
Physical And Chemical Test Results Of Electrostatic Safe Flooring Materials

April 1988

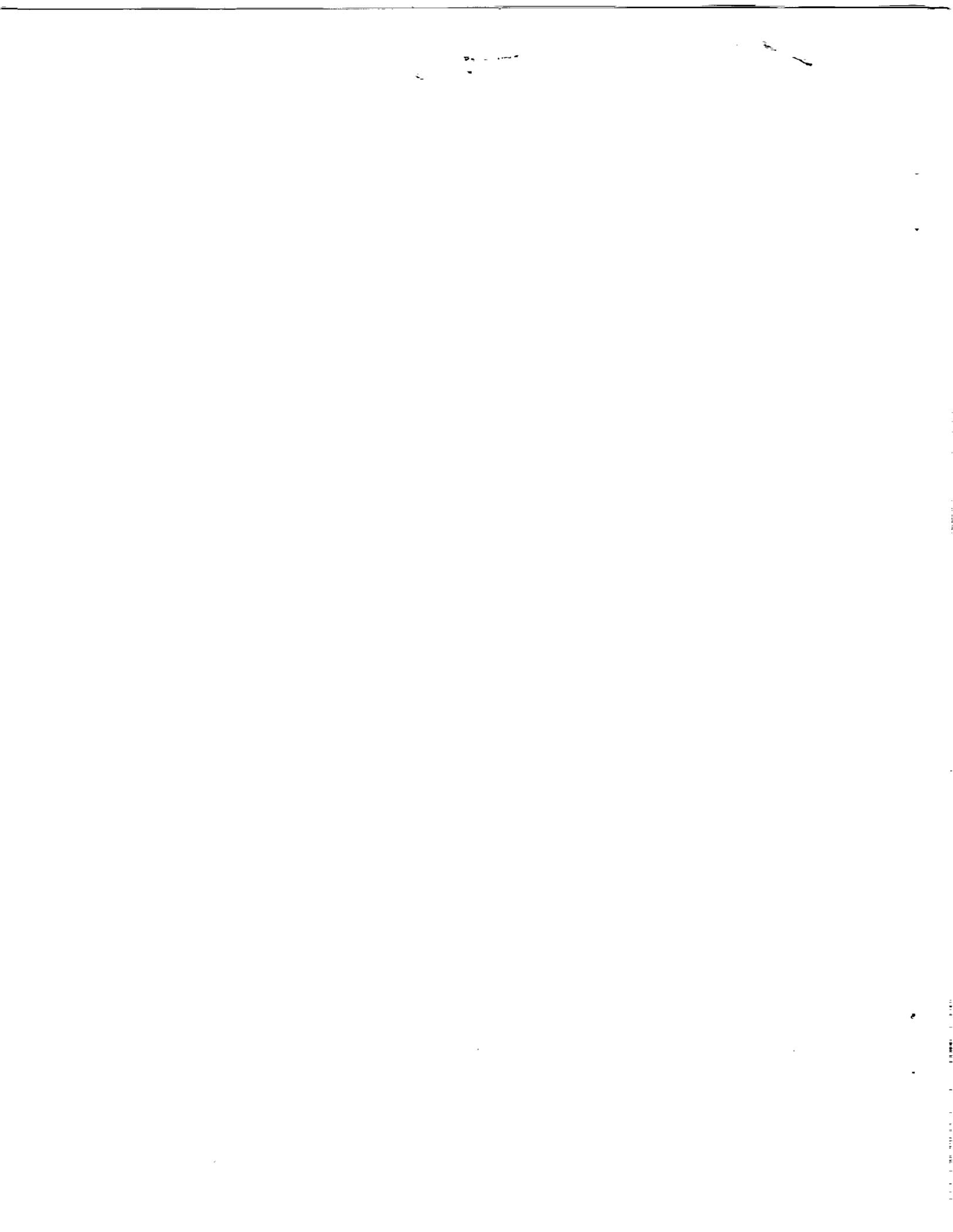
(NASA-TM-103501) PHYSICAL AND CHEMICAL TEST
RESULTS OF ELECTROSTATIC SAFE FLOORING
MATERIALS (NASA) 21 p CSCL 13B

N91-10194

Unclas
63/31 0309751



National Aeronautics and
Space Administration



Physical And Chemical Test Results Of Electrostatic Safe Flooring Materials

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April 1988

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TEST REPORT

Physical and Chemical Test Results of
Electrostatic Safe Flooring Materials

ISSUED BY

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ABSTRACT

This test program was initiated because a need existed at the Kennedy Space Center (KSC) to have this information readily available to the engineer who must make the choice of which electrostatic safe floor to use in a specific application. The information contained in this study, however, should be of value throughout both the government and private industry in the selection of a floor covering material.

