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TMD 313 Fabric Analysis and Performance Testing

Fabric Sample 7A

Dear Customer,

Thank you again for choosing our humble business to provide you with the testing and results you require to produce top notch products.

We are saddened to inform you that this fabric choice is not ideal for its specified end use of upholstery. The main result that led us to this decision was the testing of the fabric's colorfastness to light. The ASTM specifications clearly state that fabrics used in upholstery should retain a level 4 ranking on the color comparison grey scale after 40 hours of direct light exposure. The linen fabric you have provided us reached a level 3.6 rating in under 10 hours. This is well below the minimum requirement and should any customer of yours use this fabric near light, it could change drastically in color in as little as a day.

The fabric failed marginally in a few other tests including the tearing strength test. The results tell us that the fill direction of the fabric is not strong enough to face the wear that upholstery fabric goes through.

While the fabric did pass most of the other required specifications such as breaking load and dimensional shrinkage, we recommend you take a look at the full report provided below in order to be completely informed about your decision. However, *we deeply recommend that you rethink the end-use of this fabric for upholstery as it will **not** create a long-lasting and quality product.* We will gladly test the next fabric you choose should you continue the process of creating homewares.

Thank you for choosing us and have a lovely day,

Melissa Kennelly



The Full Report

To determine the performance ability of Fabric sample 7A a linen upholstery fabric, the basic performance tests were carried out as follows. The samples of fabric were taken from both the warp and the fill direction of the fabric and tested separately. This standard testing is important to deter the possibility of creating defective products. The following tests were performed and later compared to the ASTM specifications for the chosen end-use, upholstery.

Disclaimer:s

The ASTM specifications require the following tests that were not performed during this assessment: Surface abrasion (D4157), color fastness to burnt gas (AATCC test method 23), color fastness to ozone (1 cycle) (AATCC Test method 129), Color fastness to water and solvent (AATCC 107) flammability (must meet requirement agreed upon by the customer), and FTC requirements of correct labeling of fibers.

We also performed some tests that can be useful, but are not required by the ASTM specifications, including: water repellency test, pilling test, and the soil release test.

Breaking load test-The Breaking Load test is designed to test the overall strength of a fabric. The strength of a fabric can be affected by many variables like fabric count, weave type, threads per inch, and yarn type. The breaking load test consists of utilizing a machine called the Scott Tester, which is calibrated every year for exact results. This test is done by placing the fabric sample into the two jaws of the machine, and then turning the machine on. The machine will pull the fabric apart until it breaks and read the amount of force in pounds that it took to break the sample. The test is performed on 5 warp samples, and 8 filling samples, then the average load of each is calculated.

7A Result- For The warp samples, the results of the 5 tests were 129.7 lbs, 129.5 lbs, 130.2 lbs, 130.3 lbs, and 130.0 lbs. These results average out to ~130 lbs of force in order to break the warp of this particular fabric. The fill samples appeared to be a bit less strong than the warp, with the tests resulting in 79.9 lbs, 80.4 lbs, 80.2 lbs, 80.5 lbs, 79.8 lbs, 80.0 lbs, 80.5 lbs, and 78.9 lbs. These results average out to ~80 lbs. The minimum load for a fabric of upholstery end-use is at least 50 lbs, so the fabric passes. The probable reason for the warp being much stronger than the fill is that usually warp yarns have more of a twist, and more yarns per inch than the fill. Overall these results show that the fabric is exceedingly strong.

Tear resistance test- The tearing resistance test is less about the entire fabric giving way to weight, and is more about how much force it takes to tear one yarn. This test is more of a “real world” usage test as it is more common for one yarn to tear, rather than the entire fabric giving away. This test includes a small rip to begin from. The test is done using a pendulum machine. One end of the fabric is clamped in place, while the other is attached to the pendulum. The pendulum swings and tears the fabric from the starting rip. If the pendulum doesn’t swing very far that means the fabric takes a lot of

energy to tear, and vice versa. The reading on the attached scale is what we use to determine the amount of force.

7A Result- The warp samples resulted in the scale readings as followed; 32.0, 31.6, 31.1, 31.7, and 32.0. The average of these readings is 31.68. This result is then multiplied by 0.22 In order to convert the force into pounds. The average tearing force for the warp was 7 lbs. The fill samples resulted in the scale readings as followed; 24.1, 24.2, 24.3, 23.6, and 24.1. The average of these readings is 24.06, and when converted the average force needed to tear the fill is ~5 lbs. The ASTM standards require upholstery fabric to be resistant to tearing at a minimum of 6 lbf minimum. The warp passes this specification, but the fill does not. The fill just barely didn't pass, and since the fabric has fantastic results in the breakage test and good results on the warp samples of tearing, this slight failure should not affect the end-use too much.

