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U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards

Evaluation of Plastic Wallcovering Materials

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Evaluation of Plastic Wallcovering Materials

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ABSTRACT

The suitability of various test methods for measuring performance of plastic wallcovering materials was studied. This report contains the results of performance tests including abrasion resistance, surface texture, fungus resistance, washability and stain resistance. Based on the test results, tentative recommendations for the revision of Federal Specification CCC-W-408A, Wall Covering, Vinyl-Coated, have been developed. These recommendations are based upon the results of tests conducted on seventy-two wallcovering materials from seven manufacturers.

Key Words: Abrasion; Federal Specification CCC-W-408A; fungus resistance; stain resistance; surface roughness;vinyl wallcoverings; wallcovering materials; washability.

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1. INTRODUCTION

1.1 BACKGROUND

The use of plastic wallcovering materials in place of paint and wallpaper is increasing. These materials are comparatively high-cost items and are expected to have superior performance and longer life than the products they replace. Yet, there is limited information on their performance. The Department of Defense has used plastic wallcoverings in some military installations and encountered problems in the everyday use of materials which meet the Federal Specification for Vinyl Coated Wall Covering, CCC-W-408A[1][1,2]. As a result, the Tri-Services Materials Committee requested the National Bureau of Standards to perform a laboratory evaluation of the performance of plastic wallcovering materials and to develop, as necessary, recommendations to update of Federal Specification CCC-W-408A. Generally, a plastic wallcovering is composed of a layer of vinyl resins with stabilizers, lubricants, colorants and plasticizers laminated to a paper or cloth fabric backing [2, 3]. Suitable resins include polyvinyl chloride and copolymers which are predominantly polyvinyl chloride. In 1972, 4.18 billion pounds of polyvinyl chloride were produced with 128 million pounds being used in wallcoverings [4]. Vinyl coated wallcoverings have been classified into the following types in Fed. Spec. CCC-W-408A [1]:

	Minimum total weight (oz/yd^2)	Minimum coating weight (oz/yd^2)
Type I - Light Duty	7	5
Type II - Medium Duty	13	7
Type III - Heavy Duty	22	12

Light duty wallcoverings are intended for use in areas not subjected to heavy abrasion or traffic. In effect, they are alternatives to paint or uncoated wallpaper. Medium duty wallcoverings are intended for use where average or intermediate abrasion or traffic is encountered. Heavy duty wallcoverings are intended for use in high traffic areas such as corridors in hospitals, hotels or schools.

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[1] Figures in brackets indicate references.
[2] A copy of Federal Specification CCC-W-408A, is contained in Appendix B.

Manufacturers of plactic wallcoverings have stated that these materials are durable, abrasion resistant, maintenance free, and stain and soil resistant. Also, almost any color is available and a wide variety of textures and designs, including reproductions of grass fiber, wood, linen and moire. Since plastic wallcoverings are comparatively high cost items (installation costs of $.38 - .78/sq. ft. versus $.12 - .19/sq. ft. for painting [5]), they are expected to have superior performance and a longer life than competitive products. When problems occur with plastic wallcoverings, they can be quite expensive to correct since the coverings cannot readily be painted over and may require removal. Like paint, plastic wallcoverings also rely on proper preparation of the substrate and good adhesion to the substrate.

Relatively little quantitative information is available on the performance of plastic wallcoverings in regard to abrasion, stain removal, washability, fungus resistance, and color change. Knowledge of the behavior and advantages of various backing fabrics, adhesives, coating textures, color patterns and protective top coat is lacking.

The development of new performance tests or the modification of existing performance tests applicable to plastic wallcoverings should provide the basis for revision of the Federal Specification CCC-W-408A. This, in turn, should provide the military with an improved product requiring less maintenance.

1.2 OBJECTIVES

The objectives of the laboratory evaluation of plastic wallcovering materials described in this report were:

1. To survey the presently available commercial plastic wallcoverings, and to obtain samples of the types, colors, textures and patterns potentially useful to the military facilities engineer.
2. To evaluate laboratory test methods relating to abrasion resistance, fungus resistance, washability and stain resistance for suitability in application to plastic wallcoverings, and to develop additional test methods to measure performance.
3. To perform laboratory tests and evaluate the performance of the wallcoverings.
4. To prepare a final report summarizing the findings of the study including recommendations for improvement of Federal Specification CCC-W-408A.

2. PROCEDURE

2.1 MATERIAL CODING

Seventy-two samples of plastic wallcoverings from seven manufacturers were received. Using code letters to designate the manufacturers, the distribution of the samples by manufacturer and type according to Fed. Spec. CCC-W-408A is shown in Table 1.

Table 1
Distribution of Plastic Wallcovering Materials
by Manufacturer and Type

Manufacturer	Type I[a] Light Duty	Type II Medium Duty	Type III Heavy Duty
A		7	
B	15 (6 TC)[b]	19 (6 TC)	3
C	4	7 (1 TC)	1
D		3 (1 TC)	
E	4		
F	6 (1 TC)	1 (1 TC)	1 (1 TC)
G	1		
TOTAL	30 (7 TC)	37 (9 TC)	5 (1 TC)

[a] Type according to classification in Fed. Spec. CCC-W-408A
[b] Materials having a top coat are noted as TC.

Upon receipt, the plastic wallcovering samples were coded for identification. Details of the coding system are given in Table 2. Throughout the testing, all samples are referred to by their unique code identification. All of the plastic wallcoverings were not included in each test.

2.2 TEST METHODS

2.2.1 Abrasion Resistance

Apparatus The test apparatus consisted of a Taber Abraser[1] as described in Test Method 5306 of Federal Test Method 191 [6]. The resilient abrasive wheels used were of the CS-17 type.[2]

[1] Certain trade names and company products are identified in order to adequately specify the experimental procedure. In no case does such identification imply recommendation or endorsement by the National Bureau of Standards, nor does it imply that the products are necessarily the best available for the purpose.

[2] A resilient coarse abrasive wheel as described in "Accessories and Supplies for Taber Model 503 Abraser", distributed by Gardner Laboratory, Inc., P.O. Box 5728, Bethesda, MD. 20014.

Table 2
The 7-Digit Coding System for Plastic Wallcoverings
7 Digits __ __ __ __ - _ _ _

Digit	Variable	
1	Manufacturer	A to G
2	Type	1 = Type I (Light Duty) 2 = Type II (Medium Duty) 3 = Type III (Heavy Duty)
3	Color	1 = Off white 2 = Green 3 = Orange accent 4 = Wood grain 5 = Yellow 6 = Multicolor pattern 7 = Brown 8 = Metallic
4	Coating	1 = no top coat 2 = with top coat
5,6,7	Sample number	Sequential number of sample as received

Test Specimen The test specimen consisted of a 105 mm (4 1/8 in) square of material applied to a piece of cardboard having an adhesive upper surface. A hole was punched in the center of the specimen to accommodate the 6 mm (1/4 in) shaft of the platform. Triplicate test specimens were prepared.

Procedure The entire test specimen was placed under a 2900g (6.4 lb) weight to flatten the specimen and adhere materials whose back surfaces were uneven due to the texture. After 24 hours, the test specimen was removed, brushed with a soft brush to remove loose dirt or dust, and weighed to the nearest 0.001g. Before placing the test specimens on the platform, the wheels were refaced for 50 cycles with an abrasive paper of the S-11[1] type to remove plastic dust or other residue from the wheel surfaces. Then the surfaces of the wheels were brushed to remove loose particles. The humidity in the room in which the sample preparation and testing was done remained constant during the procedures. The test specimen was positioned on the platform and clamped securely. The vacuum pickup nozzle was placed in position slightly above the surface of the specimen. The abrading wheels were then lowered into test position

[1]Abrasive paper, 150 Grit.

and a 1000 g load placed on each. The counter was cleared to zero before starting the vacuum and abrading for 500 cycles. The platform rotated at approximately 70 rpm. The test specimen was removed, brushed, and reweighed.

