



ARCHIVED - Archiving Content

Archived Content

Information identified as archived is provided for reference, research or recordkeeping purposes. It is not subject to the Government of Canada Web Standards and has not been altered or updated since it was archived. Please contact us to request a format other than those available.

ARCHIVÉE - Contenu archivé

Contenu archivé

L'information dont il est indiqué qu'elle est archivée est fournie à des fins de référence, de recherche ou de tenue de documents. Elle n'est pas assujettie aux normes Web du gouvernement du Canada et elle n'a pas été modifiée ou mise à jour depuis son archivage. Pour obtenir cette information dans un autre format, veuillez communiquer avec nous.

This document is archival in nature and is intended for those who wish to consult archival documents made available from the collection of Public Safety Canada.

Some of these documents are available in only one official language. Translation, to be provided by Public Safety Canada, is available upon request.

Le présent document a une valeur archivistique et fait partie des documents d'archives rendus disponibles par Sécurité publique Canada à ceux qui souhaitent consulter ces documents issus de sa collection.

Certains de ces documents ne sont disponibles que dans une langue officielle. Sécurité publique Canada fournira une traduction sur demande.

TM-10-98
TESTING OF GARMENT COMPONENTS OF
CROWD CONTROL EQUIPMENT IN RELATION
TO PROTECTION AGAINST HEAT AND FLAME

By: Textile Analysis Service,
University of Alberta

TECHNICAL MEMORANDUM

Submitted by
Canadian Police Research Centre

August, 1998

NOTE: Further information
about this report can be
obtained by calling the
CPRC information number
(613) 998-6343

EXECUTIVE SUMMARY

Some concerns were raised by Vancouver Police Department with respect to the fire retardant properties of certain garment components of a crowd control equipment ensemble. The Canadian Police Research Centre was approached to sponsor the testing of the material.

This Technical Memorandum is the test report prepared by the Textile Analysis Service of the University of Alberta at Edmonton.

It is reprinted for the information of the Canadian police community.

The Canadian Police Research Centre would like to thank Det.Cst. Kevin Critchley of the Vancouver Police Department for initiating this study.

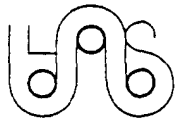
SOMMAIRE

Des questions ont été soulevées par le service de police de Vancouver relativement aux propriétés ignifugeantes de certains éléments de la tenue utilisée pour le contrôle des foules. Le Centre canadien de recherches policières a été invité à commanditer l'essai de ce matériel.

Le présent document technique est le rapport préparé par le "Textile Analysis Service" de l'Université de l'Alberta à Edmonton.

Il est produit à titre d'information à l'intention de la communauté policière du Canada.

Le Centre canadien de recherches policières tient à remercier l'agent-detective Kevin Critchley du service de police de Vancouver d'avoir entrepris cette étude.



Textile Analysis Service 315 Printing Services Building
University of Alberta Edmonton Alberta T6G 2N1

phone (403) 492-3832
Fax (403) 492-4111

TEST REPORT

This Report Contains 11 pages

Client Det/Cst. 1556 Kevin Critchley
Patrol Division District 3, Team 9
Vancouver Police Department
312 Main Street
Vancouver, BC
V6A 2T2

Date September 17, 1997
Invoice M 42706

Reference No 20-012-28

ARTICLES TESTED

Garment components of a Crowd Control Equipment ensemble:
9.5 oz/sq yd Proban FR cotton coverall
8 oz/sq yd (non-FR) 65% polyester/35% cotton ballistic protection vest
7.3 oz/sq yd nylon and lycra padded football girdle
Only the fabric components of the listed garments were tested. The Kevlar ballistic protection panels and the polystyrene & hard plastic pads were removed from the vest. The polystyrene pads were removed from the football girdle. The padding materials were not tested.

A pair of boots was also submitted for comment.

TESTING REQUESTED

Concerns expressed by the client regarding the properties of the garments in relation to protection against heat and flame were to be addressed. The specific hazard of concern, as identified by the client, is exposure to small gasoline bombs (or "Molotov Cocktails"). Specific questions were asked by the client and the report will focus on these issues. Where possible, test results are provided to support comments.

