# Easy care, machine washable, wool–polyester suits

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## Background

Ground breaking innovations readily come to mind, for example the light bulb, integrated circuits and lasers. However, not all innovations are ground breaking or are conceived in a single Aha! moment. Some innovations are a response to the changing environment and the need to maintain a competitive edge in the marketplace. The washable wool-containing suit is an example of an innovative product conceived to combat a number of potential threats to the wool formal suiting market; for example, increased dry-cleaning costs and the trend to more active consumer lifestyles. The development of this innovative suit does not require significant change; rather, it requires incremental improvements and strict quality control throughout the manufacturing pipeline, from the fabrics used to produce the suit and accessories incorporated into the design to the procedures used to tailor the suit. Performance standards and processes are described to aid the fabric supplier and garment maker to produce wool-blend easy-care washable garments. These processes are designed to maximise the desirable attributes of wool to give the wearer both comfort and a smart appearance, while minimising the time and care required to maintain these garments. Using the approach described, wool-blend suits can be produced that can be machine washed in a mesh bag and, after drip-drying, require little effort to restore them to a pressed appearance.

This presentation will cover the essential requirements for washable garments with easy-care performance followed by a discussion on the performance requirements for fabrics destined for washable suits, the requirements of the accessories and, finally, the procedures that should be adopted during garment making to ensure the final garment will perform adequately during washing.

Consumers all over the world are demanding clothing to match their active lifestyles. They require garments that are durable, lightweight and comfortable to wear, but are also easily maintained.

The rising cost of dry-cleaning and environmental concerns about the future use of chlorinated solvents, especially in Europe, has increased the demand for washability and easy-care attributes in many garments. Consumers may become unwilling in the future to dry-clean any but the most expensive worsted and woollen garments.

The progressive move in recent years towards lighter weight, soft handling fabrics is somewhat incompatible with the production of easy-care garments because the smooth drying properties are invariably compromised.

The success of wrinkle free cotton trousers in the 90s heightened consumer awareness of the advantages of easy-care garments to the extent that wrinkle-free is now expected for all cotton garments.

## Easy care requirements

After laundering in a washing bag and drip-drying, a machine washable suit must show no shrinkage, physical damage, surface fuzzing or pilling. The seams of the trousers and jackets must remain flat and without pucker, while any creases must be sharp; for example in the trouser leg. The fabric must shed all but the finest wrinkles so the garment can be worn immediately with little or no ironing. All these properties must be achieved without impact on the natural attributes of wool, such as drape and handle.

Depending on garment type and market segment, the necessary performance specifications may vary. The Woolmark standards, in particular W1 (see www.wool.com), are a good starting point for assessing easy-care performance. For an easy-care garment we believe that it is essential that the following criteria are met after around 20 domestic machine wash cycles:

- total linear shrinkage must be less than 3% and cuff edge felting less than 1%
- a smooth dry rating of better than 4 after drying
- the crease rating must be better than 4, with the seams open and without pucker
- the formation of fuzz and pilling must also be kept to a minimum; that is, the increase in fuzz on laundering should be less than 0.3 mm when measured using the SiroFAST system of fabric objective measurement.

The technology is most suitable for fabrics containing around 60% wool and 40% polyester. While fabric dimensional stability and shrink resistance are necessary requirements for easy-care performance, they are not sufficient. The ongoing trend to lighter woven fabrics has presented a challenge to garment manufacturers, who are well aware that these fabrics buckle and distort more readily than heavier fabrics. The properties of the fabric that contribute to appearance and successful make-up must be adequate to allow the garment maker to cut and sew the fabric into garments that look good without pucker or distortion after manufacturing and after laundering. Because of these additional requirements, it is recommended that fabric mechanical properties be objectively measured.

Objective measurement and the development of control zones for fabric mechanical properties, and correction by refinishing if necessary, ensures that the fabrics have good handle and are easy to tailor and that garments keep their shape during wear. By measuring these properties, a garment maker can decide whether it will be difficult to make up before the fabric has been cut. While numerous fabric objective measurement systems are available (for example, KES-F), the SiroFAST system is recommended due to its simplicity.

In addition to measuring the fabric mechanical properties, shrink resistance, fabric smoothness after laundering, surface appearance or fuzzing and the capability of the fabric to be permanently set, a measure of shape stability, must also be assessed. Fabrics that do not meet the necessary performance standards for easy-care applications must be rejected and replaced by alternatives.

