WESTEX™

A WORLD LEADER IN FLAME RESISTANT FABRICS

White Paper

UltraSoft® and Indura® Brand Flame Resistant Fabrics

vs.

Generic/Off-Brand Flame Resistant Cotton and Cotton Blend Fabrics

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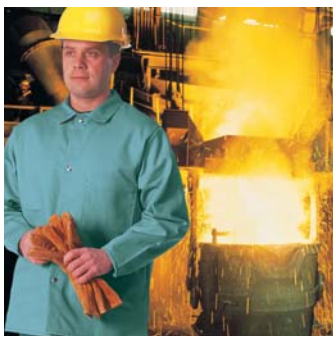


Ferrous Metals & Welding

Executive Summary

Every day, workers in maintenance and electrical, utilities, oil, gas, petrochemical, chemical, steel and many other industries work in environments that may expose them to hazards that could cause severe or fatal burns. Many companies have made significant commitments to identify and quantify the hazards their employees may face on a daily basis. These companies have also made large investments in flame resistant (FR) protective clothing programs to protect against these hazards. It is important to recognize that in the event of a momentary electric arc flash, flash fire or molten metal splash exposure, the FR fabric used to construct the garment is a critical factor in determining the amount of protection the garment will afford the wearer. The fabric is also a main factor in determining the comfort, durability and the overall value equation of an FR protective clothing program; therefore, it is important to fully investigate the flame resistant fabric options available and specify the FR fabric your company has selected by brand name. This will help ensure that a marginally lower up-front investment on a generic/off-brand doesn't lead to employee injuries, program dissatisfaction or significant additional costs downstream. Additionally, in today's litigious society it is important to have the support of a well established, reputable fabric manufacturer that carries appropriate liability insurance coverage.

This white paper will address flame resistant cotton and cotton blend fabrics and identify some important factors that should be considered when specifying a brand of FR fabric for a protective clothing program. The paper will also provide information about the many unseen details and technologies that are built into market-proven brands like UltraSoft® and Indura®.

Introduction

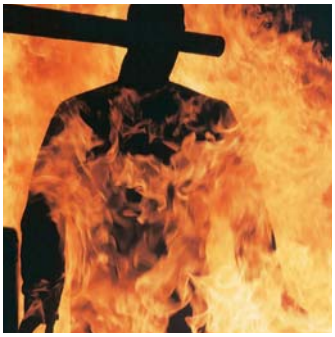
Over the past decade, the flame resistant (FR) protective clothing market has experienced continued growth due to new regulations and an increased awareness of the importance of wearing FR clothing when a potential exposure to an electric arc flash, flash fire or molten metal splash hazard exists. This growth trend is expected to continue and is now being driven primarily by the new revisions in the NFPA 70E Standard (*Standard for Electrical Safety in the Workplace*). The NFPA 70E standard now states "employees shall wear FR clothing wherever there is a possible exposure to an electric arc flash." UltraSoft® flame resistant fabrics have achieved a leading market share over FR synthetic fabrics due to a superior balance of protection, comfort and value. This emerging opportunity, coupled with the mounting pressure on textile companies to diversify for survival, has motivated various domestic and foreign textile mills to attempt to produce generic/off-brand flame resistant cotton and cotton blend fabrics.

It is not uncommon for a textile mill to diversify and offer various finishes for special applications; however, **flame resistant fabrics represent a very unique and complex situation since they are designed to protect and save lives.** When electric arc flash, flash fire or molten metal splash accidents occur, the protection afforded by the finished garment depends almost entirely on the type and brand of FR fabric. Therefore, we believe it is important to understand the experience and capabilities of the flame resistant fabric manufacturer and the technology they employ to produce the flame resistant fabrics. This includes the type of equipment, technology, process controls, quality monitoring systems, and internal laboratory testing and documentation procedures to ensure consistent quality and performance on every lot of material. The fabrics should also have been tested extensively at independent laboratories such as Kinectrics for electric arc flash and the University of Alberta for flash fire. Any testing that has been conducted by end users at independent laboratories, such as KEMA Powertest, should be analyzed as well. This will help the end user gain a better understanding of the protective capabilities these fabrics exhibit when exposed to electric arc flash and flash fire hazards. The FR fabric manufacturer should provide an invitation to their customers and end users to witness this independent testing. In addition, they should offer access to their production, laboratory and warehousing facilities along with the support of experienced personnel who can assist in this education process.