STANDARDS REFERENCED Standards pertaining to the performance requirements of garment components of crowd control equipment are not known to Textile Analysis Service. The following standards for protective clothing were referenced with respect to test procedures and fabric performance requirements for protection against heat and flame hazards:

1. C**/CGSB-155.20 (Eighth Draft) Workwear for Protection Against Hydrocarbon Flash Fire
2. CAN/CGSB 153.1 Fire Fighters' Protective Clothing for Protection Against Heat and Flame

... 2

ABOUT THIS TEXTILE ANALYSIS SERVICE REPORT:

The findings of this report were made by experienced analysts and are based on current Textile Analysis Service knowledge. It is assumed that the information supplied by the client was valid and complete.

Samples submitted for testing are accepted on the understanding that the report issued can not form the BASIS of, or instrument for, any legal liability against the Textile Analysis Service and applies specifically to the sample tested and not necessarily to the bulk.

The report is considered to be the privileged information of the client (person/agency requesting the analysis). The Textile Analysis Service will not release details, or copies, of the report without the permission of the client. The contents of the report are not to be abstracted (summarized) or reproduced in part WITHOUT the written permission of the Textile Analysis Service. The report may be reproduced in whole.

In the event of the improper use of this report, the Textile Analysis Service reserves the right to withdraw it or to adopt any other remedy which may be appropriate.

TEST METHODS

CAN/CGSB-4.2 Textile Test Methods

No. 27.10 Flame Resistance - Vertically Oriented Textile Fabric or Fabric Assembly
Surface Ignition procedure

C/CGSB-155.20** (Eighth Draft) Workwear for Protection Against Hydrocarbon Flash Fire

Par. 7.1 Flame Resistance Test:

CAN/CGSB-4.2-M77 Textiles Test Methods

No. 27.10 Flame Resistance - Vertically Oriented Textile Fabric or Fabric Assembly
Edge ignition procedure as outline in par 7.1.1 of C**/CGSB-155.20 (Eighth Draft)

Par. 7.2 Thermal Protection Test

Fabrics were tested in accordance with:

ASTM D 4108 - 87

Thermal Protective Performance of Materials for Clothing by Open Flame Method

7.2.1 single layer, with spacer test: specimen mounting procedure as described in par
7.2.4.4 a of C**/CGSB-155.20 (Eighth Draft)

7.2.2 single layer, without spacer test: specimen mounting procedure as described in par
7.2.4.4 b of C**/CGSB-155.20 (Eighth Draft)

7.2.3 multi-layer, without spacer test: specimen mounting procedure as described in par
7.2.4.4 c of C**/CGSB-155.20 (Eighth Draft)

Par. 7.3 Heat Resistance and Thermal Shrinkage Tests

TEST RESULTS

Details of test results are provided on the final 6 pages of the report.

EVALUATION & DISCUSSION

Key points concerning the use of the garments, as reported by the client:

- a) The girdle is worn beneath the coverall;
- b) The vest is designed to be worn OVER the flame resistant coverall. No flame retardant has been applied to the vest fabric;
- c) The hazard of concern is the "Molotov Cocktail" which uses gasoline as a fuel source.

Comments: Although gasoline is the fuel of primary concern, the standard **flammability tests** performed by this lab do not utilize gasoline as a fuel source. The fuel used in the flammability testing was propane. Clean fabrics were tested. The flame resistance and protective performance of the fabrics when contaminated with a liquid fuel, such as gasoline, will be different from non-contaminated fabrics.

Comments addressing specific concerns raised by the client:

1. Coverall:

The open hip pocket design of the coverall is a concern. The opening could provide direct access of flames to the nylon and lycra girdle worn underneath. (As discussed below, the girdle may present a hazard.) This problem could be remedied by a design change. The hip opening could be permanently closed with stitching, or, access to the body or garment layers worn underneath the coverall could be retained by adding a closure, such as Velcro or a snap, to the hip opening.

