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Report

Received:

Two shirts made of Ulfrotté Original thermal undergarment fabric and two remnants of the fabric from which the shirts were made. The samples have been labelled as:

1. Shirt and fabric remnant, navy blue, 60% wool/25% polyester/15% polyamide blend, 200 g/m². TNO sample number: 84004/01.42.01
2. Shirt and fabric remnant, navy blue FR, 70% wool/18% polyamide/12% aramide blend, 400 g/m². TNO sample number: 84004/01.42.02

Additional information:

The shirts were well packed in a cardboard box. Size, fabric composition and care instructions were clearly presented on the outside of the box.

Made using a tube-knitted construction with only two seams, the well crafted shirts both have a sewn-in label, which clearly indicates the size, care instructions, fabric composition and weight. The shirts are attractively finished.

Assignment:

Assess the shirts' breathability, the insulation value (in the unlaundered state and after laundering three times), shrinkage and distortion, abrasion resistance, fuzzing/pilling, bursting strength and colour fastness to artificial light, perspiration and laundering.

Test methods:

- | | |
|---|--|
| -Breathability, skin model, Ret value: | ISO 11092:1993 (EN 31092:1993) |
| -Insulation value, Ret value: | ISO 11092:1993 (EN 31092:1993) |
| -Shrinkage & laundering: | ISO 6330:2001, 3A, 60°C, tumble dry |
| -Distortion: | BS 2819:1990 |
| -Abrasion resistance (Martindale method): | ISO 12947-2, 9 kPa load, criterion:
a single worn thread (woven) |
| -Bursting strength: | ISO 13938-1:1999 |
| -Pilling (ICI method): | ISO 12945-1:2000, assessed after
15,000 revolutions |
| -Colour fastness to artificial light: | ISO 105 B02:1999, assessed using
the blue scale, which ranges from
1 (low) to 8 (high) |

Date

11 May 2004

Project number

007.84004/01.42

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Client reference

Your visit on 13 February 2004

The Standard Conditions for Research Instructions given to TNO, as filed at the Registry of the District Court and the Chamber of Commerce in The Hague, shall apply to all instructions given to TNO.



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-Colour fastness to perspiration: ISO 105 E04:2002, assessed using the grey scale, which ranges from 1 (low) to 5 (high)

-Colour fastness to laundering: ISO 105 C08:2001, assessed using the grey scale, which ranges from 1 (low) to 5 (high)

Results:

➤ *Breathability*

Ret value in m ² Pa/W	Unlaundered state	After laundering once	After laundering three times
Navy blue remnant, 200 g/m ² , 84004/01.42.01	9.9	11.2	11.8
Navy blue FR remnant, 400 g/m ² , 84004/01.42.02	10.4	10.9	12.1

Classification:

Category 1: Ret > 40	Poor breathability
Category 2: 20 < Ret ≤ 40	Moderate breathability
Category 3: Ret < 20	Good breathability

➤ *Thermal resistance*

Ret value in m ² K/W	Unlaundered state	After laundering three times
Navy blue remnant, 200 g/m ² , 84004/01.42.01	146 · 10 ⁻³	199 · 10 ⁻³
Navy blue FR remnant, 400 g/m ² , 84004/01.42.02	165 · 10 ⁻³	156 · 10 ⁻³

Classification:

1. Standard undergarments	Ret < 40 · 10 ⁻³ m ² K/W
2. Low thermal insulation	Ret = 40-60 · 10 ⁻³ m ² K/W
3. Moderate thermal insulation	Ret = 60-80 · 10 ⁻³ m ² K/W
4. High thermal insulation	Ret > 80 · 10 ⁻³ m ² K/W

➤ *Shrinkage & distortion*

Shrinkage after laundering (60°C, tumble dry)	length (%)	width (%)
Shirt Navy blue, 200 g/m ² , 84004/01.42.01	2.7	7.8
Shirt Navy blue FR, 400 g/m ² , 84004/01.42.02	-2.2	7.7



