



Flame is removed from sample after three seconds. Mrs. Meyer observes residual flame time and char length for each specimen.



Cotton flannelette fabric with flame retardant finish has self-extinguished after three seconds of exposure to flame.

## Effect of Laundering on a Flame Retardant Fabric

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The effect of selected laundering conditions on a cotton flannelette fabric with a flame retardant finish was investigated. Samples of the fabric were laundered using a high and low phosphate detergent in moderately hard and softened water. The fabric maintained flame retardancy when either a high or low phosphate detergent was used and in both moderately hard and softened water. However, softened water was significantly more effective in maintaining flame retardancy than hard water.

### Introduction

The problem of burn injuries associated with accidental ignition of clothing and other household fabrics was the reason that Federal legislation has been enacted to protect consumers. A number of textile products must pass government flammability standards, including carpets and rugs, children's sleepwear and mattresses. Much emphasis has been placed on children's flame retardant sleepwear, because the largest number of fabric ignition burn accidents occur in the 5-9 age group (Flammable Fabrics Act Report, Fiscal Year 1974).

Flammability refers to the ease with which a substance may ignite and support a fire. Flame retardant fabrics are designed to resist igniting when exposed to a flame, to inhibit the spread of a flame or to be self-extinguishing. Flame retardancy can be achieved by the use of flame retardant fibers or by the use of flame retardant finishes on fabrics.

*Mrs. Meyer completed the study as a requirement for her M.S. degree in Textiles and Clothing, Mrs. Janecek is associate professor, Department of Textiles and Clothing.*

Two standards have been passed requiring all children's sleepwear to be flame retardant; DOC FF 3-71, covering sizes 0-6X, which became law in July, 1973; and DOC FF 5-74, covering sizes 7-14, which became law in May, 1975. These standards require the garments or fabric used in such garments to be flame retardant through 50 launderings under specified conditions. Garments must be clearly labeled stating that they comply with this standard, and must include any care instructions needed to maintain the flame retardancy.

The U. S. Consumer Product Safety Commission has published a fact sheet, "Laundering Procedures for Flame Retardant Fabrics." The fact sheet recommends phosphate detergents, warm water wash temperature (105° to 120°F) and tumble dry-low heat. The sheet suggests that care labels should be checked before using a bleach. Chlorine bleach may cause some flame retardant finishes on cotton fabrics to be ineffective, whereas it may be used on synthetic fabrics. Fabric softeners should be used sparingly so that a buildup on the fiber doesn't cause the fabric to lose its flame resistant properties.

Any type of buildup on the fiber surface can inhibit the effectiveness of a flame retardant finish. Use of soap and low or non-phosphate detergents can result in a buildup of soap curds on the fiber surfaces (LeBlanc and LeBlanc, 1973, Pacheco and Carfagno, 1972). Laundering in hard water can result in deposits of calcium and magnesium on the fibers, causing a gray color and a stiff harsh feel to the fabric, as well as inhibiting the flame retardant finish (Purchase, 1972, LeBlanc and LeBlanc, 1973).

A flammability study was done in the Department of Textiles and Clothing comparing the effectiveness of a flame retardant finish on cotton flannelette fabric when laundered in both high and low phosphate detergent and with moderately hard and soft water.

### Experimental Procedure

The test fabric in this study was 100 per cent cotton flannelette with a flame retardant finish, Firegard ® (Trademark of Lowenstein & Sons, Inc.). A market survey was used to determine commonly-used detergents at the various phosphate levels. A high phosphate detergent of 12.3 per cent phosphorus and a low phosphate detergent of 8.7 per cent phosphorus were used. Untreated, moderately hard Fargo water, 7-8 grains per gallon hardness, and water softened by a precipitating type water softener were used in this study.

Laundering variables studied were the use of high phosphate detergent in moderately hard water, high phosphate detergent in soft water, low phosphate detergent in moderately hard water and low phosphate detergent in soft water.

Specimens were cut to 3.5 x 10 inches for testing purposes. Fabric specimens were laundered in a 4-pound load, using a normal wash cycle of 12 minutes as specified in the Children's Sleepwear Standard, DOC 3-71. Wash water temperatures of 140 ± 5°F and rinse water temperatures of 105 ± 5°F were used. Each wash load was tumble-dried. Specimens were withdrawn for testing after the 10th, 25th and the 50th laundering cycles.

Prior to testing, specimens were dried in a forced draft drying oven for 30 minutes and placed in a desiccator for 30 minutes to cool. Conditioned specimens were mounted with the bottom edge even with the bottom edge of the specimen holder. In the flame retardancy test, a specimen was placed vertically in the test chamber and a flame applied to the bottom edge for 3 seconds. Specimens were evaluated on residual flame time, which is the length of time the specimen continued to burn after the flame was removed; and the char length or the area burned before the specimen extinguished.

