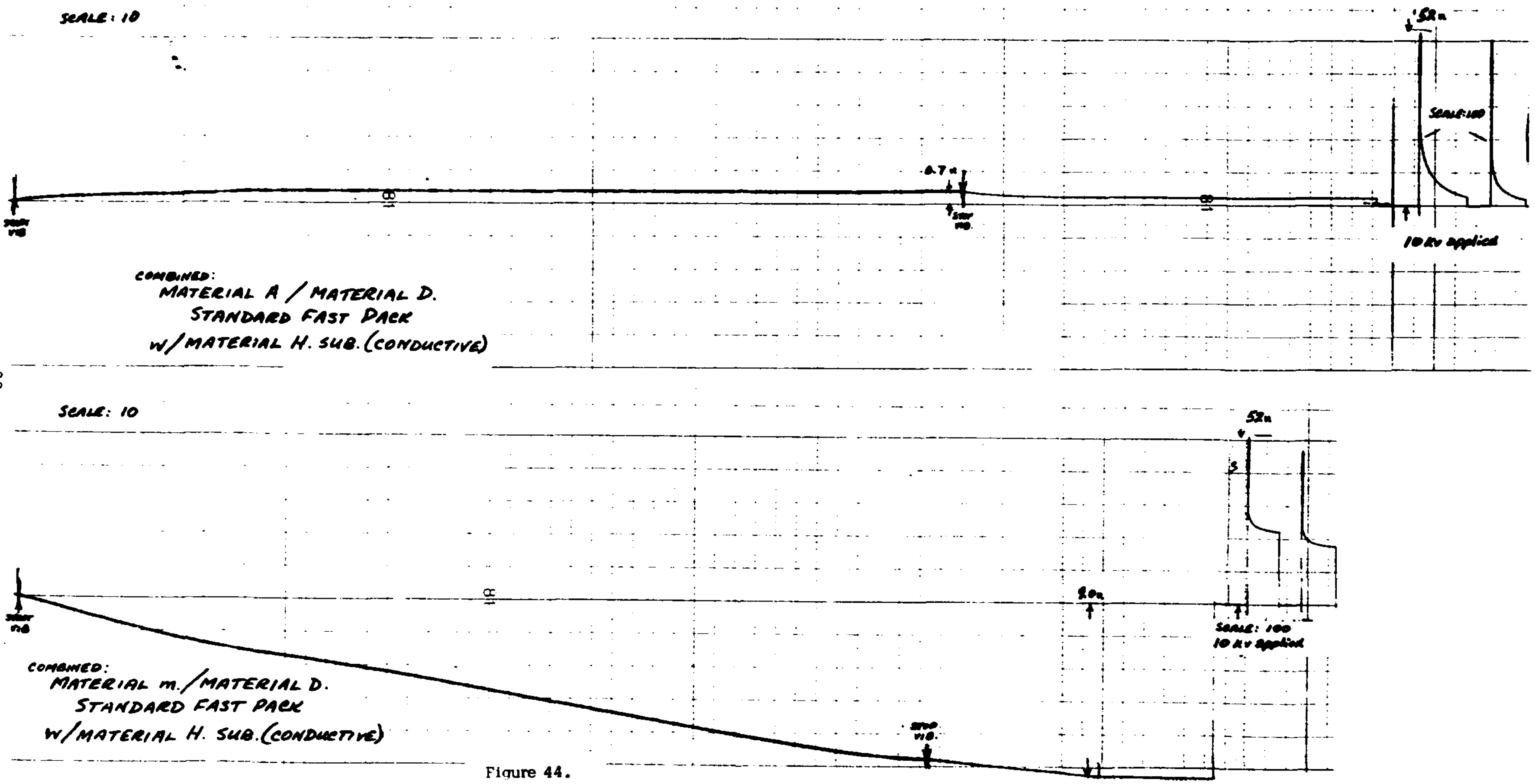

SCALE: 10
COMBINED:
MATERIAL A / MATERIAL D.
STANDARD FAST PACK
W/MATERIAL H. SUB. (CONDUCTIVE)
10 kv applied
SCALE: 10
COMBINED:
MATERIAL m. / MATERIAL D.
STANDARD FAST PACK
W/MATERIAL H. SUB. (CONDUCTIVE)
SCALE: 100
10 kv applied

Figure 44.