Included in this report are the test results of 18 floor covering materials which by test evaluation at KSC are considered electrostatically safe (i.e., these coverings satisfy the KSC electrostatic safety criteria). Tests were done and/or the data compiled in the following areas:

- (1) Electrostatics.
- (2) Flammability.
- (3) Hypergolic compatibility.
- (4) Outgassing.
- (5) Floor type.
- (6) Material thickness.
- (7) Available colors.

Each section contains the test method used to gather the data, the KSC acceptance criteria (when applicable), and the test results. A "quick-look" summary of the test results is shown on page IV.

COMPANY	PRODUCT NAME	FLOOR TYPE	THICKNESS (INCHES)	ELECTRO-STATIC 30% KH	FLAME	OUTGASSING (ASTM E-595-83)			HYPER. COMPAT.		COLOR**
						TNL	MWR	CVCA	IGNITES	PHYSICAL CHANGE*	
1. VINYL PLASTICS, INC.	SD-52	12" TILE AND 36" TILE FOR HEAT WELD SEAMLESS FLOOR (ALSO CUSTOM SIZES)	0.12	PASS	PASS	4.98	0.04	2.56	NO	YES	WINTER WHITE, (CASHEW, GREY, BONE)
2. VINYL PLASTICS, INC.	CON-2	12" TILE AND 36" TILE FOR HEAT WELD SEAMLESS FLOOR (ALSO CUSTOM SIZES)	0.12	PASS	PASS	4.62	0.04	2.06	NO	YES	WHITE (BEIGE, TORTUISE, CLOUD, SAND, EMERALD, GLACIER)
3. CROSSFIELD PRODUCTS CORP.	DEXOTEX-CONDUCTIVE CHEMINERT TOPPING	MULTICOMPONENT MIXTURE/ APPLIED IN PLACE	0.25	PASS	PASS	1.43	0.42	0.02	NO	YES	GREY
4. CROSSFIELD PRODUCTS CORP.	DEXOTEX-CONDUCTIVE AJ53C DRESSING	MULTICOMPONENT MIXTURE/ APPLIED IN PLACE	0.25	PASS	PASS	1.13	0.26	0.03	NO	YES	BLACK-302
5. STONEHARD	STONCLAD-AT	TWO-COMPONENT EPOXY MIXTURE APPLIED IN PLACE	0.25	PASS	PASS	1.01	0.05	0.06	NO	YES	BLACK-196
6. STONEHARD	STONLUX-AT	TWO COMPONENT EPOXY MIXTURE APPLIED IN PLACE	0.13	PASS	PASS	5.11	0.08	0.03	NO	YES	BEIGE-320 (GREY, CUSTOM)
7. MORA FLOORING	MORAPLAN DUO EL	24" TILE AND ROLL	0.10	PASS	FAIL	2.76	0.14	0.58	NO	YES	254 (GREEN, BEIGE, BLACK DOT)
8. MORA FLOORING	MORAPLAN DUO EL	24" TILE AND ROLL	0.10	PASS	FAIL	2.95	0.11	0.63	NO	YES	253 (GREY, BLACK DOT)

**SEE TABLE 3

**COLORS SHOWN IN PARENTHESES WERE NOT TESTED

"QUICK SUMMARY"