Garment makers may be more familiar with fabric properties that determine the life of a garment, for example, tear strength, abrasion resistance and pilling. Less apparent are those important fabric properties that are crucial for the appearance and successful make-up of structured garments. These include, weight, thickness, relaxation shrinkage, hygral expansion, extensibility, bending, shear, and pressing performance.

By objectively measuring these properties a garment maker can decide whether a fabric will be difficult to make up or will perform poorly during laundry, before the fabric has been cut.

## SiroFAST fabric objective measurement

The SiroFAST system of fabric objective measurement was originally designed to predict the performance of fabrics in garment making as an aid to the garment makers in buying fabrics and to assist fabric producers in providing fabrics that would make up into high quality garments. Since its adoption by industry, the technology has been used in a much wider range of application.

SiroFAST is a set of instruments and test methods for measuring mechanical and dimensional properties of wool fabrics. These measurements allow the prediction of fabric performance in garment manufacture and the appearance of the garment during wear. The system was designed to be relatively inexpensive, reliable, accurate, robust and simple to operate. A simple method of interpreting the data to predict fabric performance is an integral part of the system.

SiroFAST consists of five components:

- SiroFAST-1 is a compression meter that measures fabric thickness
- SiroFAST-2 is a bending meter that measures the fabric bending length
- SiroFAST-3 is an extension meter that measures fabric extensibility
- SiroFAST-4 is a test procedure for measuring dimensional properties of fabric
- SiroFAST Press Test is a set of instruments that measures the pressing performance of fabric.

Ideally a fabric piece 0.5 metres by full width is necessary for testing; however, if cut, minimum samples of 500 mm warp x 750 mm weft or 300 mm warp x 1500 mm weft can be used. Test samples are cut to 150 mm x 50 mm.

The tests are performed in the order SiroFAST-1, 2 and 3, as this avoids deformations that would affect later results.

The dimensional stability test and press angle require separate samples.

The sample size for the dimensional stability is 300 mm x 300 mm and for the press test angle is 20 mm x 40 mm.

SiroFAST-1: 5 replicates

SiroFAST-2: 3 warp and 3 weft replicates

SiroFAST-3: 3 warp, 3 weft and 6 bias replicates (3 left bias and 3 right bias)

Press Test Angle: 3 warp and 3 weft

A number of fabric properties are calculated from other measurements using the SiroFAST suite of instruments. These calculated properties include bending rigidity, shear rigidity, formability and finish stability.

The key to the effective use of Fabric Objective Measurement is correct interpretation of the data. Measurement of fabric properties using SiroFAST is a relatively simple process, but interpretation of the data to assess the potential performance of the fabric in garment manufacture is much more difficult. SiroFAST uses a control chart as an aid to interpreting the data. This approach is not new and has been recommended for other objective measurement systems.

Fabric properties are measured using the SiroFAST system and a fingerprint is formed by plotting properties of the fabric on the appropriate scales and then joining the dots. Computer software is available to perform this task automatically. A wide range of information can be obtained from direct observation of the fingerprint's position in relation to the 'grey zones' on the SiroFAST chart.

The grey zones on the chart indicate where potential problems can be anticipated in the manufacture of suits or structured jackets. Slightly different zones would be used for other applications, such as women's dress goods or pleated skirts.

Software is available for use with SiroFAST, which allows the user to adjust limits to meet changing garment designs and skill levels in their factory. The grey zones on the SiroFAST chart are not intended for use only as 'accept or reject' zones. They should be used as indicators that forewarn the garment maker that problems can be anticipated and these problems should be considered in garment manufacture.

If any of the measured properties fall within the 'grey zones' indicating potential problems, the SiroFAST software will print a set of warnings related to those properties at the bottom of the control chart. The software does not provide any interpretation of the results.

## Relaxation shrinkage

The dimensional changes in fabric caused by relaxation processes are due to partial or complete loss of cohesive set in the fibres. Since fabrics are most commonly cohesively set under tension at many stages of finishing, both accidentally and by design, relaxation often leads to contraction or shrinkage of the fabric. Hence, the term 'relaxation shrinkage' is often used loosely to describe the results of the loss of cohesive set.

Inadequate (negative) relaxation shrinkage produces:

- growth of garment panels during manufacture
- poor matching of panels
- seam puckering if growth occurs after sewing.

While excessive relaxation shrinkage produces:

- excessive shrinkage during garment manufacture (especially pressing) and laundering
- poor size matching of garment panels, especially when one panel has been subjected to more processing than another (for example, fusing or pressing)
- seam puckering when components have different processing histories (for example, pressing)
- incorrect sizing.

