A Survey of Standards for the U.S. Fiber/Textile/Apparel Industry

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A SURVEY of STANDARDS for the U.S. FIBER/TEXTILE/APPAREL INDUSTRY

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ABSTRACT

This report documents a survey of standards relevant to the U.S. Fiber/Textile/Apparel (FTA) industry. The standards are discussed in four main groups—integration standards, test methods, quality standards, and standard reference data and materials. The Appendix of the report lists the titles of all standards found, grouped together by the organization responsible for them. Those organizations are also listed along with contact information for them. The report attempts to bring together useful information concerning FTA standards as a starting point to support the industry in intelligently planning future standards' development efforts.

KEYWORDS

apparel, fiber, integration, quality, specifications, standards, test methods, textile
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1 INTRODUCTION

The Fiber/Textile/Apparel (or FTA) industry is one of the largest manufacturing industries in the United States. It employs over one and a half million people, accounting for ten percent of all jobs in the U.S. manufacturing sector. Apparel and textile products shipped each year are worth well over one hundred billion dollars. The success of the FTA industry in the United States is critical to the economic well-being of our country.

However, in the last decade, the FTA industry's domestic markets, which are key, have been seriously eroded by foreign imports. As a result, hundreds of thousands of jobs have been lost over the past ten years and new job opportunities have been missed as well.

The American Textile Partnership (AMTEX), initiated in mid-1992, is a collaboration of industry research consortia and academia working in conjunction with the U.S. Department of Energy (DOE) national laboratories, to provide assistance to the U.S. FTA industry to recover its domestic market share and enhance its global competitiveness. In June 1995, the National Institute of Standards and Technology (NIST) in the U.S. Department of Commerce (DoC) officially joined the AMTEX collaboration. The survey described in this report is the first effort undertaken by NIST in the AMTEX effort. The goal of the survey is to help identify the standards that apply to the entire FTA industry.¹

1.1 Purpose

The survey is intended to benefit the Demand Activated Manufacturing Architecture (DAMA) Project, one of the key AMTEX projects. The main goal of DAMA is to reduce the long cycle time that it takes for a product to ultimately work its way through the "apparel pipeline"—from fiber production to an apparel product on the retail shelf. The long cycle time costs the industry an estimated $25 billion a year due to stockouts, inventory, and distressed pricing. The goal of DAMA is to greatly reduce that loss by improving the efficiency of information exchange throughout the pipeline and enabling effective action as a result of that information. Understanding what standards apply throughout the pipeline should be useful to that effort.

This paper reports on the results of that survey. It identifies standards related to the FTA industry, identifies and describes the organizations responsible for approving those standards, and directs the reader to the appropriate sources for further information.

¹AMTEX identifies the FTA industry by the term "integrated textile complex," and has coined the acronym, "ITC."
1.2 Scope

The survey covers both national and international standards and standards organizations involved with and relating to the fiber, textile, and apparel industries. This includes industry standards, which make up the majority of the standards found, as well as any specifications issued by the government (such as the MIL-series). This report focuses on standards that are currently in effect, although past standards and current work may be mentioned to provide additional background and understanding.

There are many products of the fiber and textile sectors of the FTA industry that do not go through the entire life-cycle apparel pipeline (from fiber to textile to apparel to customer). Standards relating to fiber products that do not end up as textiles, but are rather used for industrial purposes, are included within the scope of this survey. Also included are fiber products such as rope or webbing, which do not eventually become part of a garment. In addition, any products that are fabricated from fiber and textile products are included. However, the main focus of this survey concentrates on standards used in the apparel pipeline.

1.3 Methodology

A general search of standards for the industry was accomplished through database searches as well as the use of other reference material. The sources used are listed in Appendix A. The approach was centered on determining the standards organizations for different sectors of the industry. The standards organizations are listed in Appendix B. After identifying the organizations, lists of their standards were obtained. The listings are transcribed for use in Appendix C. For the purposes of discussing the standards in the text, they were organized into four main groups.

1.4 Reader's Guide

Section 2 provides an overview of the different groups for the standards that were found. Sections 3 through 6 describe each group of standards in greater detail. Section 7 concludes the main text of the paper with a brief summary.

Following the text are five appendices—A, B, C, D, and E. Appendix A contains a list of references that are referred to in the text as well as additional references that are useful for further information. Appendix B identifies standards' organizations relevant to the FTA industry with a brief description of each and contact information. Appendix C lists the titles of the standards found over the course of this survey. The documents are grouped according to the standards organization responsible for each. Appendix D contains a glossary of terms related to the FTA industry. Appendix E is a brief list of acronyms used in the paper, intended for quick reference.

2 OVERVIEW OF FTA STANDARDS

Based on an examination of the types of FTA standards found (determined by looking at titles, content, and usage), standards were divided into four broad types. The standards are divided into integration standards, test methods, quality standards, and standard reference data and materials. Although divided for the purposes of discussion, standards listed in Appendix C are grouped by publishing organization.

The first group contains integration standards. These are standards which allow one system or activity to communicate with another. The types of communications may range from one machine
communicating with another on a shop floor to one company ordering materials or products from a supplier. Integration standards are covered in more detail in Section 3.

The second, and largest, group of standards found contains test methods and procedures. These are methods for testing properties of anything from raw fibers, to yarns, to woven fabrics, or even the machinery used to make textiles. The standards themselves are arranged in the form of an experiment format, with sections on materials, procedures, and observations. Properties determined by this group of tests range from the tensile strength of raw cotton fiber to a fabric's ability to resist fading or running (colorfastness). More detail about test methods can be found in Section 4.

The third group is quality standards. These deal with more functional properties of a finished fabric or apparel product. Quality standards specify how to determine if certain products are suitable for the application intended. The specification might cover the protective ability of a fireproof jacket, or the stitch spacing of a dress. The bulk of these standards are military specifications for combat apparel, but there are many important standards which apply to other areas. Section 5 discusses quality standards in greater detail.

The remaining group of standards consists of standard reference materials (SRM), standard reference data (SRD), and terminology. An SRM is used to rate by direct comparison other data or materials for different applications. An SRD is a collection of numerical information accepted as accurate within a domain. For example, anthropometric data (body measurements of different types of people), is used by companies for apparel sizing (an example of SRD), and standard color or color change charts or samples are used in the apparel industry for direct comparison tests relating to colorfastness (an example of SRM). More detail can be found in Section 6.

Figure 1 (on page 4) shows the grouping used in this discussion. In the figure, the four broad groups of standards are each decomposed further to show the types of standards contained.

3 INTEGRATION STANDARDS

Integration is the process of unifying separate items, that is to make multiple objects (whether they be machines, computers, or entire sectors) act as if they were one unit. This is contingent upon accurate communication of ideas and information between the (different) parties involved. For this to occur, both parties must agree upon and use the same protocol, or "language." There are many accepted standards of communication for the multitudes of different interfaces existing in the FTA industry. These interfaces exist from one end of the FTA life cycle to the other, and the efficiency and effectiveness of the communication across these junctions has a major effect on the efficiency of the industry.

Since the area of integration is so important, special attention is needed here. Time delays between the different phases in the life cycle are due most directly to ineffective communication. These delays (manifested in the need to keep large inventory) are responsible for $25 billion being lost annually. The loss occurs through markdowns, stockouts, and inventory maintenance. The other result of lack of integration is that the FTA industry as a whole cannot respond to demand directly, but rather must anticipate it, a less desirable situation.

This section will discuss integration standards that are in existence now, as well as describe some standards that are under development. Some of the most important work is still underway, so special attention will be given to these up-and-coming protocols. Division of the integration-related standards is done by what type of interface is affected. The three processes discussed are business transactions, automated manufacturing, and product data exchange.
3.1 Business/EDI Transactions

Put simply, electronic data interchange (EDI) is the process of conducting business electronically, rather than by paper. Communication occurs between two computers, rather than between two people\(^2\). This includes many different types of transactions, such as placing orders, transferring funds (payment), and confirming receipt of goods. Although the task of creating electronic protocols to replace all the different (paper) forms used in various kinds of businesses is daunting, the benefits in terms of efficiency, accuracy, and ability to trace make it more than worthwhile.

\(^2\) Shaw, p. 5. 1994.
Because the information is transmitted rather than mailed, EDI is faster than the traditional paper method. Since the "forms" don't have to pass through as many different sets of hands, danger of an order being miswritten, misplaced, or permanently lost is almost completely eliminated. And lastly, electronic transmission allows one to trace the history of a form, a feature not always available with normal mail.

Although EDI began in the 1960s, standards development didn't begin until 1978, when the American National Standards Institute (ANSI) founded the Accredited Standards Committee (ASC) X12. This organization was chartered with the responsibility of creating transaction sets (protocol for a specific business exchange) for electronic commerce. X12 grew over time and has established over two hundred different transaction sets through more than a dozen subcommittees. Although these standards have been very widely used in North America, most industries have found it necessary or desirable to modify the basic transaction sets in different ways to better suit their business.

The international EC/EDI effort is known as the United Nations Electronic Data Interchange for Administration, Commerce, and Transport (UN/EDIFACT or just EDIFACT) standard. UN/EDIFACT came about with the merger of the original EDIFACT with the United Nations Trade Data Interchange (UN/TDI). This standard has often been seen as a competitor to X12, though in fact their methods of organization and design rules are quite similar. By the very nature of EDI only one protocol can be used, unless the two are somehow made compatible. For this reason, ASC X12 announced a deadline for converting to the international standard. This was initially set for 1997, but was later extended to at least 1999, pending a poll of EDI users that will be conducted the same year as the original deadline. As part of the EDIFACT initiative, the International Organization for Standardization's (ISO) Technical Committee (TC) 154 developed some syntax rules, which were first published in 1988. They have since been revised.

In the FTA industry, EDI standards work can be divided into three domains: textile, apparel, and retail. The Fabric and Supplier Linkage Council (FASLINC) was established to adapt X12 standards to the specific needs of textile companies and their suppliers (in the fiber sector). This is accomplished mainly by inserting textile-specific codes into existing transaction sets, but a few new transaction sets were actually developed by FASLINC and approved by ASC X12. FASLINC as an entity was discontinued and its standards and responsibilities were transferred to the Apparel Textile Manufacturers Institute (ATMI).

The Textile Apparel Linkage Council (TALC) and the Sundries and Findings Linkage Council (SAFLINC) promote and develop electronic commerce standards for clothing manufacture. Founded in 1986, TALC is responsible for interactions between fabric suppliers and apparel companies. SAFLINC handles business with the suppliers of non-textile materials needed for garments, such as zippers and buttons. These two organizations were merged to form TALC/SAFLINC, which is now part of the American Apparel Manufacturers Association (AAMA).

There are several EDI standards used in the apparel-retail sector. The Uniform Communication Standards (UCS) began development in the early 1980's for use by the grocery industry, but has

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since been expanded in its scope and application\textsuperscript{7}. It consists of about thirty transaction sets, as well as the stated protocol of using the public phone system with a modem speed of 4800 or 9600 baud. The Warehouse Information Network Standard (WINS) consists of seven transaction sets for that aspect of retail. The emerging standards for use by all types of merchandising industries is the Voluntary Interindustry Communication Standard (VICS). VICS is a subset of ANSI X12 pertaining specially to retail. The domains for UCS and VICS overlap. For more information on any of these standards, contact the Uniform Code Council at the address and number listed in Appendix B.

