SATRA Technology Centre Ltd
Wyndham Way, Telford Way, Kettering
Northants NN16 8SD, United Kingdom
Tel: +44 (0) 1536 410000
Fax: +44 (0) 1536 410626
e-mail: info@satra.co.uk

UKAS TESTING
0248

Customer: Asia Sun (Taiwan) Inc
No. 49, Jingjian 1st Road
Guanyin Shiang
Taoyuan
Taiwan, ROC

Contact: Sunny Lin

Technical Report

Subject: EN ISO 20471:2013, , EN469:2005, BSENISO14116:2008
Your Ref: Reflective Material – B940 (FRA187)
High durability flame resistant silver reflective fabric - industrial wash
Our Ref: SPC0219605/1345/04
Date: 17th December 2013

Conditions of Issue:

This report may be forwarded to other parties provided that it is not changed in any way. It must not be published, for example by including it in advertisements, without the prior, written permission of SATRA.

Results given in this report refer only to the samples submitted for analysis and tested by SATRA. Comments are for guidance only.

Tests marked † fall outside the UKAS Accreditation Schedule for SATRA. All interpretations of results of such tests and the comments based upon them are outside the scope of UKAS accreditation and are based on current SATRA knowledge.

A satisfactory test report in no way implies that the product tested is approved by SATRA and no warranty is given as to the performance of the product tested. SATRA shall not be liable for any subsequent loss or damage incurred by the client as a result of information supplied in the report.

Report signed by: M Gamble
Position: PPE Technologist
Department: Safety Product Centre

Technical Report

INTRODUCTION

Retro-reflective material B940 (FRA 187) was tested against EN 471:2003+A1:2007, under our reference SPC0197193/1134/5/1, Issue 2, in 2011. Since that time EN 471:2003+A1:2007 has been revised and published as EN ISO 20471:2013. We have been requested to assess the material against the retroreflective performance requirements of EN ISO 20471:2013 using the results of the previously reported work. While it is possible to do this as the procedures followed by SATRA in the EN 471:2003+A1:2007 tests were the same as those specified in EN ISO 20471:2013, it was agreed that the assessment would not be solely based on these results. Instead a limited number of repeat tests - to clauses 6.1 and 6.2 rainfall of EN 471:2003+A1:2007/EN ISO 20471:2013 - would be carried out on a sample of current production of the tape and used in the assessment. The sample was received by SATRA on the 6th November 2013. The results of the tests to clause 6.1 obtained with this sample are given on page 4 and the result of the test to 6.2 rainfall is incorporated in the table on page 5 together with the results of the earlier work.

CONCLUSIONS

Sample Reference	EN471:2003+A1:2007 / EN ISO 20471:2013	Result
B940 (FRA187) High durability flame resistant silver reflective fabric – industrial wash	Clause 6.1 Retro-reflective Performance of new materials	PASS Separate
	Clause 6.2 Retro-reflective after pre-treatment	PASS
	Clause 6.2 Retro-reflectivity after washing, (ISO6330) 50 cycles, 60°C	PASS
	Clause 6.2 Retro-reflectivity after 30 wash cycles, 92°C	PASS
	Clause 6.2 Retro-reflectivity after dry cleaning, (ISO3175, normal) 50 cycles	PASS
	Clause 6.2 Retro-reflectivity after Industrial washing (ISO 15797) 50 cycles, 85°C.	PASS
	EN469:2005	
	Clause 6.5, Annex B.3.1	PASS
	Clause 6.1, Annex B.3.2	PASS
	ISO14116:2008	
	Index Value - after 100 washes, 60°C	PASS, Index 3

TESTING

The sample was treated as a separate performance material.

TEST REQUIREMENTS

EN ISO 20471:2013 Minimum coefficient of retro-reflection in cd/(lx•/m^2) for separate performance retroreflective material.

Observation angle	**Entrance angle β_1 ($\beta_1 = 0$)**							
	5°		**20°**		**30°**		**40°**	
	See Note 1	**See Note 2**	**See Note 1**	**See Note 2**	**See Note 1**	**See Note 2**	**See Note 1**	**See Note 2**
12'	330	*247.5*	290	*217.5*	180	*135*	65	*48.8*
20'	250	*187.5*	200	*150*	170	*127.5*	60	*45*
1°	25	*18.9*	15	*11.3*	12	*9*	10	*7.5*
1° 30'	10	*7.5*	7	*5.25*	5	*3.75*	4	*3*

Note 1: Requirements for materials that are not considered to be orientation sensitive, or for the strongest direction when the materials are considered to be orientation sensitive.

Note 2: Requirements for the weakest direction when materials are considered to be orientation sensitive.