Color fastness- Fabric's color can change because of many factors like light, washing, staining, abrasion and more. Testing the color fastness includes the usage of "Grey Scales", one for color change and one for staining. The scales go from 5 (no change or stain) to 1 (big color change or lots of staining). The results of each test are compared to the grey scales and differences are noted and rated.

~To Laundering- To test the color-fastness of washing, we use an accelerated test (AATCC Test Method 61) in which we attach the sample to a multifiber swatch containing acetate, cotton, nylon, polyester, acrylic and wool. The samples and fiber strip are put into a cannister with steel balls and detergent and are then laundered at 45°C for 45 minutes. The samples are then dried at 50°C for 15 minutes. This process is equal to about 5 launderings in a home washing machine. Once completed, the fabric strips are compared to the staining grey scale, while the original fabric is compared to the color change grey scale. Each sample is looked at by 3 different observers and the ratings are then averaged.

7A Result- For color change due to laundering, the sample rated at 3.5, 4, and 4 on the grey scale for an average rating of about 3.8. This result means that there was a bit of color change, but nothing incredibly dramatic. The staining results of the fabric and Acetate ranked at 4, 4.5, and 4 for an average of about 4.2 on the stain grey scale meaning there was a tiny bit of staining, but again nothing too dramatic. Lastly, the effect of staining on wool was assessed at 3.5, 4, and 4 which averages out to a rating of about 3.8. Again a bit of staining, but not much more than a 1 level drop from no staining at all. There is no specification for color-fastness to laundering for upholstery fabrics, but the ratings for color-fastness to water and solvents must be above a 4. So, all sample results are close to, if not passing the specification.

~To Light- Sunlight has the ability to cause color fading on fabrics. This is an important factor for upholstery fabrics because it could be used as curtains, or on a piece of furniture placed by a window. The process of fading is slow, so this test is done with a powerful xenon-arc light source. This machine allows us to expedite the effect of fading. The fabric sample is placed into a mask with at least 4 sections. Each section of the fabric is revealed to the light source after 10, 20, or 40 hours. Then, the

original fabric, the 10 hour exposed sample, the 20 hour exposed sample, and the 40 hour exposed sample are all compared to the color change grey scale. It is then determined how many hours it approximately takes for the fabric sample to reach the rating of 4 on the color change scale.

7A Result- The results of the colorfastness to light test were disappointing. The averaged result for after 40 hours of light exposure was about 3.1, after 20 hours about 3.1 and after 10 hours an average rating of 3.7. These results mean that the fabric faded past a level 4 rank in less than 10 hours. The ASTM standard says that fabrics should take a minimum 40 hours of exposure to light to reach level 4 fading.

~To Crocking- Some dyes sit on top of the fabric rather than absorbing into the fibers. This makes the color very easy to rub off. Crocking is done by taking a crock square, which is basically just a small piece of white fabric, and clipping it onto a peg of the crocking machine. The test fabric is then placed under the peg and the “crock cloth”, a handle on the machine is cranked and the crock cloth rubs back and forth on the test sample ten times. This happens with a dry crock cloth, and a wet crock cloth. The stains on the crock cloths are measured on a chromatic transference scale from 5 (no staining) to 1 (vibrant staining) by three different observers. The multiple ratings are then averaged out.

7A Result- The dry crocking results for the fabric sample 7A were averaged to a 5 rating, meaning there was no visible staining. The ASTM standards require upholstery fabrics to meet a minimum of a 4 rating for dry crocking, meaning the samples meets the requirement. The wet crocking results averaged to a 4 rating, meaning there was some slight staining. The ASTM standards require a minimum of a 3 rating for wet crocking, so while there was a bit of staining, the samples still meets the requirements.

~To Perspiration (Not required by ASTM)- This test is not required for upholstery fabric because the end-use does not entail a lot of contact with sweat. However, the test was still executed. This test entails attaching a fabric sample to a multifiber strip that is soaked in an artificial sweat solution. The sample and the multifiber are both placed in between steel plates in a perspirometer, this is then put into an oven overnight at a normal body temperature. The results of color change on the sample and staining of the multifiber are compared to their respective grey scales and recorded by 3 different observers and then averaged.