Flammability standards require that no individual test specimen burn its entire 10-inch length. The average char length for five specimens shall not exceed seven inches. The standard also states that no specimen burn longer than 10 seconds after the flame has been removed.

Samples were analyzed for differences in results when comparing the number of launderings, the two levels of phosphate in detergents used and the hardness of the water. Unlaundered samples were used to evaluate the initial level of flame retardancy as determined by char length and residual flame time.

### Results and Discussion

Unlaundered samples had an average char length of 2.8 inches and an average residual flame time of 0.7 seconds. Individual char lengths of laundered specimens ranging from 1.7 to 5.3 inches, with no specimen having burned its entire 10-inch length. Residual flame times ranged from .3 to 4.0 seconds, well below the 10-second maximum.

**Table 1. Residual flame time and char length of samples laundered 10, 25 and 50 times.**

| Launderings         | Residual flame time |                 |
|---------------------|---------------------|-----------------|
|                     | sec.                | Char length in. |
| 10                  | 1.2                 | 2.8             |
| 25                  | 1.3                 | 2.9             |
| 50                  | 1.7*                | 3.2*            |
| Unlaundered control | 0.7                 | 2.8             |

\*Indicates a significant difference at *p* less than .05 level.

Flame retardancy was maintained through 50 launderings for test specimens in both high and low phosphate detergents and in the moderately hard and soft water classifications. The average char length did increase as launderings progressed, indicating some decrease in effectiveness of the flame retardant finish. This increase was significant at the .05 level of probability when comparing samples laundered 10 times with those laundered 50 times.

**Table 2. Average char length and residual flame time for samples laundered in high phosphate and low phosphate detergent.**

| Sample                   | Residual flame time |                 |
|--------------------------|---------------------|-----------------|
|                          | sec.                | Char length in. |
| High phosphate detergent | 1.6                 | 3.0             |
| Low phosphate detergent  | 1.3                 | 2.8             |
| Unlaundered control      | 0.7                 | 2.8             |

Comparisons of specimens laundered in the two detergent types revealed no significant differences in residual flame time or char length. Specimens laundered in high phosphate (12.3 per cent) detergent had an average char length of 3.0 inches. Specimens laundered in low phosphate (8.7 per cent) detergent had an average char length of 2.8 inches. Both levels of phosphate in the detergents were found to be effective in maintaining flame retardancy.

Care labels on flame retardant items often caution against the use of low phosphate detergents as well as non-phosphate detergents and soaps. Previous studies indicated non-phosphate detergents and soaps were not as successful in maintaining flame retardancy (Brysson, et al., 1971; Pacheco and Carfagno, 1972; Perkins, et al., 1971).

Loeb (1971) and Purchase (1972) noted that low phosphate detergents were not effective when there was a heavy amount of soil. The effectiveness of a low phosphate detergent in maintaining flame retardancy in this study was found to be comparable to the high phosphate detergents when unsoiled samples were used. Low phosphate detergent may be used in flame retardant clothing if lightly soiled, especially if double amounts of detergent are used as recommended on some care labels.

**Table 3. Average char length and residual flame time for samples laundered in hard and soft water.**

| Water type          | Residual flame time | Char length |
|---------------------|---------------------|-------------|
|                     | sec.                | in.         |
| Hard water          | 1.7                 | 3.2         |
| Soft water          | 1.2*                | 2.6*        |
| Unlaundered control | 0.7                 | 2.8         |

\*Indicates a significant difference at *p* less than .01 level.

Soft water was found to be significantly more effective in maintaining flame retardancy in both detergent types. The average char length of 2.6 inches for samples laundered in soft water was significant over the average char length of 3.2 inches for samples laundered in hard water.

Use of soft water may permit a wider range of detergent types in laundering flame retardant items. This will be especially important in areas where the water is very hard or the phosphate level in detergents is limited or banned.

Since the study was completed, the percentage of phosphates in detergents has been reduced. The detergent designated as low phosphate would

presently be considered a high phosphate detergent.

Results indicate some tolerance to variables in the laundering procedure while maintaining flame retardancy. This tolerance is important to allow for differences in water hardness, amount of phosphate in detergents and variations in laundering procedures.

### Conclusions

1. All specimens evaluated met the Children's sleepwear Standard, DOC FF 3-71.
2. The high and low phosphate detergents were effective in maintaining this flame retardant finish in both moderately hard and soft water.
3. Samples laundered in the moderately hard water did not respond in a similar manner to those laundered in soft water.
4. Soft water was highly significant in maintaining the effectiveness of this flame retardant finish.
5. With additional launderings, char lengths and residual flame times tended to increase.

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