Evaluation The weight loss after 500 cycles from the triplicate specimens was averaged to determine the averaged weight loss for each plastic wallcovering.

2.2.2 Surface Texture

Apparatus The test apparatus consisted of an aluminum oxide powder[1] having an average particle size of 27 μm (approximately 1 x 10^{-3} in) and a straight edge.

Test Specimen One test specimen, 40 mm x 40 mm (1.57 in x 1.57 in) was cut from the plastic wallcovering material.

Procedure The test specimen was placed on a flat longitudinal surface with its decorative surface up. The aluminum oxide powder was spread on the surface, and a straight edge was used to distribute the material evenly over the textured surface and to remove excess. The aluminum oxide powder was then transferred to a tared aluminum weighing dish and weighed.

Evaluation The weight of aluminum oxide powder per unit area was used as an indicator of the degree of texture of the wallcovering. The greater the weight of powder, the more highly textured the material.

2.2.3 Fungus Resistance

Apparatus The test cabinet consisted of an environmental chamber (as described in ASTM D3273 [7]) set to maintain a relative humidity of 95 to 98 percent at a temperature of 32.5° ± 1°C (90 ± 2°F) while providing a continuous inoculation of the surface of exposed panels with mold spores.

Test Specimen The test specimen consisted of a piece of plastic wallcovering approximately 100 mm x 100 mm (4 in x 4 in) adhered to a 75 mm x 100 mm (3 in x 4 in) glass plate having a small hole midway between two sides and about 25 mm (1 in) from a third side. A 25 mm x 100 mm (1 in x 4 in) strip of material down one side was not attached to the glass. 3.2 ml of adhesive was applied to a 75 mm x 100 mm

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[1] S.S. White Airdent Powder No. 1 for Cutting. S.S. White Dental Manufacturing Co., Philadelphia, PA.

spreading rate of 100 ft^2/gal. No adhesive was applied to the strip of material not to be adhered to the glass. The glass plate was placed on the adhesive surface of the test specimen and pressed down with a roller. Care was taken not to force the adhesive past the edges. Excess adhesive was removed. A hole was made in the wallcovering corresponding to the hole in the glass and a wire was placed through it. The wallcovering and glass surfaces were wiped with ethyl alcohol. The specimens were placed in a constant temperature and humidity room for 24 hours to cure. Triplicate test samples were prepared.

Procedure The test panels were hung vertically in the environmental chamber with the bottom of the specimen approximately 75 mm (3 in) above the surface of the inoculated soil. Sufficient spacing was allowed to permit free circulation of air and prevent contact between panels or with wall surfaces. The test specimens were distributed randomly about the chamber. After 4 weeks, the test specimens were removed, air dried overnight in a well-ventilated room and evaluated.

Evaluation The test specimens were examined visually in accordance with ASTM D-3274 [8] to determine if fungus was present.

2.2.4 Washability

Apparatus The test apparatus consisted of an electric motor mounted on a flat metal plate and a mechanism through which the motor imparted a reciprocating motion to a sponge or a brush at a rate of 37 $\pm$ 2 cycles (74 $\pm$ 4 strokes) per minute. The sponge and brush were similar to those described in Test Methods 6141 [9] and 6142 [10] of Federal Test Method Standard 141a.

Test Specimen The test specimen consisted of an approximately 150 mm x 430 mm (6 in x 17 in) sample of wallcovering material with soil applied in the center across the width of the material. The soiling medium was prepared and applied in accordance with Test Method 6141 of FTM Std. No. 141a. After application, it was allowed to air dry for 16 hours in a well-ventilated room; then, using a stiff brush the excess soil was carefully brushed off. The soiling medium was not baked as described in the washability procedure in Fed. Spec. TT-P-29 [11], since preliminary experiments indicated that the heat caused the organic solvent in the soiling medium to penetrate the wallcovering.

Procedure The test specimen was clamped in place on the apparatus so that the soiled portion was approximately in the middle of the cleaning stroke. The sponge or brush traveled lenthwise along the test specimen. The sponge was prepared and renewed after each 25 cycles as described in Test Method 6141 of FTM Std. No. 141a. After 100 cycles using a sponge with grit, the sponge was replaced with a brush. The brush was prepared by immersing the brush bristles in water at 25° to 30°C (77° to 86°F) for 30 minutes to a depth of 13 mm (1/2 in). The brush was then removed from the water and rubbed with cake grit soap, conforming to Fed. Spec. P-S-571, Type A [12], 25 times back and forth (25 times in each direc-

P-S-571, Type A [12], 25 times back and forth (25 times in each direction) using moderate pressure. Care was taken to completely cover the entire surface of the brush with each stroke of grit soap. The brush was inserted into the holder and the motor started. After each 25 cycles, the brush was removed, washed with water and the grit soap applied as outlined above. When 100 cycles had been completed using the brush, the test specimen was removed and the entire surface rinsed with water. After the test specimen had air dried, reflectance and gloss measurements were taken as described in Test Method 6141 on an unsoiled area and an area where soil had been applied.

Evaluation Comparison of the reflectance and gloss measurements from the soiled and unsoiled areas indicated the success in removing the soil and the degree of change in appearance.

2.2.5 Stain Resistance

Apparatus The test apparatus consisted of glass rings of approximately 28 mm (1 in) OD, 25 mm (1 in) ID and 12 mm (1/2 in) wide, suitable adhesives for attaching the glass rings to the test specimens, watch glasses, and the staining agents listed in Table 3.

Table 3
Staining Agents Used in Stain Resistance Test

1. 5% acetic acid
2. 10% ammonia
3. beet juice
4. 10% citric acid
5. 95% ethyl alcohol
6. 3% hydrogen peroxide
7. 1% iodine in ethyl alcohol
8. 100% isopropyl alcohol
9. 100% methyl alcohol
10. 6.6% urea in water
11. distilled water
12. acetone
13. amyl acetate
14. naptha
15. turpentine
16. chocolate syrup
17. coffee
18. "Tintex" dye
19. food coloring
20. hair dye
21. household detergent
22. 5% household soap
23. washable ink
24. "Mercurochrome"
25. olive oil
26. 5% phenol
27. sodium bisulphite (sat. soln.)
28. 4% sodium hypochlorite
29. 1% trisodium phosphate
30. tea
31. mustard (dry in water)
32. shoe polish (paste)

Test Specimen The test specimen consisted of an approximately 150 mm x 500 mm (6 in x 20 in) sample of wallcovering. Thirty glass rings were attached to the test specimen using a suitable adhesive. Carnauba wax was adequate as an adhesive for most staining agents, however, for organic reagents, i.e., acetone, amyl acetate, naptha, turpentine, an epoxy adhesive which was not dissolved by organics was chosen.

Procedure The method of test followed the procedures described in the National Electrical Manufacturers Association (NEMA) LD1-2.05 Method of Test for Resistance of Surface to Stains [13]. However, the test procedure was modified by the use of glass rings to contain the stains. The staining agents were placed in the glass rings on the test specimen, covered with watch glasses to prevent evaporation and allowed to stand at a temperature of 24°C (75°F). At the end of 16 hours, the covers were removed, the staining agents discarded, and the glass rings and the adhesive were removed. The specimen was rinsed with water, brushed lightly with a soapy solution, then rinsed with distilled water. After air drying, the material was examined for a stain by placing the specimen in a horizontal position at normal table height under a ceiling height white fluorescent light.