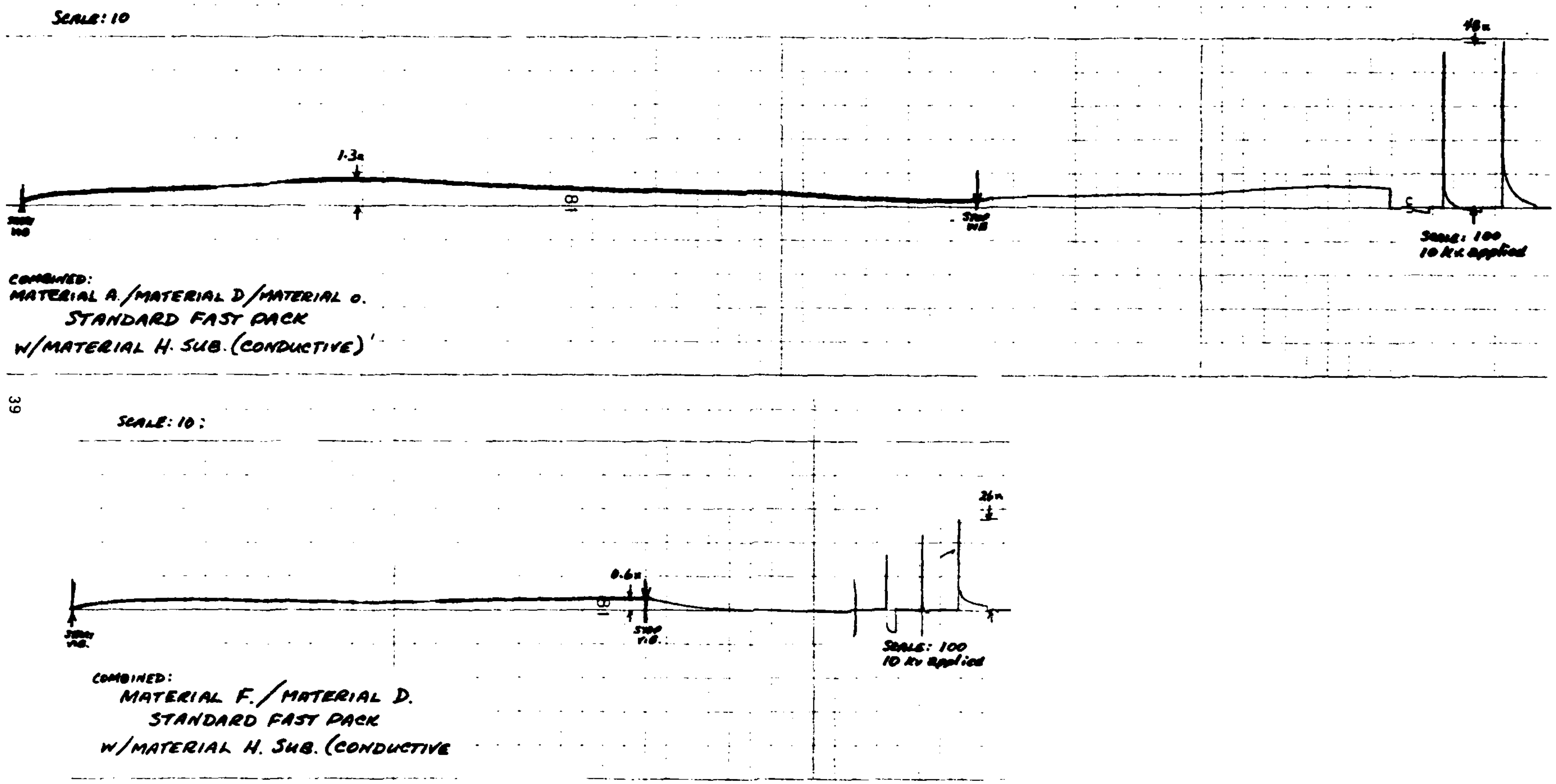

SCALE: 10
1.3"
START
STOP
48"
SCALE: 100
10 KV applied
COMBINED:
MATERIAL A./MATERIAL D/MATERIAL O.
STANDARD FAST PACK
W/MATERIAL H. SUB. (CONDUCTIVE)
SCALE: 10 ;
0.6"
26"
SCALE: 100
10 KV applied
COMBINED:
MATERIAL F./MATERIAL D.
STANDARD FAST PACK
W/MATERIAL H. SUB. (CONDUCTIVE

Figure 45.

(1) Single material static-free standard fast pack. Of the claimed or proven static-free materials, materials A and D proved to have the most desirable antistatic properties. In the case of material A, a very low level of static charge buildup was evidenced. Application of vibration actually neutralized a very small negative charge within the pack. Once the vibration was removed, the pack returned to this small charge. In some of the recordings, at this point, it is significant to note that within 5 to 10 seconds of vibration removal, static charge buildup occurred prior to release. This effect was caused by the vibration table frequency reaching pack resonance as it came to a complete stop. This resonance caused an increase in the rubbing action between materials for a short time. Material D evidenced negligible charge buildup. Materials C and E exhibited similar performance during buildup to a fairly low voltage level. However, material C released this charge completely whereas material E did not. Material F showed the next highest level of voltage buildup with only a slight tendency to release this charge during the test interval. Material G produced the highest voltage level also with a slight tendency to release the charge.

(2) Single material, "common," standard fast pack. Of the common packaging materials tested, material p showed the least tendency for static buildup. Materials n and q were next most desirable with materials s, o, t, and m following in that order. Insofar as release of the charge, materials p and q showed a slight tendency toward this effect. Material t exhibited no change while materials m, n, o, and s showed an actual increase in static charge buildup following removal of vibration.

(3) Triboelectric effect tab[illegible] for (1) and (2) above. As a summary of the results for both common and [illegible]imed or proven static-free materials, the following table is provided for comparison in the order of desirability for use with static-charge sensitive components.

| Material designation | Buildup | Release |
|---|---|---|
| D - Conductive black polyolefin | Excellent | Excellent |
| A - Hexagonal pink polyethylene | Very good | Very good |
| C - Transparent pink polyethylene | Very good | Very good |
| p - Single face corrugated | Very good | Good |
| E - Opaque coated barri[illegible] | Good | Fair |
| n - MIL-B-121 barrier | Good | Fair |
| q - Cohesive corrugated | Good | Fair |
| s - Polyethylene foam pouch | Fair | Poor |
| o - MIL-B-131 barrier | Poor | Poor |
| t - Packaging machine film laminate | Poor | Poor |
| m - Bubble plain polyethylene | Poor | Poor |
| F - Transparent metallized laminate | Poor | Poor |
| G - Opaque foil laminate | Poor | Poor |

(4) Corona discharge effect ((1) and (2) above). All of the tested packs for (1) and (2) above exhibited similar characteristics regarding their shielding ability against an external 10 Kv charge with some exceptions. In general, the slope and time duration of the static charge release path can be analyzed to provide the following ranking:

| Material description | Time duration |
|---|---|
| D | 120 microsec |
| t | 34 sec |
| A | 35 sec |
| E | 38 sec |
| C | 39 sec |
| p | 44 sec |
| q | 45 sec |
| n | 48 sec |
| s | 48 sec |
| F | 52 sec |
| o | 62 sec |
| m | 64 sec |
| G | 72 sec |

All of the packs experienced a static charge in the range of 12 to 17 volts. However, in the case of material D, most of this charge was given up in 120 microseconds versus a time range for the other materials from 34 to 72 seconds.

(5) Ground ribbon fast pack. With a conductive polyolefin ribbon attached to the outside surface of material F (presumably with a conductive metal additive), the material showed some improvement in resistance to static buildup over that indicated in (1) above. However, ability to release the charge showed no improvement. With an identical ribbon attached to the inside surface, charge polarity was reversed and the magnitude of buildup reduced to a good level similar to that of materials E and n in (1) above. Regarding high voltage discharge effect, voltage evidenced by the sensor was greatly reduced where a conductive strap is attached to the material F inside surface.