In addition to the complexities of the FR engineering process and its impact on protection, there are several other important factors that need to be carefully considered. These factors include the consistency and quality of the base material, dyes, shrinkage control and inventory support. All of these items can have a major impact on the overall success and ultimate value equation of a program, especially in an industrial laundry environment. Finally, **an FR fabric's market experience is extremely important in determining the wear life and overall performance of flame resistant cotton and cotton blend garments.**

Flame Resistant (FR) Clothing Protects Against a Variety of Hazards

Electric Arc Flash



Flash Fire

Molten Metal Splash

When electric arc flash, flash fire or molten metal splash accidents occur, the protection afforded by the finished garment depends almost entirely on the type and brand of FR fabric.

Brief History of Durable FR Cotton Finishing Technology

There are several different technologies available to make cotton fabrics flame resistant, starting with the most basic "topical" non-durable applications that can be removed in a single laundering and progressing up to engineered fabrics that are flame resistant for the life of the garment. The durable FR "ammonia cure" finishing technology was developed over three decades ago. Westex's own first-generation ammonia cure product, Proban®/ FR-7A® is only guaranteed to retain its FR characteristics for 25 industrial or 50 home launderings and is an example of this type of "out-of-the-box" ammonia cure technology.

Other FR cotton finishing technologies, such as heat cure systems that utilize conventional textile finishing equipment to apply flame retardant chemicals, are generally not recommended for use in protective clothing. These finishes typically require special care procedures when washed by industrial laundries and some have "shelf life" issues; consequently, they only have a minute share of the protective clothing market and will not be further addressed in this paper.

As industrial laundries became more involved in the flame resistant clothing market, they opted for inherently FR fabrics, (which retain their flame resistance throughout the garment life) in an effort to reduce potential liability issues. Industrial laundries typically use higher temperatures and aggressive chemistries to thoroughly remove soiling; therefore, it became necessary to improve on the "out-of-the-box" ammonia cure treating process for FR cotton fabrics to effectively compete with inherently FR fabrics. In 1987, after significant research and development, Westex introduced Indura® brand flame resistant fabrics with a *guarantee of flame resistance for the life of the garment*. The proprietary Westex technology marked a major advancement in ammonia cure processes, and completely changed the performance of flame resistant cotton. Since the introduction of Indura®, millions of garments have been incorporated into protective clothing programs worldwide. Westex's continued investment in research and development has lead to UltraSoft®, a blended fabric that offers a much longer wear life, softer feel and superior protection, in addition to guaranteed flame resistance for the life of the garment.

In 1987, after significant research and development, Westex introduced Indura® brand flame resistant fabrics with a guarantee of flame resistance for the life of the garment.

FR Fabric *Manufacturers*—What to Look For

Since the FR fabric used to construct the clothing is the primary determining factor in the protection, comfort, durability and cost of the finished garment, the first critical consideration when evaluating products is the company behind the production of the fabrics. The complicated processing demands and the pivotal nature of FR fabrics require the FR fabric manufacturer to have the following qualities:

The majority of knowledge and expertise in finishing FR cotton and cotton blend fabrics is gained from experience. The vast majority of this experience is proprietary to the company that makes the investment of time and resources.

Experience

The majority of knowledge and expertise in finishing FR cotton and cotton blend fabrics is gained from experience. The vast majority of this experience is proprietary to the company that makes the investment of time and resources. The fabric manufacturer should have a proven track record of quality to ensure consistent performance.

- Westex, established in 1919, has been finishing flame resistant fabrics for over a half a century and has the most advanced systems, equipment and technical staff in the business. Westex is the world's largest manufacturer of flame resistant cotton and cotton blend fabrics.