COMPANY	PRODUCT NAME	FLOOR TYPE	THICKNESS (INCHES)	ELECTRO-STATIC 30% RH	FLAME	OUTGASING (ASTM E-595-83)		HYPER. COMPAT.		COLOR**	
						TML	CVCH	IGNITES	PHYSICAL CHANGE*		
9. NURA FLOORING	NORAMENT 928	1 METER SQUARE TILE	0.20	PASS	PASS	5.47	0.63	1.49	NO	YES	928 GREY
10. NURA FLOORING	NORAPLAN 938	24" TILE AND 48" ROLL	0.10 TO 0.16	PASS	PASS	6.29	0.90	1.23	NO	YES	938 GREY
11. NURA FLOORING	NORAMENT 927	1 METER SQUARE TILE	0.20	PASS	PASS	5.47	0.63	1.49	NO	YES	927 BLACK
12. FLEXCO	CLASS A	12", 24", 36" SQUARE (PRE-GROOVED FOR HEAT WELD)	0.12	PASS	PASS	5.95	0.07	3.03	NO	YES	WHITE (CREAM, GRAY, IVORY, BEIGE, STEEL)
13. FLEXCO	CLASS B	12", 24", 36" SQUARE (PRE-GROOVED FOR HEAT WELD)	0.12	PASS	PASS				NO	YES	WHITE (CREAM, GRAY, IVORY, BEIGE, STEEL)
14. WEATHERGUARD-MARBLEDID PRODUCTS, INC.	SPARKPROOF	TWO-COMPONENT CONDUCTIVE MAGNESITE MIX APPLIED IN PLACE	0.37 TO 1.00	PASS	PASS	0.52	0.05	0.05	NO	YES	RED-BROWN #114
15. WEATHERGUARD-MARBLEDID PRODUCTS, INC.	RED TOPCOAT	TWO COMPONENT MAGNESITE MIX APPLIED IN PLACE	0.37 TO 1.00	PASS	PASS	11.62	6.86	0.01	NO	YES	BRICK RED
16. SELBY BATTERSBY AND COMPANY	NOVALITE (CONDUCTIVE)	THREE COMPONENT MIX	0.25 TO 1.00	PASS	PASS	1.01	0.24	0	NO	YES	
17. DATWYLER-DIST. TSK TEK STIL CONCEPTS, INC.	UNIFLOOR STATIC DISSIPATIVE	48" ROLL, 12" 24" SQUARE TILE	.093	PASS	PASS	8.14	0.09	4.52	NO	YES	COLOR 0086 WHITE (GREY, BEIGE, GREEN, MARBLE)
18. DATWYLER-DIST. TSK TEK STIL CONCEPTS, INC.	UNIFLOOR CONDUCTIVE 6000	60" ROLL, 12" 20" TILE	.083	PASS	PASS	9.49	0.06	6.23	NO	YES	WHITE WITH BLACK IRREGULAR LINES

*SEE TABLE 3

**COLORS SHOWN IN PARENTHESES WERE NOT TESTED

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1.0 INTRODUCTION

Floor covering materials are used quite extensively at KSC to satisfy the flooring needs in a large variety of building types. Some applications include the assembly of payloads and the mating of upper stage solid or liquid rocket boosters. Other applications may include chemical or electronic laboratories, office complexes, and industrial facilities. In some applications the floor loading may be only foot traffic while in others it may be forklift traffic, much heavier vehicular traffic, or large and heavy air lift pallets which require a smooth seamless floor. While each of these applications may require various special flooring requirements the one requirement common to all is that the floor must be of a material which does not generate or retain large electrostatic voltages.

The flooring materials selected for testing in this study were selected by an exhaustive review of the Thomas Register for all floor materials advertised or known as having good electrostatic properties as well as a thorough search at technical conferences such as the annual EOS/ESD Symposium. It was the author's attempt to locate every floor material manufacturer which made a floor material that would pass the KSC electrostatic safety criteria. Many companies contacted did not have such a product available while others provided samples of materials that failed to satisfy this standard. The materials listed in this report were therefore selected by a thorough search and testing process to identify electrostatic safe flooring materials (note: Those that did not pass the electrostatic test were not included in this study). In such a study it may be safe to assume that some products escaped being considered but it is likely most of the products believed

to have satisfactory electrostatic properties were included in this study.