(6) Single material, modified fast pack (polystyrene). Of the common and static-free materials selected for this test, the following table is developed for triboelectric effect:

| Material designation | Buildup | Release |
|---|---|---|
| D | Excellent | Excellent |
| C | Very good | Good |
| B | Very good | Fair |
| A | Very good | Fair |
| s | Good | Fair |
| o | Good | Fair |
| m | Fair | Poor |
| F | Poor | Poor |

It can be seen that this table compares well with that for the standard fast pack, particularly as regards the ranking. However, materials A and C demonstrated significantly less ability to release the static charge buildup. Conversely, materials s, o, and m showed improved ability in this area. Testing for high voltage effect was limited to materials C, D, and F. Times for charge dissipation were greatly reduced from that of the standard fast pack for Materials C and F, while material D permitted a somewhat lower value, i.e., 9 volts versus 12 volts. The significant point in these tests was the observed change in slope and therefore the release path produced by the substitution of polystyrene cushions for the convoluted polyurethane.

(7) Single material, modified fast pack (polyethylene). Only two materials were tested for triboelectric effect. Materials F and G had demonstrated the poorest antistatic characteristics to this point. However, material G improved significantly in the area of static buildup. Material F, on the other hand, showed further poor characteristics in all areas.

(8) Single material, standard fast pack, conductive sleeve. Of the selected materials for testing of triboelectric effects with the altered fast pack, the following rankings apply:

| Material designation | Buildup | Release |
|---|---|---|
| D | Excellent | Excellent |
| F | Very good | Very good |
| B | Very good | Fair |
| n | Fair | Fair |
| m | Poor | Poor |

The only significant change noted in this table is the greatly improved performance of material F in both buildup and release characteristics. For purposes of the high voltage checks, the material B test was recorded on the storage oscilloscope since it had not been performed in (4) above. Time duration for the release would have ranked it just below material C at 43 seconds. Voltage levels were actually higher for materials F and m at 28 and 43 volts respectively. However, the release time for material F was significantly faster than material m.

(9) Combination materials, standard fast pack, conductive sleeve. As a summary of the results for various material combinations of both claimed and proven static-free materials, the following table is provided (material closest to the sensor is indicated first):

| Material designation | Buildup | Release |
|---|---|---|
| F/D | Very good | Excellent |
| A/D | Very good | Very good |
| r/D | Very good | Fair |
| A/D/o | Good | Fair |
| m/D | Poor | Poor |
| o/D | Poor | Poor |

This test showed the effect of placing another material within a proven static-free bag; i.e., conductive black polyolefin. The results indicated that the individual performance of material D was only slightly sacrificed, whereas the combination with material F improved the release characteristics of that material. Where a MIL-B-131 was used over a combination of materials A and D, some degradation in their performance was noted. Very high levels of voltage were noted in most combinations when corona discharge tests were conducted; the range being from 48 to 54 volts. Combination F/D exhibited a level of only 26 volts. Of the remaining, most rapid release was obtained from A/D/o and A/D in that order.

(10) Combination materials, standard fast pack. As a potential packaging procedure for the Navy's low voltage PCBs, a pack was tested using material D inclosed first in material A and second in material m. No desiccant was used. Results were identical to that obtained in (3) above in either combination D/A or D/m. Characteristics were the same for either triboelectric effect or corona discharge. However, in handling the pack (while being monitored by the electrometer) and opening of the material D bag within the outer material wrapping, charge buildup was significantly higher from personal contact where material m was used. This was assumed to be a good simulation of the actions which could be expected when the item is taken out for usage.

3. Conclusions.

a. The test procedure adopted for these project tests proved to be quite reliable, and allowed for excellent comparisons between both common and static-free materials. These comparisons were significant in that they more closely duplicated the anticipated effects associated with real-world package handling conditions, i.e., floating packs without benefit of grounding straps. Improvement is certainly possible in areas of controlled isolation of tested materials as well as in the testing of a greater number of material combinations.

b. The use of a desiccated and dehumidified chamber provided an excellent conditioning atmosphere which both simulated sealed desiccated bag conditions and offered a conducive environment for the buildup and release of static charge within and without the tested packs. Such an approach was prompted by the Navy's concern for the packaging of PCBs.

c. Method 4046, FTMS 101, requires extensive improvement to encompass an "in-package performance test" similar to that used in this project; or it should be supplemented by such an approach. Certainly, Method 4046 can be considered an indicator of anticipated performance but final acceptance of claimed antistatic properties must be further verified as with the testing accomplished herein.

d. Difficulties with Method 4046 and the primary specification for materials, MIL-B-81705, include test instrumentation problems, decay time limits, and the method by which flat samples are "perfectly" charged and then "perfectly" discharged. The latter does not provide complete data for static charge propensity determinations and obviously does not consider triboelectric effects of material combinations.

e. The use of the adopted test procedure has confirmed that damage may occur to low voltage PCBs both through triboelectric effects and corona discharge. This may occur despite the use of static-free materials qualifying with existing Government specifications. The use of certain of these static-free materials therefore provides a false sense of security.

f. Specifically, the Navy's packaging procedure, wherein the PCB is intimately wrapped with a layer of transparent pink hexagonal shape cushioning material, may permit sufficient static charge levels to reach the item during either transit or storage. Such levels would be dependent upon vibratory conditions which may exist in transit or upon proximity of PCB packs to high static charge sources in these handling modes. The use of desiccant may certainly amplify possible static buildup due to the conducive dry condition within the sealed bag.

g. Opaque electrically conductive polyolefin was shown to have excellent properties in both resistance to static charge buildup and the time duration in which applied charges are held. However, comparable levels of static voltages were evidenced in the test results when corona discharge tests were conducted.

h. Common packaging materials exhibited similar or better performance than certain claimed static'free materials. Paper materials performed as well or better than some of the metallized or foil-type laminate materials.

i. The transparent pink film and hexagonal shape cushioning materials were fairly consistent in their performance where one outer material is changed: polystyrene, polyethylene, or conductive fiberboard. Where the transparent gray nickel-coated laminate is used in conjunction with another static-free material, its properties are greatly enhanced. Individually, however, it exhibits poor performance.

j. The use of conductive fiberboard appears to be inconclusive at this time except as a method for obtaining improved properties from the material cited in i above.

k. Insofar as an acceptable substitute for the Navy's low-voltage PCBs, the use of a conductive black polyolefin bag intimately protecting the item showed excellent protection. Where cushioning protection is necessary, the use of a surrounding wrap of transparent hexagonal shape material provides some prevention against static discharge during handling by the user. The use of desiccant, in a pack of this type, of course, increases the danger of damage at the time of opening.