Stretching of the fabric followed by setting with heat or pressure decatising should be avoided as this tends to reduce the extensibility of the fabric, leading to a harsher handle and impaired intrinsic shrink resistance of the fabric. Seams are easier to sew without pucker and the garment more comfortable to wear the more extensible the fabric. On the other hand, it is easy to impart excessive relaxation shrinkage to highly extensible fabric. Nevertheless, the advantages gained from maximising the extensibility of the fabric out-weight the problems associated with minimising relaxation shrinkage.

## Seam pucker

One critical area in the manufacture of a washable suit is in eliminating seam pucker as this detracts from the overall appearance of the garment and is extremely difficult for the consumer to remove with a hand iron if it reappears after laundering. Pressing does not remove sewing faults and, although pressing may hide these faults, they may reappear after the first laundering cycle. Hence, any puckering, poor seam formation or fabric distortion must be corrected by resewing and not by pressing. Many factors, including the properties of the fabric, contribute to pucker formation during sewing.

Feeder pucker results from one ply advancing faster than the other. It tends to be worse at higher sewing speeds. Machines with both upper and lower feeding mechanisms are preferred.

Pucker caused by sewing threads can be identified by cutting the thread in the seam – pucker in this area should disappear. Care must be taken in choosing threads that will not shrink. Excessive thread tensions must also be avoided during sewing.

Some faults appear when the garment takes up moisture in a humid environment. This could be recurring pucker that has been pressed out temporarily. Alternatively, it may be caused by excessive hygral expansion, where the growing fabric has puckered adjacent to the held, seamed area. Hygral expansion is less likely to be an issue for wool–polyester blend fabrics.

Inherent pucker is caused by the properties of the fabric and in some instances the fabric may need to be refinished to correct and modify the intrinsic properties of the fabric to enable it to be sewn without pucker.

The tendency of a fabric to buckle when it is compressed in its own plane is known as 'formability'. Formability is calculated from the product of low-load extensibility and the bending stiffness of a fabric. As formability is calculated from the bending rigidity, and bending rigidity is derived from bending length and fabric weight, it is easy to see why lightweight fabrics tend to have low formability.

When a seam is sewn, the thread always compresses the fabric to some degree and the lower the formability of a fabric, the more likely the seam will pucker. Formability has also been shown to relate directly to the maximum degree of overfeed that can be accommodated in a fabric seam without causing buckling. Hence, low or inadequate formability will result in seam pucker and poor overall garment appearance. This is one of the most critical fabric parameters in managing seam pucker in washable suits.

The example in the PowerPoint presentation shows a fabric that presented difficulties with seam pucker because of its low extensibility and formability (dotted line). After re-finishing by the fabric supplier, the fingerprint was more acceptable (full line) and the garment was made up without any problems.

In most cases, the garment maker, once alerted to the potential problem with a fabric, can take more care during make-up to overcome the problem.

## Finish stability

Finish stability or flat stability are terms normally applied to the changes in fabric thickness that occur when the fabric is relaxed in water or steamed and re-conditioned. In the last stages of dry finishing, wool containing fabrics are often flattened by pressing and decatising to remove any remaining creases and impart a smooth flat finish. These processes reduce the thickness of the fabric as well as changing the surface geometry of the fabric. If the conditions used are mild, for example, pressing, decatising and continuous decatising, the fibres will only be cohesively set and the stability of these finishes will be low. When these fabrics become wet, the fabric thickness will substantially increase and any permanently set creases (such as running marks introduced during dyeing) will reappear.

On the contrary, if more severe setting conditions are used at the end of the finishing sequence, for example, pressure decatising, the changes will be more permanent and the flat stability and finish stability will be high. Hence, inadequate finish stability can result in changes in handle and appearance; for example, loss of lustre or fabric surface becomes uneven or reappearance of fabric distortions, such as running marks.

Finish stability is given by:

- Finish Stability =100 * Surface thickness/Surface thickness released.

The wool–polyester blend fabric should be heat set at 180$^{o}$C to stabilise the fabric before dyeing. This process also improves the smooth drying properties of colour woven fabrics.

## Fabric finishing

During any finishing process it is important to ensure that stretching of the fabric is avoided in order to prevent the introduction of excessive relaxation shrinkage. Setting of a stretched fabric tends to reduce extensibility leading to a harsher handle, impaired intrinsic shrink resistance of the fabric and low formability and, hence, the potential for seam pucker during garment making.