Evaluation The samples were rated using a 0, 1, 2 system:

0 = completely unaffected
1 = slight stains, slight change in surface texture or appearance
2 = heavy permanent stain; surface texture more than slightly affected; more than slight change in gloss.

3. RESULTS

3.1 SURVEY AND SELECTION OF WALLCOVERING MATERIALS

The plastic wallcoverings tested in this program were commercial products. To select the specific materials, sample books containing small material samples were acquired from the producers. These books illustrated the wide variety of materials on the market from lightweight, flowered patterns to heavy duty materials designed for rugged use. They also showed that a number of important material parameters can vary from one wallcovering material to another and these could influence the test results. The important parameters for this project were: type, coating, texture, color, as well as manufacturer. A short explanation of each follows:

Type Plastic wallcoverings are generally divided into three types on the basis of the weight of plastic, as specified in Federal Specification CCC-W-408A. However, not only does the thickness of the plastic vary, but the cloth backing which supports the plastic is also substantially heavier for Types II and III, than Type I. The result is that a Type III material weighs more than three times as much per unit area as a Type I material.

Coating To improve their cleaning properties, some plastic wallcoverings have an additional clear protective coating (top coat) bonded to the surface. The most commonly used top coat is a poly (vinylfluoride) (PVF) film. In areas likely to be dirtied or subjected to stains, manufacturers recommend wallcoverings with a top coating.

Texture A third factor which greatly increases the variety in wallcoverings is the surface texture which ranges from very smooth to highly embossed. The surface texture has an influence on the ease of cleaning. The greatest variation in texture is found among the Type II wallcoverings. These have sufficient plastic thickness to permit any desired embossing design. The Type I materials are fairly thin and consequently tend to be smooth or have only a light textured effect. The Type III, heavy duty materials are made for specialized purposes and since they are intended to be more protective than decorative, the selection is limited to relatively smooth texture.

Color Plastic wallcovering materials are available in hundreds of solid colors or patterns. Plastics have color imparted to them in two ways. A pigment or dye is added during the manufacturing process making the entire thickness of plastic uniform in color, or a pattern is printed on the surface to give a desired design or effect. In general, this latter method is used only on some of the lightest weight materials.

Manufacturer A number of major plastic wallcovering manufacturers were identified. Wallcoverings differ from one producer to another in color and appearance, and in the amount and type of fillers, pigments, plasticizers, and other additives. These can affect the properties of the finished product. For this reason, while all plastic wallcoverings have poly (vinyl chloride) resin as the basic ingredient, certain product characteristics may be influenced by the addition of components during the manufacturing process.

Due to the number of manufacturers and the diversity of their materials, it was not possible to test one specimen of each material. However, it is believed that enough materials were chosen to give a range representative of the materials on the market. The test materials were selected to include each Type with textures as similar as possible from manufacturer to manufacturer. When available, a material with a top coat was chosen. The colors were restricted to three: off-white, pale green, and orange. When it was not possible to get all three colors, the off-white sample alone was requested. In some cases, manufacturers provided other colors of material.

3.2 LABORATORY EVALUATION

Laboratory evaluation of the wallcovering materials fell into four areas: abrasion resistance, fungus resistance, washability, and stain

resistance. Although Fed. Spec. CCC-W-408A has no requirements for the latter three performance components, they have been problem areas associated with the performance of wallcoverings.

3.2.1 Abrasion Resistance

The abrasion resistance test included in Fed. Spec. CCC-W-408A is an oscillatory cylinder (Wyzenbeck) method (Fed. Test Method Std. No. 191, Method 5304 [14]). After study, this method was judged to be inappropriate and instead, the Taber Abrasion test was chosen for use in the laboratory evaluation. There were several reasons the Wyzenbeck method was considered inappropriate: first, it is intended to test woven fabrics; second, results are evaluated with respect to the breaking strength of the unsupported fabric, a property which does not have the same relevance to the abrasion resistance of plastic wallcoverings adhered to a wall; and lastly, since wallcoverings are usually intended to replace painted surfaces, they should be evaluated in the same manner as paints. The Taber Abrasion test is commonly used to test organic coatings. It evaluates the resistance of a wallcovering material to abrasion intended to simulate regular use or cleaning. It consists of abrading the surface of the material and then determining the amount of material that has been removed. The abrasion resistance of 43 materials was evaluated. Only the off-white material was tested where three colors of the same texture wallcoverings had been received. In addition, wallcoverings supplied in just a single color were tested. Based upon preliminary tests, the abrasion conditions chosen were 500 cycles with a 1000g load on each wheel of the abrader. The results are given in Table 4.

The 18 Type I wallcoverings had an average weight loss of 0.055g with the average weight losses for various materials ranging from 0.006g to 0.166g. Only five of the Type I materials tested had an average weight loss greater than 0.055g. Excluding the four Type I materials with average weight losses greater than 0.100 g, the average weight loss for the remaining Type I materials was 0.031 g. The average weight loss for the 22 Type II wallcoverings was 0.039g with the average weight losses for different materials ranging from 0.021g to 0.060g. Ten of the materials tested had a weight loss greater than 0.039g. The five top coated Type II wallcoverings had an average weight loss of 0.039g. The average weight loss for the three Type III wallcoverings was 0.030g. The average weight loss for all of the materials with a topcoating was 0.043 g, and for those without it was 0.045 g.

It appears that with the exception of the four Type I materials having average weight losses greater than 0.100g, there were not large differences in abrasion resistance between the three types of wallcoverings. Some of the variations within each Type are the results of differences in the surface texture. The presence of a top coating did not appear to affect the abrasion resistance of the wallcovering.

Table 4
Taber Abrasion Resistance of Plastic
Wallcoverings, 500 Cycles, 1000g Load on Each Wheel

Type	Sample Code[a]	Average Loss (g)	Loss Range of Triplicates (g)
Type I	E111-001	0.109	.101 - .115
	E161-002	0.166	.160 - .170
	E161-004	0.156	.150 - .163
	F161-007	0.012	.008 - .016
	F161-008	0.122	.122 - .123
	F112-010	0.049	.046 - .051
	B141-021	0.034	.033 - .037
	B141-022	0.021	.020 - .022
	B112-024	0.036	.035 - .036
	B112-027	0.063	.046 - .085
	B111-030	0.014	.013 - .015
	B111-033	0.027	.010 - .036
	B111-034	0.042	.035 - .048
	C161-058	0.034	.031 - .036
	C141-059	0.033	.028 - .042
	C111-060	0.031	.030 - .033
	C111-061	0.031	.030 - .031
	G181-072	0.006	.005 - .007
Type II	F222-011	0.024	.046 - .051
	A211-013	0.047	.042 - .054
	A211-015	0.051	.050 - .052
	A211-016	0.045	.038 - .052
	D211-018	0.044	.038 - .054
	D212-019	0.044	.041 - .046
	D211-020	0.027	.025 - .031
	B211-023	0.033	.031 - .035
	B211-037	0.033	.033 - .034
	B211-039	0.033	.032 - .034
	B212-042	0.040	.038 - .042
	B211-045	0.037	.035 - .039
	B212-048	0.049	.048 - .050
	B211-051	0.053	.052 - .054
	B211-054	0.029	.021 - .034
	C211-062	0.022	.021 - .023
	C211-063	0.021	.018 - .023
	C211-064	0.032	.029 - .036
	C211-065	0.028	.023 - .031
	C211-066	0.060	.057 - .064
	C211-067	0.060	.044 - .078
	C212-069	0.039	.036 - .043
Type III	F312-012	0.045	.023 - .025
	B311-055	0.020	.016 - .026
	C311-068	0.024	.021 - .026

[a] In the seven digit sample code, the first character = manufacturer, second character = Type, third character = color, fourth character = coating, last three characters = sequential number of sample as received. See Table 2 for details.