EN ISO 20471:2013 Requirements for retroreflective performance after test exposure cd/(lx•/m^2)

Exposure	**Observation angle 12', Entrance angle 5° See note 1**		**Observation angle 12', Entrance angle 5° See note 2**	
	Separate Performance	Combined Performance	Separate Performance	Combined Performance
Abrasion	100	30	*75*	*22.5*
Flexing	100	30	*75*	*22.5*
Folding at cold temperatures	100	30	*75*	*22.5*
Temperature variation	100	30	*75*	*22.5*
Rainfall	100	15	*75*	*11.25*
Washing	100	30	*75*	*22.5*
Dry cleaning	100	30	*75*	*22.5*

Separate performance retro-reflective material and combined performance material must also meet minimum specified requirements after being exposed to various pre-treatments and also under the influence of rainfall. After exposure a separate performance material, which is measured at the measurement condition of observation angle 12' and entrance angle 5°, must achieve a minimum coefficient of retro-reflection value of 100cd/(lx·m^2). A combined performance material, measured under the same conditions, must meet the minimum requirements of 30cd/(lx·m^2), and under the influence of rainfall it must be 15cd/(lx·m^2).

RESULTS

Results: Material as received – *x* orientation

Observation angle	Entrance angle				UoM (%)
	5º	20º	30º	40º	
12’	[330] 503	[290] 468	[180] 311	[65] 186	± 8.0 (See note 3)
20’	[250] 324	[200] 320	[170] 232	[60] 146	
1º	[25] 49.7	[15] 79.8	[12] 88.3	[10] 66.3	
1º 30’	[10] 18.2	[7] 29.5	[5] 41.6	[4] 37.2	

All measurements in cd/(lx·m^2) Minimum requirements for separate perf. material shown in [square brackets]

Results: Material as received – *y* orientation

Observation angle	Entrance angle				UoM (%)
	5º	20º	30º	40º	
12’	[330] 492	[290] 488	[180] 319	[65] 196	± 8.0 (See note 3)
20’	[250] 321	[200] 317	[170] 238	[60] 154	
1º	[25] 50.3	[15] 76.6	[12] 82.8	[10] 65.2	
1º 30’	[10] 19.3	[7] 27.2	[5] 38.1	[4] 35.2	

All measurements in cd/(lx·m^2) Minimum requirements for separate perf. material shown in [square brackets]

Orientation Sensitive Check Test

Sample direction	Observation angle	Entrance angle	UoM (%)	Sensitive/ Non-sensitive
		5º		
x - direction	12’	503	± 8.0 (See note 3)	Materials having coefficients of retroreflection that differ by more than 15% are defined as orientation sensitive
y - direction	12’	492		
Difference between *x* & *y* direction		11	------	Non-sensitive
Difference expressed as a percentage (%)		2.2		

RESULTS

EN ISO 20471:2013 Clause	Pre-Treatment		Observation angle 12', Entrance angle 5° x orientation cd/(lx· m^2)	Observation angle 12', Entrance angle 5° y orientation cd/(lx· m^2)	UoM % (See note 3)	PASS / FAIL
7.4.1	Abrasion		469	462		PASS
7.4.2	Flexing		403	396		PASS
7.4.3	Folding @ Cold Temperature		407	405		PASS
7.4.4	Exposure to Temperature Variation		443	441		PASS
7.4.5	Rainfall		197	----		PASS
7.5.2	Washing: 60°C:	20 cycles	441	440		PASS
7.5.2	Washing: 60°C:	30 cycles	415	414		PASS
7.5.2	Washing: 60°C:	40 cycles	413	412		PASS
7.5.2	Washing: 60°C:	50 cycles	354	352		PASS
7.5.2	Washing: 92°C:	10 cycles	390	388	±8.0	PASS
7.5.2	Washing: 92°C:	25 cycles	253	250		PASS
7.5.2	Washing: 92°C:	30 cycles	278	276		PASS
7.5.2	Ind. Washing: 85°C:	5 cycles	329	323		PASS
7.5.2	Ind. Washing: 85°C:	25 cycles	250	248		PASS
7.5.2	Ind. Washing: 85°C:	50 cycles	163	162		PASS
7.5.3	Dry Cleaning:	10 cycles	431	433		PASS
7.5.3	Dry Cleaning:	25 cycles	372	359		PASS
7.5.3	Dry Cleaning:	40 cycles	363	363		PASS
7.5.3	Dry Cleaning:	50 cycles	275	266		PASS

* Results, other than 7.4.5, previously reported in SPC0197193/1134/5/1, Issue 2.