Over the past 20 years flooring materials have been routinely tested in the NASA Materials Testing Laboratory, but only for specific applications, as the use directed. This routine testing has resulted in a large quantity of data but it has never been compiled into a single file. In addition, complete testing of all properties was not done for every material. The purpose of this study was, therefore, to establish a more complete technical data base for electrostatically safe floorings from which the responsible engineer could select the flooring that best suits the technical needs of the application. This flooring materials data base includes the following tested properties: (1) Electrostatic, (2) flammability, (3) hypergolic compatibility, and (4) outgassing. In addition, the following other material properties have been included: (1) Floor type, (2) material thickness, and (3) available color. Included in this report are the test methods used, the acceptance criteria used by KSC, and the test results. A summary of the data is included on page IV of this report.

2.0 ELECTROSTATIC TESTING

Increasing attention is being given to the problem of static electricity because of its ability to damage or destroy certain semiconductor devices, unexpectedly initiate ordnance devices, ignite explosive atmospheres, and surprise workers performing critical tasks, causing undesirable consequences and injuries to occur. The triboelectric test device used to evaluate the electrostatic properties of the materials in this report was developed at KSC. It evaluates two distinct

electrostatic properties of a material. One is the material's capability to develop a charge. This property is shown by the peak triboelectric voltage generated. The second property is the ability to discharge this surface electrical charge to a grounded frame. This is best shown by the decay curve shape and/or the voltage remaining 5 seconds after rubbing has ceased.

- 2.1 Test Specification - (1979, Malfunction/Materials Analysis Section, Materials Analysis Branch, Fluids and Analysis Division, Ground Systems Directorate. MMA-1985-79, Rev. 1) The floor samples were cut into 7.6-inch square samples. These samples were then stored for a minimum of 24 hours at 30% relative humidity. After storage, they were mounted in the grounded test fixture and tested at this humidity. The test consisted of rubbing each test sample for 10 seconds with a foam-backed felt Teflon rubbing wheel to triboelectrically generate the charge. The charged sample was then placed in front of the detector head which measured the surface voltage generated. This voltage was received by a digital storage oscilloscope which produced a display of voltage versus time as well as a digital readout.
- 2.2 Electrostatic Acceptance Criteria - Materials were considered acceptable for use at KSC if the electrostatic voltage generated by the triboelectric device decayed below 350 volts in 5 seconds.
- 2.3 Table 1 lists the results and evaluations of the electrostatic testing at 30% relative humidity.

3.0 FLAMMABILITY TESTING

A fire near the orbiters, payloads, ordnance materials, hypergols, or practically anywhere at KSC could potentially destroy millions of dollars worth of equipment and endanger hundreds of lives. To reduce the risk of fire, materials in controlled areas must decrease the probability of ignition to a minimum and restrict potential fires to well-defined isolated areas. The following flooring materials parameters are used to determine the flammability characteristics: Combustibility, propagation rate, self-extinguishing properties, and total burn time.

3.1 Test Specification - AVO dated August 2, 1979,
Subject: Requirements for carpet at KSC/CCAFS. The test is a modified version of ASTM D635. The flooring material was cut into six 6" x 1/2" samples. Each sample was in turn mounted horizontally by a clamp holding one end of the sample. The flame was applied to the unmounted end by a "Cleanweld B igniter." This igniter has a diameter of 0.125 inches and is one inch long. The igniter is ignited by three turns of 20 gauge bare nickel chromium wire which is caused to glow by a direct current power source. The blue tip of this flame just contacts one edge of the test sample.

3.2 Acceptance Criteria - Materials shall be considered noncombustible, or self-extinguishing if, less than 5 inches of the sample is consumed. A failure of any one of six samples constitutes failure of the material.

3.3 Results - Table 2 lists the burn lengths, burn times, propagation rates, and the overall pass or fail evaluation of each material.

4.0 HYPERGOLIC COMPATIBILITY TESTING

The hypergolic compatibility test identifies those floor materials that may not resist hypergolic exposure.

4.1 Test Specification - The test samples were tested for compatibility with the following hypergolic fluids: Monomethyl hydrazine, nitrogen tetroxide, and hydrazine. In this test the samples were cut into 2-inch squares and immersed in the appropriate hypergolic fluid for one hour. These specimens were then rinsed with distilled water, air dried, and observed for any visible effects.