Of interest was the comparison of abrasion resistance and the source of the wallcoverings. Table 5 is based upon data of Table 4. The average weight loss among the seven manufacturers ranges from 0.006g to 0.144g, while the average weight loss among the three types ranges from 0.030g to 0.055g. These differences may be related to differences in composition or manufacturing processes.

Table 5
Comparison of Abrasion Resistance[1] of Plastic
Wallcoverings from Different Manufacturers

Manufacturer	Number of Samples	Average loss, g
E	3	0.144
F	5	0.050
A	3	0.048
D	3	0.038
B	16	0.035
C	12	0.035
G	1	0.006

[1]Taber Abraser, 500 cycles, 1000 g load on each wheel

3.2.2 Surface Texture

An effort was made to determine the surface texture and its effect on abrasion resistance. The results are given in Table 6. The quantity of aluminum oxide powder retained by the surface was an indication of the texture. Based on the amount of aluminum oxide retained, three categories of texture were established, i.e., 1) 1250mg-400mg; 2) 399mg-100mg; 3) 99mg-1mg.

The six samples in the 1 category had an average weight loss in the abrasion test of 0.044g; the nineteen samples in the 2 category had an average weight loss in the abrasion test of 0.046g; and the eighteen samples in the 3 category had an average weight loss in the abrasion test of 0.043g. Since the abrasion resistance of the materials in the three surface texture categories is almost identical, there does not seem to be any correlation between abrasion resistance and surface texture as determined by this method.

Table 6
Determination of Surface Texture

Sample Code	Aluminum Oxide Powder Retained (mg)
E111-001	98.0
E161-002	130.6
E141-004	88.4
E161-007	50.9
F161-008	132.1
F112-010	36.8
F222-011	192.7
F312-012	39.4
A211-013	57.5
A211-015	233.3
A211-016	384.7
D212-018	65.2
D212-019	60.5
D212-020	351.7
B141-021	69.3
B141-022	39.8
B211-023	108.6
B122-024	78.0
B112-027	222.2
B111-030	258.2
B111-033	492.5
B111-034	413.9
B211-037	124.5
B211-039	225.1
B212-042	304.9
B211-045	371.2
B212-048	326.5
B211-051	1023.6
B211-054	1256.5
B311-055	79.3
C161-058	82.8
C141-059	50.5
C111-060	335.1
C111-061	283.5
C211-062	62.2
C211-063	215.6
C211-064	356.8
C211-065	272.4
C211-066	447.6
C211-067	515.4
C311-068	42.6
C212-069	61.8
G181-072	15.1

3.2.3 Fungus Resistance

Although there is currently no fungus resistance test in CCC-W-408A, one was removed from a prior version some years ago after it was cited as being unnecessary. However, the military services have reported problems with fungus growth on wallcoverings used in rooms having high humidity such as bathrooms and kitchens. The fungus growth can occur on the front plastic surface, the cloth backing, or the adhesive.

The test method for Mildew Resistance utilized by the Chemical Fabrics and Film Association [15] consists of burying the samples in soil for 14 days. Since this is not a realistic comparison to the type of exposure encountered by wallcoverings, this method was not chosen. Instead, the wallcovering samples were placed in a humid chamber containing mold spores and the degree of fungal growth was noted.

Thirteen materials were exposed in the fungus resistance test (ASTM D3273). These materials were selected from wallcoverings manufactured by six manufacturers and included three samples with top coating. Most materials were off white color with a few other colors represented.

The specimen holders (Figures 1 & 2) were glass, and the wallcoverings were adhered to the glass with the manufacturers' recommended adhesives. The 25 mm by 100 mm (1 inch by 4 inches) overlap of the wallcoverings was designed to measure any effect of the fungi on the backing material alone as no adhesive was applied to this area. Thus the growth of fungi on the surface of the wallcovering, the backing, and the adhesive could be readily determined visually.

Figure 1. The front surface of a test specimen for the fungus resistance test.

Figure 2. The back surface of a test specimen for the fungus resistance test. The right portion of the specimen shows the glass substrate to which the plastic wallcovering material was ahered. The left side of the test specimen, where the code number is written, is the area where the effect of fungi was evaluated on the backing material alone.

Of the thirteen materials tested in triplicate, only three had no fungus growth on the front surface of any of the test specimens. Figures 3 and 4 illustrate examples of fungal growth on the wallcovering surface. A material having no fungal growth is illustrated in Figure 1. Two materials also had no growth on the exposed backing of the material, see Figure 2. Fungal growth on the backing material is illustrated in Figures 5 and 6. The adhesives also promoted the fungal growth as only a few of the test specimens were free of fungi around the edges at the interface between the material and the glass. An example of fungal growth around the edges can be seen in Figure 7. Nine of the materials developed fungus growth in the adhesive under the glass. This is illustrated in Figure 6.

This evidence indicates that mildew or fungi grow easily on most of the plastic wallcoverings and their adhesives. Consequently, some type of fungicide seems necessary in the adhesives, the wallcovering materials, or a treatment of the surfaces.

Figure 3. An example of fungal growth on a wallcovering material.

Figure 4. An example of fungal growth on a wallcovering material.

Figure 5. The backing material at the left has developed fungal growth during the fungus resistance test.

Figure 6. An example of fungal growth on the exposed backing material (left side) and in the adhesive between the wallcovering and the glass.

Figure 7. A test specimen exhibiting fungal growth in the adhesive around the edges.

3.2.4 Washability

Since plastic wallcovering materials are intended to have long lifetimes, it is important that they can be easily and repeatedly cleaned without losing their original appearance.

Forty-five wallcovering materials were included in the washability test. The results of the reflectance and gloss measurements are given in Table 7. Only two materials had an original gloss greater than 15 and only eight materials had a gloss change more than 2 units. The changes in reflectance of the wallcoverings after the washability tests were often much greater than that of an interior flat latex paint,conforming to Fed. Spec. TT-P-29H, e.g., par. 3.4.12 . . . "The reflectance of the cleaned area shall be not less than 95 percent of the value measured on the unsoiled area before the test; the 85° gloss shall be not greater than 20." One likely cause of the poor washability of many of the wallcoverings as indicated by the reflectance was the differences in texture. Textured materials are more difficult to clean than smooth surfaces. The effect of any top coating on the cleanability of the wallcoverings was generally overriden by the texture.