7A Result- The color change of the fabric after the experiment was recorded as 5, 5, and 4.5 which averages to a rating of about 4.8 on the color change grey scale. This means there is very little color change to perspiration exposure. The staining of acetate was recorded as 4.5, 4, and 4 which averages out to about 4.2 on the staining grey scale. This means there was little staining. And finally the staining of wool was recorded as 4, 4.5, and 4, also averaging out to about 4.2 on the staining grey scale. This means there was little staining here as well. To reiterate, this test is not required by ASTM because upholstery fabrics rarely come into contact with sweat.

Pilling test (Not required by ASTM)- To determine if a fabric produces pilling when rubbed, the samples are placed into a cork-lined drum along with some lint and spun for 30 minutes. The result is then compared to a visual pilling scale that is 5 (no pilling) to 1 (a lot of pilling). This is done 3 times with 3 different observers and then the ratings are averaged out. This test is not listed in the upholstery fabric ASTM specifications.

7A Result- The pilling test resulted in an average rating of about 4, which is just a slight amount of pilling. This test may not be required but it is useful because of the wear upholstery fabric should withstand.

Dimensional change (shrinkage) test- When washed and dried, fabrics may shrink. Large samples from the width and length of the fabric are taken and marked using a shrinkage template. The fabric will be marked three times in the warp direction and three times in the filling direction. This provides a specific known measurement between the marks. The sample is then put through three wash and dry cycles. After, the cycles, the fabric is assessed with the shrinkage template by lining up one of the marks with it's original spot on the template, and reading the percent shrinkage that the opposite marks align with on the template.

7A Result- After averaging out all of the measurements of the lines for the warp samples, the percent of shrinkage was about 5%. Then the measurements for the lines of the fill samples were collected and averaged, this came to a shrinkage of about 3%. The amount of shrinkage that is specified by the ASTM is a maximum of 5%, meaning the sample we tested passed.

Soil release test (Not required by ASTM)- Fabrics could be particularly avid at holding on to oily stains. . Using large samples from the width and length of the fabric, 5 drops of oil are placed on a sample and then put through one wash/dry cycle. The stain removal is compared with the AATCC stain release replica chart and rated 5 (oil stain is completely removed) to 1 (oil stain hasn't changed). While not required by the ASTM specifications, the ability to remove stains from products such as chairs or couches is a useful advantage.

7A Result- after averaging the ranking of the samples from three different observers after washing, the final rating of the soil release capability was about 1.5, meaning the oil stains barely changed. This result tells us that the fabric is very difficult to remove oil from.

Appearance after laundering (Not required by ASTM)- Some fabrics may become wrinkled when washed and dried. Large samples from the width and length of the fabric are washed and dried three times and then hung up and compared to AATCC replicas to determine how wrinkly the fabric is. The samples are then rated on a scale of 5 (no wrinkles) to 1 (a lot of wrinkles).

7A Result- The average ranking of the sample's appearance after laundering was just under a 3.5. Anything above a 3.5 is considered to not need ironing. This tells us that the sample would require ironing after washing.

Water Repellency (Not required by ASTM)- To test water repellency, the fabric is stretched onto a hoop. Above there is a funnel with a spray head on the bottom. 250 mL of water is poured into the funnel and sprayed into the fabric, Once the water has run through the sample while still in the hoop is tapped to remove excess droplets. The water pattern that is absorbed into the fabric is then compared with an AATCC rating scale of 100 (no water remaining) to 1 (fabric retains water on both sides).

7A Result- The water repellency test while not required by the ASTM is useful for upholstery fabrics because this could translate into the fabric's ability to wick away stains. This would be a useful attribute of this fabric since it rated poorly on the soil release test. The average scaling for this test came to about 74%, meaning it wicked away most of the water, but absorbed around 20-30%. This is a satisfactory result.