The cover flaps on the thigh pockets provide insufficient coverage of the opening and, as suspected by the client, might allow fuel to enter and accumulate in the pockets. As well, the exposed opening of the pocket provides a fabric edge for ignition. This problem could be remedied by lengthening the ends of the cover flap so that when closed, the flap extends beyond the edges of the pocket and prevents exposure to the pocket opening and edges by fuels or flames.

The results of the flame resistance test carried out on the coverall fabric (refer to p. 5) indicate that the fabric has good flame resistance. A concern about the durability of the flame resistant finish was expressed by the client. This lab has found through past experience that Proban FR cotton fabrics retain their flame resistant properties after repeated launderings. However, this does not imply an endorsement or warranty of this fabric by Textile Analysis Service. The manufacturer of Proban FR cotton fabrics (Westex Inc., ph. 773-523-7000) should be contacted for detailed information regarding the guarantee on the fabric.

The results of the thermal protective performance (TPP) tests carried out on the Proban FR cotton fabric indicated that it meets the thermal protection requirements of a draft standard for flame protective workwear (refer to pp. 9&10).

It should be emphasized that any flame resistant fabric which is contaminated with a flammable substance will have reduced flame resistance and thermal protection properties because the flammable contaminant will provide fuel for burning.

2. Vest:

It was reported that the vest is designed to be worn over the Proban FR cotton coverall. The vest itself is not constructed from a flame resistant fabric and the fabric was found to perform poorly in the flame resistance test (refer to p. 6). The use of a non-flame resistant garment over a flame resistant garment is not recommended. Although the flame resistant garment may not necessarily ignite if the over-garment burns, the presence of a burning garment in the assembly, especially if it is in immediate contact with the ignition source, provides a burn hazard to the wearer. In the vertical bum test, the vest fabric was observed to burn rapidly, with a high flame until the fabric was completely destroyed. It is strongly recommended that this vest be constructed of a flame resistant fabric if it is to be used in situations where flame hazards exist.

The design of the vest provides several openings and exposed edges. The openings may allow flames or fuel to enter the garment assembly. The many fabric edges provide points for ignition if flames contact the garment. The results of the edge ignition flame resistance test indicated that the polyester and cotton fabric readily ignited when a flame was applied to the edge of the fabric. It is advised that the design of this garment be reconsidered and an attempt be made to better secure the openings and reduce the amount of exposed fabric edges. If the vest is constructed from a flame-resistant fabric, the edge-ignition hazard will be reduced. Modifications made to the garment to reduce the opportunities for it to ignite, or support burning, in a flame hazard situation are recommended.

3. Football girdle:

Generally, nylon and lycra fabrics can be a thermal hazard if they are exposed to high enough temperatures to promote melting. Nylon, depending on the variety, will start to melt at temperatures which range from 210° to 260°C. The heat resistance test was used to evaluate the potential melting hazard of the girdle fabric at a temperature of 260°C (refer to p. 11). The fabric was found to melt and form a sticky, molten mass at the bottom of the test chamber.

The nylon and lycra girdle fabric was found to have poor flame resistance in the vertical burn test (refer to p. 7). The girdle fabric ignited, burned with an intense flame, and burning, molten drips fell from the test specimen. It is believed that direct contact of an ignition source with this fabric could present a bum hazard. In order to determine if the girdle fabric would burn when worn beneath the coverall fabric a surface ignition flame resistance test was carried out (refer to p. 8). The coverall fabric was placed over top of the girdle fabric and a flame was applied to the surface of the coverall fabric. During this test the girdle fabric did not ignite. However, during the 12 second period of the test, the girdle fabric was found to melt and stick to the coverall fabric.

The TPP test was also used to evaluate the girdle fabric. This test evaluates the time required to reach a 2nd degree burn using a 2 cal/cm²/sec flame. The higher the TPP value, the more protective the fabric. When the results of TPP tests with the girdle fabric beneath the coverall fabric are compared to the results of the tests without the girdle fabric it is found that the girdle fabric increases the TPP value (improves the thermal protection). This is primarily a result of the addition of an extra layer of fabric.