The fabric should be conditioned and pressure decatised to complete the finishing process. A fabric pH of between six and eight and a moisture regain of between 12 and 16%, based on the wool component of the fabric, is required on entry to the pressure decatiser to achieve a high level of permanent set. For a 50:50 wool–polyester blend the fabric regain will be between 6 and 8%.

## Test methods – fabric

Shrink resistance of fabrics is assessed in a standard test that measures both relaxation shrinkage and felting shrinkage in machine washing. Felting shrinkage occurs most rapidly in the creases and cuffs of men's trousers and impairs garment appearance long before the flat areas of the garment begin to felt. Hence, the assessment of (differential) cuff-edge shrinkage is also important. Wash testing based on Woolmark Test Methods involves washing the fabric or garment using a combination of the 7A and 5A Wascator washing cycles. The 7A cycle has a rather gentle washing action and is essentially similar to a domestic ‘wool wash’ or ‘delicate’ machine-wash cycle. The 7A cycle is used to relax the fabric (for example, to determine relaxation shrinkage). The 5A wash cycle provides a more severe washing action to achieve an ‘accelerated’ wash test. Approximately seven to 10 washes using the 7A cycle are necessary to achieve a similar impact on the fabric or garment as one wash using the 5A cycle. Consequently, three washes using the 5A cycle are expected to have the same impact as 20 washes in a domestic washing machine using a ‘wool wash’ cycle, around 20 domestic washes being the expected life of the garment.

Smooth dry performance is also an important part of easy-care and is assessed by allowing the test samples to air dry on a smooth surface after the washing cycle is completed and compared against a set of reference photographic standards.

Fuzzing of flat areas impairs garment appearance and may be measured directly or assessed visually after each wash and (tumble) dry cycle. Like shrinkage, fuzzing occurs most rapidly on the cuffs and pocket edges. Fabric thickness measurements can be used to objectively measure fuzz. The term ‘fuzz increase’ is defined as the difference between the thickness of the wet-relaxed and conditioned fabric before washing and that after washing and drying.

Seam smoothness and crease retention are also important elements of easy-care garments and must be assessed.

The ability of a fabric to shed the wrinkles imposed during laundering when the garment is wet is called ‘smooth dry performance’. Smooth dry performance is also an important part of easy-care and is assessed by allowing the test samples to air dry on a smooth surface after the washing cycle is completed and compared against a set of five reference photographic standards. A rating of 4 or above is recommended for washable suits.

The propensity of a fabric to be permanently set is determined by steam pressing folded samples of the fabric using a 10 s steam/10 s bake/10 s vacuum cycle. Snippets (5 mm) of yarn are extracted from the warp and weft creases and placed in water at 50°C for 30 minutes. The water is cooled to near room temperature by adding cold water. The snippets and some of the liquor are transferred to Petri dishes and the angle formed by the yarn snippets measured using a protractor. Measurement of the angle is simplified if an overhead

projector is used to project images of the snippets onto a screen. A minimum of 10 snippets is measured in each of the warp and weft direction and the mean angle ($\alpha$) calculated. The level of permanent set is normally expressed as a percentage of the original angle. Permanent Set (%) = $(180 - \alpha)/1.8$.

To produce garments with good wash stability, flat seams and sharp creases, particularly in trousers, permanent set in excess of 40% is necessary.

## Garment accessories

Many accessories are not suitable as a result of delamination on exposure to water, shrinkage or changes in mechanical properties (removal of sizes) during laundering. All accessories must be rigorously tested to determine whether they will perform adequately even if the manufacturer claims washability. Components that do not perform adequately should be replaced by alternatives. The excessive retention of water after washing is also undesirable as it causes unacceptably long drying time and may result in water marks due to water migration during drying.

The use of solid coloured buttons is recommended as a starting point, as abrasion during laundering may cause some discolouration of buttons that have only a surface coating.

The use of metal zippers is not recommended.

Samples of garment accessories (400 mm x 400 mm) should be overlocked and wash-tested to assess suitability for easy-care garments. Samples of fusible interlining (300 mm x 300 mm) should be fused onto a stable shell fabric (400 mm x 400 mm) following the manufacturer's recommendations for time, temperature and pressure, and wash-tested and assessed for delamination or deterioration. Alternative (washable) products should be sourced and tested if the accessories normally used do not provide adequate easy-care performance.