4. Recommendations.

a. The adopted "in-package performance" test procedure should be investigated for improvement in controlled isolation of packs and the generation of greater voltage magnitudes. The latter may be achieved through a search in vibratory frequency until pack resonances are obtained, this capability not being available with the chamber utilized.

b. With the improvement in a.above, further testing should be conducted using various material combinations. DARCOMPSCC should also monitor results of the many newer static-free materials which can be anticipated in the future to include the complete variety of conductive container materials which are coming into accelerated usage.

c. Action should be taken to request improvement in the type of instrumentation utilized for Method 4046, FTMS 101. In connection with this, an evaluation should be requested of MIL-B-81705 with a major objective being the incorporation of an "in-package performance" test procedure similar to that used in this project.

d. For purposes of the Navy's packaging of low-voltage PCBs, packaging prescriptions should be changed to identify the use of intimate protection achieved by a conductive black polyolefin bag with the addition of a transparent hexagonal shape cushioning wrap. Desiccant, unless proven to be necessary by the item manager, is not recommended.

e. Phase II of this project should address a, b, and c above with the addition of variable humidity control for determining overall effects on static voltage buildup.

## APPENDIX A

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
Washington, DC 20362

IN REPLY REFER TO
05D231/AVA
4030
Ser 114

From: Commander, Naval Sea Systems Command 21 Dec 1979
To: Director, Defense Army Readiness Command

Subj: Test & Evaluation (T&E) of Packaging (Barrier and Desiccant) Materials

Ref: (a) DoD Joint Regulation, Packaging and Materials Handling, Lead Activities for Testing Packaging Materials and Processes, NAVMATINST 4030.8, DARCOM Regulation 700-17 of 27 April 1978

(b) Proposed MIL-STD-XXX, Electrostatic Discharge Control Program for Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) of 15 October 1979

1. By reference (a), the U.S. Army Development and Readiness Command Packaging, Storage and Containerization Center (DARCOMPSCC) is assigned the lead activity for subject matter.

2. Electronic sensitive devices such as printed circuit (PC) cards, that may be damaged from electrostatic charges are packaged in antistatic free barrier materials or bags conforming to the requirements of specification MIL-B-81705 or MIL-B-117, Type I, Class A, Style E. In some applications additional protection is provided by the use of desiccant, MIL-D-3464, Type II. The packaging concepts comply with the requirements of Military Standard MS 90363, Sheet 4 of 10 and 9 of 10.

3. Appendix I, Table I-1 to reference (b) provides a listing of electrostatic discharge sensitive (ESDS) parts catagorized by part type and their sensitivity range. Recent information on low voltage PC boards which are electrostatic sensitive are found to be unsatisfacory for use. One of the reasons given for the possible device failures is the use of desiccant in the packaging concept.

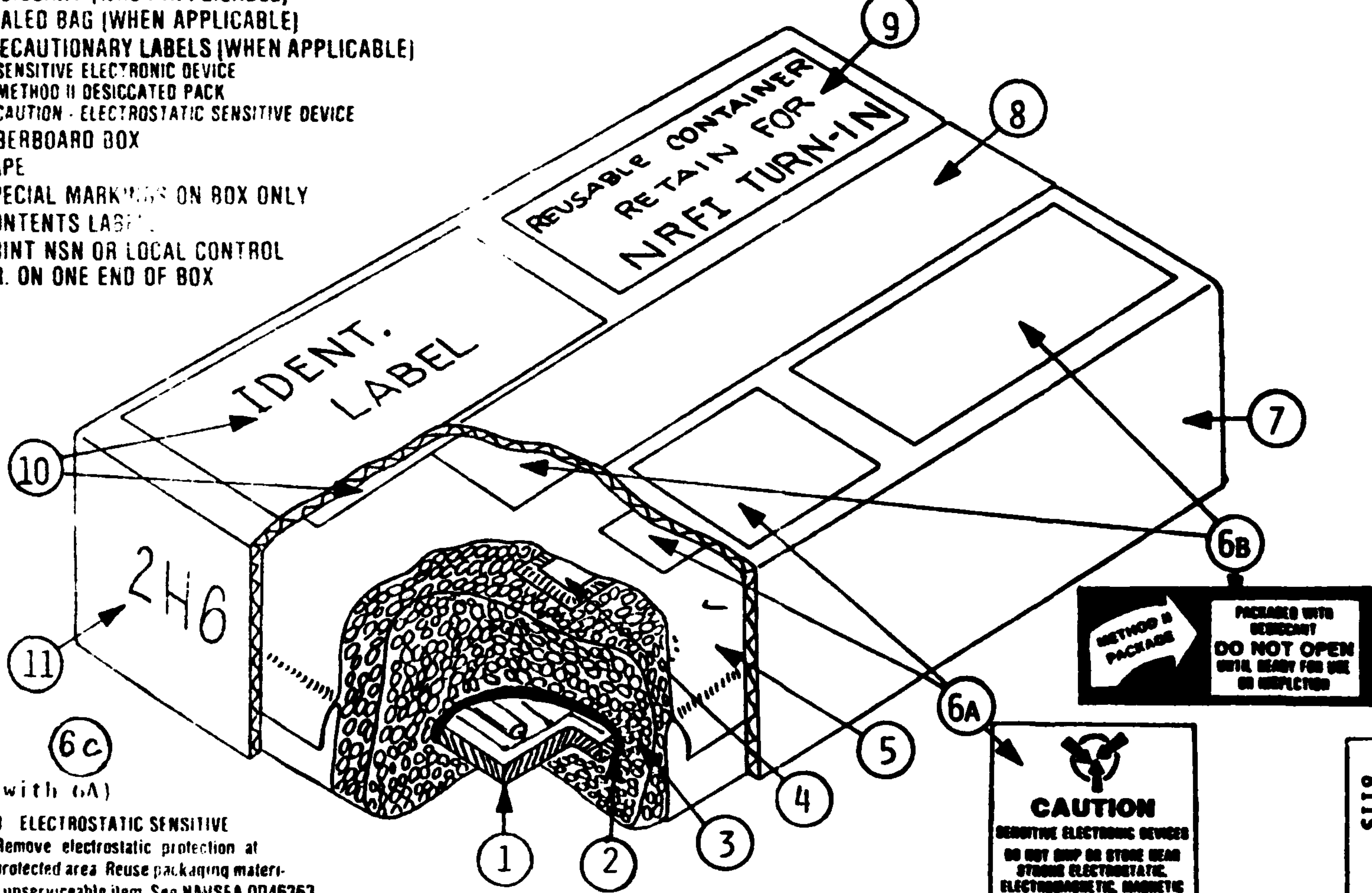
4. It is requested that tests be performed on the paragraph 2 packaging concepts to determine (a) the minimum and maximum voltages that may generate within the package, (b) the relative humidity within the package, and (c) the need for desiccant for protection of electrostatic sensitive items.