The condition of the girdle fabric at the end point (2nd degree bum) was evaluated. In the test where the girdle fabric was in direct contact with the sensor, the girdle fabric was not found to melt or stick to the sensor. However, the girdle does appear to have started to undergo physical changes (softening) as a result of the flame exposure. In the test where the girdle fabric was separated from the sensor with a 1/4" spacer, at the second degree bum point, the nylon and lycra girdle fabric had melted and stuck to the coverall fabric.

The nylon and lycra fabric is considered to be a potential thermal hazard due to the fact that it melts and the molten polymer may stick to the skin, causing severe burn injuries. Design changes in the coverall would reduce the possibility of direct exposure of the girdle to flames. The heat transfer through the outer fabric layers (exposed to flames) to the girdle fabric may create a burn hazard, if the exposure is long enough and/or the temperatures reached high enough to cause the nylon and lycra fabric to soften and/or melt. Such conditions would vary in "real life" situations.

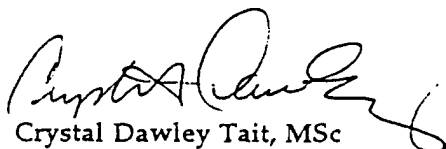
It may be possible to find a similar knit under-garment constructed from a flame resistant fabric (e.g. Nomex, Kennel, Proban) blended with lycra (for stretch). Market research would be required to determine the availability of such a product. If suitable fabrics are available, garments may need to be custom made. If a suitable flame resistant fabric is not available, a cotton and lycra stretch fabric would be an improvement over the nylon and lycra fabric. Cotton does not melt and the chance of a bum injury created by a melted material would be reduced.

4. Boots:

It is agreed that the boots are sturdy and well made. The nylon content of the upper material should not be a serious concern. The heavy nylon fabric is very tight over the boot and it would likely take a substantial flame to ignite it. It is more likely that burning contaminants (e.g. gasoline) on the boot would present a greater hazard than the materials used to construct the boot.

CONCLUSIONS

1. Minor design changes to the coveralls, e.g. closing the hip openings and extending the pocket flaps, should improve the protective properties of this garment.
2. If the ballistic protection vest is to be used over top of the coverall and thus be in a position to possibly receive direct contact with flames, changes should be made. The ballistic vest should be constructed from a flame resistant fabric if it is to be used in situations where a flame hazard may exist. Design changes which would reduce the size of the openings in the garment and the number of exposed fabric edges should be considered.
3. It is recommended that the nylon & lycra girdle fabric be replaced. A flame resistant knit fabric incorporating lycra would be ideal. However, if such a product is not commercially available, a cotton & lycra blend knit fabric would be recommended. The possibility for direct contact of the girdle with flames should be eliminated.
4. The boots are not believed to be of significant concern with respect to flame hazards.
5. Any flame resistant fabric or garment which is contaminated with a flammable substance will have reduced flame resistance and thermal protection properties because the flammable contaminant will provide fuel for burning.


 Crystal Dawley Tait, MSc
 Textile Technologist

TEST RESULTS: C**/CGSB-155.20 (Eighth Draft), par 7.1 Flame Resistance Test

Test Conditions

Specimen Condition: oven dried at 105° C for 1 hr, and cooled in dessicator prior to testing

Specimen Size: 80 x 200 mm

Burner Position: flame applied to lower edge at a 30° angle to the vertical axis of the fabric

Burner Gas: Propane

Ignition Flame application Time: 12 seconds

Sample: Proban FR cotton COVERALL fabric
326 g/sq m (9.6 oz/sq yd)