3.2 Manufacturing Automation

Much of the manufacturing of textiles is automated. Monitoring and control of the many different machines present on the shop floor can require a lot of people, in the worst case one per machine. Although most of the machines don't require constant monitoring or input, setting them up or changing a weaving pattern, for example, can take a lot of time. Even shutting down a machine often requires a long process, and can be dangerous if there are personnel in the wrong places on the shop floor. This is important because utility companies commonly offer textile manufacturers significant saving on their electricity if they can shut down power in a short span of time (this reduces the peak load and keeps the power company from switching to less efficient back-up generators).

Integrating the manufacturing process allows an entire shop floor to be run from the convenience (and safety) of one central control booth. This can only take place if all the machines are compatible with the controller and each other. Presently, companies making textile machinery use proprietary methods of storing and communicating information such as speed of a process or error warnings. As a result, these machines can only be integrated with others made by the same company—an inconvenience for textile manufacturers who may already have other equipment. If the makers of textile machinery adopted voluntary standards for shop floor data, CIM for textiles would be much easier to achieve.

One of the major proponents of computer-integrated manufacturing (CIM) for the FTA industry is ATMI. To aid in the development of voluntary standards, ATMI is working on a dictionary of data elements for control and monitoring of textile processes. The rationale is that in order to come up with a universal data set for a certain process, one must first identify all the different variables involved. This is being done in conjunction with ISO TC 72, and will be published in parts as ISO 10782. The first part covers spinning and related processes. At the present time, the dictionary contains over 100 variables that require attention, as well as definitions and a method of organization. It is currently in the draft stage and under committee review.

Also, the Apparel Research Committee (ARC) of AAMA has been developing standards related to CIM (as well as product data, which will be discussed in the next section), for apparel manufacturing. The first AAMA standard published and approved by ANSI is a modified version of Gerber Garment Technology, Inc.'s protocol for automated cutting machines\textsuperscript{8}. A second standard of AAMA deals with pattern data interchange (PDI)\textsuperscript{9}. The PDI standard also pertains to interfacing computer-aided design (CAD) systems with computer-aided manufacturing (CAM) systems. Work is in progress on a standard for NC stitching machines and a CIM architecture standard\textsuperscript{10}.

\textsuperscript{7} Uniform Code Council, p. 2. 1994.
\textsuperscript{8} ANSI/AAMA-001-1992 : "Standard for Numerically Controlled Cutting Machines."
\textsuperscript{9} ANSI/AAMA-292-1993 : "Standard for Pattern Data Interchange - Data Format."
\textsuperscript{10} AAMA. 1995.
3.3 Product Data Exchange

Product data includes information from every stage in the life cycle of a product. This extends from initial design through manufacturing, shipping, and even recycling of the product. A standard for product data has as its goal the accommodation of all the computer interfaces a product will encounter, thus integrating the life cycle. The benefits include independence from any particular software tools (such as a certain CAD system); continuity of data (same format of information can follow the product through the different stages of its life); and the ability to communicate a neutral data format between different departments, sectors, and even industries.

The international standard for development of total product data is called STEP (standard for the exchange of product model data). It is being developed in conjunction with ISO by TC 184/SC 4. STEP is being published (in many parts) as ISO 10303. Parts of STEP that have already finished the approval process include standards relating to drafting and design. At the present time, there are over forty more ISO 10303 parts in some stage of planning, development, or approval.

STEP is an open methodology and framework for the development of product data models and specifications. STEP uses a language for modeling information that is known as EXPRESS\(^{11}\). Within STEP, Application Protocols (APs) are created that specify the product information requirements within the scope of particular applications. In addition to these APs, a large amount of generic information, applicable to various kinds of products and applications, is used. This saves the AP developers from redundant effort. Each AP contains a number of important elements, including a scope for the AP, application reference model (ARM) which describes the information requirements and constraints in the terminology of that particular domain, application interpreted model (AIM) that is a representation of the ARM in terms of STEP constructs,\(^{12}\) and methods for testing conformance of an implementation of the standard (conformance testing, abbreviated as CT).

The effort to extend STEP to apparel product data has been undertaken by the Apparel Product Data Exchange Standard (APDES) project at NIST. This project is funded by the Defense Logistics Agency (DLA) which is interested in streamlining the process of contracting uniform design and manufacture through adoption of integration standards; and improving garment fit by replacing the traditional ready-to-wear sizing with a made-to-measure system.

A prototype AP (to be used as a straw man for an official ISO STEP AP and containing all the parts of an STEP AP except for the AIM) for ready-to-wear pattern making has been under development at NIST. The AP covers ready-to-wear pattern making, focusing on the "representation of two-dimensional (flat) patterns generated by the traditional ready-to-wear pattern making and grading method."\(^{13}\) A prototype AP for made-to-measure pattern making is also under development. The ultimate goal, of course, is to incorporate all information that describes an apparel product in terms of STEP.

Other work related to apparel product data is being done by AAMA/ARC. As mentioned earlier, ARC has published an apparel pattern data interchange standard approved by ANSI. This standard is based largely upon the Drawing Interchange file format (DXF) developed by AutoDesk™, Inc. for their AutoCAD® product\(^{14}\). In addition to continuing research, ARC is tasked with promoting

\(^{11}\text{Schenck. 1994.}\)
\(^{12}\text{Lee & Moncarz, p. vi. 1994.}\)
\(^{13}\text{Lee & Moncarz, p. iii. 1994.}\)
the move towards CIM standards within the apparel community and identifying technologies that will enable the U.S. apparel sector to become more competitive globally. Current product data work includes developing implementation guidelines for the pattern data interchange standard, a standard for grade rule table exchange to support the pattern data exchange standard, and a plotter data exchange standard.

The area of integration standards is one that seems to warrant special attention by those in the FTA industry, especially in the apparel sector, where losses to foreign competition are greatest (due to intensive labor requirements). A large portion of the apparel sector is made up of small and medium-sized companies who lack the resources to develop their own standards and protocols. Potential exists for increasing efficiency through integration and automation standards development (and implementation).

4 TEST METHODS

In order for an industry with hundreds of suppliers selling (what is supposed to be) the same product to hundreds (or even thousands) of buyers, standards are needed to insure that products of the same type are uniform (and to rate goods based on their quality). FTA is such an industry, where multitudes of cotton growers and wool farms sell tens of thousands of tons of raw fiber to the fabric manufacturers who, in turn, sell many bolts of colored fabric to the apparel manufacturers. It is absolutely essential that the apparel sewers, who produce the end product, have materials to work with that are of high and consistent quality.

At virtually every step in the transformation of raw fibers to finished apparel, inspections are made and tests are done. Specific physical (and sometimes chemical) properties of the fiber, or textile, or apparel are tested to insure that they meet the requirements of the manufacturer and its buyers. It is important that each company uses the same tests for the same property, so that the results can be interpreted consistently by those working with the manufacturer and their customers. To this end, standards organizations are formed and standard test methods and procedures created and published.

Most test methods consist of three main sections: purpose and scope, procedure, and evaluation method. The purpose and scope describe exactly what property is to be tested by the method and to what type or types of fibers or fabrics or yarns it pertains. The procedure section is at the heart of the test, and explicitly describes what steps to take in order to perform the test. The procedure details what supplies, chemicals, or special equipment to use and how to use them. Lastly, the evaluation section tells the tester what exactly to look for in rating the particular property being observed and very often refers to a control sample or a standard reference system, such as the American Association of Textile Chemists and Colorists (AATCC) Chromatic Transference Scale.

Test methods apply to the fiber and textile segments of the industry, but in general not the apparel sector, as the physical properties that can be tested completely objectively have already been taken care of. Evaluation of finished apparel garments are done by means of quality standards and specifications, which are covered in a later section. Test methods relating to the fiber and textile sectors of the FTA industry are described in turn below.

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16 AAMA. 1995.
4.1 Fibers

The fiber sector harvests raw natural fibers (or produces raw man-made filaments) and sells these fibers to the textile sector. The most basic properties of these fibers (and filaments) need to be known by both sectors. To this end, many tests are performed and their results recorded. The main properties of interest include length and length distribution, strength and elongation, maturity, and adhesion to other materials, such as steel or rubber. These properties are important because they directly relate to how the fibers will act during the spinning process.

The tests used for fibers and textiles are created and published by two main organizations. They are the American Society for Testing and Materials (ASTM), and ISO TC 38. With respect to leather goods, the American Leather Chemists Association (ALCA) publishes standards, as does ISO. Approximately 90 of ALCA’s 140 or so test methods have been adopted by ASTM. These organizations play a key role in the development of standards. Since they are independent of any particular company, their standards are used throughout the sector. Having external standards also saves each grower or distributor from having to develop and adopt its own standards, which wouldn’t be universal anyway.

Although some of the test methods apply to all types of fibers, most are specifically targeted at one type each. This is due to the intrinsic differences between man-made and natural fibers, and the further differences between cotton and wool (the natural fibers used most often). So, although the properties being tested are limited in number, the number of test methods are proliferated by the variety of fiber types.

4.2 Textiles

The business of the textile sector is to take raw fibers and filaments and convert them into fabrics which can then be sewn into garments. This process involves three main steps. In the first, the yarn manufacturer prepares the fibers or filaments (through carding, drawing, and roving), spins it into cones of yarn, and then winds the yarn onto spools. During the second stage, the slashing plant chemically treats the yarn, preparing it for the next step. The last, and most involved process is accomplished at the weaving plant. The yarn is woven (or knitted) into fabric first. After that, the fabric is prepared, dyed, and finished. Lastly, the fabric is cut for shipping to the garment sewing plants.

Throughout this process numerous checks are made. After every major step of the fabric manufacturing process, at least a visual inspection is done. Test methods applying to textiles are concerned with a wide range of features. These include strength, flammability, creasing, and dimensional change due to different environmental factors. The property that is most thoroughly tested is colorfastness. The importance of that particular behavior of a textile is shown in that almost half of ISO’s 114 standards related to fabrics deal with colorfastness.

There are a few organizations that publish test methods for textiles. At the national level, AATCC and ASTM both make standards. ISO TC 38 publishes standards, including test methods, on the international level. As its name implies, AATCC is most concerned with chemical and biological properties of fabrics and colorfastness, though some physical properties are covered. ASTM tests are very physical in nature, dealing with aspects such as abrasion resistance, moisture, and mass. There are many more tests applying to textiles made by AATCC than by ASTM. ISO tests are dominated by tests for colorfastness, since many of the other textile-related standards are reference information and not test methods.
5 QUALITY STANDARDS

A major part of the body of standards which affect the FTA industry are general quality standards or specifications. Unlike the integration standards and the test methods, quality standards are concrete expectations for a finished product of a certain type. The expectations conveyed through the document vary in content from flammability (such as a fireproof coat) to appearance, and vary in detail from a general durability specification to a military standard for a uniform specifying every design particular.

Quality standards are used for many different products in the FTA industry. In most cases, the standard applies to high-level concepts in a finished product, rather than minute details. For instance, there are not many quality standards applying to raw fibers, since examining most of the properties of those fibers require specific tests. In keeping with the organization philosophy, the quality standards have been sectioned on the basis of their area of application. The major areas of interest are general apparel, special and protective clothing, military specifications, and textile manufacturing machinery.