4.2 Acceptance Criteria - The material shall not ignite nor have penetration through the sample.

4.3 Results - Table 3 lists the results of the hypergolic compatibility tests.

5.0 OUTGASSING TEST

Flooring materials are used in and around the shuttle spacecraft and its variety of payloads. However, it is possible that the flooring material itself could become a source of contamination, especially to sensitive optical surfaces. This type of contamination could occur through the outgassing of vapors that recondense on an optical surface. Certain systems of the shuttle orbiter and its payloads are especially sensitive to this type of contamination. The outgassing test is done to evaluate the

flooring material with adhesive applied to a thin metal foil backing as a potential source of contamination. The parameters measured are: total mass loss (TML), collected volatile condensable materials (CVCM), and water vapor regained (WVR).

- 5.1 Test Specification - (ASTM Method E595-83) The tests for TML, CVCM, and WVR were done as specified in the reference ASTM test. Briefly stated, the test specimen is conditioned in a degreased container (boat) at 23°C and 50% relative humidity for 24 hours. The boat with the sample is then weighed and placed in a vacuum below 10^{-4} Torr with the sample temperature maintained at 125°C. The vapor released from the sample is condensed on a previously weighed collector plate maintained at 25°C. After 24 hours, the vacuum chamber is repressurized with a dry inert gas and the specimen and collector plates are weighed. The sample is then stored for 24 hours at 23°C and 50% relative humidity and again weighed. The TML, CVCM, and WVR are then calculated from the test data.
- 5.2 Acceptance Criteria - The material's TML should not exceed 1.0% and the CVCM should not exceed 0.1%. These values for TML and CVCM may be surpassed with the approval of the appropriate materials engineer.
- 5.3 Results - Table 4 shows the results of the TML, CVCM, and WVR tests.

TABLE 1 - ELECTROSTATIC TEST DATA - VOLTAGE
30% RELATIVE HUMIDITY

MATERIAL NAME	MFGR.	PEAK	5 SEC.	PASS/FAIL
1. SD-52	VPI	722	249	PASS
2. CON-2	VPI	247	143	PASS
3. DEXOTEX, CHEMINERT	CROSSFIELD	207	129	PASS
4. DEXOTEX, AJ-53C	CROSSFIELD	187	104	PASS
5. STONCLAD AT	STONEHARD	198	185	PASS
6. STONLUX AT	STONEHARD	644	255	PASS
7. NORAPLAN DUO EL	NORA	-149	< 100	PASS
8. NORAPLAN DUO EL	NORA	240	111	PASS
9. NORAMENT 928	NORA	301	110	PASS
10. NORAPLAN 938	NORA	301	< 100	PASS
11. NORAMENT 927	NORA	127	< 100	PASS
12. FLEXCO CLASS A	FLEXCO	436	299	PASS
13. FLEXCO CLASS B	FLEXCO	344	201	PASS
14. SPARK PROOF	WEATHERGUARD	185	< 100	PASS
15. RED TOPCOAT	WEATHERGUARD	215	< 100	PASS
16. NOVALITE	SELBY	309	168	PASS
17. UNIFLOOR STATIC	DATWYLAR	224	< 100	PASS
18. UNIFLOOR CONDUCTIVE	DATWYLER	185	< 100	PASS

TABLE 2 - FLAMMABILITY

MATERIAL NAME	MFGR.	BURN TIME (SECONDS)	BURN LENGTH (INCHES)	PROPAGATION RATE (INCHES/MINUTE)	SELF EXTINGUISHED	PASS/FAIL
1. SD-52	VPI	43	1	0.023	YES	PASS
2. CON-2	VPI	47	1	0.021	YES	PASS
3. DEXOTEX, CHEMINERT	CROSSFIELD	31	1	0.032	YES	PASS
4. DEXOTEX, AJ-53C	CROSSFIELD	31	1	0.032	YES	PASS
5. STONCLAD AT	STONEHARD	97	1	0.010	YES	PASS
6. STONLUX AT	STONEHARD	99	1	0.010	YES	PASS
7. NORAPLAN DUO EL	NORA	CONSUMED	CONSUMED		NO	FAIL
8. NORAPLAN DUO EL	NORA	CONSUMED	CONSUMED		NO	FAIL
9. NORAMENT 928	NORA	177	1	0.006	YES	PASS
10. NORAPLAN 938	NORA	95	1	0.010	YES	PASS
11. NORAMENT 927	NORA	157	1	0.006	YES	PASS
12. FLEXCO CLASS A	FLEXCO	30	1	0.033	YES	PASS
13. FLEXCO CLASS B	FLEXCO	37	1	0.027	YES	PASS
14. SPARK PROOF	WEATHERGUARD	DID NOT	IGNITE	0		PASS
15. RED TOPCOAT	WEATHERGUARD	DID NOT	IGNITE	0		PASS
16. NOVALITE	SELBY	DID NOT	IGNITE	0		PASS
17. UNIFLOOR STATIC	DATWYLER		0.5		YES	PASS
18. UNIFLOOR CONDUCTIVE	DATWYLER		0.5		YES	PASS