Specimen	Duration of Afterflame (sec)	Dripping	Length of Damaged Area (mm)	Observations of Burning
Warp				The fabric ignites briefly during flame exposure period but does not support burning by the end of the test. No afterflame was observed. No melting or dripping occurred.
1	0.0	none	62	
2	0.0	none	76	
3	0.0	none	58	
4	0.0	none	82	
5	0.0	none	62	
Warp Average (std dev)	0.0 (0.0)	none	68 (10.4)	
Weft				
1	0.0	none	66	
2	0.0	none	68	
3	0.0	none	68	
4	0.0	none	70	
5	0.0	none	67	
Weft Average (std dev)	0.0 (0.0)	none	68 (1.5)	
Average of All Specimens	0	none	68	

Flame Resistance Requirements of C**/CGSB-155.20 (Eighth Draft), par 6.1.1.1:

The protective fabric shall be tested in accordance with par 7.1 and shall have an average damaged length of not more than 100 mm in either direction and average afterflame of not more than 2.0 s. There shall be no melting or dripping,

CONCLUSION:

The Proban FR cotton coverall fabric tested meets the requirements for flame resistance.

TEST RESULTS: C**/CGSB-155.20 (Eighth Draft), par 7.1 Flame Resistance Test

Test Conditions

Specimen Condition: oven dried at 105° C for 1 hr, and cooled in dessicator prior to testing

Specimen Size: 80 x 200 mm

Burner Position: flame applied to lower edge at a 30° angle to the vertical axis of the fabric

Burner Gas: Propane

Ignition Flame application Time: 12 seconds

Sample: cotton and polyester VEST fabric
271 g/sq m (8 oz/sq yd)

Specimen	Duration of Afterflame (sec)	Dripping	Length of Damaged Area (mm)	Observations of Burning
Warp 1	25	none	200	The fabric ignites during the flame exposure period and continues to burn upon removal of the ignition flame. High afterflame was observed. After termination of the burning, the remains continued to afterglow for >60 seconds. In each case, the entire specimen was destroyed. Because of the obvious failure of the first three specimens from each fabric dimension, testing of the full set of specimens was not carried out.
2	27	none	200	
3	26	none	200	
4				
5				
Warp Average (std dev)	26 (1.0)	none	200 (0.0)	
Weft 1	25	none	200	
2	25	none	200	
3	24	none	200	
4		none		
5		none		
Weft Average (std dev)	25 (0.6)	none	200 (0.0)	
Average of 411 Specimens	25	none	120	

Flame Resistance Requirements of C**/CGSB-155.20 (Eighth Draft), par 6.1.1.1:

The protective fabric shall be tested in accordance with par 7.1 and shall have an average damaged length of not more than 100 mm in either direction and average afterflame of not more than 2.0 s. There shall be no melting or dripping.

CONCLUSION:

The cotton and polyester vest fabric tested does not meet the requirements for flame resistance.

TEST RESULTS: C**/CGSB-155.20 (Eighth Draft), par 7.1 Flame Resistance Test

Test Conditions

Specimen Condition: oven dried at 105° C for 1 hr and cooled in dessicator prior to testing

Specimen Size: 80 x 200 mm

Burner Position: flame applied to lower edge at a 30° angle to the vertical axis of the fabric

Burner Gas: Propane

Ignition Flame application Time: 12 seconds

Sample: nylon & lycra football GIRDLE fabric
248 g/sq m (7.3 oz/sq yd)

Specimen	Duration of Afterflame (sec)	Dripping	Length of Damaged Area (mm)	Observations of Burning
Warp				The fabric burns with an intense blue flame. The fabric melts and flaming, molten pieces drip from fabric. The afterflame time was long. Because of the obvious failure of this fabric, not all specimens were tested, extras were used for additional tests.
1	90	yes, flaming	148	
2	110	yes, flaming	200	
3	120	yes, flaming	200	
4	90	yes, flaming	200	
5				
Warp Average (std dev)	103 (15)	yes	187 (26)	
Weft				
1	141	yes, flaming	200	
2	161	yes, flaming	200	
3	150	yes, flaming	200	
4				
5				
Weft Average (std dev)	151 (10)	yes	200 (0.0)	
Average of All Specimens	123	none	193	

Flame Resistance Requirements of C**/CGSB-155.20 (Eighth Draft), par 6.1.1.1:

The protective fabric shall be tested in accordance with par 7.1 and shall have an average damaged length of not more than 100 mm in either direction and average afterflame of not more than 2.0 s. There shall be no melting or dripping.