Table 7
Washability of Plastic Wallcovering Materials

Sample Code	Daylight Directional Reflectance		85° Gloss	
	Reflectance on New Material[1]	% Reflectance Retained	Gloss on New Material[1]	Gloss Change[1] After Test
E111-001	88.3	97.2	3.0	0.5
E161-002	36.5	81.8	1.3	0.5
E161-003	79.4	88.3	1.9	-0.1
E161-004	77.2	101.4	2.8	0.8
F161-005	64.5	93.6	64.7	8.3
F111-008	67.8	92.3	1.6	-0.2
F112-010	60.3	97.5	6.7	3.0
F222-011	68.0	83.1	2.1	0.3
F312-012	62.7	100.8	12.6	2.0
A211-013	82.7	92.6	4.9	0.2
A211-015	82.8	41.1	0.5	-0.2
A211-016	60.4	63.1	0.6	-0.2
D211-018	60.6	96.9	5.0	0.5
D212-019	60.9	98.7	8.5	1.9
D211-020	63.9	77.5	0.8	-0.1
B141-021	9.9	110.1	6.8	1.8
B141-022	8.1	107.4	6.2	-5.0
B211-023	67.4	82.3	0.8	-0.2
B112-024	66.7	94.0	2.5	0.7
B112-027	74.2	86.8	1.4	0.4
B111-030	67.2	92.6	0.9	-0.2
B111-033	66.1	75.0	0.7	0.1
B111-034	58.8	74.3	0.7	-0.5
B211-037	62.8	76.3	0.9	-0.1
B211-039	75.9	79.8	0.8	-0.5
B212-042	76.9	78.3	1.2	0.3
B211-045	61.4	90.6	0.8	-0.4
B212-048	63.9	77.3	1.4	0.4
B221-051	79.3	88.1	0.5	-0.1
B211-054	58.4	86.1	0.6	-0.1
B311-055	64.5	98.4	2.6	-2.3
B311-056	64.8	99.5	5.5	-2.6
C161-058	76.3	86.9	1.3	-2.0
C141-059	8.6	97.7	6.0	-2.3
C111-060	74.2	63.2	0.8	-0.3
C111-061	73.4	66.9	0.7	-0.1
C211-062	75.7	73.4	0.8	-0.5
C211-063	73.6	72.1	0.6	-0.3
C211-064	61.4	95.0	0.6	-0.4
C211-065	54.5	92.1	0.8	-1.4
C211-066	71.0	84.4	0.5	-0.3
C211-067	68.8	77.0	0.7	-0.5
C311-068	74.6	98.0	3.9	-3.5
C212-069	70.7	96.6	4.5	-0.6
G181-072	4.8	292.0	87.0	37.4

[1]Average of two readings.

3.2.5 Stain Resistance

Although Fed. Spec. CCC-W-408A has no requirement for stain resistance, this property is important since plastic wallcoverings are often found in areas of heavy use such as kitchens and cafeterias. If a material is stained, efforts to remove the stain may include vigorously scrubbing the material with an abrasive material. This could abrade the plastic without removing the stain, particularly when it has penetrated the plastic. If a plastic wallcovering is badly stained, it may require costly replacement of the material.

The stain resistance test results are summarized in Table 8. The staining agents that affected the wallcoverings most were paste shoe polish, iodine, "Tintex" dye, hair dye, acetone, washable ink and amyl acetate. The use of a protective top coating improved the stain resistance markedly but did not protect against paste shoe polish, iodine, "Tintex" dye, hair dye and acetone. In general, other than acetone, the organic solvents such as amyl acetate, naptha, isopropyl alcohol, ethyl alcohol and turpentine did not affect the wallcovering materials having a protective top coat.

The names of some of the stains listed in Table 8 may not sound familiar, but these stains are often found in households. For example, vinegar contains acetic acid, orange juice has citric acid, liquor contains ethyl alcohol, hair bleach contains hydrogen peroxide, rubbing alcohol is isopropyl alcohol, fingernail polish remover contains amyl acetate.

4. SUMMARY AND CONCLUSIONS

A total of 72 plastic wallcovering materials obtained from seven manufacturers was examined. Seventeen samples had a protective top coat. The abrasion resistance, fungus resistance, washability and stain resistance of the materials were evaluated to develop recommendations for a revision of Federal Specification CCC-W-408A, Wall Covering, Vinyl-Coated. The recommendations are included in Appendix A.

In evaluating the abrasion resistance, a Taber Abrasion Test was used with 500 cycles, and a 1000g load on each wheel. Since significant differences were found in abrasion resistance within wallcovering Types I, II, and III, including texture and top coating, the use of an abrasion resistance test should be desirable to evaluate the performance characteristics of plastic wallcoverings for other than decorative purposes. Some of the differences may have been related to differences in composition or manufacturing processes.

The fungus resistance test results of the plastic wallcoverings indicated that the plastic material, the cloth backing and the adhesive all may support fungus growth. A performance requirement for fungus

Table 8
Summary of Stain Test Results

Staining Agent	Total Staining Sum[1]	Number of Samples Affected[2]	Number of Samples Having Top Coat Affected[3]
10% citric acid	0	0	0
3% hydrogen peroxide	0	0	0
water	0	0	0
mustard	0	0	0
methyl alcohol	1	1	0
6.6% urea	1	1	0
5% household soap	1	1	0
10% ammonia	3	2	0
chocolate syrup	3	3	0
1% trisodium phosphate	3	3	0
5% acetic acid	5	5	0
5% phenol	6	6	0
beet juice	7	7	0
5% household detergent	7	4	0
olive oil	8	7	0
saturated solution of sodium bisulphite	13	10	0
tea	14	14	1
4% sodium hypochlorite	17	11	0
turpentine	24	19	2
coffee	26	25	0
ethyl alcohol	29	29	1
isopropyl alcohol	41	38	1
naptha	57	42	1
"Mercurochrome"	63	48	8
food coloring	68	47	2
amyl acetate	99	55	1
washable ink	100	58	9
acetone	117	65	13
hair dye	120	68	14
"Tintex" dye	122	68	14
1% iodine in ethyl alcohol	126	67	14
shoe polish	136	68	14

[1]The total staining sum is the sum of the stain ratings for a particular staining agent for the 69 materials tested. The maximum total stain sum is 138. The stain ratings were: 0=unaffected; 1=slight stain, slight change in surface texture or appearance; 2=heavy permanent stain, surface texture more than slightly affected, more than slight change in gloss.

[2]A total of 69 samples was tested.

[3]A total of 14 samples with a top coat was tested.

resistance should be included in Federal Specification CCC-W-408A. The design of the sample holder uniquely allows examination of the plastic surface, the backing material and the adhesive.

The washability characteristics of the wallcovering materials as indicated by the reflectance differences were frequently below that of an interior latex flat paint. This seems to be due to the texture of the wallcovering material. The rougher textured materials were more difficult to clean. Since plastic wallcoverings are expected to perform better than paints and have a longer life, the inclusion of a washability requirement into Federal Specification CCC-W-408A is a necessity. Reflectance differences should be no greater than 10%. The 85° gloss difference should be no greater than 2 units.

The ability of a plastic wallcovering material to resist staining by commonly used household stains is especially important since these wallcoverings are intended to have a long life and are expensive to replace. Materials such as paste shoe polish, iodine, "Tintex" dye, and hair dye caused permanent stains on all plastic wallcoverings even if a protective top coating was present. Four stain reagents affected none of the plastics while eleven reagents affected less than nine of the materials. A protective top coat significantly improved the stain resistance and was seriously marked by only the reagents mentioned above and "Mercurochrome", washable ink and acetone. Since many common staining agents affect some plastic wall coverings, for military use the top coat is advisable for areas where such staining agents may be present.

5. ACKNOWLEDGMENT

We wish to thank Ms. Mildred Post for her assistance with the Fungus Resistance Test. We also wish to thank the manufacturers and suppliers who donated the materials used in this project.

6. REFERENCES

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[2] Skeist, I., Ed., Plastics in Building, Reinhold Publishing Corp., New York, 1966, p. 162.

[3] Modern Plastics Encyclopedia, McGraw-Hill, New York, 1968, p. 534.