TABLE 3 - HYPERGOLIC COMPATIBILITY

MATERIAL NAME	MANUFACTURER	N ₂ H ₄	MMH	N ₂ O ₄
1. SD-52	VPI	SLIGHT YELLOWING	NVR*	NVR
2. CON-2	VPI	SLIGHT YELLOWING	NVR	NVR
3. DEXOTEX, CHEMINERT	CROSSFIELD	BUBBLED, FROTHED, SEVERELY DEGRADED	NVR	SOME DELAMINATION
4. DEXOTEX, AJ-53C	CROSSFIELD	BUBBLED, FROTHED, SPALLED	NVR	NVR
5. STONCLAD AT	STONEHARD	BUBBLED, FROTHED, SEVERELY DEGRADED	NVR	NVR
6. STONLUX AT	STONEHARD	SEVERELY DEGRADED	SLIGHT SURFACE ROUGHENING	BUBBLED AND PEELED
7. NORAPLAN DUO EL	NORA	EMBRITTLLED AND CRACKED	NVR	NVR
8. NORAPLAN DUO EL	NORA	EMBRITTLLED AND CRACKED	SLIGHT YELLOWING	SLIGHT YELLOWING
9. NORAMENT 928	NORA	EMBRITTLLED AND CRACKED	NVR	NVR
10. NORAPLAN 938	NORA	EMBRITTLLED AND CRACKED	SLIGHT DISCOLORATION	SLIGHT DISCOLORATION
11. NORAMENT 927	NORA	EMBRITTLLED AND CRACKED	NVR	NVR
12. FLEXCO CLASS A	FLEXCO	SLIGHT YELLOWING	NVR	NVR
13. FLEXCO CLASS B	FLEXCO	SLIGHT YELLOWING	NVR	NVR
14. SPARK PROOF	WEATHERGUARD	SEVERELY DEGRADED	BLEACHED	BLEACHED
15. RED TOPCOAT	WEATHERGUARD	SLIGHT DEGRADATION	BLEACHED	BLEACHED
16. NOVALITE	SELBY	SLIGHT REACTIVITY, DULLING, LEFT WHITE GLAZE	NVR	NVR
17. UNIFLOOR STATIC	DATWYLER	SLIGHT REACTIVITY, DISCOLORATION,	NVR	NVR
18. UNIFLOOR CONDUCTIVE	DATWYLER	SLIGHT REACTIVITY, DISCOLORATION, SWELLING	NVR	NVR

*NVR - NO VISIBLE REACTIVITY

TABLE 4 - OUTGASSING

MATERIAL NAME	MFGR.	TML (%)	WVR (%)	CVCM(%)
1. SD-52	VPI	4.98	0.04	2.56
2. CON-2	VPI	4.62	0.04	2.06
3. DEXOTEX, CHEMINERT	CROSSFIELD	1.43	0.42	0.02
4. DEXOTEX, AJ-53C	CROSSFIELD	1.13	0.26	0.03
5. STONCLAD AT	STONEHARD	1.01	0.05	0.06
6. STONLUX AT	STONEHARD	5.11	0.08	0.03
7. NORAPLAN DUO EL	NORA	2.76	0.14	0.58
8. NORAPLAN DUO EL	NORA	2.95	0.11	0.63
9. NORAMENT 928	NORA	5.47	0.63	1.49
10. NORAPLAN 938	NORA	6.29	0.90	1.23
11. NORAMENT 927	NORA	5.47	0.63	1.49
12. FLEXCO CLASS A	FLEXCO	5.95	0.07	3.03
13. FLEXCO CLASS B	FLEXCO			
14. SPARK PROOF	WEATHERGUARD	0.52	0.05	0.05
15. RED TOPCOAT	WEATHERGUARD	11.62	6.86	0.01
16. NOVALITE	SELBY	1.10	0.24	0.00
17. UNIFLOOR STATIC	DATWYLAR	8.14	0.09	4.52
18. UNIFLOOR CONDUCTIVE	DATWYLER	9.49	0.06	6.23