/s/ J. B. Alfers
J. B. ALFERS
By Direction

REVIEWER ACTIVITIES:
Navy

USER ACTIVITIES:
Army-GL

1. ITEM
2. WRAP (WHEN APPLICABLE)
3. CUSHIONING
4. DESICCANT (WHEN APPLICABLE)
5. SEALED BAG (WHEN APPLICABLE)
6. PRECAUTIONARY LABELS (WHEN APPLICABLE)
   a. SENSITIVE ELECTRONIC DEVICE
   b. METHOD II DESICCATED PACK
   c. CAUTION - ELECTROSTATIC SENSITIVE DEVICE
7. FIBERBOARD BOX
8. TAPE
9. SPECIAL MARKINGS ON BOX ONLY
10. CONTENTS LABEL
11. PRINT NSN OR LOCAL CONTROL NR. ON ONE END OF BOX




6c
(Use with 6A)

CAUTION ELECTROSTATIC SENSITIVE DEVICE: Remove electrostatic protection at use or in protected area. Reuse packaging materials for the unserviceable item. See NAVSEA OD46363 for protective handling or testing measures for this item.

FED. SUP CLASS 8115

APPROVED 30 March 1979 REVISED C

ENTIRE STANDARD REVISED

| | | | |
|---|---|---|---|
| NAVY SA | INTERNATIONAL INTEREST | TITLE Box, Fiberboard, with Cushioning for Special, Minimum Cube Storage and Limited Reuse Applications | MILITARY STANDARD |
| ARMY-GL | | | MS 90363 |
| | SUPERSEDES MS 90363F, July 1977 | | SHEET 1 OF 10 |

FED. SUP CLASS 8115

1. Items shall be cleaned in accordance with process C-1 of MIL-P-116, and shall be packaged in accordance with the applicable narrative instructions of this standard and the specific instructions identified by a Dash Number.

a. For items under 10-pounds, inside dimensions of the completed package shall not exceed the corresponding dimensions of the base item by more than 1/2-inch. Addition of 1 2-inch to length or width of --2 packages for desiccant is permitted.

b. For items over 10-pounds, pads, cells or die cuts fabricated from domestic fiberboard complying with PPP-F-320 shall be added as required to provide an even distribution of weight and a compact non-shifting load.

2. Items coated with a preservative shall be wrapped with barrier material conforming to MIL-B-22191, Type II and secured with pressure sensitive tape.

3. Unless otherwise specified by the applicable dash number, the items shall be cushioned with cushioning materials complying with one of the following specifications: PPP-C-795, Class 1, PPP-C-1842, PPP-C-1752, Types I, II, III, IV and V or PPP-C-1797. Apply sufficient number of wraps to obtain stated cushioning thickness.

| ITEM WEIGHT RANGE (POUNDS) | CUSHIONING THICKNESS (INCHES) |
|---|---|
| 1 or less | 1/4 |
| Over 1 but less than 5 | 1/2 |
| Over 5 but less than 10 | 3/4 |
| Over 10 but less than 15 | 1 |
| Over 15 but less than 25 | 1-1 2 |
| Over 25 but less than 40 | 2 |
| Over 40 but less than 55 | 2-1 2 |
| Over 55 but less than 70 | 3 |
| Over 70 through 100 | 3-1 2 |

4. Box, Fiberboard shall conform to PPP-B-636, Type CF or SF. Style OPF shall be used for electronic circuit boards and other flat items. Box for items weighing 40 pounds or more shall be class weather-resistant.

Exception: Items with bare dimensions of less than 3" x 2-1/2" x 1-1 2" may alternately be packaged in metal edged or setup paperboard boxes (full telescope type) conforming to PPP-B-665 or PPP-B-676.

5. Tape shall conform to PPP-T-45, Type II, Class 1 (Strippable) for fiberboard boxes (PPP-B-636) and PPP-T-60 for metal edged and setup paperboard boxes (PPP-B-665, PPP-B-676).

6. Two contents labels are required — one on the bag and the other on the fiberboard box. Marking shall be in accordance with MIL-STD-129 and marking format shall be as follows:

| | |
|---|---|
| National Stock No. or Local Control No. | 6A 1220-00-065-7656 |
| Mfg. Dwg or Part No. (When applicable) | 2443101 |
| Nomenclature | Amplifier |
| SPALT or Modification No. and Date (When applicable) | SPALT 102 4-74 |
| Contract or Order No. | N00024-72-A [illegible] |
| Manufacturer's Name | ABC Company |
| Serial No. (When applicable) | Serial No. 246 |
| Level of Preservation and Date | A 1-79 |
| Shelf Life Markings (When applicable — see MIL-STD-129) | |

7. In addition to the above markings, the National Stock Number (NSN) or Local Control Number (MCN, PICN, etc.) shall be marked on one end of the box and statement "Reusable Container Retain for NRFI Turn-in" (Not Ready for Issue) shall be marked on upper right hand corner.