[4] Gottesman, Roy T., Chemistry and Technology of Polyvinyl Chloride, Applied Polymer Science. J. Kenneth Creaver and Toy W. Tess, Ed., Organic Coatings and Plastics Chemistry, Div. of the Am. Chem. Soc., Washington, DC, 1975.

[5] Godfrey, Robert S., Ed., Building System Cost Guide 1977, Robert Snow Means Company, Inc., Duxbury, Mass 02332 (1977).

[6] Abrasion Resistance of Cloth; Rotary Platform, Double-Head (Taber) Method, Method 5306, Fed. Test Method Std. No. 191, Textile Test Methods, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 (1968).

[7] Test for Resistance to Growth of Mold on the Surface on Interior Coatings in an Environmental Chamber, D3273, ASTM Book of Standards, Part 27 (American Society for Testing and Materials, Philadelphia, Pennsylvania 19103, 1977).

[8] Evaluating Degree of Surface Disfigurement of Paint Films by Fungal Growth or Soil and Dirt Accumulation, D3274, ASTM Book of Standards, Part 27 (American Society for Testing and Materials, Philadelphia, Pennsylvania 19103, 1977).

[9] Washability of Paints, Method 6141, Fed. Test Method Std. No. 141a, Paint, Varnish, Lacquer, and Related Materials; Methods of Inspection, Sampling, and Testing, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 (1965).

[10] Scrub Resistance, Method 6142, Fed. Test Method Std. No. 141a, Paint, Varnish, Lacquer, and Related Materials; Methods of Inspection, Sampling, and Testing, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 (1965).

[11] Federal Specification TT-P-29H, Paint, Latex Base, Interior, Flat, White and Tints, 8 pages, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 (March 1974).

[12] Federal Specification P-S-571F, Soap, Scouring (Cake Form), and Soap, Scrubbing, Alkaline (Powder Form), 15 pages, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 (February 1973).

[13] Method of Test for Resistance of Surface to Stains, LD 1-2.05, Laminated Thermosetting Decorative Sheets, National Electrical Manufacturers Association, New York, New York 10017 (1971).

[14] Abrasion Resistance of Cloth; Oscillatory Cylinder (Wyzenbeck) Method, Method 5304.1, Fed. Test Method Std. No. 191, Textile Test Methods, Superintendent of Documents, U.S. Government Printing Office, Washington D.C. 20402 (1968).

[15] Mildew Resistance, CFFA-14, Standard Test Methods, Chemical Fabrics and Film Association, New York, New York 10017 (1972).

APPENDIX A

TENTATIVE RECOMMENDATIONS FOR THE REVISION OF FEDERAL SPECIFICATION CCC-W-408A, WALL COVERING, VINYL-COATED

A1. INTRODUCTION

Tentative recommendations for the revision of the Federal Specification for Vinyl-Coated wallcoverings have been developed. These recommendations are based upon the results of tests conducted on seventy-two wallcovering materials. The tests are intended to be used in evaluating the performance of plastic wallcovering materials and may be more severe than real life situations. The recommendations were developed to reflect performance characteristics which wallcovering materials would be expected to show in service; they include revision in the abrasion resistance test and addition of fungus resistance, washability, and stain resistance tests.

A2. RECOMMENDATIONS

A2.1. ABRASION RESISTANCE

The current test method in Federal Specification CCC-W-408A should be replaced by Test Method 5306 of Federal Test Method 191.[1]

Apparatus The test apparatus should consist of a Taber Abraser or its equivalent as described in Test Method 5306. The abrasive wheels should be resilient of the CS-17 [2] type or equivalent. A load of 1000g should be placed on each wheel. The platform should rotate at approximately 70 rpm.

Test Specimen The test specimen shall consist of a 105 mm (4 1/8 in) square of material applied to a piece of cardboard having an adhesive upper surface. A hole shall be punched in the center of the specimen to accomodate a 6 mm (1/4 in) shaft of the platform. Triplicate test specimens shall be prepared. The entire test specimen shall be placed under a 3000 g weight to flatten it and adhere materials whose back surface is uneven. After 24 hours, remove the test specimen, brush with soft brush to remove loose dirt or dust.

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[1] Abrasion Resistance of Cloth; Rotary Platform. Double-Head (Taber) Method, Method 5306, Fed. Test Method Std. No. 191, Textile Test Methods, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 (1968).

[2] A resilient coarse abrasive wheel as described in "Accessories and Supplies for Taber Model 503 Abraser", distributed by Gardner Laboratory, Inc., PO Box 5728, Bethesda, MD. 20014.

Procedure Before placing the test specimen on the platform, reface the wheels for 50 cycles with an abrasive paper of the S-11[3] or equivalent type. Then brush the surface of the wheels to remove loose particles. The humidity in the room in which the sample preparation and testing is done should remain constant during the procedures. Weigh the test specimen to the nearest 0.001 g, position it on the platform and clamp securely. Place the vacuum pickup nozzle in position slightly above the surface of the specimen. Lower the abrading wheels into test position. Clear the counter to zero, start the vacuum and abrade for 500 cycles. Remove the test specimen, brush, and reweigh.

Evaluation The weight loss from three specimens shall be averaged to determine the averaged weight loss for the wallcovering material.

Requirement The average weight loss of the three specimens should not exceed 0.060 g for Type I, 0.050 g for Type II, or 0.040 g for Type III.

A2.2 FUNGUS RESISTANCE

A test method to evaluate fungus resistance of plastic wallcoverings should be added.

Apparatus The test cabinet should consist of an environmental chamber (as described in ASTM D3273 [4]) capable of maintaining a relative humidity of 95 to 98% at a temperature of 32.5 ± 1°C (90 2°F) while providing a continuous inoculation of the surface of exposed panels with mold spores.

Test Specimen Adhere a 100 mm x 100 mm (4 in x 4 in) piece of wallcovering to a 75 mm x 100 mm (3 in x 4 in) glass plate having a small hole midway between two sides and about 25 mm (1 in) from the top. A 25 mm x 100 mm (1 in x 4 in) strip of material down one side is not attached to the glass. Apply manufacturer's recommended adhesive to a 75 mm x 100 mm (3 in x 4 in) area of the back of the test specimen using a spreading rate of 100 ft^2/gal (equivalent to 3.2 ml/sample). No adhesive was applied to the strip of material not to be adhered to the glass. Place the glass plate on the test specimen and press down. Roll over the surface to adhere more firmly. Care should be taken not to force the adhesive out past the edges. Remove any excess adhesive. Make a hole in the test specimen corresponding to the hole in the glass and place a wire through it. Wipe the wallcovering and glass surfaces with ethyl alcohol. Leave the test specimens to cure in a constant temperature and humidity room for 48 hours. Triplicate test samples should be prepared.

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[3] Abrasive paper, 150 Grit.

[4] Test for Resistance to Growth of Mold of the Surface on Interior Coatings in an Environmental Chamber, D3273, ASTM Book of Standards, Part 27, American Society for Testing and Materials, Philadelphia, PA 19103 (1977).

Procedure Hang the test panels vertically in the environmental chamber with the bottom of the specimen approximately 75 mm (3 in) above the surface of the inoculated soil. Allow sufficient spacing to permit free circulation of air and prevent contact between panels or with wall surfaces. Distribute the test specimens randomly about the chamber. After 4 weeks, remove the test specimens, air dry, and evaluate.

Evaluation The test specimen should be examined to determine if there is fungus growth on the front surface, the uncovered backing strip 25 mm x 100 mm (1 in x 4 in), the edges at the adhesive, or in the adhesive under the glass.