APPENDIX A

MANUFACTURERS OF MATERIALS TESTED
COMPANY NAMES AND ADDRESSES

<u>COMPANY</u>	<u>PRODUCT</u>
CROSSFIELD PRODUCTS CORP. 140 VALLEY ROAD ROSELLE PARK, N.J. 07204 (201) 245-2800	DEXOTEX
DATWYLER LTD, ALTDORF, SWITZERLAND DISTRIBUTOR: TSK TEK STIL CONCEPTS, INC. P.O. BOX 67 HADDONFIELD, N.J. 08033 (609) 428-4464	UNIFLOOR
FLEXCO P.O. BOX 553 TUSCUMBIA, AL 35674 (800) 633-3151	FLEXCO
NORA FLOORING 7 BALLARD WAY LAWRENCE, MA 01843 (617) 689-0530	NORAPLAN, NORAMENT
SELBY, BATTERSBY & COMPANY 5200 WHITLEY AVE. PHILADELPHIA, PA 19143 (215) 474-4790	NOVALITE

COMPANY

STONEHAND
PARK AVE
P.O. BOX 308
MAPLE SHADE, N.J. 08052
(800) 257-7953

VINYL PLASTICS, INC.
3123 SOUTH 9TH STREET
SHEBOYGAN, WI
(414) 458-4664

WEATHERGUARD-MARBLELOID PRODUCTS, INC.
2515 NEWBOLD AVE.
BRONX, N.Y. 10462
(212) 828-8300

PRODUCT

STONCLAD, STONLUX

CONDUCTILE

SPARKPROOF, RED TOPCOAT



Report Documentation Page

1. Report No. TM 103501		2. Government Accession No.		3. Recipient's Catalog No.									
4. Title and Subtitle Physical and Chemical Test Results of Electrostatic Safe Flooring Materials				5. Report Date April 15, 1988									
				6. Performing Organization Code DM-MSL-2									
7. Author(s) R. H. Gompf				8. Performing Organization Report No. MTB-316-87									
				10. Work Unit No.									
9. Performing Organization Name and Address Materials Testing Branch, DM-MSL-2 Kennedy Space Center, FL 32899				11. Contract or Grant No.									
				13. Type of Report and Period Covered									
12. Sponsoring Agency Name and Address				14. Sponsoring Agency Code									
15. Supplementary Notes													
16. Abstract <p>This test program was initiated because a need existed at the Kennedy Space Center (KSC) to have this information readily available to the engineer who must make the choice of which electrostatic safe floor to use in a specific application. The information contained in this study, however, should be of value throughout both the government and private industry in the selection of a floor covering material.</p> <p>Included in this report are the test results of 18 floor covering materials which by test evaluation at KSC are considered electrostatically safe. Tests were done and/or the data compiled in the following areas:</p> <table><tr><td>(1) Electrostatics</td><td>(5) Floor type</td></tr><tr><td>(2) Flammability</td><td>(6) Material thickness</td></tr><tr><td>(3) Hypergolic compatibility</td><td>(7) Available colors</td></tr><tr><td>(4) Outgassing</td><td></td></tr></table> <p>Each section contains the test method used to gather the data and the test results. A "quick-look" summary of the test results is shown on page IV.-</p>						(1) Electrostatics	(5) Floor type	(2) Flammability	(6) Material thickness	(3) Hypergolic compatibility	(7) Available colors	(4) Outgassing	
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(2) Flammability	(6) Material thickness												
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17. Key Words (Suggested by Author(s)) Electrostatic, Triboelectric, Floor Covering, Flammability, Hypergolic Compatability, Offgassin			18. Distribution Statement Unlimited										
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of pages 19	22. Price										