Technology

There are several different finishing technologies available to produce FR cotton and cotton blend fabrics. The most advanced process publicly available for durable FR cotton finishing is the "ammonia cure" system, which is being utilized by several textile finishers globally. **Although the basic chemistry in an ammonia cure process may be similar, the technology and application of this system can vary significantly from finisher to finisher.**

- Westex's first-generation fabrics, introduced in the early 1970's utilized an "out-of-the-box" ammonia cure system similar to most of the ammonia cure finishers today. Because this "out-of-the-box" system produces fabrics whose FR properties can be removed by laundering over time, Westex began a major research and development program, which in 1987 resulted in an advanced proprietary technology, and Indura® was introduced. Although the foundation of Westex's fabric technology utilizes an ammonia cure system and similar chemistry to "out-of-the-box" finishers, the advanced Westex process combines custom-engineered equipment with additional proprietary processing steps at nearly every stage of the engineering process. This superior Westex technology has led to the market-proven guarantee of flame resistance for the life of the garment in both home and high temperature industrial laundry systems.

Equipment

The type of equipment used can have an impact on the overall consistency and performance of a flame resistant cotton product.

- Westex utilizes custom-engineered equipment to produce their line of fabrics. The equipment optimizes the performance, consistency and quality of the finished product and is a key component in manufacturing UltraSoft® and Indura® fabrics.

Process controls

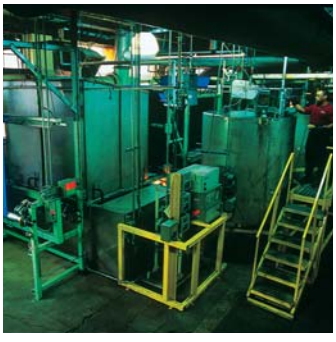
After the proper technology has been identified and the equipment has been installed, it is imperative that it is used properly on a consistent basis. To accomplish this goal, process controls and parameters for these controls must be established.

- Westex has set the parameters and process controls based on decades of experience. Advanced computer-monitoring equipment is utilized to maintain unparalleled consistency. This all but eliminates the "lot-to-lot" and day-to-day variation inherent in "out-of-the-box" finishing equipment.

Westex — Chicago Plant

Westex — Georgia Plant

The advanced Westex technology combines custom engineered equipment with additional proprietary processing steps at nearly every stage of the engineering process.



Westex's custom-engineered finishing equipment.

Westex quality control inspection line, Chicago Plant.

Since Westex's primary business is the production of flame resistant fabrics, the technicians are extensively trained to focus on the preparation and testing of flame resistant fabrics.

Westex has the most experienced technical staff in the industry, with over 50 years experience in finishing flame resistant fabrics. Westex is capable of providing unparalleled support to the protective clothing market.

Over 90% of Westex orders are in stock and shipped within 2 days.

Quality Control

The quality control procedures for FR fabrics are far more critical than non-FR fabrics. With FR fabrics, the quality and consistency of the flame resistant finish should be the primary focus of the manufacturer. FR fabrics represent a "non-standard" lot for those manufacturers that do not specialize in flame resistant fabrics. Operating outside of a company's core competency can lead to quality issues. Operators, quality control managers and laboratory personnel in these non-specialized companies have to recognize that atypical procedures would need to be followed for each lot of FR fabric. The quality control team must be experienced in the evaluation and testing of FR fabrics. Other important quality factors include shrinkage control and physical properties, which include strength and feel or "hand" of the fabric.

- Westex has a government-certified laboratory with a full staff of experienced technicians. Since Westex's primary business is the production of flame resistant fabrics, and has been for decades, the technicians are extensively trained to focus on the preparation and testing of flame resistant fabrics. **Flame resistant fabric testing is the norm at Westex, not the exception.**

Technical Support

The FR fabric manufacturer should offer technical assistance from professionals with experience and an in-depth understanding of the FR engineering process, textiles and end-use applications.

- Westex has the most experienced technical staff in the industry. Westex's continuous involvement in industry committees spans several decades. These committees have created standards to protect workers from electric arc flash, flash fire and molten metal splash exposures. Westex's technical staff has conducted thousands of tests at independent laboratories to measure the performance of FR fabrics to these hazards. Customers and end users are invited to attend this testing to see the exposures live.