5.1 General Apparel

The majority of garments which are manufactured are sold to retailers who in turn sell them through stores. The success of the apparel sector, and to a large part the whole FTA industry, is determined by whether people, especially those in the United States, buy the clothes that the garment companies sew. It is of paramount importance that the garments put on the shelf be of consistently high quality, and it is in the interests of the manufacturers to minimize the number or seconds that cannot be sold for full price.

There are many standards used to ensure that garments sold to a customer satisfy minimum quality as defined by those standards. Most manufacturing and also retail companies have their own inspections, but national and international specifications do exist. These are written by ASTM on the national level. ASTM has about fifty performance specifications, each applying to a different type of apparel, such as knitted overcoat fabrics for men and women\textsuperscript{18}, or swim wear\textsuperscript{19} fabrics. In addition, some smaller apparel manufacturers and retailers adopt the inspection criteria of large, established companies such as J.C. Penny, Inc., making such procedures \textit{de facto} standards.

It is important to note that most of these specifications are standards of quality for the fabrics used to sew the garments. They insure that the clothing made will meet some basic standards of durability and, in some cases, fit. ASTM publishes several standards relating to fit, as opposed to the fifty or so fabric-related performance specifications mentioned earlier. The manufacturers and designers of clothing who use these standards still have the ability to make whatever they want, provided the material it is made from meets the specifications they have voluntarily adopted. In the end, it is beneficial for fabric manufacturers to use these quality standards so potential customers in the apparel sector will know that they are not buying shoddy materials.

5.2 Special/Protective Clothing

The area of special and protective clothing is one of the most sensitive to quality. This is for the obvious reason that the consequence of product failure is often injury to the wearer of the garment.

\textsuperscript{18} D 3562 - 92 (ASTM) : "Performance Specification for Men's and Women's Sliver Knitted Overcoat and Jacket Fabrics."

\textsuperscript{19} D 3994 - 94 (ASTM) : "Performance Specification for Men's, Women's, and Children's Woven Swimwear Fabrics."
(This is much worse than merely inconveniencing or alienating a customer, the result of general apparel defects.) For this reason, quality standards must be more demanding and much less tolerant of deviations. As a result, the field of protective clothing has a relatively large number of fairly specific quality standards and specifications associated with it.

Standards relating to protective and other special clothing can be differentiated on the basis of what exactly the garment they relate to is intended to do (or in most cases prevent against). Special clothing is needed for use in a variety of hazardous environments; it may protect against electricity, chemicals, fire, or even cold. Because of the large number of fires and firefighters, fire-protective clothing is probably the most common protective clothing, though electrically insulated and chemical-protective clothing are very important in their respective industries.

Specifications for special clothing are published by ISO TC 94 on an international level. The National Fire Protection Association (NFPA) writes national requirements for protective clothing for fighting fires. There are many other standards that relate to protective clothing which are not quality standards, but rather test methods applied to the fabric from which these garments are made. These standards are published primarily by ASTM and ISO.

5.3 Military Specifications and Standards

The U.S. Armed Forces are probably the largest single customer for apparel made in the United States. The Department of Defense (DoD) spends hundreds of millions of dollars every year purchasing uniforms and other textile-based equipment. The consistent quality of garments purchased is highly valued by the military, more so than in the civilian market. In addition to the uniforms looking the same, they must meet strict requirements for durability and reliability, since many of them are ultimately intended for combat. It is also important that the clothing is functional and easy to wear under a wide variety of conditions. To insure the consistency, toughness, and utility of their uniforms, DoD publishes specifications generally referred to as the "MIL-" standards or specifications.

There are over 600 MIL-specifications that detail the requirements of specific apparel and textile-related products and a dozen or so MIL standards that detail the requirements of a category of apparel and textile-related products. These specifications vary greatly in content. On one side of the spectrum, quality standards exist that cover all uses of certain fabrics or textiles in military equipment\textsuperscript{20}. At the other extreme, some MIL-specifications are detailed requirements for the making of a certain garment\textsuperscript{21}. There are also a substantial number of standards that involve textile products other than apparel. Examples of this would be fabric hoses and life preservers. Since these are still products of the FTA industry as a whole, they have been included within the scope of this survey.

Military specifications follow a specific format. Each has six sections—scope, applicable documents, requirements, quality assurance provisions, packaging, and notes. The scope section specifies exactly what the document applies to, for instance a polyester/cotton broadcloth durable press shirt.\textsuperscript{22} The next section lists other documents that the manufacturer must adhere to in making the garment. These include federal and other military specifications and standards, as well as test methods published by private organizations such as AATCC and the American Iron and Steel Institute (AISI)—for steel rings, zippers, and fasteners. The third section details expectations, while the fourth section explains how those requirements are to be verified. The

\textsuperscript{20} MIL-C-429A : "Cloth, Twill, Nylon."
\textsuperscript{21} MIL-C-1509H : "Coat, Food Handler's (Steward)."
\textsuperscript{22} MIL-44041C(GL) : "Shirt, Man's, Short Sleeve, Polyester Cotton, Army Green 415, Durable Press."
packaging section is self-explanatory. The last part of every MIL-specification contains information of a general or explanatory nature that may be helpful, but is not mandatory.

The current system of military specifications is designed to insure total uniformity. Every detail of the sewing process is dictated. There are typically a dozen or more other documents referenced in each MIL-specification. The reference to each consists only of the name and number of the standard. No indication is given to the manufacturer of where to find the information that pertains directly to the making of the garment. Unless the scope of the item referred to is very narrow, this can make it difficult for the contractor to comply. Companies are left to search a possibly very large document from cover to cover to find what might be a very small section applicable to their product.

At the present time, proposals are being made to use commercial specifications because they are simpler. The format for the new series is known as a commercial item description (CID). The main difference is that the new format will specify what is desired, and allow the contractor to make it in the most efficient method available. Previously, the MIL-documents gave exact instructions for making the item, which placed sometimes unnecessary demands on the companies contracted to do the job. In addition, some of the specifications will be given in terms of performance, rather than requiring a certain material, giving the maker leeway in choosing the most desirable way to meet the requirements. This will make the process of procuring uniforms faster and more efficient.

5.4 Textile Machinery

The process of making textiles from fibers and filaments is almost completely done by machine. Setting up and loading the equipment is still often done manually, but the actual spinning, weaving, etc. is done automatically. Therefore, the sector depends on these devices consistently working in the proper manner. Standards are used to insure the safety and reliability of textile machinery.

The primary publishers of specifications for textile machinery are ISO TC 72 and ASTM. Most of these documents apply to key pieces of the machines, such as the rings and travelers on ring spinning machines23, or the cones for yarn winding24. There are also a good number of standards which give definitions and terminology relating to different types of textile equipment. These will be discussed in the next section.

6 STANDARD REFERENCE INFORMATION

Standard reference information is necessary in any field where uniformity and consistency is important. This information makes repeatability possible by providing accepted standards that can be used for comparison purposes and computation purposes. For example, AATCC has a standard table for gray-scale color change25. This table is intended for use with the test methods they developed. Use of that table insures that the evaluation given to the textile will not depend on the tester, but rather be objective (with respect to the AATCC standard). The test results will also be reproducible.

24 ISO 111:1978: "Textile Machinery and Accessories — Cones for Yarn Winding (Cross Wound) — Half Angle of the Cone 4 Degrees 20.''
Standard reference information can be divided into three categories: standard reference data (SRD), standard reference materials (SRM), and terminology. These are described below.

### 6.1 SRD

Standard reference data (SRD) refers to a collection of scientific or technical measurements, values, or facts that can be represented quantitatively. SRD is accepted as correct within a particular domain of expertise to be used as the basis of further calculations or decisions. A very simple example from the field of engineering is the assignment of the value for the constant \( \pi \). \( \pi \) is the ratio of a circle's circumference to its diameter, and its value can only be estimated to a specified level of precision. For the purpose of taking a test, students may be told to use the value of 3.14 for \( \pi \). Therefore, they should all get the same answer, and their answers should conform with the professor's solutions. Although simple and far removed from the FTA industry, this analogy illustrates both the nature of SRD and its significance.

It is easy to see the importance of these accepted values when the opposite scenario is considered. If there was no accepted value for \( \pi \), each student would make an independent best guess, or use whatever approximation the student felt appropriate. Some might use 3.14, others might extend it to five or six places, while a handful might just truncate the fraction and go with 3. More ambitious students might use string and ruler to measure the constant directly from a circular object. (Others might forget entirely and just guess 7.) Depending on what is being done with the number, the end results could be drastically different (and in some cases drastically wrong).

In the apparel industry, an important set of standard reference data are the different dimensions that make up size. To achieve a good fit, the apparel manufacturer needs accurate measurements of the human body. This is called anthropometric data. The first standard set of body dimensions was compiled by the National Bureau of Standards (NBS, now NIST) in the 1950's. In 1983, the Department of Commerce withdrew these voluntary standards. ASTM took over responsibility. The D-13.55 Body Measurement for Apparel Sizing sub-committee of ASTM has published standard tables of measurements for ladies\textsuperscript{26}, infants\textsuperscript{27}, and women over fifty-five\textsuperscript{28}. Sizing standards for children, men, and large women are in different stages of committee review. With the exception of the sizing for women over 55, all of these standard tables are based on the original anthropometric survey conducted by NBS. D-13.55 is currently trying to rally industry support to update the anthropometric survey to reflect the changing population of the country. Internationally, ISO TC 133 has an international standard of anthropometric data\textsuperscript{29} and sizing.

From surveys of body measurements, standards for actual sizing of garments are derived. NBS had developed close to twenty voluntary apparel sizing standards which it published in the late 1960s. These covered all the most common types of apparel, from shirts to gloves. Although girls and women were part of the anthropometric survey, there were no voluntary standards relating specifically to women's clothing. The NBS-sizing standards were withdrawn in 1983. On an international level, ISO TC 133 publishes ten standards relating to clothing size for both sexes. A bibliography dealing with apparel sizing was published by NIST in 1994\textsuperscript{30}.

\textsuperscript{26} ASTM D 5585 - 93. "Standard Table of Body Measurements for Adult Female Misses Figure Type Size 2-20."
\textsuperscript{27} ASTM D 4910 - 89. "Standard Table of Body Measurements for Infants, Ages 0 to 18 Months."
\textsuperscript{28} ASTM D 5586 - 94. "Standard Tables of Body Measurements for Women Aged 55 and Older (All Figure Types)."
\textsuperscript{30} Lee 1, 1994.
Although the NBS anthropometric data and sizing recommendations were valuable, some larger manufacturers have done work to improve the fit of their garments for their customer population. Of the companies in the U.S., Sears, Roebuck and Company, Inc. has the distinction of doing the most body size and clothing fit research. With the knowledge they have gained, they publish pages of details on sizing and fitting of garments. Although Sears has placed special emphasis on this in the past, reducing returns and increasing customer satisfaction through improving the way apparel fits remains a goal of all clothing manufacturers.