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Distortion	Unlaundered state	After laundering once
	(%)	(60°C) (%)
Shirt Navy blue, 200 g/m ² , 84004/01.42.01	1.5	4.5
Shirt Navy blue FR, 400 g/m ² , 84004/01.42.02	3.6	3.6

➤ *Abrasion resistance*

Abrasion resistance	Number of revolutions until one thread is worn		
	average	highest value	lowest value
Navy blue remnant, 200 g/m ² , 84004/01.42.01	67,000	67,000	67,000
Navy blue FR remnant, 400 g/m ² , 84004/01.42.02	>100,000	>100,000	>100,000

➤ *Bursting strength*

Bursting strength	Bursting strength (kPa)		
	average	highest value	lowest value
Navy blue remnant, 200 g/m ² , 84004/01.42.01	526	585	460
Navy blue FR remnant, 400 g/m ² , 84004/01.42.02	568	600	535

➤ *Pilling (ICI method)*

Pilling	After 7,500 revolutions	After 15,000 revolutions
Navy blue remnant, 200 g/m ² , 84004/01.42.01	4	3-4
Navy blue FR remnant, 400 g/m ² , 84004/01.42.02	4-5	3

➤ *Colour fastness to artificial light*

Colour fastness to artificial light	Assessment (from 1 to 8)
Navy blue remnant, 200 g/m ² , 84004/01.42.01	5-6
Navy blue FR remnant, 400 g/m ² , 84004/01.42.02	6-7



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➤ *Colour fastness to perspiration*

Colour fastness to perspiration pH=5.5	Dis-coloration	Staining					
		wool	acrylic	PES	PA	cotton	acetate
Navy blue remnant, 200 g/m ² , 84004/01.42.01	4-5	4-5	4-5	4-5	3-4	4-5	4-5
Navy blue FR remnant, 400 g/m ² , 84004/01.42.02	4-5	4-5	4-5	4-5	3-4	4-5	4

Colour fastness to perspiration pH=8.0	Dis-coloration	Staining					
		wool	acrylic	PES	PA	cotton	acetate
Navy blue remnant, 200 g/m ² , 84004/01.42.01	4-5	4-5	4-5	4-5	3-4	4-5	4-5
Navy blue FR remnant, 400 g/m ² , 84004/01.42.02	4-5	4-5	4-5	4-5	3	3	4

➤ *Colour fastness to laundering*

Colour fastness to laundering	Dis-coloration	Staining					
		wool	acrylic	PES	PA	cotton	acetate
Navy blue remnant, 200 g/m ² , 84004/01.42.01	4-5	4-5	4-5	4-5	4-5	4-5	4-5
Navy blue FR remnant, 400 g/m ² , 84004/01.42.02	4-5	4-5	4-5	4-5	4	4-5	4-5



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Conclusion:

Both fabrics offer good breathability and extremely high thermal resistance. Shrinkage in length and width resulting from laundering is within the normal range for undergarments. The distortion of the 200 g/m² fabric falls within the acceptable range of 3-4%. The distortion of the 400 g/m² fabric is good.

The abrasion resistance and bursting strength of both fabrics is good, meeting the guidelines maintained for both (i.e. 50,000 revolutions for abrasion resistance and 350 kPa for bursting strength).

Scoring a 3 after 15,000 revolutions, fuzzing/pilling just meets the acceptable levels for undergarments. The colour fastness of both fabrics to artificial light, laundering and perspiration is good.

The fabric's construction (i.e. woollen pile interwoven with a synthetic base) ensures effective moisture regulation and water vapour permeability. The fabric has tactile properties (i.e. it feels soft against the skin).

Project manager:
R. Boerboom, B.Sc.

A handwritten signature in blue ink, appearing to read 'R. Boerboom', is located below the project manager's name.

Approved by:
J. Brinks

A handwritten signature in blue ink, appearing to read 'b.a. W. J. Brinks', is located below the approved by name.