8. Material unit packaged in accordance with this standard shall always be packed for shipment as specified in associated instructions or procurement documents.

9. The requirements of this standard take precedence over documents referenced herein. Referenced documents shall be of the issue in effect on date of invitation for bid.

| CUSTODIAN | INTERNATIONAL INTEREST | TITLE | MILITARY STANDARD |
|---|---|---|---|
| [illegible] NPD-GL | | Box, Fiberboard, with Cushioning for Special, Minimum Cube Storage and Limited Reuse Applications | |
| | SUPERSEDES MS 90363E, July 1977 | | SHEET 2 OF 10 |

APPROVED 30 March 1979 REVISED

FED. SUP CLASS 8115

| Dash No. | MIL-STD-726 Code Table IIc | MIL-P-116 Method of Preservation |
|---|---|---|
| -1 | GQ | IA-8 |

1. Pins, knobs, and other sharp protrusions shall be protected with caps, plugs, connector covers, rigid foam plastic (MIL-P-26514) or fiberboard (PPP-F-320).

2. Use heat sealed aluminum foil lamina bags conforming to Type I or II. Class E, Style 1 or Type I, Class F, Style 1 of MIL-B-117.

3. Marking of electromagnetic sensitive items only, such as solid state devices (diodes, transistors, integrated circuits and microcircuits) and/or electronic modules, circuit boards and equipment components in which solid state devices are incorporated. Use two sensitive electronic items labels of MIL-STD-129 (2" x 2" or less) as specified for intermediate packages - one on the bag and one on the fiberboard box.

USER ACTIVITIES:

REVIEWER ACTIVITIES:

This military standard is approved for use by all Departments and Agencies of the Department of Defense. Selection for all new engineering and design applications and for repetitive use shall be made from this document.

APPROVED 30 March 1979 REVISED

| | | | |
|---|---|---|---|
| P.A. NAVY - SA<br>Other Cust. ARMY - GL | INTERNATIONAL INTEREST | TITLE Box, Fiberboard, with Cushioning for Special, Minimum Cube Storage and Limited Reuse Applications | MILITARY STANDARD<br>MS 90363 |
| Procurement Specifications | SUPERSEDES: MS 90363F, July 1977 | | SHEET 3 OF 10 |

FED. SUP CLASS
8115

| Dash No. | MIL-STD-726 Code Table IIc | MIL-P-116 Method of Preservation |
|---|---|---|
| -2 | GR | IIc |

USER ACTIVITIES:

1. Pins, knobs and other sharp protrusions shall be protected with caps, plugs, connector covers, rigid foam plastic (MIL-P-26514) or fiberboard (PPP-F-320).

2. Desiccant shall conform to MIL-D-3464, Type II.

3. Heat sealed aluminum foil lamina barrier bags shall conform to Type I or II, Class E. Style 1 of MIL-B-117.

4. Marking of electromagnetic sensitive items only, such as solid state devices (diodes. transistors, integrated circuits and mi rocircuits) and/or electronic modules, circuit boards and equipment components in which solid state devices are incorporated. Use two sensitive electronic items labels of MIL-STD-129 (2" x 2" or less) as specified for intermediate packages - one on the bag and one on the fiberboard box.

REVIEWER ACTIVITIES:

REVISED

APPROVED

| | | | |
|---|---|---|---|
| P.A. NAVY-SA | INTERNATIONAL INTEREST | TITLE Box, Fiberboard, with Cushioning for Special, Minimum Cube Storage and Limited Reuse Applications | MILITARY STANDARD |
| Other Cust. ARMY-GL | | | MS 90363 |
| Procurement Specifications | SUPERSEDES: MS 90363F, July 1977 | | SHEET 4 OF 10 |

FED. SUP CLASS 8115

| Dash No. | MIL-STD-726 Code Table IIc | MIL-P-116 Method of Preservation |
|---|---|---|
| -3 | GP | IC-1 |

1. Pins, knobs and other sharp protrusions shall be protected with caps, plugs, connector covers, rigid foam plastic (MIL-P-26514) or fiberboard (PPP-F-320).

2. Use transparent barrier bag conforming to Type I, Class C, Style 2 of MIL-B-117 (Do not use for field force sensitive electronic items).

USER ACTIVITIES:

REVIEWER ACTIVITIES:

This ... standard is approved for use by all Departments and Agencies of the Department of Defense. ... for all new engineering and design applications and for repetitive use shall be made from this document

APPROVED 30 March 1979 REVISED

| | | | |
|---|---|---|---|
| Custodians: NAVY-SA; Other Cust: ARMY-GL | INTERNATIONAL INTEREST | TITLE Box, Fiberboard, with Cushioning for Special, Minimum Cube Storage and Limited Reuse Applications | MILITARY STANDARD MS 90363 |
| Procurement Specifications | SUPERSEDES: MS 90363F, July 1977 | | SHEET 5 OF 10 |

8115-0431

FED. SUP CLASS
S115

| Dash No. | MIL-STD-726 Code Table IIc | MIL-P-116 Method of Preservation |
|---|---|---|
| –4 | FX | I |

1. Protect sharp edges and protrusions with barrier material conforming to MIL-B-22191. Type II.

2. Items coated with a preservative shall be wrapped with barrier material conforming to MIL-B-22191, Type II and secured with pressure sensitive tape.

3. No bag required.

USER ACTIVITIES:

REVIEWER ACTIVITIES:

This military standard is approved for use by all Departments and Agencies of the Department of Defense. Selection for all new engineering and design applications and for repetitive use shall ... from this document.

APPROVED 30 March 1979 REVISED

| | | | |
|---|---|---|---|
| P.A. NAVY-SA<br>Other Cust ARMY-GL | INTERNATIONAL INTEREST | TITLE Box, Fiberboard, with Cushioning for Special, Minimum Cube Storage and Limited Reuse Applications | MILITARY STANDARD<br>MS 90363 |
| Procurement Specifications | SUPERSEDES | MS 90363F, July 1977 | SHEET 6 OF 10 |

FED. SUP CLASS
8115

| Dash No. | MIL-STD-726 Code Table IIc | MIL-P-116 Method of Preservation |
|---|---|---|
| -5 | FY | III |

1. Pins, knobs and other sharp protrusions shall be protected with caps, plugs, connector covers, rigid foam plastic (MIL-P-26514) or fiberboard (PPP-F-320).