### 6.2 SRM

Standard reference materials are physical artifacts that are used for direct comparison with the sample being evaluated. The reference material is accepted as a standard for the property it exemplifies. SRMs are often used when dealing with qualitative aspects of an item, such as color or texture. ("Qualitative aspects," as used here, refers to those properties that are generally not measured by the industry directly due to technology limitations. For example, as technology advances, measurements of texture may be more scientifically conducted than by a comparison with known textures, as it is generally done in the textile industry today.) In order to have some degree of consistency and control over properties, the properties must be converted to a quantitative base. This is done by selecting an arbitrary point of reference which the property of a particular physical artifact exudes. Then samples may be measured relative to the "standard," consequently providing an objective measurement of the "qualitative" property.

Many, if not most, of the pertinent properties of fibers, textiles, and apparel are qualitative. However, many of these properties can be quantified through a certain method of testing. A few can not. As mentioned earlier, a large percentage of the test methods relating to the fiber and textile sectors relate to colorfastness. AATCC has developed scales for evaluating color change (mentioned before), as well as transference and staining reference standards. These SRMs are directly compared with the sample that has been through the test procedure (and also a control sample in tests relating to color change).

Another type of SRM which warrants mention is the model form. Model forms are actual molds of the human body used to check sizing for apparel. NBS made standard model forms for girls', boys', and toddlers' apparel of different sizes. These were developed in conjunction with the anthropometric survey discussed above in Section 6.1. Although these may be used for reference, apparel manufacturers have their own model forms for all types of people and sizes.

### 6.3 Terminology

The largest number of reference standards developed for the FTA industry relate to vocabulary and definitions. Standard terminology is very important because it facilitates communication. Since some words have multiple meanings, and there are many ways to describe or designate a certain object, discussion can often become obfuscated. Having precise definitions for key items and ideas in a field has always been the responsibility of that area's standards organizations. The FTA industry is no exception.

The task of publishing definitions and vocabulary on an international level has been undertaken by ISO. There are approximately forty-five ISO standards which define terminology for everything.

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from stitches$^{34}$ to fibers$^{35}$. Some of the standards which fall into this category deal with words, while a slightly smaller number define some physical aspect of a piece of equipment, such as which side is left and which is right$^{36}$. ISO's terminology standards are most heavily concentrated in the area of textile machinery, where there are many different types of machines, each with a plethora of parts that may need definitions to refer to them.

ASTM has written roughly fifteen standards defining terminology for the FTA industry. Over half of these standards deal with textiles (yarns and fabrics) and textile properties, while a smaller number deal with the textile manufacturing and apparel sewing processes. A few of the documents apply to labeling of apparel. There is a terminology specifically for wool$^{37}$, but not for the other fibers. This may be because wool requires a lot of processing before it can be spun into yarn. Dealing with plant fibers such as cotton and flax, is simpler. One standard of special interest to the apparel sector defines terminology for apparel sizing$^{38}$. Overall, these documents seem to cover a good portion of the industry.

7 SUMMARY

The primary purpose of this survey was to identify the standards that apply to the U.S. FTA industry. To compete effectively in the global marketplace, the FTA industry must operate as efficiently as possible. By developing and adopting new standards where they are needed, and improving existing standards where possible, many benefits in terms of reduced wait time and elimination of unnecessary effort can be realized by the industry as a whole.

As can be seen by a perusal of the appendix, the number of standards related to the FTA industry is voluminous. The intent of this paper was to bring together in one document a listing of the standards and standards' organizations associated with the FTA industry. That compilation represents a first step to determine where to concentrate resources on further standards' development.

Industry feedback is necessary to draw conclusions concerning the prioritization of future standards' efforts. For example, in what parts of the FTA manufacturing process are the current standards effective? What is it about those standards and the way they are implemented that makes them effective? Where does there seem to be a lack of unity in standards—where different standards are used by different people for the same purpose? The answers to these and other questions can provide insight into where standards are helping and where they are holding back the FTA industry, and how improvement of the standards can make the FTA industry more competitive.

$^{36}$ ISO 92:1976. "Textile Machinery and Accessories — Spinning Machinery — Definition of Side (Left or Right)."
APPENDICES

A REFERENCES


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39 Reports from the National Institute of Standards and Technology are available from the National Technical Information Service, Springfield, VA 22161.


B  FTA STANDARDS ORGANIZATIONS

The following is a list of organizations publishing and/or developing standards and specifications related to the FTA industry. This listing of organizations is intended to save time by bringing them together in one place. In addition to the contact information, a short description and sometimes notes are included beside each listing.

American Apparel Manufacturers Association (AAMA)  
2500 Wilson Blvd., Suite 301  
Arlington, VA 2201  
(703) 524-1864  
FAX: (703) 522-6741  
Sanctioned by ANSI\(^\text{40}\) to create standards for the apparel sector of the FTA Industry. Responsible for TALC/SAFLINC voluntary integration standards.

American Association of Textile Chemists and Colorists (AATCC)  
One Davis Drive  
P.O. Box 12215  
Research Triangle Park, North Carolina 27709  
(919) 549-8141  
FAX: (919) 549-8933  
Responsible for test methods and procedures relating to physical and chemical properties of textiles. Sanctioned by ANSI.

American Leather Chemists Association (ALCA)  
Tanners Bldg.  
University of Cincinnati-Loc. 14  
Cincinnati, Ohio 45221  
(513) 556-1197  
FAX: (513) 556-2377  
Publishes test methods for evaluating raw leather and leather products. Most standards adopted by ASTM.

American National Standards Institute (ANSI)  
11 W. 42nd Street, 13th Floor  
New York, New York 10036  
(212) 642-4900  
FAX: (212) 398-0023  
Sanctions standards from industry organizations in all fields for use on a national level.

American Society for Testing and Materials (ASTM)  
1916 Race Street  
Philadelphia, Pennsylvania 19103-1187  
(215) 299-5585  
FAX: (215) 977-9679  
Publishes standards covering many different materials. D-13 Committee responsible for textiles. Uses ALCA standards for leather.

American Textile Manufacturers Institute, Inc. (ATMI)  
1801 K Street, NW, Suite 900  
Washington, D.C. 20006  
(202) 862-0500  
FAX: (202) 862-0570  
Responsible for FASLINC standards.

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\(^{40}\) "Sanctioned by ANSI" means that many or most of the standards they publish are approved and adopted by ANSI as U.S. national standards.
International Organization for Standardization (ISO)
1, rue de Varembe
Case postale 56
CH-1211 Genève 20
Switzerland
+ 41 22 749 01 11
FAX: + 41 22 733 34 30

Standards relating to almost all fields. Members from 100
countries. 182 technical committees (TCs), 630 subcommittees. TCs
of interest include 38 - Textiles, 72-Textile Machinery, 94 - Protective
Clothing, and 133 - Sizing Systems.

National Fire Protection Association
One Batterymarch Park
P.O. Box 9101
Quincy, Massachusetts 02269-9101
(617) 770-3000
FAX: (617) 770-0700

Responsible for standards and codes relating to fire safety. These include
specifications for protective clothing (primarily for fire fighting).

SAE International (SAE)
400 Commonwealth Drive
Warrendale, Pennsylvania 15096-0001
(412) 776-4841
FAX: (412) 776-4026

Publishes specifications for high-performance textiles such as aramid-
fiber.

Uniform Code Council
8163 Old Yankee Road, Suite J
Dayton, Ohio 45458
(513) 435-3870

Responsible for UCS and VICS retail EDI standards.

The following organizations are not directly involved in writing standards, but serve other
important capacities related to FTA standards.

American Textile Partnership (AMTEX)
Laboratory Program Office
Pacific Northwest Laboratory
P.O. Box 999
Richland, WA 99352
(509) 375-2306

Industry Program Office
P.O. Box 4670
Wilmington, DE 19807
(302) 999-6733
FAX: (302) 999-6736

Collaboration of FTA industry and
DOE. Develops technologies to
address industry needs. Helps
industry to optimize product
quality and market responsiveness
while minimizing costs and
environmental impacts.

AMTEX projects are coordinated
trough the Laboratory Program
office (of DOE) and the Industry
Program Office.

National Institute of Standards and Technology (NIST)
Manufacturing Systems Integration Division
Room A127, Bldg. 220
Gaithersburg, Maryland 20899
(301) 975-3508
FAX: (301) 258-9749

Current efforts include the Apparel
Product Data Exchange Standard
(APDES) project.

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C  FTA STANDARDS LISTINGS

The following is a listing of FTA standards obtained from the organizations listed in Appendix B. The listings were obtained when possible from the organizations that issue the standards. The listings have been reformatted so that they will be consistent across the standards organizations. For the most recent information or to purchase any of these standards, contact the appropriate organization directly. Information for contacting any of these organizations can be found in Appendix B: FTA Standards Organizations.

C.1 AAMA Standards

The American Apparel Manufacturers Association is in the process of creating and publishing a number of standards which are important to the integration of apparel manufacturing. The standards which have been generated thus far are the following:

C.2 AATCC Test Methods and Procedures\[^{42}\]

The standards listed are organized first according to the following categories:

- **BIOLOGICAL PROPERTIES**
- **COLORFASTNESS**
- **DYEING PROPERTIES**
- **EVALUATION PROCEDURES**
- **IDENTIFICATION AND ANALYSIS**
- **PHYSICAL PROPERTIES**

Within each category standards are listed in numerical order, according to their identification number in the left column. All standards are test methods unless otherwise noted.

### BIOLOGICAL PROPERTIES

<table>
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<tr>
<th>Number</th>
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<td>24-1993</td>
<td>Insects, Resistance of Textiles to, p. 75.</td>
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### COLORFASTNESS

<table>
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<tr>
<th>Number</th>
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<td>3-1989</td>
<td>Colorfastness to Bleaching with Chlorine, p. 19.</td>
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<td>6-1994</td>
<td>Colorfastness to Acids and Alkalis, p. 21.</td>
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<td>22</td>
<td>Colorfastness to Crocking: Rotary Vertical Crockmeter Method, p. 23.</td>
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<td>11-1989</td>
<td>Colorfastness to Carbonizing, p. 28.</td>
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<tr>
<td>16-1993</td>
<td>Colorfastness to Light, p. 33.</td>
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<tr>
<td>61-1994</td>
<td>Colorfastness to Laundering, Home and Commercial; Accelerated, p. 94.</td>
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<tr>
<td>116-1994</td>
<td>Colorfastness to Degumming, p. 192.</td>
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\[^{42}\] AATCC Technical Manual, pp. 5-14. 1995. All page numbers in this section refer to this document.
119-1994
Color Change Due to Flat Abrasion (Frosting) Screen Wire Method, p. 202.

120-1994
Color Change Due to Flat Abrasion (Frosting) Emery Method, p. 202.

125-1991
Colorfastness to Water and Light: Alternate Exposure, p. 214.

126-1991
Colorfastness to Water (High Humidity) and Light: Alternate Exposure, p. 215.

129-1990
Colorfastness to Ozone in the Atmosphere under High Humidities, p. 219.

131-1990
Colorfastness to Pleating; Steam Pleating, p. 30.

132-1993
Colorfastness to Dry-cleaning, p. 225.

133-1994
Colorfastness to Heat; Hot Pressing, p. 228.

139-1989
Colorfastness to Light; Detection of Photochromism, p. 241.

145-1985

153-1985

157-1990
Colorfastness to Solvent Spotting; Perchloroethelyene, p. 284.

162-1991
Colorfastness to Water: Chlorinated Pool, p. 297.