Result Data

BREAKING LOAD: (ASTM D5034) GRAB METHOD, CRT MACHINE

| Specimen # | Breaking Load (pounds) | |
|------------|------------------------|--------|
| | Warp | Fill |
| 1. | 129.7 | 79.9 |
| 2. | 129.5 | 80.4 |
| 3. | 130.2 | 80.2 |
| 4. | 130.3 | 80.5 |
| 5. | 130.0 | 79.8 |
| 6. | | 80.0 |
| 7. | | 80.5 |
| 8. | | 78.9 |
| Average | 129.94 | 80.025 |

Calculation:

To convert pounds to Newtons, multiply by 4.44
(Report pounds and Newtons as whole numbers)

Results:

Average breaking load:

Warp = 130 lbf 577 Newtons

Filling = 80 lbf 355 Newtons

TEAR RESISTANCE: FALLING PENDULUM METHOD (ASTM D1424)

Data:

| Specimen # | Tear Resistance (Scale Reading) | |
|------------|---------------------------------|-------|
| | Warp | Fill |
| 1. | 32.0 | 24.1 |
| 2. | 31.6 | 24.2 |
| 3. | 31.1 | 24.3 |
| 4. | 31.7 | 23.6 |
| 5. | 32.0 | 24.1 |
| Average | 31.68 | 24.06 |

Calculation:

Average Scale Reading x 100 = Tearing Force (gm)

Average Scale Reading x 0.22 = Tearing Force (lb)

(Report results to the nearest 100g, nearest 1lb)

Results:

Average tearing force: Warp = 3168 (gm) 7 (lb)

Filling = 2406 (gm) 5 (lb)

COLORFASTNESS TO LIGHT (AATCC 16E)

Data:

| Grey Scale Rating | Observer 1 | Observer 2 | Observer 3 | Average |
|--|--------------|------------|------------|---------|
| 10 hours | 3.5 | 3.5 | 4.0 | 3.666 |
| 20 hours | 3.5 | 3.0 | 3.0 | 3.166 |
| 40 hours | 3.0 | 3.5 | 3.0 | 3.166 |
| | 3.333 | 3.333 | 3.333 | |
| Hours to cause Fading to Grey Scale Step 4 | Less than 10 | | | |

Results:

Light fastness rating: Hours/Fading Units to Step 4 = Less than ten hours

COLORFASTNESS TO CROCKING (AATCC 8)

Data:

| Chromatic Transference Rating | Observer 1 | Observer 2 | Observer 3 | (Average) |
|-------------------------------|------------|------------|------------|-----------|
| Dry Crocking | 5 | 5 | 5 | 5 |
| Wet Crocking | 3.5 | 3.5 | 4.0 | 3.666 |

Results:

Dry Crocking 5 Wet Crocking 4

COLORFASTNESS TO LAUNDERING (AATCC 61, 2A method)

Data:

| Grey Scale Ratings | Observer 1 | Observer 2 | Observer 3 | (Average) |
|--------------------|------------|------------|------------|-----------|
| Any Color Change | 3.5 | 4.0 | 4.0 | 3.833 |
| 2. Staining of: | | | | |
| Acetate | 4.0 | 4.5 | 4.0 | 4.166 |
| Wool | 3.5 | 4 | 4 | 3.833 |

Results:

Color change 3.8

Staining of Acetate= 4.2

Staining of Wool = 3.8

COLORFASTNESS TO PERSPIRATION (AATCC 15)

Data:

| Grey Scale Ratings | Observer 1 | Observer 2 | Observer 3 | (Average) |
|------------------------------------|------------|------------|------------|-----------|
| 1. Color change of original fabric | 5 | 5 | 4.5 | 4.83 |
| 2. Staining of: Acetate | 4.5 | 4 | 4 | 4.167 |
| Wool | 4 | 4.5 | 4 | 4.167 |

Results:

Color change 4.8

Staining of Acetate = 4.2 Staining of Wool = 4.2

PILLING (ASTM D3512-1982)

Data:

| Observer | Rating |
|----------|--------|
| 1. | 4.0 |
| 2. | 4.0 |
| 3. | 3.5 |
| Average | 3.83 |

5 = no pilling, 4 = slight, 3= moderate, 2= severe, 1 = very severe

Result:

Average Pilling Rating 4, slight pilling

DIMENSIONAL CHANGE (AATCC 135)

Data:

| | Warp | Filling |
|--------------------|------|---------|
| Specimen 1, Line 1 | 5.1 | 2.9 |
| Line 2 | 5.1 | 3.1 |
| Line 3 | 4.8 | 3.0 |
| Specimen 2, Line 1 | 4.7 | 2.9 |
| Line 2 | 5.0 | 2.9 |
| Line 3 | 5.0 | 2.8 |
| Specimen 3, Line 1 | 4.7 | 3.0 |
| Line 2 | 5.1 | 2.7 |
| Line 3 | 5.0 | 3.1 |
| Average % change | 4.94 | 2.93 |