## Garment make-up

Patterns should be adjusted so the back seam is at least 20 mm wide in the jacket and 15 mm in trousers to aid stability and smoothness. Fancy stitching, pocketing and other fashion devices may cause problems in laundering and should, where possible, be avoided until experience is gained with garments of a more simple construction.

Overlocking and reverse lock stitching of fabric and accessory panels is recommended to prevent fraying of edges during laundering; for example, chest canvas and lining. Sewing threads, thread tension and stitch types should be chosen to minimise puckering, consistent with adequate seam strength. Correct tension on the seam joining the waistband to the garment is vital as any puckering in this region after washing tends to detract from the overall appearance of the garment. The buttons should be firmly attached through the entire thickness of the lapel to prevent their loss during laundering.

Fusible interlinings are recommended because they contribute to the stability of the cloth during washing. It is important that the manufacturer's recommendations for fusing time and temperature are strictly followed and that they are fused one layer at a time (for example, fused at 160°C for 12 seconds at 2 bar pressure). The fusible interlining should be tested carefully to ensure there is no shrinkage or delamination during machine washing and drying of the garment. Any problems are generally encountered after the first wash cycle. Steaming without pressure directly onto fused panels from a steam press or iron must be avoided, as this will cause delamination and deformation of the interlining.

Any puckering, poor seam formation or fabric distortion must be corrected by resewing and not by pressing. Pressing does not remove sewing faults and, although pressing may hide

these faults, they may reappear after the first laundering cycle. Garments should be inspected for quality before pressing as well as on completion.

After laundering it is essential that all seams remain flat without puckering and all creases are sharp in order to minimise or eliminate completely the need to iron the garment. To achieve this, the creases and seams must be permanently set in the desired configuration during garment make up. This is particularly important for trouser seams and creases and the back and side seams of the jacket. These seams need to be steam pressed for 10 seconds and baked for 10 seconds before commencing the vacuum cycle in order to permanently set the polyester and provide adequate shape retention.

Trousers should be left unhemmed, as the final pressing and setting operation permanently sets the fabric, making it impossible to remove the hem crease if the trouser length needs to be increased. Fabric panels that are steam pressed for longer than around three seconds in an incorrect configuration should be discarded as the creases cannot be adequately removed by repressing and will reappear after laundering.

The wash performance of completed sample garments should also be assessed before committing time and resources to full production. It is also recommend that during production a number of sample garments be selected at random and their performance assessed as a quality control measure.

## Garment testing

Garments should be washed according to the method and instructions provided to the consumer on the garment label; that is, a mesh washing bag should be used if the normal washing procedure stipulates its use. The garments need to be removed immediately after the laundering cycle is completed to prevent the formation of sharply defined creases and folds. After removal from the machine the garments should be given a gentle shake and placed onto a jacket or coat hanger and any obvious deformations, such as pocketing, lapel or collar turning, should be adjusted to ensure the garments dry in the desired configuration. The trousers should be given a gentle shake and then hung by the legs in a closed configuration using a skirt hanger to achieve maximum appearance retention.

Performance standards and processes have been presented to aid the fabric supplier and garment maker to produce wool-polyester blend easy-care garments.

These processes are designed to optimise the desirable attributes of wool to give the wearer both comfort and a smart appearance, while minimising the time and care required to maintain these garments.

# Questions

1. To permanently set creases and seams they must be pressed using a steam/bake/vacuum cycle for what period of time (given in seconds)?

    a. 2/2/2

    b. 5/5/5

    c. 10/10/10

    d. 20/20/20

2. Easy-care performance requires that garments have which of the following properties?

    a. Shrink resistance

    b. Crease retention

    c. Easy ironing

    d. All of the above

3. During fabric finishing, why is it important to maintain fabric extensibility?

    a. To maximise inherent shrink resistance

    b. To improve fabric handle

    c. To minimise seam pucker during sewing

    d. All of the above

4. If a piece of fabric or garment is accidentally steam pressed for an extended period in the wrong place, what action should be taken?

    a. It should be steam pressed to remove the crease

    b. It should be discarded completely

    c. It should be gently ironed to remove the crease

5. Fabric, accessories and garments are usually assessed for easy-care performance using a Wascator 5A cycle as an accelerated test procedure. What is the minimum number of 5A Wascator cycles that should be achieved for easy-care performance?

    a. One

    b. Two

    c. Three

    d. Five

6. If seam pucker or sewing faults are observed during garment making, how should they be removed?

    a. Gently ironing

    b. Steam pressing

    c. Doing nothing

    d. Unstitching and re-sewing