163-1992
Colorfastness: Dye Transfer in Storage; Fabric-to-Fabric, p. 299.

164-1992
Colorfastness to Oxides of Nitrogen the Atmosphere Under High Humidities, p. 301.

165-1993
Colorfastness to Crocking: Carpets - AATCC Crockmeter Method, p. 303.

172-1990
Colorfastness to Non-Chlorine Bleach in Home Laundering, p. 321.

173-1992
CMC: Calculation of Small Color Differences for Acceptability, p. 324.

177-1993
Colorfastness to Light at Elevated Temperature and Humidity; Water Cooled Xenon Lamp Apparatus, p. 336.

**DYEING PROPERTIES**

140-1992

141-1994
Compatibility of Basic Dyes for Acrylic Fibers, p. 245.

146-1994
Dispersibility of Disperse Dyes: Filter Test, p. 258.

154-1991
Thermal Fixation Properties of Disperse Dyes, p. 278.

155-1991
Transfer of Disperse Dyes on Polyester, p. 280.

156-1991
Transfer of Basic Dyes of Acrylics, p. 282.

159-1994
Transfer of Acid and Premetallized Acid Dyes on Nylon, p. 288.

161-1992
Chelating Agents: Disperse Dye Shade Change Caused by Metals; Control of, p. 262.

166-1993
Dispersibility Stability of Disperse Dyes at High Temperature, p. 305.

167-1993
Foaming Propensity of Disperse Dyes, p. 307.

170-1989

176-1993
Speckliness of Liquid Colorant Dispersions: Evaluation of, p. 335.

**EVALUATION PROCEDURES**

Evaluation Procedure 1
Gray Scale for Color Change, p. 348.

Evaluation Procedure 2
Gray Scale for Staining, p. 350.

Evaluation Procedure 3
Chromatic Transference Scale, p. 351.

Evaluation Procedure 4
Standards Depth Scales for Depth Determination, p. 352.

Evaluation Procedure 5
### IDENTIFICATION AND ANALYSIS

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<td>78-1989</td>
<td>Ash Content of Bleach Celluloid Textiles, p. 105.</td>
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<tr>
<td>82-1989</td>
<td>Fluidity of Dispersion of Cellulose from Bleached Cotton Cloth, p. 108.</td>
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<td>94-1992</td>
<td>Extractable Content of Greige and/or Prepared Textiles, p. 141.</td>
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<td>110-1989</td>
<td>Whiteness of Textiles, p. 163.</td>
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<td>144-1992</td>
<td>Alkali in We Processed Textiles: Total, p. 254.</td>
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<tr>
<td>168-1992</td>
<td>Chelating Agents: Active Ingredient Content of Poly amino polycarboxylic Acids and Their Salts; Copper PAN Method, p. 311.</td>
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### PHYSICAL PROPERTIES

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<td>27-1989</td>
<td>Wetting Agents, Evaluation of Rewetting Agents, p. 82.</td>
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<td>43-1989</td>
<td>Wetting Agents for Mercerization, p. 93.</td>
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<td>76-1989</td>
<td>Electrical Resistivity of Fabrics, p. 103.</td>
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Weather Resistance: Exposure to Natural Light and Weather, p. 171.
Weather Resistance: Exposure to Natural Light and Weather through Glass, p. 165.
Electrostatic Clinging of Fabrics: Fabric to Metal Test, p. 188.
Oil Repellency: Hydrocarbon Resistance Test, p. 198.
Soil Release: Oily Stain Release Method, p. 221.
Electrostatic Propensity of Carpets, p. 230.
Dimensional Changes in Automatic Home Laundering of Woven on Kit Fabrics, p. 233.
Bond Strength of Bonded and Laminated Fabrics, p. 236.
Rug Back Staining of Vinyl Tile, p. 239.
Shampooing: Washing of Textile Floor Covering, p. 240.
Appearance of Flocked Fabric after Repeated Home Laundering and/or Coin-Op Dry-Cleaning, p. 247.
Appearance of Apparel and Other Textile End Products After Repeated Home Laundering; Text, p. 249.
Dimensional Changes in Automatic Home Laundering of Garments.
Soil Redeposition, Resistance to: Launder-Ometer Method, p. 270.
Dimensional Changes on Dry-cleaning in Perchloroethylene: Machine Method, p. 287.
Carpets: Cleaning of; Hot Water (Steam) Extracting Method, p. 321.
Barre: Visual Assessment and Grading, p. 345.
Chlorine, Retained, Tensile Loss: Multiple Sample Method, p. 186.
Dimensional Restoration of Knitted and Woven Fabrics after Laundering, p. 292.
Retention of Creases in Fabrics after Repeated Home Laundering, p. 119.
This standards listing contains the names and numbers of all ALCA's test methods and definitions. Most of them related to leather in general, and a few specifically apply to leather for footwear purposes. Some of these standards have been adopted and re-published by ASTM. The names of ALCA/ASTM standards are followed by their ASTM document number (in parentheses).

A1 Analysis of Vegetable Tanning Materials - General (ASTM D4899)
A5 Extraction of Raw and Spent Materials
A6 Moisture in Raw and Spent Materials
A10 Preparation of Solution of Liquid Extracts (ASTM D4901)
A11 Preparation of Solution of Solid, Pasty and Powdered Extracts (ASTM 4905)
A12 Cooling of Analytical Solutions (ASTM D4904)
A13 Evaporation and Drying of Analytical Solutions (ASTM 4902)
A20 Total Solids and Water (ASTM D4903)
A21 Soluble Solids and Insolubles
A22 Nontannins and Tannin
A25 Analysis of Tannery Liquors
A30 Sugar in Tanning Materials
A31 Method for Copper and Iron in Tanning Materials
A40 Color Tests with Sheepskin Skiver
A50 Lignosulfonates (Sulfite Cellulose) (ASTM D4900)
A60 Official Certification
B1 Analysis of Vegetable-Tanned Leathers - General
B2 Preparation of Sample for Analysis (ASTM D2813)
B3 Moisture (ASTM D3790)
B4 Hexane Extract of Leather (ASTM D2876)
B5 Nitrogen Content (Kjeldahl) and Hide Substance (ASTM D2868)
B8 Water-Soluble Matter of Vegetable-Tanned Leather (ASTM D2876)
B9 Soluble Non Tannin and Uncombined Tannin
B10 Glucose
B11 Insoluble Ash of Vegetable-Tanned Leather (ASTM D2875)
B12 Combined Tannin and Degree of Tannage
B15 Total Ash in Leather (ASTM D2617)
B16 Magnesium as Epsom Salts
B20 pH of Water (ASTM 2810)
B30 Official Certification
C1 Determination of Chromium in Chrome Tanning Liquors (ASTM D3898)
C5 Determination of Acidity of Chrome Tanning Liquors (ASTM D3813)
C10 Calculation Basicity of Chrome Tanning Liquors (ASTM D3897)
C11 Determination of pH of Chrome Tanning Liquors (ASTM D2815)
D1 Preparation of Composite Sample for Chemical Tests (ASTM D2813)
D5 Mineral Leathers - General
D10 Chromic Oxide in Leather (Perchloric Acid Oxidation) (ASTM 2807)

43 Methods of Sampling and Analysis. 1994.
ALCA Standards

D20 Sulfates (Total, Neutral and Combined Acid) (ASTM D1655)
D21 Total Chlorides (D4563)
D30 Sulfate Basicity (ASTM D4654)
D35 Acidity (pH) (ASTM D2810)
E1 Conditioning Leather and Leather Products for Testing (ASTM D1610)
E2 Measuring Area of Leather Test Specimens (ASTM D2346)
E3 Measuring Thickness of Leather Units (ASTM D1814)
E4 Measuring Thickness of Leather Test Specimens (ASTM D1813)
E5 Width of Leather (ASTM D1516)
E10 Tongue Tear Strength (ASTM D1704)
E11 Buckle Tear Strength (ASTM D1813)
E12 Stitch Tear Strength, Single Hole (ASTM D4786)
E13 Stitch Tear Strength, Double Hole (ASTM D1705)
E14 Bursting Strength of Leather by the Ball Method (ASTM D2207)
E15 Tensile Strength of Leather (ASTM D2209)
E16 Breaking Strength of Leather by the Grab Method (ASTM 2208)
E17 Elongation of Leather (ASTM 2211)
E30 Water Absorption (Static) of Leather (ASTM D1815)
E32 Permeability to Water Vapor (ASTM D5052)
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| MIL-V-44362 (1)             | Vest, Grenade, Carrier (for 40-mm Grenades). | FSC 8415 |
| A-A-55227                   | Pocket, Ammunition Magazine, Enlisted Men's, M-1923. | FSC 8465 |
| A-A-55240                   | Apron, Construction Worker's. | FSC 8415 |
| MIL-V-81523A Valid Notice 2| Vest, Survival Equipment, Type SV-2A. | FSC 8415 |
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| MIL-U-44164A | Undershirt, Cold Weather, Polypropylene. FSC 8415 |
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MS35807  Hosiery, Handwear, and Clothing Accessories: Men's FSC Class 8440. FSC 8440
MIL-N-41804E  Neckties, Men's, Four-in-Hand. FSC 8440.
MIL-G-41187E  Gloves, Men's, Cloth, Dress, White. FSC 8440
MIL-B-43515A Valid Notice 1  Belt, Man's, Waist, Blue 334 (Army Band Uniform). FSC 8405
MIL-N-43741B  Handkerchief, Ham's, Cotton, Knitted. FSC 8440
MIL-S-43823A Valid Notice 1  Socks, Men's, Nylon, Cushion Sole, Stretch Type, OG 106. FSC 8440
MIL-G-44108A  Gloves, Combat Vehicle Crewman's, Summer. FSC 8415
A-A-50015B  Socks, Ribbed Knit, Stretch Type. FSC 8440
A-A-50016A  Gloves, Men's: Cloth, Leather Palm, Knitted Wristlet, Size Medium. FSC 8415
A-A-50021A  Gloves, Men's, Cloth, Leather Palm with Gauntlet. FSC 8415
A-A-50356B  Handkerchief, Men's or Women's. FSC 8440
A-A-50386  Gloves, Men's and Women's. FSC 8440
A-A-52055  Gloves, Men's and Women's, Leather, Light Duty. FSC 8415
A-A-52203  Suspenders, Trouser (Flying Suit). FSC 8440
A-A-55079  Socks: Men's, Cushion Sole, Stretch Type. FSC 8440
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A-A-2523B Case, Dispatch, Molded Plastic. FSC 8460
A-A-2724 Portfolio, Plastic. FSC 7510
MIL-T-10798L Trunk Locker, Barracks. FSC 8460
MIL-T-16381B Trunk, Locker, Barracks; and Tray. FSC 8460
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MIL-S-37180 Valid Notice 1 Satchel, Physician's, Boston Style, Three Compartments. FSC 6532
MIL-K-41835D Kit Bag, Flyer's. FSC 8460
A-A-50083 Bag, Plastic, Folded Garment. FSC 8105
A-A-55062A Suitcase, Flyers. FSC 8460
A-A-55179 Bag, Money. FSC 8460
A-A-55192 Case, Map. FSC 8460
A-A-55205 Bag, Personal Effects. FSC 8465
MIL-C-81808 Chest, Collapsible. FSC 8460
MIL-K-83782A Valid Notice 1 Kit Bag, Flyer's. FSC 8460
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MIL-B-833G Belt, Trousers, Cotton Webbing, with Clip. FSC 8440
MIL-C-1002J Case, Field, First Aid Dressing, Leather (Military Police). FSC 8465
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AN8018 Rev A Valid Notice 1 Horn, Flyer's Relief Tube. FSC 4730
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MIL-S-10055D Strap, Packboard: Quick Release. FSC 8465
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| MIL-B-21880D | Belt, Military Police (White). FSC 8465 |
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| MIL-B-29378 (1) | Belt, Man's: Ceremonial, Officers. FSC 8440 |
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| MIL-C-40126F | Cup, Water Canteen (for Insulated Canteen). FSC 8465 |
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| MIL-S-43013C Valid Notice 1 | Sling, Universal, Individual Load Carrying. FSC 8465 |
| MIL-C-43103D | Canteen, Water, Plastic, with Screw Cap. FSC 8465 |
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A-A-55106 Whistle, Ball, Plastic. FSC 8465
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A-A-55193 Holder, Cartridge, Belt, Cal .38, Leather, Black, 6-Round. FSC 8465
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A-A-55197 Belt, Man's, Waist, Blue 334 (Army Band Uniform). FSC 8405
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A-A-55245 Necklace, Personnel, Identification Tag. FSC 8465
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Part A02: Grey Scale for Assessing Change in Color.
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Part A04: Method for the Instrumental Assessment of the Degree of Staining of Adjacent Fibers.
Part B01: Colour Fastness to Light: Daylight.
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Part B03: Colour Fastness to Weathering: Outdoor Exposure.
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Part P01: Colour Fastness to Dry Heat (Excluding Pressing).
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Part X01: Colour Fastness to Carbonizing : Aluminum Chloride.
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Part Z: Colorant Characteristics.
Part Z01: Colour Fastness to Metals in the Dye-Bath : Chromium Salts.
Part Z02: Colour Fastness to Metals in the Dye-Bath : Iron and Copper.