Production Capacity and Inventory Support

The FR fabric manufacturer should be committed to the business and should have adequate production capacity to accommodate the demands of the market. Since the timeline to produce FR fabrics is extended, the manufacturer should commit to adequate levels of inventory to properly service the market.

- Westex has a proven track record of providing a high level of service to the market. Westex has a significant amount of additional production capacity that can be utilized when demand increases. In addition, Westex carries large volumes of several hundred different items in stock and over 90% of all orders are shipped within two days.

FR *Fabrics*—What to Look For

There are many "unseen" details that go into the production of flame resistant cotton and cotton blend fabrics. This starts with the production of the base material, dyeing, preparation, FR engineering process, internal laboratory testing, external laboratory testing and market support all the way to the proven performance of the FR fabric in the market. The following will identify some of these unseen details:

There are many "unseen" details that go into the production of flame resistant cotton and cotton blend fabrics.

Base Material- "Greige Goods"

Specifying the proper greige goods and receiving consistent quality from the mill can improve the wear life and ultimate value of a program.

- UltraSoft® and Indura® are produced with high strength ring-spun yarns, which are woven to strict custom-engineered specifications. Westex's specifications for the construction of the base fabric were designed to work well with the Westex engineering process and optimize wear performance. UltraSoft® fabrics contain a very specialized high tenacity nylon fiber that has excellent abrasion resistance properties. The weave is engineered to focus this excellent abrasion resistance on the surface of the fabric to optimize garment wear life.

High quality greige goods being processed.

Fabric Preparation

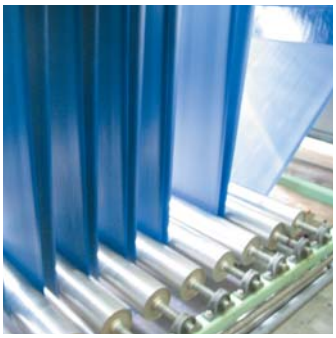
Flame resistant cotton fabrics must be properly prepared to ensure that the fabric is in its optimum state for further processing.

- Westex employs advanced proprietary fabric preparation steps that specifically prepare the fabrics for this process.

The Dyeing Process

Utilizing the proper dyes on a consistent basis will optimize qualities, like lightfast and colorfast performance and dye retention.

- UltraSoft® and Indura® fabrics are dyed using the highest quality dyes available for cotton fabrics to assure optimal lightfast and colorfast performance on a consistent basis.

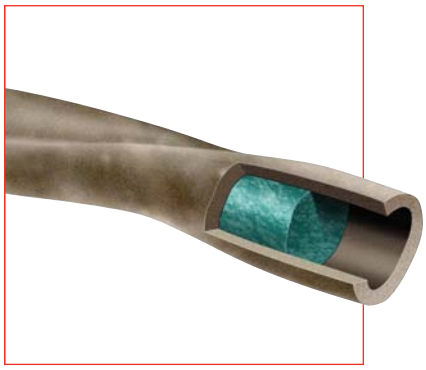


Westex utilizes custom-engineered equipment to produce UltraSoft® and Indura®.

FR Engineering Process

As previously mentioned, there are a several different finishing technologies available to produce FR cotton and cotton blend fabrics. The most advanced process publicly available for durable FR cotton finishing is the ammonia cure system, which is being utilized by several textile finishers globally. The technology and application of the ammonia cure system can vary significantly from finisher to finisher.

- Although the foundation of Indura® utilizes an ammonia cure system, the proprietary multi-step Westex finishing technology represents a significant advancement over the standard "out-of-the-box" ammonia cure system that is being used by textile finishers all over the world. Westex's original ammonia cure product, Proban®/FR-7A®, which was introduced in the 1970's, utilizes this "out-of-the-box" system. Westex only guarantees the flame resistance of Proban®/FR-7A® for 25 industrial or 50 home launderings,



The engineering process for UltraSoft® and Indura® flame resistant fabrics forms a long-chain flame retardant polymer impregnated into the core of each cotton fiber.