Requirement No fungal growth shall be evident on the test specimen.

A2.3 WASHABILITY

A test method to evaluate the washability of plastic wallcovering materials should be added.

Apparatus The test apparatus should consist essentially of an electric motor mounted on a flat metal plate and a mechanism through which the motor will impart a reciprocating motion to a sponge or a brush at a rate of 37 ± 2 cycles (74 ± 4 strokes) per minute. The sponge or brush shall travel lengthwise along the test panel. The sponge and brush shall be similar to those described in Test Methods 6141 [5] and 6142 [6] of Federal Test Method Std. 14la.

Test Specimen The test specimen should consist of a wallcovering material sample approximately 150 mm x 430 mm (6 in x 17 in) with soil applied in the center across the width of the material. The soiling medium should be prepared and applied in accordance with Test Method 6141 of FTM Std. No. 14la. After application allow to air dry for 16 hours in a well ventilated room, then, using a stiff brush carefully brush off the excess soil.

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[5] Washability of Paints, Method 6141, Fed. Test Method Std. No. 14la, Paint, Varnish, Lacquer, and Related Materials; Methods of Inspection, Sampling, and Testing, Superintendent of Documents, U.S Government Printing Office, Washington, DC 20402 (1965).

[6] Scrub Resistance, Method 6142, Fed. Test Method Std. No. 14la, Paint, Varnish, Lacquer, and Related Materials; Methods of Inspection, Sampling, and Testing, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 (1965).

Procedure Clamp the test panel in place on the apparatus so that the soiled portion is approximately in the middle of the cleaning stroke. Prepare the sponge initially and renew it after each 25 cycles as described in Test Method 6141 of FTM Std. No. 141a. After 100 cycles using a sponge with grit, replace the sponge with a brush. Prepare the brush by immersing the brush bristles in water at 25° to 30°C (77° to 86°F) for 30 minutes to a depth of 130 mm (1/2 in). Remove the brush from the water and rub cake grit soap, conforming to Fed. Spec. P-S-571, Type A [7,8] 25 times back and forth (25 times in each direction) across the brush using moderate pressure. Be sure to completely cover the entire surface of the brush with each stroke of grit soap. Insert the brush into the holder and start the motor. After each 25 cycles, remove the brush, wash with water and apply grit soap as outlined above. When 100 cycles have been completed using the brush, remove the test specimen and rinse the entire surface with water. When dry, take reflectance and 85° gloss measurements as described in Test Method 6141 of FTM Std. 141a on an area where soil had been applied and on a piece of new material. The new material should be used to compare because the unsoiled area on the sample gets contaminated with soil, soapy water and grit during the cleaning procedure.

Evaluation The wallcovering materials shall be evaluated by comparing change in reflectance and gloss measurements, as well as visual examination.

Requirement The reflectance of the cleaned area shall not be less than 90% of the value measured on a piece of new material. The 85° gloss shall not change more than 2 units.

A2.4 STAIN RESISTANCE

A test method to evaluate stain resistance of plastic wallcovering materials should be added.

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[7] Cake Bon Ami, Dy and Frick's Spar Polish, etc., are suitable for this purpose.

[8] Federal Specification P-S-571, Soap, Scouring, (Cake Form), and Soap, Scrubbing, Alkaline (Powder Form), 15 pages (February 1973), Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Apparatus The test apparatus consists of glass rings of approximately 30 mm (1.2 in) OD with 25 mm (1 in) ID and covers. The staining agents include:

1. 10% citric acid
2. 3% hydrogen peroxide
3. distilled water
4. dry mustard (in water)
5. 6.6% urea
6. 5% household soap
7. 10% ammonia
8. chocolate syrup
9. 1% trisodium phosphate
10. 5% acetic acid
11. 5% phenol
12. beet juice
13. 5% household detergent
14. olive oil
15. sodium bisulphite (sat. soln.)
16. tea
17. 4% sodium hypochlorite
18. coffee
19. "Mercurochrome"
20. food coloring
21. washable ink

Test Specimen The test specimen should consist of an approximately 150 mm x 500 mm (6 in x 20 in) sample. Adhere 21 glass rings to it using a suitable adhesive. Carnauba wax is an adequate adhesive for most reagents.

Procedure Apply the staining agents to the test specimen, cover and allow to stand at a temperature of 24°C (75°F). At the end of 16 hours, remove the covers, discard the staining agents, then remove the glass rings and the adhesive. Rinse the specimen with water, brush lightly with a soapy solution, then rinse with water. After air drying, examine the material for a stain by placing the specimen in a horizontal position at normal table height under overhead ceiling height white fluorescent light.

Evaluation Rate the samples using a 0, 1, 2 system

0 = completely unaffected
1 = slight stains, slight change in surface texture or appearance
2 = heavy permanent stain, surface texture more than slightly affected, more than slight change in gloss.

Requirement Type I materials shall be completely unaffected by staining agents one through fourteen. Type II materials shall be completely unaffected by reagents one through eighteen. Type III materials and any plastic wallcovering having a clear top coating shall be unaffected by all staining agents.

APPENDIX B

CCC-W-408A
October 7, 1971
SUPERSEDING
Fed. Spec. CCC-W-408
May 8, 1963

FEDERAL SPECIFICATION

WALL COVERING, VINYL-COATED

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers vinyl-coated wall covering.

1.2 Classification. The vinyl wall covering shall be of the following types, as specified (see 6.2).

Type I - Light Duty.
Type II - Medium Duty.
Type III - Heavy Duty.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

Federal Specification:

PPP-P-1136 - Packaging and Packing of Coated (Plastic; Rubber) and Laminated Fabrics.

Federal Standards:

Fed. Std. No. 123 - Marking for Domestic Shipment (Civil Agencies).
Fed. Test Method Std. No. 191 - Textile Tests Methods.

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

(Single copies of this specification and other Federal Specifications required by activities outside the Federal Government for bidding purposes are available without charge from Business Service Centers at the General Services Administration Regional Offices in Boston, New York, Washington, DC, Atlanta, Chicago, Kansas City, MO, Fort Worth, Denver, San Francisco, Los Angeles, and Seattle, WA.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

Military Standards:

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129 - Marking for Shipment and Storage.

(Copies of Military Specifications and Standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of the specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on date of invitation for bids or request for proposal shall apply.

American Society for Testing and Materials (ASTM) Standards:

D751 - Testing Coated Fabrics.
E84 - Surface Burning Characteristics of Building Materials.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.)

National Motor Freight Traffic Association, Inc., Agent:

National Motor Freight Classification.

(Application for copies should be addressed to the American Trucking Association, Inc., Tariff Order Section, 1616 P Street, N.W., Washington, DC 20036.)

Uniform Classification Committee, Agent

Uniform Freight Classification.

(Application for copies should be addressed to the Uniform Classification Committee, Room 202 Union Station, 516 W. Jackson Blvd., Chicago, IL 60606.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Material.

3.1.1 Supporting material. The supporting substrate of the material shall be of cotton cloth, nonwoven fiberglass, asbestos, or other suitable materials, the use of which enables the vinyl-coated wall covering to meet the requirements of this specification.

3.1.2 Coating compound. The coating compound shall be formulated from virgin polymerized or copolymerized vinyl chloride resin, suitably plasticized, stabilized, and integrally pigmented.

3.1.3 Top coating. When necessary to meet the requirements of table I, a clear top coating or film may be used.

3.1.4 Coated wall covering. The physical properties for vinyl wall covering covered by this specification shall conform to the requirements of table I.