Physical Properties
ISO Standards


Reference


Physical Properties


Part 2: Methods for Obtaining Laboratory Samples.
Part 3: Specimen Cleaning Procedures.
Part 4: Values Used for the Commercial Allowances and the Commercial Moisture Regains.

TEXTILE FABRICS

Reference


ISO Standards

ISO 3759:1984

ISO 7211-1 to 6:1984
Part 2: Determination of Number of Threads per Unit Length.
Part 3: Determination of Crimp of Yarn in Fabric.
Part 4: Determination of Twist in Yarn Removed from Fabric.

ISO 8498:1990

ISO 8499:1990

ISO 9092:1988

ISO 9354:1989
Textiles—Weaves—Coding System and Examples. TC 38/SC 20.

ISO 11224:1993
Textiles—Nonwovens—Web Formation and Bonding—Vocabulary. TC 38.

Physical Properties
ISO 675:1979

ISO 811:1981
Textile Fabrics—Determination of Resistance to Water Penetration—Hydrostatic Pressure Test. TC 38/SC 2.

ISO 2649:1974

ISO 3005:1978
ISO 3801:1977
Textiles—Woven Fabrics—Determination of Mass per Unit Length and Mass per Unit Area. TC 38.

ISO 3932:1976

ISO 3933:1976

ISO 4920:1981
Textiles—Determination of Resistance to Surface Wetting (Spray Test) of Fabrics. TC 38/SC 2.

ISO 5081:1977
Textiles—Woven Fabrics—Determination of Breaking Strength and Elongation (Strip Method). TC 38.

ISO 5082:1982

ISO 5084:1977
Textiles—Determination of Thickness of Woven and Knitted Fabrics (Other than Textile Floor Coverings). TC 38.

ISO 7771:1985
Textiles—Determination of Dimensional Changes of Fabrics Induced by Cold-Water Immersion. TC 38/SC 2.

ISO 9073-1 to 5:1989
Part 1: Determination of Mass per Unit Area.
Part 2: Determination of Thickness.
Part 3: Determination of Tensile Strength and Elongation.
Part 4: Determination of Tear Resistance.

ISO 9290:1990
Textiles—Woven Fabrics—Determination of Tear Resistance by the Falling Pendulum Method. TC 38.
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tional Details and Instructions for Use. TC 38/SC 12. |

### Physical Properties

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<td>ISO 1763:1986</td>
<td>Carpets—Determination of Number of Tufts and/or Loops per Unit Length and per Unit Area. TC 38/SC 12.</td>
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<table>
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<th>Description</th>
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Textile Machinery


Spinning Machines, Reference


Spinning Machines, Specifications

Part 1: Main Dimensions.
Part 2: Spring Bottoms.
Part 1: T-Rings and Their Appropriate Travellers.
Part 2: HZCH-, HZ- and J-Rings and Their Appropriate Travellers.
ISO Standards

ISO 6171:1982  Textile Machinery and Accessories—Bead Wires and Corresponding Grooves for Cards—Main Types and Dimensions. TC 72/SC 1.

Winding Machines and Equipment, Reference
Part 4: Quality Classification of Flanges for Weaver's Beams, Warper's Beams and Sectional Beams.
Part 9: Dyeing Beams for Textile Fabrics.
**ISO Standards**

**Winding Machines and Equipment Specifications**


Part 1: Recommended Values of Inner Diameters and Lengths.
Part 2: Tubes for Open-End Spinning Machines.
Part 3: Tubes for Tape Yarns.
Part 4: Tubes for Textured Yarns.


**Weaving Machines, Reference**


Part 2: Accessories—Vocabulary.


Weaving Machines, Specifications


Part 2: Metal Reeds with Plate Baulk—Dimensions and Designation.
Part 3: Metal Reeds with Double-Spinning Baulk—Dimensions and Designation.
Part 4: Plastic Bound Metal Reeds—Dimensions and Designation..


ISO Standards


ISO 5245:1977 Textile Machinery and Accessories—Weft Pirs with Rings (27mm and 30mm) for Automatic Winding at the Loom. TC 72/SC 3.

ISO 5246:1977 Textile Machinery and Accessories—Ringless Weft Pirs (24mm and 27mm) for Automatic Winding at the Loom. TC 72/SC 3.


Knitting Machines


Part 1: Latch-Type Needles.
Part 2: Bearded Needles.
Part 3: Compound Needles.


Part 2: Warp Let-off, Fabric Take-up and Banking.

Dyeing and Finishing Equipment

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ISO 2417:1972 Leather—Determination of Absorption of Water. IULTCS.
ISO 2418:1972 Leather—Laboratory Samples—Location and Identification. IULTCS.
ISO 2419:1972 Leather—Condition of Test Pieces for Physical Tests. IULTCS.
ISO 2420:1972 Leather—Determination of Apparent Density. IULTCS.
ISO 2588:1985 Leather—Sampling—Number of Items for a Gross Sample. IULTCS.
ISO 3376:1976 Leather—Determination of Tensile Strength and Elongation. IULTCS.
ISO 3377:1975 Leather—Determination of Tearing Load. IULTCS.
ISO 3378:1975 Leather—Determination of Resistance to Grain Cracking, and of Crack Index. IULTCS.
ISO 3379:1976 Leather—Determination of Distension and Strength of Grain—Ball Burst Test. IULTCS.
ISO 3380:1975 Leather—Determination of Shrinkage Temperature. IULTCS.
ISO 4044:1977 Leather—Preparation of Chemical Test Sample. IULTCS.
ISO 4047:1977 Leather—Determination of Sulphated Total Ash and Sulphated Water-Insoluble Ash. IULTCS.
ISO Standards

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<td>ISO 4048:1977</td>
<td>Leather—Determination of Matter Soluble in Dichloromethane. IULTCS.</td>
</tr>
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<td>ISO 5397:1984</td>
<td>Leather—Determination of Nitrogen Content and &quot;Hide Substance&quot;—Titrimetric Method. IULTCS.</td>
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<td>Leather—Determination of Water-Soluble Magnesium Salts—EDTA Titrimetric Method. IULTCS.</td>
</tr>
<tr>
<td>ISO 5400:1984</td>
<td>Leather—Determination of Total Silicon Content—Reduced Molybdosilicate Spectrometric Method. IULTCS.</td>
</tr>
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<td>Leather—Tests for Colour Fastness—Colour Fastness of Small Samples to Dry-Cleaning Solutions. IULTCS.</td>
</tr>
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CLOTHING

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   Part 1: PVC-Coated Fabrics.
   Part 3: Natural Rubber- and Synthetic Rubber-Coated Fabrics.


STEP47

ISO 10303-1 to 203:1994-95
   Part 41: Fundamentals of Product Description and Support.
   Part 42: Geometry and Topology Representations.
   Part 43: Representation Specialization.
   Part 44: Product Structure Configuration.
   Part 101: Draughting.
   Part 201: Explicit Draughting.
   Part 203: Configuration-Controlled Design.

47 This listing includes only the STEP initial release. There are many other parts in some stage of the development and approval process.
C.7 NFPA Apparel Standards\textsuperscript{48}

The following are performance specifications for clothing to protect against hazardous environments. Most of them relate to fire fighting. The standards are listed in numerical order.

NFPA 1971 Protective Clothing for Structural Fire Fighting
NFPA 1972 Helmets for Structural Fire Fighting
NFPA 1973 Gloves for Structural Fire Fighting
NFPA 1974 Protective Footwear for Structural Fire Fighting
NFPA 1975 Station/Work Uniforms for Fire Fighters
NFPA 1976 Protective Clothing for Proximity Fire Fighting
NFPA 1977 Protective Clothing and Equipment for Wildland Fire Fighting
NFPA 1983 Fire Service Life Safety Rope, Harness, and Hardware
NFPA 1991 Vapor-Protective Suits for Hazardous Chemical Emergencies
NFPA 1992 Liquid Splash-Protective Suits for Hazardous Chemical Emergencies
NFPA 1993 Support Function Protective Clothing for Hazardous Chemicals Operations