CONCLUSION:

The nylon & lycra girdle fabric tested does not meet the requirements for flame resistance.

TEST RESULTS: CAN/CGSB-4.2 No 27.10M91 Flame Resistance - Vertically Oriented Fabric
Surface Ignition Test

Test Conditions

Specimen Condition: oven dried at 10.5° C for 1 hr, and cooled in dessicator prior to testing

Specimen Size: 80 x 200 mm

Burner Position: flame applied perpendicular to the fabric surface

Burner Gas: Propane

Ignition Flame application Time: 12 seconds

Note: This test was carried out with remaining fabric from the football girdle, there was insufficient fabric to test 5 specimens in each fabric dimension.

Sample: Composite Sample:

Proban FR cotton COVERALL fabric, 326 g/sq m (9.6 oz/sq yd) - with
nylon & lycra football GIRDLE fabric, 248 g/sq m (7.3 oz/sq yd)
coverall fabric exposed to flame

Specimen	Duration of Afterflame (sec)	Dripping	Length of Damaged Area coverall/girdle (mm)	Observations of Burning
Warp 1	0	no	58 / 53	The Proban FR cotton fabric did not exhibit any unusual burning. The nylon & lycra girdle fabric, not directly exposed to flame, melted and a hole was formed in the area of flame impingement on the outer fabric. The nylon & lycra fabric did not ignite, or drip.
2	0	no	43 / 19	
3	0	no	56 / 28	
4				
5				
Warp Average	0	none	52 / 33	

An additional test was carried out where a composite specimen was exposed to the flame for 45 seconds. The nylon & lycra fabric did not ignite it just melted away from the heat source. After approximately 40 seconds of flame exposure, no more changes in the nylon & lycra fabric were observed.

TEST RESULTS: C/CGSB-155.20 (Eighth Draft), par 7.2 Thermal Protection Test****7.2.1. With Spacer Test**

Burner Gas: Propane

State of Specimens: Conditioned @ 20°C, 65% RH

Sensor Position: 1/4 inch spacer separates sensor from surface of specimen

Calibrated Exposure Energy: 148 ± 3.7 °C in 10 sec

SAMPLE: Single Layer Sample
 Proban FR cotton COVERALL fabric, 326 g/sq m (9.6 oz/sq yd)

Specimen	2nd Degree Burn Criteria Exceeded (sec)	TPP Value	Comments
1	5.11	10.22	
2	5.38	10.76	
3	5.38	10.75	
4	5.00	10.00	
5	5.10	10.20	
Average	5.2	10.4	
std dev		0.3	

Single Layer Thermal Protection Requirements of C/CGSB-155.20 (Eighth Draft)****Workwear for Protection Against Hydrocarbon Flash Fire**

par 6.1.2.1 (TPP with spacer): The protective fabric as received from the mill shall exhibit an average Thermal Protective Performance (TPP) value of 6 or greater, with no individual value less than 5.5, when tested in accordance with par 7.2, with the spacer (spaced test). The average test result using this method shall be indicated on the garment label.

SAMPLE: Composite Sample:
 Proban FR cotton COVERALL fabric, 326 g/sq m (9.6 oz/sq yd) - with
 nylon & lycra football GIRDLE fabric, 248 g/sq m (7.3 oz/sq yd)
 coverall fabric exposed to flame, girdle fabric next to sensor

Specimen	2nd Degree Burn Criteria Exceeded (sec)	TPP Value	Comments
1	12.96	25.91	5th test specimen spoiled, no extras to redo test.
2	12.96	25.92	
3	13.73	27.46	
4	13.68	27.36	
5	n/a	n/a	
Average	13.3	26.7	nylon & lycra fabric melts and sticks to Proban layer.
std dev		0.9	

Multi-Layer/Composite Sample Thermal Protection Requirements of C/CGSB-155.20 (Eighth Draft)****Workwear for Protection Against Hydrocarbon Flash Fire**

No requirements for multi-layers tested with a spacer.