which is typical of "out-of-the-box" ammonia cure finishes. Because of the critical nature of FR protective clothing, which is designed to protect and save lives, Westex does not believe that this type of "out-of–the-box" technology is sufficient to support a guarantee of flame resistance for the life of the garment. The details of the Westex engineering process are proprietary but, in part, it involves a special fabric preparation process, custom-engineered equipment, several additional steps in the multi-step FR engineering process, computer monitoring equipment and extensive laboratory testing. These additional advanced processes lead to our ***guarantee of flame resistance for the life of the garment*** in either home or high temperature industrial laundry systems. This guarantee has been proven in the marketplace where millions of garments made from the Westex product line have been installed in successful protective clothing programs for nearly two decades.

The Westex technology involves a special fabric preparation process, custom-engineered equipment, several additional steps in the multi-step FR engineering process, computer monitoring equipment and extensive laboratory testing.

Fabric Softening

Flame resistant finishing can lead to a stiffer feel than that of non-flame resistant fabrics. Improperly softening fabrics could have detrimental effects on physical characteristics and garment wear life.

- Westex's proprietary multi-step fabric softening process involves a unique balance of chemical and mechanical procedures that have no negative effect on the strength or flame resistance of the material, which results in optimal wear life performance on a consistent basis. The advanced Westex technology provides dramatically improved softness and comfort.

Shrinkage Control

It is very important to achieve consistent shrinkage performance when processing flame resistant cotton and cotton blend fabrics. Fabrics that are not properly pre-shrunk can significantly reduce the wear life and value equation of the clothing. There is a safety issue as well, because garments that exhibit excessive shrinkage may not be worn properly or may not be worn at all.

Westex's double-shrunk technology represents a major improvement in the progressive shrinkage that cotton garments experience throughout their life and it is far superior to any other process utilized today.

- Westex's proprietary double-shrunk shrinkage technology was developed in 1997. This technology represents a major improvement in the progressive shrinkage that cotton garments experience throughout their life and it is far superior to any other process utilized today. This advanced double-shrunk technology is engineered into every yard of UltraSoft® and Indura® fabric.

Internal Laboratory Testing & Documentation Procedures

The testing procedures of flame resistant cotton and cotton blend fabrics are demanding. The testing must be conducted on a consistent basis, which includes sampling at numerous intervals throughout each production lot. This is especially important if the finisher does not possess computer equipment on the FR finishing line to monitor the consistency of the application. With FR fabrics the quality and consistency of the flame resistant finish should be the primary focus.

In the event of an arc flash, flash fire or molten metal splash accident, a comprehensive laboratory report and retained samples of the production lot must be readily available. This is a necessary step in accident investigations. Other basic textile characteristics, such as fabric shrinkage, breaking and tearing strength, construction, weight, and other factors must be tested and documented as well.

- Westex has a government-certified laboratory with a full staff of experienced technicians who administer a full battery of tests, including flammability, full physical properties and shrinkage on samples consistently throughout each production lot of UltraSoft® and Indura® fabrics. Westex verification testing involves both physical testing, as well as computer controlled monitoring. These reports, along with retained samples from the lot, are filed in Westex's laboratory and available for inspection.

Westex quality control station.

External Laboratory Testing

The critical nature of flame resistant protective clothing fabrics requires that extensive testing at independent laboratories be carried out to evaluate the protective capabilities these fabrics exhibit when exposed to electric arc flash and flash fire hazards. Kinectrics (for electric arc flash) and the University of Alberta (for flash fire) are examples of independent laboratories that specialize in testing fabrics for performance from these hazards. In addition, end users may want to analyze the performance of FR fabrics for their specific hazard potential. This is common in molten metal applications and one large electric utility company actually conducted electric arc flash evaluations for their unique situation.

The critical nature of flame resistant protective clothing fabrics requires that extensive testing at independent laboratories be carried out.