These specifications for the most part relate to high performance aramid and para-aramid textile materials. They are listed in numerical order.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3901B #</td>
<td>Organic Fiber (Para-Aramid), Yarn and Roving, High Modulus (Oct 92)</td>
</tr>
<tr>
<td>3901/1B #</td>
<td>Yarn, Organic Fiber (Para-Aramid), High Modulus, OY 390 (2689)/23.5 Tensile Strength, 18 (125)/982 Tensile Modulus, 195 Denier, 0.6% Finish (Oct 92)</td>
</tr>
<tr>
<td>3901/2B #</td>
<td>Yarn, Organic Fiber (Para-Aramid), High Modulus, OY 390 (2689)/24.5 Tensile Strength, 17.5 (121)/934 Tensile Modulus, 380 Denier, 0.6% Finish (Oct 92)</td>
</tr>
<tr>
<td>3901/3B #</td>
<td>Yarn, Organic Fiber (Para-Aramid), High Modulus, OY 390 (2689)/25.5 Tensile Strength, 16.5 (114)/900 Tensile Modulus, 1140 Denier, 0.6% Finish (Oct 92)</td>
</tr>
<tr>
<td>3901/4B #</td>
<td>Yarn, Organic Fiber (Para-Aramid), High Modulus, OY 390 (2689)/24.3 Tensile Strength, 18 (125)/982 Tensile Modulus, 1420 Denier, 0.6% Finish (Oct 92)</td>
</tr>
<tr>
<td>3901/5B #</td>
<td>Yarn, Organic Fiber (Para-Aramid), High Modulus, OY 450 (3103)/23.0 Tensile Strength, 17.5 (121)/780 Tensile Modulus, 7100 Denier, 0.6% Finish (Oct 92)</td>
</tr>
<tr>
<td>3901/6B #</td>
<td>Yarn, Organic Fiber (Para-Aramid), High Modulus, OY 500 (3447)/23.5 Tensile Strength, 7.5 (121)/800 Tensile Modulus, 4560 Denier, 0.6% Finish (Oct 92)</td>
</tr>
<tr>
<td>3901/7A #</td>
<td>Yarn, Organic Fiber (Para-Aramid), High Modulus, OY 390 (2689)/21.5 Tensile Strength, 16.5 (114)/825 Tensile Modulus, 2160 Denier, 0.6% Finish (Oct 92)</td>
</tr>
<tr>
<td>3901/8A #</td>
<td>Yarn, Organic Fiber (Para-Aramid), High Modulus, OY 390 (2689)/21.5 Tensile Strength, 18 (124)/982 Tensile Modulus, 195 Denier, 1.2% Finish (Oct 92)</td>
</tr>
<tr>
<td>3901/9A #</td>
<td>Yarn, Organic Fiber (Para-Aramid), High Modulus, OY 390 (2689)/24.5 Tensile Strength, 17.5 (121)/934 Tensile Modulus, 380 Denier, 1.2% Finish (Oct 92)</td>
</tr>
<tr>
<td>3901/10A #</td>
<td>Yarn, Organic Fiber (Para-Aramid), High Modulus, OY 390 (2689)/23.6 Tensile Strength, 16.5 (114)/885 Tensile Modulus, 1140 Denier, 1.2% Finish (Oct 92)</td>
</tr>
<tr>
<td>3901/11A #</td>
<td>Yarn, Organic Fiber (Para-Aramid), High Modulus, OY 390 (2689)/22.2 Tensile Strength, 16.5 (114)/870 Tensile Modulus, 1420 Denier, 1.2% Finish (Oct 92)</td>
</tr>
<tr>
<td>3901/12A #</td>
<td>Yarn, Organic Fiber (Para-Aramid), High Modulus, OY 390 (2689)/21.5 Tensile Strength, 16.5 (114)/870 Tensile Modulus, 1420 Denier, 1.2% Finish (Oct 92)</td>
</tr>
<tr>
<td>3902B #</td>
<td>Cloth, Organic Fiber (Para-Aramid), High Modulus, for Structural Composites (Oct 89)</td>
</tr>
</tbody>
</table>

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# A previous issue of this document has DODISS acceptance. DODISS adoption means that the document has been coordinated by the tri-services and is approved for military use.
3903A +  Cloth, Organic Fiber (Para-Aramid), High Modulus, Epoxy Resin Impregnated (Oct 85)
3903/1A +  Cloth, Organic Fiber, High Modulus, Epoxy Resin Impregnated, OC Style 120, 175 (350) (Jan 88)
3903/2A +  Cloth, Organic Fiber, High Modulus, Epoxy Resin Impregnated, OC Style 181, 175 (350) (Jan 88)
3903/3A +  Cloth, Organic Fiber, High Modulus, Epoxy Resin Impregnated, OC Style 281, 175 (350) (Jan 88)
3903/4A +  Cloth, Organic Fiber, High Modulus, Epoxy Resin Impregnated, OC Style 328, 175 (350) (Jan 88)

3904A  Fiber, Organic (Para-Aramid), Yarn and Roving, Intermediate Modulus, for Cables, Cordage, and Woven Goods (Apr 89)
3904/1A  Yarn, Organic Fiber (Para-Aramid), Intermediate Modulus, 200 Denier, 1.75% Finish (Apr 89)
3904/2A  Yarn, Organic Fiber (Para-Aramid), Intermediate Modulus, 400 Denier, 1.75% Finish (Apr 89)
3904/3A  Yarn, Organic Fiber (Para-Aramid), Intermediate Modulus, 1000 Denier, 1.75% Finish (Apr 89)
3904/4A  Yarn, Organic Fiber (Para-Aramid), Intermediate Modulus, 1000 Denier, 1.5% Finish, for Weaving (Apr 89)
3904/5A  Yarn, Organic Fiber (Para-Aramid), Intermediate Modulus, 1500 Denier, 1% Finish, for Cable and Cordage (Apr 89)
3904/6  Yarn, Organic Fiber (Para-Aramid), Intermediate Modulus, 1500 Denier, 7.0% Finish, for Cable and Cordage (Apr 89)
3904/7  Yarn, Organic Fiber (Para-Aramid), Intermediate Modulus, 1500 Denier, Zero Finish, for Cable and Cordage (Apr 89)
3904/8  Yarn, Organic Fiber (Para-Aramid), Intermediate Modulus, 1500 Denier, 1.0% Finish, for Weaving (Apr 89)
3904/9  Yarn, Organic Fiber (Para-Aramid), Intermediate Modulus, 3000 Denier, 0.9% Finish, for Non-Apparel Ballistic Applications (Apr 89)
3904/10  Roving, Organic Fiber (Para-Aramid), Intermediate Modulus, 15,000 Denier, 7.0% Finish, for Cable and Cordage (Apr 89)
3904/11  Roving, Organic Fiber (Para-Aramid), Intermediate Modulus, 15,000 Denier, 1.0% Finish, for Cable and Cordage (Apr 89)
3904/12  Roving, Organic Fiber (Para-Aramid), Intermediate Modulus, 9000 Denier, 7.0% Finish, for Cable and Cordage

3907  Cloth, Aramid, Plain and Basket Weave (Oct 85)
3907/1  Cloth, Aramid, 5 oz per sq. yd (170g/m²), Basket Weave (Oct 85)

* DODISS adopotion means that the document has been coordinated by the tri-services and is approved for military use.
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<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3907/2</td>
<td>Cloth, Aramid, 4.3 oz per sq. yd (145g/m²), Plain Weave (Oct 85)</td>
</tr>
<tr>
<td>3908A</td>
<td>Cloth, Aramid (Para), Plain Weave, Thermally Stable (Jan 92)</td>
</tr>
<tr>
<td>3909</td>
<td>Cloth, Parachute, Aramid, Intermediate Modulus (Jul 85)</td>
</tr>
<tr>
<td>3909/1</td>
<td>Cloth, Parachute, Aramid, 3.0 oz per sq. yd (100 g/m²), 350 lb per in. (61,300 N/m) (Jul 85)</td>
</tr>
<tr>
<td>3909/2</td>
<td>Cloth, Parachute, Aramid, 2.25 oz per sq. yd (75 g/m²), 250 lb per in. (43,800 N/m) (Jul 85)</td>
</tr>
<tr>
<td>3909/3</td>
<td>Cloth, Parachute, Aramid, 2.0 oz per sq. yd (68 g/m²), 230 lb per in. (40,275 N/m) and 220 lb per in. (38,525 N/m) (Jul 85)</td>
</tr>
</tbody>
</table>
GLOSSARY

This glossary contains terms common to the fiber, textile, and apparel sectors of the FTA industry, and some terms appearing in the titles of standards listed in Appendix C: FTA Standards Listing. They are listed alphabetically.

alpaca/alpacea 1. Animal belonging to the species of Llama; it produces a short textile fiber of 4 inches in one year's growth.
2. A thin cloth made of the woolly hair of the alpaca often with dyed silk, cotton, or another fiber in the weft.

anthropometry The study and technique of human body measurement.

barre 1. A crossover striped cloth with stripes formed by weft from selvage; either woven or printed.
2. A defect due to variation in the number of picks per inch.

bast/bass Strong woody fibers obtained from the stem, leaves, or fruit of various trees and plants, and known as bast or hard fibers. They are used especially in the manufacture of ropes, cordage, matting, etc.

beam A cylinder of wood or metal on which the warp from the warping machine is wound before weaving; it is called the yarn beam or weaver's beam, backbeam or section beam.

chambray 1. A plain woven cotton or linen fabric with colored warp and white filling that gives a mottled colored surface; used for shirts, children's clothes, and dresses.
2. A similar but heavier carded yarn fabric used for work-shirts and children's play clothes.

chelation The chemical process of forming a ring compound by joining a chelating agent to a metal ion.

CID Commercial Item Description: The new format for specification of military items, including clothing. It will replace the traditional "MIL-specs." The CID gives the manufacturer more freedom in determining processes and in some cases materials to meet performance criteria.

CIM Computer Integrated Manufacturing: The process of monitoring and controlling manufacturing processes on the shop floor electronically. This requires that machines of different types made by various manufacturers communicate with one another.

colorfastness/fastness Retentive quality of firmness of dyes; such as fastness to light, perspiration, salt water, washing, etc. Fast colors are durable or lasting. (Note that the term, "colorfastness," is referred to in that

50 The entries in this glossary were obtained from the following references (some entries have been modified):
Link, 1954.
colorimeter

1. An instrument for measuring the depth of color in a liquid by comparison with a standards liquid of the same tint.
2. An instrument or device for determining and specifying colors by reference either to other colors or to certain complex stimuli.

cotton

A soft white fibrous substance covering the seeds of various malvaceous plants. Careful selection has greatly improved the quality and increased the length of the fiber known as staple-length. On account of its cheapness, cotton is the most important of textile products. The most important property of cotton is the spiral-like appearance or convolution of its fiber which gives it a natural twist, causing the fibers to adhere together while the yarn is being formed. The cotton staple falls into one or more categories in each group:

<table>
<thead>
<tr>
<th>Quality</th>
<th>Color</th>
<th>Feel, Handle</th>
<th>Defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Even</td>
<td>Fair</td>
<td>Soft</td>
<td>Sandy</td>
</tr>
<tr>
<td>Irregular</td>
<td>Good</td>
<td>Firm</td>
<td>Dusty</td>
</tr>
<tr>
<td>Good</td>
<td>Spotted</td>
<td>Hard</td>
<td>Leafy</td>
</tr>
<tr>
<td>Very Good</td>
<td>Stained</td>
<td>Rough</td>
<td>Husky/Howly</td>
</tr>
<tr>
<td>Strong</td>
<td>Tinged</td>
<td>Towy</td>
<td>Neppy</td>
</tr>
<tr>
<td>Weak</td>
<td>Highly Colored</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silky</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Stapled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short Stapled</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Damaged</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coarse</td>
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</tr>
</tbody>
</table>

In the United States, the cotton receives one of the following overall grades (with "1" being of the highest quality):

1) Middling Fair
2) Strict Good Middling
3) Good Middling
4) Strict Middling
5) Middling
6) Strict Low Middling
7) Low Middling
8) Strict Good Ordinary
9) Good Ordinary

crocking

The tendency of excess dye to rub off.

crockmeter

A laboratory device for measuring the fastness of dyes to rubbing.

degumming/boiling off

A process by which the natural gum of silk is dissolved and the released fibers are freed to be drawn.
The process of eliminating sizing (stiffening materials) from grey goods preparatory to bleaching, dyeing etc. The sizing substance is first made soluble by an acid or enzyme, then washed out.