2. No bag is required.

USER ACTIVITIES:

REVIEWER ACTIVITIES:

This military standard is approved for use by all Departments and Agencies of the Department of Defense. Selection for all new engineering and design applications and for repetitive use shall be made from this document.

APPROVED 30 March 1979 REVISED

| P A NAVY-SA | INTERNATIONAL INTEREST | TITLE Box, Fiberboard, with Cushioning for Special, Minimum Cube Storage and Limited Reuse Applications | MILITARY STANDARD MS 90363 |
|---|---|---|---|
| Other Cust ARMY-GL | | | |
| Procurement Specifications | SUPERSEDES | MS 90363F, July 1977 | SHEET OF 10 |

FED. SUP CLASS
8115

| Dash No. | MIL-STD-726 Code Table IIc | MIL-P-116 Method of Preservation |
|---|---|---|
| -8 | GA | IA-8 Electrostatic Free |

1. Pins, knobs, leads, terminals and other sharp protrusions shall be protected with noncorrosive and electrostatic free caps, plugs, connector covers, protective carriers or rigid foam plastic meeting the static test requirements of MIL-B-81705. Lead and terminal configuration shall be maintained as manufactured.

2. Cushion (complete coverage) with electrostatic free cushioning material conforming to PPP-C-1842, Type III or other electrostatic free cushioning material certified as conforming to the static electricity test requirements of PPP-C-1842, Type III. The cushioning shall be noncorrosive and shall not flake, powder or shed. Loose fill types are prohibited.

3. All items, apply sufficient number of wraps to obtain stated cushioning thickness.

4. Use heat sealed aluminum foil lamina and electrostatic free barrier bag conforming to Type I, Class F, Style 1 of MIL-B-117.

5. Two sensitive electronic items labels of MIL-STD-129 (2" x 2" or less) as specified for intermediate packages and two special caution markings are required – one of each on the bag and on the fiberboard box. The special caution markings shall be as follows:

> "CAUTION -- ELECTROSTATIC SENSITIVE DEVICE: Remove electrostatic protection at use or in protected area. Re[illegible] packaging materials for the unserviceable item. See NAVSEA OD46363 for protecti[illegible] [illegible]ling or testing measures for this item".

NOTE: Use for items which are both electrostatic and electromagnetic sensitive such as solid state devices (diodes, transistors, integrated circuits and microcircuits) and/or electronic modules, circuit boards and equipment components in which solid state devices are incorporated.

USER ACTIVITIES:

REVIEWER ACTIVITIES:

This military standard is approved for use by all Departments and Agencies of the Department of Defense. [illegible] for all new engineering and design [illegible] and for repetitive use shall [illegible] document

APPROVED 30 March 1979 REVISED

| | | | |
|---|---|---|---|
| PA NAVY-SA | INTERNATIONAL INTEREST | TITLE Box, Fiberboard, With Cushioning for Special, Minimum Cube Storage and Limited Reuse Applications | MILITARY STANDARD |
| [illegible] ARMY-GL | | | MS 90363 |
| [illegible] Specifications | SUPERSEDES: MS 90363F, July 1977 | | SHEET 8 OF 10 |

FED. SUP CLASS 8115

| Dash No. | MIL-STD-726 Code Table IIc | MIL-P-116 Method of Preservation |
|---|---|---|
| –7 | GB | IIc Electrostatic Free |

1. Pins, knobs, leads, terminals and other sharp protrusions shall be protected with noncorrosive and electrostatic free caps, plugs, connector covers, protective carriers or rigid foam plastic meeting the static test requirements of MIL-B-81705. Lead and terminal configuration shall be maintained as manufactured.

2. Cushion (complete coverage) with electrostatic free cushioning material conforming to PPP-C-1842, Type III or other electrostatic free cushioning material certified as conforming to the static electricity test requirements of PPP-C-1842, Type III. The cushioning shall be noncorrosive and shall not flake, powder or shed. Loose fill types are prohibited.

3. All items, apply sufficient number of wraps to obtain stated cushioning thickness.

4. Desiccant shall conform to MIL-D-3464, Type II.

5. Use heat sealed aluminum foil lamina and electrostatic free barrier bag conforming to Type I, Class F, Style 1 of MIL-B-117.

6. Two sensitive electronic items labels of MIL-STD-129 (2" x 2" or less) as specified for intermediate packages and two special caution markings are required – one of each on the bag and on the fiberboard box. The special caution markings shall be as follows:

> "CAUTION – ELECTROSTATIC SENSITIVE DEVICE: Remove electrostatic protection at use or in protected area. Reuse packaging materials for the unserviceable item. See NAVSEA OD46363 for protective handling or testing measures for this item".

NOTE Use for items which are both electrostatic and electromagnetic sensitive such as solid state devices (diodes, transistors, integrated circuits and microcircuits) and or electronic modules, circuit boards and equipment components in which solid state devices are incorporated.

USER ACTIVITIES:

REVIEWER ACTIVITIES

APPROVED 30 March 1979 REVISED

| | | | |
|---|---|---|---|
| CA NAVY SA | INTERNATIONAL INTEREST | TITLE Box, Fiberboard, with Cushioning for Special, Minimum Cube Storage and Limited Reuse Applications | MILITARY STANDARD |
| PREP. CUST ARMY-GL | | | MS 90563 |
| Procurement Specifications | SUPERSEDES: MS 90563F, July 1977 | | SHEET 9 OF 10 |

FED. SUP CLASS 8115

| Dash No. | MIL-STD-726 Code Table IIc | MIL-P-116 Method of Preservation |
|---|---|---|
| -8 | GC | IC-1 Electrostatic Free |

1. Pins, knobs, leads, terminals and other sharp protrusions shall be protected with noncorrosive and electrostatic free caps, plugs, connector covers, protective carriers or rigid foam plastic meeting the static test requirements of MIL-B-81705. Lead and terminal configuration shall be maintained as manufactured.