Pass/fail criteria based on tests without the 1/4 inch spacer.

TEST RESULTS: C**/CGSB-155.20 (Eighth Draft), par 7.2 Thermal Protection Test

7.2.2 Without Spacer Test

Burner Gas: Propane

State of Specimens: Conditioned @ 20°C, 65% Rli

Sensor Position: sensor in contact with surface of specimen

Calibrated Exposure Energy: 148 ± 3.7 °C in 10 sec

SAMPLE: Single Layer Sample
Proban FR cotton COVERALL fabric, 326 g/sq m (9.6 oz/sq yd)

Specimen	2nd Degree Burn Criteria Exceeded (sec)	TPP Value	Comments
1	4.17	8.34	
2	3.79	7.58	
3	3.95	7.91	
4	4.12	8.24	
5	3.90	7.80	
Average	4.0	8.0	
std dev		0.3	

Single Layer Thermal Protection Requirements of C**/CGSB-155.20 (Eighth Draft)

Workwear for Protection Against Hydrocarbon Flash Fire

par 6.1.2.2 (TPP without spacer): The protective fabric as received from the mill shall also be tested in accordance with par 7.2 without the spacer (contact test). There is no minimum TPP requirement, using this however, for information method, purposes, the average test result shall be indicated on the garment label.

SAMPLE: Composite Sample:
 Proban FR cotton COVERALL fabric, 326 g/sq m (9.6 oz/sq yd) - with
 nylon & lycra football GIRDLE fabric, 248 g/sq m (7.3 oz/sq yd)
 coverall fabric exposed to flame, girdle fabric next to sensor

Specimen	2nd Degree Burn Criteria Exceeded (sec)	TPP Value	Comments
1	6.05	12.10	nylon & lycra fabric scorches, softens and sticks to Proban fabric. No sticking to sensor, does not fully melt.
2	5.93	11.86	
3	5.94	11.88	
4	5.82	11.64	
5	5.66	11.32	
Average	5.9	11.8	
std dev		0.3	

Multi-Layer Thermal Protection Requirements of C**/CGSB-155.20 (Eighth Draft)

Workwear for Protection Against Hydrocarbon Flash Fire

par 6.2.2.1 (TPP without spacer): The composite of all components in a multi-layer garment as received from the manufacturer shall exhibit an average Thermal Protective Performance (TPP) value of 5 or greater when tested in accordance with par. 7.2, without a spacer. In addition, no individual TPP value shall be less than 4.5,

TEST RESULTS: C**/CGSB-155.20 (Eighth Draft) Workwear for Protection Against Hydrocarbon Flash Fire
par 7.3 Heat Resistance and Thermal Shrinkage Tests

TEST CONDITIONS:

Exposure Temperature: $260 \pm 3^{\circ}\text{C}$

Exposure Time: 5 minutes

Specimen Size: 150 mm x 150 mm

Number of Specimens Tested: one (Three specimens should be tested, however, after the obvious failure of the first specimen, repetition was considered to be unnecessary.)

Sample Tested	Average Dimensional Change	Description of Specimens after Exposure
nylon & lycra football girdle 248 g/sq m (7.3 oz/sq yd)	Warp: n/a Filling: n/a	The fabric melted and dripped onto the floor of the oven to form a molten mass. Shrinkage/dimensional change could not be determined from the remains.

Heat Resistance Requirements of C**/CGSB-155.20 (Eighth Draft), par 6.1.3:

The protective fabric and other textile materials shall not melt, separate or ignite when individually tested in accordance with par 7.3.

Thermal Shrinkage Requirements of C**/CGSB-155.20 (Eighth Draft), par 6.1.4:

When tested in accordance with par 7.3, the protective fabric shall not shrink more than 5% in any direction.

CONCLUSION:

The nylon & lycra fabric does not meet the above requirements for Heat Resistance and Thermal Shrinkage.

(end of report)