1. The process of pulling out or elongating the sliver of the cardsing machine.
2. Various processes, including giling, reducing, and roving, by which slivers are converted into rovings of the required thickness for spinning.

Any tough substance composed of threadlike tissues and capable of being spun and woven; the minimum length for fibers to be spun into yarn is one-fifth of an inch. Vegetable fibers are yielded by the bast of plants, excepting cotton, which is the hairy tuft of the seed. The following table gives a list of fibers by origin:

<table>
<thead>
<tr>
<th>Animal</th>
<th>Vegetable</th>
<th>Mineral</th>
<th>Synthetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wool</td>
<td>Cotton</td>
<td>Asbestos</td>
<td>Rayon</td>
</tr>
<tr>
<td>Hair</td>
<td>Hemp</td>
<td>Metals</td>
<td>Nylon</td>
</tr>
<tr>
<td>Silk</td>
<td>Flax</td>
<td></td>
<td>Vinyon</td>
</tr>
<tr>
<td>Sinew</td>
<td>Jute</td>
<td></td>
<td>Aralac</td>
</tr>
<tr>
<td></td>
<td>Ramio</td>
<td></td>
<td>Glass</td>
</tr>
<tr>
<td></td>
<td>Phormium</td>
<td></td>
<td>Paper</td>
</tr>
</tbody>
</table>

1. A thread or threadlike object, an appendage or a separate fiber; the extreme length of filaments permits their being used in a yarn without twist or with very low twist, and they are usually made into yarn without the spinning operation required for fibers.
2. The single individual unit which is extracted by the silkworm or by the spinneret.
3. Continuous filaments are synthetic and regenerated fibers which have a short staple.
4. Monofilament is a simple filament of sufficient size to function as a yarn in normal textile operation.
5. Multifilament is a rayon yarn with a very large number of fine filaments.

Small, miscellaneous materials used in the apparel manufacture process; not of textile origin; these would include buttons and zippers.

A plant cultivated for its fibers; the long silky bast fiber freed from the stem by retting and various mechanical processes is used in the manufacture of a thread which is woven into a cloth generally known as linen.

A twilled fabric in which warp threads predominate; used as material of clothing for both sexes.
hand/handle (fabric)  The reaction to the sense of touch, when raw material or goods are grasped in the hand to judge their quality, taking into account especially their fineness and softness.

havelock  A cloth covering for a cap, with a flap to cover and protect the back of the neck.

heald/heddle  1. One of the sets of parallel double cords or wires on the loom, which with their mounting compose the harness used to guide the warp.  
2. To draw the warp threads with a heddle hook through the heald-eyes or comb, which is a loop formed in each heald.

hemp  A plant cultivated for its touch bast fibers, which is obtained similarly to flax; it is used for making cloth and cordage.

huck/huckabauk  A cotton cloth with a rough surface obtained by short floats of warp and weft threads on a plain weave ground texture; employed for towels.

integration  The process of brining all parts of a system or process together and making them compatible.

kemp  Thick opaque and wavy fibers with a pointed tip and root, which are shed periodically into the fleece; they develop in nearly all breeds of sheep but principally in mountainous and carpet wool types. They greatly reduce the value of the wool because of the inferior spinning properties; they do not show up dyes.

knitting  1. The process of making a fabric by interlacing one or more yarns in a series of connected loops by means of needles, either by hand or by machines; there are rectilinear and circular knitting machines employed to make jerseys, stocking, and the like.  
2. Gauge: a standard measure of the fineness of a knitted fabric obtained by counting the number of needles in a given unit of space.

medullated (wool)  This differs from true kemp because it is not shed but grows with the wool; it is distinguished by the coarser diameter of the medullated cells.

mercerization  A process to which cotton yarn is subjected to produce luster and shrinkage; the material is treated in a caustic soda solution for one minute and in tension, then neutralized and washed off.

modulus  A constant or coefficient that expresses the degree to which a substance possesses some property.

nep  1. Lumps or rolled up and tangled wool fibers which curl up in carding and sometimes also in combing by inefficient setting of the cylinders or rollers; they should be cleared out of the sliver in combing.  
2. A cluster of fibers in the wool staple.
3. Little knots formed in cotton by immature fibers in the wool staple.

**nonwovens**

Materials, such as felts, which undergo neither the weaving nor the knitting process. Such fibers may be forced together and the cohesion produced by that process is enough for the intended applications.

**pack**

1. A bundle or a bale of raw material or of goods; to bale, to load.
2. A measure of scouring wool or wool top weighing 240 lbs.

**pirn (weft)**

1. A single-headed bobbin or spool in which head and barrel are shaped conically.
2. Yarn wound on the weaver's shuttle.

**roving/roving-frame**

1. Final product of the drawing process obtained on the roving frames called also dandles, resulting in a strand of wool of the desired thickness for spinning it into a worsted yarn.
2. Drawing process before spinning in worsted yarn manufacture.

**saponification**

1. Chemical process of soap-making.
2. The decomposition of any ester into the corresponding alcohol and fatty acid; also, the similar production of an acid from some other derivative.
3. *Saponification number:* milligrams of potassium hydride needed to saponify 1.0000 milligrams of the oil, fat, etc., that is being tested.

**sisal**

Approximately 300 species of plants which grow in desert and subtropical regions and supply very strong, smooth, yellowish bast fibers; they are used for upholstery and as substitutes of flax and hemp in the manufacture of sackcloths and carpets.

**size/sizing**

1. Stiffening or finishing threads, yarn, or fabrics by the use of sizes and glutinous materials; it can be done by means of a sizing apparatus attached to the loom (as in the slasher-sizer) or as a finishing process. There are three types of sizing as follows:

<table>
<thead>
<tr>
<th>Table 3: Sizing Types</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Light Sizing</strong></td>
</tr>
<tr>
<td>Up to 10% of size.</td>
</tr>
<tr>
<td>Gives a better handle to the cloth.</td>
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<td></td>
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</tbody>
</table>

2. Determination of the count of rovings or yarns.
3. The process of mapping sets of dimensions for a garment to one numerical value. For instance, a size 7 dress denotes particular circumferential and linear measurements. Accurate anthropometric data is crucial to effective sizing.
slashing
A process in which sizing is applied to warp threads in their full width; it is used to size the warp yarn with a starch or like substance that will lay all the fibers parallel, and add strength to the yarn; this enables to go through weaving without damage.

sliver
A continuous strand of cotton, wool, or other fiber, in a loose untwisted state, produced by a carding, drawing or combing machine.

spinning
1. Final drawing of a carded or combed sliver or roving into a yarn inserting the required degree of twists, and winding it upon a cone; this is usually done by ring spinning, the air-jet system, or the open-end centrifugal process.
2. Wool spinning is done by either the woolen or worsted method.
3. Cotton Spinning joins and twists together a series of short fibers to make a thread of desired fineness and length; it consists of the following operations: opening and cleaning the bales, carding or loosening and parallellizing the fibers, drawing the slivers to a uniform length, spinning the slivers into yarn, and winding the yarn from the cones onto spools.
4. Dry spinning is the method for flax, hemp, jute, etc., as well as rayon.

stoving
1. The submitting of dampened wool, yarn or cloth to an agent, such as sulfur dioxide fumes, for bleaching.
2. Treating of the silk cocoon by heating to kill the chrysalis.

sundries
Miscellaneous articles used in sewing garments; not of textile origin; these would includes buttons, zippers, etc.

tannin
1. Tannic acid.
2. A chemical substance capable of promoting tanning.

tanning
The art or process of making leather from rawhides.

textile
Material capable of being spun or woven, knitted, felted, bonded, or crocheted.

vulcanization
A process that increases the strength, resiliency, and freedom from stickiness of a material by combining it with sulfur or other additives in the presence of heat and pressure.

warp/warping
1. A series of threads which are extended lengthwise in the loom and crossed by the weft; it is usually longer and harder twisted than the weft.
2. Warping is the arranging of the chain or series of warp threads according to quality and color, winding them off the bobbins and on to a special beam attached to the loom.

weaving
1. The process of interlacing a series of longitudinal yarns with another yarn running crosswise and known as the weft or filling, on machines called looms.
weaving (con’t)

2. A particular pattern or design of weaving such as plain, twill, satin, herringbone, hopsack, etc.

3. Cross weaving is a style of weaving which produces open work effects such as seen in gauze and lenos; it is produced by crossing one warp thread with another, first to one side and then to the other in some definite order.

weft

The thread which is thrown through the warp at right angles by means of a shuttle; it is, as a rule, softer spun and weaker than warp yarn.
### LIST OF ACRONYMS

The following is a list of key acronyms used in this paper. Many of them refer to organizations. A brief description and contact information for these organizations can be found in Appendix B: FTA Standards Organizations.

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>AAMA</td>
<td>American Apparel Manufacturers Association</td>
</tr>
<tr>
<td>AATCC</td>
<td>American Association of Textile Chemists and Colorists</td>
</tr>
<tr>
<td>ALCA</td>
<td>American Leather Chemists Association</td>
</tr>
<tr>
<td>AMTEX</td>
<td>American Textile Partnership</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
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<tr>
<td>APDES</td>
<td>Apparel Product Data Exchange Standard</td>
</tr>
<tr>
<td>ARC</td>
<td>(AAMA) Apparel Research Committee</td>
</tr>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>ATMI</td>
<td>Apparel Textile Manufacturers Association</td>
</tr>
<tr>
<td>CIM</td>
<td>Computer-Integrated Manufacturing</td>
</tr>
<tr>
<td>DAMA</td>
<td>(AMTEX) Demand-Activated Manufacturing Architecture</td>
</tr>
<tr>
<td>EC</td>
<td>European Community</td>
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<tr>
<td>EDI</td>
<td>Electronic Data Interchange</td>
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<tr>
<td>EDIFACT</td>
<td>Electronic Data Interchange for Administration, Commerce, and Transport</td>
</tr>
<tr>
<td>FASLINC</td>
<td>Fabric and Supplier Linkage Council</td>
</tr>
<tr>
<td>FTA</td>
<td>Fiber/Textile/Apparel (Industry)</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
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<tr>
<td>ITC</td>
<td>Integrated Textile Complex</td>
</tr>
<tr>
<td>NBS</td>
<td>National Bureau of Standards (name changed to NIST in 1988)</td>
</tr>
<tr>
<td>NFPA</td>
<td>National Fire Protection Association</td>
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<tr>
<td>NIST</td>
<td>National Institute of Standards and Technology</td>
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<tr>
<td>SAE</td>
<td>Society of Automotive Engineers</td>
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<tr>
<td>SAFLINC</td>
<td>Sundries and Finding Linkage Council</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
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<tr>
<td>SRD</td>
<td>Standard Reference Data</td>
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<tr>
<td>SRM</td>
<td>Standard Reference Material</td>
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<tr>
<td>STEP</td>
<td>Standard for the Exchange of Product Model Data</td>
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<tr>
<td>TALC</td>
<td>Textile Apparel Linkage Council</td>
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<tr>
<td>TDI</td>
<td>Trade Data Interchange</td>
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<tr>
<td>UCS</td>
<td>Uniform Communication Standards</td>
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<tr>
<td>VICS</td>
<td>Voluntary Interindustry Communication Standard</td>
</tr>
<tr>
<td>WINS</td>
<td>Warehouse Information Network Standard</td>
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