2. Cushion (complete coverage) with electrostatic free cushioning material conforming to PPP-C-1842, Type III or other electrostatic free cushioning material certified as conforming to the static electricity test requirements of PPP-C-1842, Type III. The cushioning shall be noncorrosive and shall not flake, powder or shed. Loose fill types are prohibited.

3. All items, apply sufficient number of wraps to obtain stated cushioning thickness.

4. Use transparent electrostatic free barrier bag conforming to Type I, Class A, Style 2 of MIL-B-117.

5. Two sensitive electronic items labels of MIL-STD-129 (2" x 2" or less) as specified for intermediate packages and two special caution markings are required – one of each on the bag and on the fiberboard box. The special caution markings shall be as follows:

> "CAUTION – ELECTROSTATIC SENSITIVE DEVICE: Remove electrostatic protection at use or in protected area. Reuse packaging materials for the unserviceable item. See NAVSEA OD46363 for protective handling or testing measures for this item".

NOTE: Use for items which are electrostatic sensitive and are not electromagnetic sensitive items such as solid state devices (diodes, transistors, integrated circuits and microcircuits) and/or electronic modules, circuit boards and equipment components in which solid state devices are incorporated.

USER ACTIVITIES:

REVIEWER ACTIVITIES

This military standard is approved for use by all Departments and Agencies of the Department of Defense. Selection for all new engineering and design applications and for repetitive use shall be made from this document.

APPROVED 30 March 1979 REVISED

| | | | |
|---|---|---|---|
| P.A. NAVY-SA<br>Cust. ARMY-GL | INTERNATIONAL INTEREST | TITLE Box, Fiberboard, with Cushioning for Special, Minimum Cube Storage and Limited Reuse Applications | MILITARY STANDARD<br>MS 90363 |
| Procurement Specifications | SUPERSEDES: MS 90363F, July 1977 | | SHEET 10 OF 10 |

APPENDIX B

## Equipment and Material Listing

| Reference No. | |
|---|---|
| 1 | Brush Pen Type Chart Recorder, Model 440 |
| 2 | Keithley Solid State Electrometer, Model 610C w/2501 Static Detecting Head |
| 3 | Tektronix Storage Oscilloscope, Type R564B w/2A63 Differential Amplifier and 2B67 Time Base |
| 4 | Hewlett-Packard Oscilloscope Camera, Model 196A (Wollensak 3", f1.9 lense) w/Polaroid 3000 speed film |
| 5 | Industrial Instruments Insulation Breakdown Test Set, Model TS928 A/G w/5, 10, 25, 50 KV. output ranges |
| 6 | 3M Company Static Meter, Model 701 w/5, 10, 20 KV. ranges (+) or (-) |
| 7 | Zerostat Static Eliminator |
| 8 | Precision Scientific Co. Interval Timer |
| 9 | Airguide Humidity Indicator |
| 10 | Beckman Humi-Chek Precision Electronic Hygrometer w/direct reading RH scaled 10 to 95% |
| 11 | Atlantic Research Corp. Desomatic, Model CB-8 |
| 12 | Vertrod Impulse Heat Sealer, w/15-inch bar seal cap. |
| 13 | Thermatron Corporation Environmental/Vibration Chamber, Model F62-CHV-25-25-00, Chamber Volume - 4 1/2 ft. x 4 1/2 ft. x 3 ft. (60 cu. ft.) |
| 14 | Desiccant (Grade A silica gel) 560 units, consisting of:<br>68 - 4-unit bags (272 units)<br>17 - 16-unit bags (272 units)<br>2 - 8-unit bags (16 units) |

## APPENDIX C

### Tested Materials Listing

Reference Letter*

A. Transparent, Open-Cell Cushioning Material, Hexagonal Shape, Pink Color, Electrostatic Free; IAW PPP-C-1842. Antistatic property added in the form of a conductive surface layer over an extruded polyethylene resin.

B. Transparent Polyethylene Film, Pink Color, Electrostatic Free; IAW MIL-B-81705. A nonlaminated plastic sheet formed from a homogeneous antistatic resin mix.

C. Transparent Polyethylene Film, Pink Color, Electrostatic Free. Antistatic property added in the form of a conductive surface layer over an extruded polyethylene resin.

D. Opaque Electrically Conductive Polyolefin, Black Color. Volume conductivity achieved from carbon loading of the plastic resin.

E. Opaque Foil Laminate Barrier, Coated, Green Color, Electrostatic Free. Unknown antistatic property additive.

F. Transparent Laminated Film, Gray Color, Electrostatic Free. Laminate of polyethylene and polyester with the antistatic property achieved with an outer coating of conductive nickel.

G. Opaque Thin Film Laminate, Silver Color, Electrostatic Free. Laminate of polyethylene and polyester with the antistatic property achieved with a sandwiched layer of metal foil.

H. Conductive Corrugated Fiberboard. Conductivity achieved from carbon loading of the surfaces of the fiberboard. Used in sleeve portion of fast pack.

i. Standard Corrugated Fiberboard. W5c fiberboard used in sleeve portion of reusable fast pack container; NSN 8115-00-101-7647, 9 inches x 6 inches x 2 1/2 inches.

*Capital letters indicate either claimed or previously proven antistatic properties inherent with the material.

j. Convoluted Polyurethane. Used as standard cushioning media for tested fast pack container.

k. Polyethylene Foam. Used as replacement cushioning media for tested fast pack container.

l. Polystyrene Foam. Used as replacement cushioning media for tested fast pack container.

m. Transparent Flexible Cellular Cushioning Material; IAW PPP-C-795.

n. Barrier Material, Greaseproofed; IAW MIL-B-121.

o. Barrier Material, Water-vaporproof; IAW MIL-B-131.

p. Single-Faced Corrugated Wrapping; IAW PPP-P-291.

q. Single-Faced Corrugated Wrapping, w/Cohesive Properties.

r. Kraft Paper Wrapping; IAW UU-P-268.

s. Unicellular Polyethylene Foam, 1/16-inch thick sheet for pouches; IAW PPP-C-1752.

t. Laminated Skin Packaging Film, Ionomer Resin/Nylon; for use in automatic packaging machines.

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