Results:

Average change: Warp 5 % Filling 3 %

FABRIC APPEARANCE AFTER LAUNDERING (AATCC 124)

Data:

| Rating | | |
|------------|------------|------------|
| Observer 1 | Observer 2 | Observer 3 |
| 3.0 | 3.5 | 3.0 |

Result:

The Average Appearance Rating after laundering is 3.2

SOIL RELEASE (OILY STAIN METHOD) (AATCC 130)

Data:

| Rating | | |
|------------|------------|------------|
| Observer 1 | Observer 2 | Observer 3 |
| 1.0 | 1.5 | 1.0 |

Result:

The Average Soil Release Rating is 1.2

WATER REPELLENCY: SPRAY TEST (AATCC 22)

Data and Results:

| | |
|------------|------|
| Observer 1 | 70.0 |
| Observer 2 | 80.0 |
| Observer 3 | 70.0 |

Rating for Water Repellency 73.3

PERFORMANCE SUMMARY SHEET

| | |
|--|---|
| Breaking Load: Warp <u>130</u> lb Filling <u>80</u> lb | Tear Strength: Warp: <u>7</u> lb Filling: <u>5</u> lb |
|--|---|

Colorfastness to Light: Less than 10 hours (hours for Step 4 change)

Colorfastness to Crocking: Wet 4 Dry 5

| Colorfastness to.... | Laundering | Perspiration |
|----------------------|------------|--------------|
| Color change | 3.8 | 4.8 |
| Staining of: Acetate | 4.2 | 4.2 |
| Wool | 3.8 | 4.2 |

| Dimensional change | Warp | Fill |
|--------------------|------|------|
| | %5 | %3 |

| | |
|-------------------------------|---------------------------------|
| Fabric Appearance Rating: 3.2 | Pilling Rating: 4 _____ |
| Water Repellency: <u>73.3</u> | Soil Release Rating: <u>1.2</u> |

TMD 313 Fabric Analysis and Performance Testing
COMPARISON TO STANDARD PERFORMANCE SPECIFICATIONS

Standard Performance Specification for: Upholstery

Source: Annual Book of ASTM Standards

Year: 2021

Standard Number D3597-02 (reapproved 2018)

| CHARACTERISTIC | REQUIREMENT | ACTUAL | COMMENT (Pass/fail?) |
|--|---|---------------------------------|----------------------|
| Breaking load | 50 lbf | 130 lbf (warp) 80 lbf (fill) | Pass pass |
| Tearing Strength | 6 lbf | 7lbf (warp) 5 lbf (fill) | Pass FAIL |
| Colorfastness to light | 40 hours/AATCC FU (grade 4) minimum! | Less than 10 hours | FAIL |
| Colorfastness to Crocking -Wet | 3 minimum | 4 | pass |
| Colorfastness to Crocking -Dry | 4 minimum | 5 | pass |
| Dimensional Change | 5% shrinkage max | 5% (warp) 3% (fill) | Pass pass |
| Fabric Appearance rating (not required by ASTM spec) | NA | 3.2 | NA |
| Pilling rating (not required by ASTM spec) | NA | 4 | NA |
| Water repellency (not required by ASTM spec) | NA | 73.3 | NA |

| | | | |
|---|--|---|--|
| Soil release rating (not required by ASTM spec) | NA | 1.2 | NA |
| Color fastness to : a. water (not relevant is fabric is labeled “clean with solvent only”) b. solvent (ATTC 107) c. burnt gas fumes d. ozone 1 cycle | a. grade 4 min b. grade 4 min c. grade 4 min d. grade 4 min | Tested color fastness to laundering (a+b): Color change= 3.8 Staining on acetate:4.1 Staining on wool: 3.8 (c+d) NA | Color Change: FAIL Acetate: Pass Wool: FAIL (c+d) NA |
| Durability of back coating | No significant change | Not tested | NA |
| Flammability | pass | Not tested | NA |
| FTC Requirements | pass | Not tested | NA |
| Resistance to yarn slippage | 25 lbf, min | Not tested | NA |
| Surface abrasion a. Light-duty b. Medium-duty c. Heavy duty | a. 3000 cycles, min b. 9000 cycles, min c. 15,000 cycles, min | Not tested | NA |

*Note. The values in the specification are the minimum (sometimes maximum) values for acceptability. So if your fabric is way stronger than the requirement, that's OK. Don't forget to quote the lightfastness in **hours** (= AATCC AFU).