- Westex has committed a large annual budget on an ongoing basis, dedicated to independent testing at Kinectrics to fully evaluate electric arc flash performance and at the University of Alberta to fully evaluate flash fire performance of UltraSoft® and Indura®. In addition, a large electric utility company conducted an exhaustive series of electric arc flash tests in both enclosed and open-air environments at KEMA Laboratories. After investing several years and several million dollars in testing to analyze flame resistant fabric options, they specified UltraSoft® and Indura® fabrics for their FR protective clothing program. Please contact Westex if you would like information concerning this testing.

Independent Testing Laboratories

For Electric Arc Flash:

KEMA

&

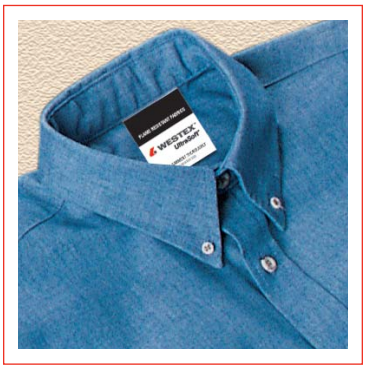
KINECTRICS

For Flash Fire:

UNIVERSITY OF ALBERTA

Market Performance

Since the finishing process for flame resistant cotton and cotton blend fabrics is so complex, there are many unseen variables that, if not properly handled, can cause serious problems and lead to significant additional costs downstream. Therefore, any information about the proven performance of the product in the field should be closely analyzed. If market information does not exist, extensive trial evaluations should be conducted, in the form of both wear testing and thorough investigation of producers' plants, processes and laboratories as previously mentioned. In order to obtain viable information from a trial, most companies, particularly industrial laundries, prefer to install garments into an actual program and monitor the status as the program develops. It typically can take three to five years to acquire some useful information to formulate an opinion on the potential value equation.



LOOK FOR THE LABEL!

- Westex's original Indura® 100% cotton fabrics were introduced in 1987 with a ***guarantee of flame resistance for the life of the garment***. Since the introduction of Indura® fabrics, millions of garments have been incorporated into successful protective clothing programs worldwide. Indura® is a proven product in the marketplace. In 1999, UltraSoft® 88% cotton, 12% high tenacity nylon blend fabrics were introduced. Since the introduction of UltraSoft®, millions of garments made with UltraSoft® have been successfully installed and maintained in companies in many different industries, including heavy and light industrial (for NFPA 70E compliance), electric utilities, oil and gas refineries, chemicals, pharmaceutical, molten metal, wildland firefighting, and many more. UltraSoft® has a proven track record of providing an excellent balance of protection, comfort and value.

Summary

The technology to produce durable flame resistant cotton and cotton blend fabrics is extremely complex. There is much more involved in building a market-proven brand then simply applying a flame retardant chemical. It starts with the experience, knowledge and capabilities of the company that stands behind the brand and progresses all the way through the engineering technologies that are built into the product and the proven performance in the market. Many end-user companies make significant investments in flame resistant protective clothing programs to protect their employees against electric arc flash, flash fire and molten metal splash hazards. Although the style and construction of the clothing plays a role in protection, the FR fabric used to construct the garment is a critical factor in determining the amount of protection it will afford the wearer. The fabric is also a major factor in determining the comfort, durability and overall value equation of an FR protective clothing program. Therefore, it is imperative to fully investigate the fabric options that are available and, after a decision is made, **the FR fabric you've selected should be specified by brand name. In addition, it is important to require that the fabric manufacturer's label be sewn into the garment for identification purposes.** This will help ensure that a future change to a generic/off-brand fabric that carries a marginally lower up-front investment doesn't lead to employee injuries, program dissatisfaction or significant additional costs downstream.

UltraSoft®

Indura®

There is much more behind a market-proven brand than a name. With millions of garments in service worldwide for nearly two decades, UltraSoft® and Indura® fabrics have a strong reputation for providing an excellent balance of protection, comfort and value. In addition, Westex, established in 1919, stands behind every yard of UltraSoft® and Indura® sold. Westex has over a half a century of experience finishing flame resistant fabrics. This experience has helped Westex build the most advanced technology, systems, equipment and technical staff in the business.

When safety is involved, the brand matters!

WESTEX™

A WORLD LEADER IN FLAME RESISTANT FABRICS

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