3.2 Color and grain. The color and grain of the vinyl wall covering shall be as specified (see 6.2).

3.3 Length and width. The length and width of the wall covering shall be as specified (see 6.2).

3.4 Marking. Each roll shall have two identical labels, one inside the wrapping and one outside the wrapping. The labels shall indicate gross length, piece length, pattern, and color identification.

3.5 Workmanship. The vinyl wall covering shall conform to the quality and grade of product established by this specification. The occurrence of defects shall not exceed the applicable quality levels.

TABLE I. Physical properties

Requirements	Type I	Type II	Type III
Total weight (ounces/square yard, min.)	7	13	22
Minimum coating weight (ounces/square yard, min.)	5	7	12
Breaking strength (pounds, min.)			
Warp	40	50	100
Filling	30	55	95
Tear strength, (scale reading, min.)			
Warp	14	25	50
Filling	12	25	50
Adhesion (pounds/inch, min.) 1/	2	3	3
Abrasion resistance (Double rubs)	200+	300+	1000+
Flame spread (max.)	25	25	25
Smoke development (max.)	50	50	50
Color fastness to light	No change	No change	No change
Blocking, (scale rating max.)	No. 2	No. 2	No. 2
Shrinkage (percent max.)			
Warp	2.0	2.0	2.0
Filling	1.0	1.0	1.5
Cold crack @ 20° F.	No change	No change	No change
Heat aging (7 days at 158° F.)	2/	2/	2/
Crocking	Good	Good	Good

1/ Nonwoven supporting materials shall be bonded to the wearing surface. When an attempt is made to pull the wearing surface from the backing by hand, the backing shall delaminate or break before failure of the bonding.

2/ The specimen shall not become stiff, brittle, soft, tacky, discolored, or show loss of grain.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.2 Sampling.

4.2.1 Lot. A lot shall consist of each type of vinyl wall covering offered for delivery at one time.

4.2.2 Visual and dimensional examination. Sampling for this examination shall be in accordance with level S-3 in MIL-STD-105. The sample unit shall be one completely fabricated roll.

4.2.3 Sampling for tests. Samples for tests shall be in accordance with level S-1 of MIL-STD-105. The sample unit shall be on completely fabricated roll.

4.3 Visual and dimensional examination. Wall covering shall be examined for the defects list in table II. The acceptable quality level shall be 2.5 percent defective for major defects and 4.0 percent defective for minor defects.

TABLE II. Classification of defects

Defects	Major	Minor
Type not as specified	X	
Dimensions not as specified	X	
Imbedded foreign matter	X	
Not the color specified	X	
Edges not cleanly and evenly trimmed (when specified)	X	
Uneven coating (blisters)	X	
Evidence of delamination	X	
Not free from grease, oil, or dirt		X
Damages or defects but not affecting function		X

4.4 Tests. Each sample selected in accordance with 4.2.3 shall be tested by the methods of Fed. Test Method Std. No. 191 as indicated in table III.

TABLE III. Tests methods

Test	Requirement	Test Method
Total weight	Table I	5041
Coating weight	Table I	5041
Breaking strength		
Warp	Table I	5100
Filling	Table I	5100
Tear strength		
Warp (1)	Table I	5132
Filling (1)	Table I	5132
Adhesion	Table I	ASTM D751
Abrasion (2)	Table I	5304
Flame spread)	Table I	ASTM E84
Smoke development)		
Color fastness (3)	Table I	5660
Blocking	Table I	5872

TABLE III. Test methods (con.)

Test	Requirement	Test Method
Heat aging	Table I	5850
Crocking	Table I	5650
Shrinkage	Table I	Par. 4.4.1
Cold crack	Table I	Par. 4.4.2

(1) Perform type I test without augmenting weight. Perform type II and III test augmenting weight.
(2) Use a fine emery cloth, such as emery '0' paper, with 3 pounds pressure and 6 pounds tension.
(3) Expose for 200 hours with coated side exposed.

4.4.1 Shrinkage. Three specimens 10 by 10 inches shall be soaked for 30 minutes in distilled water at standard conditions in accordance with Fed. Test Method Std. No. 191, then withdrawn from the water and dried in a circulating air oven at 200° F. for 30 minutes. The specimens shall then be conditioned at standard conditions for a period of 8 hours and remeasured. Determine the percent shrinkage as follows:

$$\text{Percent shrinkage} = \frac{A-B}{A} \times 100$$

A - measurement before test; B - measurement after test.

4.4.2 Cold crack. One sample 2 inches by 8 inches from each direction of the wall covering and a 1/2-inch mandrel shall be conditioned at plus 20° F. for a minimum of 30 minutes before testing. After conditioning and without removal from the test conditions, the sample shall be bent quickly 180 degrees around the 1/2-inch mandrel and the sample shall meet at not more than 1/4-inch behind the mandrel. The uncoated side of the wall covering shall contact the mandrel.

4.5 Inspection of preparation for delivery. The packaging, packing, and marking of the wall covering shall be inspected to determine conformance with the applicable requirements of section 5 of this specification.

5. PREPARATION FOR DELIVERY

5.1 Packaging. Packaging shall be level A or C as specified (see 6.2).

5.1.1 Level A. The wall covering shall be packaged in accordance with the applicable level A requirements of PPP-P-1136.

5.1.2 Level C. The wall covering shall be packaged in accordance with the supplier's standard practice.

5.2 Packing. Packing shall be level A, B, or C as specified (see 6.2).

5.2.1 Level A. The packaged wall covering shall be packed in accordance with the applicable level A requirements of PPP-P-1136.

5.2.2 Level B. The packaged wall covering shall be packed in accordance with the applicable level B requirements of PPP-P-1136.

5.2.3 Level C. The wall covering shall be packed to insure carrier acceptance and safe delivery to destination at lowest rates in compliance with Uniform Freight Classification rules or National Motor Freight Classification rules.

5.3 Marking. In addition to any special marking required by the contract or order, interior packages and shipping containers shall be marked in accordance with Fed. Std. No. 123 or MIL-STD-129, as applicable (see 6.2).

6. NOTES

6.1 Intended use.

a. Type I wall covering is intended for ceilings and as a covering for areas not subjected to abrasion.

b. Type II wall covering is for general use in areas of average traffic and scuffing.

c. Type III wall covering is for use primarily as wainscot or lower wall protection for areas exposed to damage by moveable equipment or to abusive conditions such as exist in hospitals.

6.2 Ordering data. Purchasers should select the preferred options permitted herein and include the following information in procurement documents.

a. Title, number, and date of this specification.
b. Type required (see 1.2).
c. Color and grain required (see 3.2).
d. Length and width required (see 3.3).
e. Level of packaging and level of packing required (see 5.1 and 5.2).
f. Marking required (see 5.3).

6.3 Application. Vinyl wall covering should be applied with adhesive recommended by the wall covering manufacturer in strict accordance with his printed instructions. Adhesives not attacked by fungus should be used for installations of wall covering in areas where fungal degradation is a problem.

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16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

The suitability of various test methods for measuring performance of plastic wallcovering materials was studied. This report contains the results of performance tests including abrasion resistance, surface texture, fungus resistance, washability and stain resistance. Based on the test results, tentative recommendations for the revision of Federal Specification CCC-W-408A, Wall Covering, Vinyl-Coated, have been developed. These recommendations are based upon the results of tests conducted on seventy-two wallcovering materials from seven manufacturers.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*
Abrasion; Federal Specification CCC-W-408A; fungus resistance; stain resistance; surface roughness; vinyl wallcoverings; wallcovering materials; washability.

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