Washing 60°C ISO6330, method 2A & Washing 92°C ISO6330, method 1A.
Industrial washing ISO15797:2002, washing at 85°C and drying at 155°C – see Appendix 1..
Dry cleaning according to ISO 3175, Normal cycle (perchloroethylene).

ADDITIONAL INFORMATION / NOTES

Note 3: 'UoM' denotes estimated Uncertainty of Measurement for stated test results. This uncertainty value is based on a standard uncertainty multiplied by a coverage factor k = 2, which provides for a confidence level of approximately 95%

RESULTS

EN469:2005, Clause 6.1, Annex B.3.2

REQUIREMENT

Flame spread: All materials used for visibility shall be tested as specified in 6.1 in combination with the outer layer to make it possible to take samples with the dimensions as indicated in ENISO15025:2002, procedure A. No hole formation is allowed in the materials.

TEST RESULT

Six specimens of retro-reflective tape were tested attached to *Klopman* workwear woven twill fabric - "*Challenger FR*", 360g/m^2, 75% Cotton / 25% Polyester – and, after x100 2A washing cycles, were exposed to the standard propane igniting flame. No hole formation occurred in any of the six specimens.

EN469:2005, Clause 6.5, Annex B.3.1

Heat resistance: The retroreflective.fluorescent/combined performance materials exposed for 5 min. according to the requirements of 6.5 of this European Standard shall be in accordance with 6.2 of EN471:2003 (coefficient of retroreflection after test exposure) and the retroreflective/fluorescent/combined performance materials shall not drip, ignite, melt or shrink

EN469:2005	Pre-Treatment	Observation angle 12', Entrance angle 5° x	Observation angle 12', Entrance angle 5° y
Clause 6.2	After Heat Resistance	416	404
	Shrinkage width -0.2% length -2.0% - no drip, ignition, or melting.		

ENISO14116:2008

REQUIREMENT FOR LIMITED FLAME SPREAD

Properties/Classification	Index 1	Index 2	Index 3
Flame Spread – No specimen shall permit any part of the lowest boundary of any flame or hole to reach the upper edge or vertical edge.	✓	✓	✓
Flaming debris – No specimen shall give flaming debris	✓	✓	✓
Afterglow – No afterglow shall spread from the carbonized area to the undamaged area after the cessation of flaming	✓	✓	✓
Hole formation – No specimen shall show hole formation		✓	✓
Afterflame – The afterflame time of each individual specimen shall not exceed 2s.			✓

TEST RESULT

Six specimens of retro-reflective tape were tested attached to *Klopman* workwear woven twill fabric - "*Challenger FR*", 360g/m^2, 75% Cotton / 25% Polyester – and were exposed to a standard propane igniting flame.

The results of testing were as follows:

ENISO14116:2008 – Test Results – new material

Sample Number	1	2	3	4	5	6
Flaming to edge of sample	No	No	No	No	No	No
Any occurrence of holes	No	No	No	No	No	No
Any flaming / molten debris	No	No	No	No	No	No
Flame reach sample edge	No	No	No	No	No	No
After flame (s)	1	0	0	0	1	0
Afterglow time (s)	0	0	0	0	0	0
Afterglow spread	0	0	0	0	0	0

TEST RESULT

Six specimens of retro-reflective tape were tested attached to *Klopman* workwear woven twill fabric - "*Challenger FR*", 360g/m^2, 75% Cotton / 25% Polyester – and, after x100 2A washing cycles, were exposed to the standard propane igniting flame.

The results of testing were as follows:

ENISO14116:2008 – Test Results – after-wash

Sample Number	**1**	**2**	**3**	**4**	**5**	**6**
Flaming to edge of sample	No	No	No	No	No	No
Any occurrence of holes	No	No	No	No	No	No
Any flaming / molten debris	No	No	No	No	No	No
Flame reach sample edge	No	No	No	No	No	No
After flame (s)	0	0	0	1	0	0
Afterglow time (s)	0	0	0	0	0	0
Afterglow spread	0	0	0	0	0	0

The sample meets index 3 requirements.

* * * * * * * * * * * * * * * * END OF REPORT * * * * * * * * * * * * * * * *

Appendix 1

ISO15797 TEST CONDITIONS

Industrial washing at 85°C

Procedure	Table 4.8 of standard ISO15797:2002, modified to 85°C
Machine	Girbau 19kg
Loading Ballast	13.5kg polyester/cotton
Detergent	20g/kg dry load, using a reference detergent without optical brightener
Cycle	Washing 20min at 85°C 3 rinses of 3 minutes each Final spin 3 minutes

Drying: finishing cabinet at 155°C

Procedure	to standard ISO15797:2002
Machine	SEBI cabinet
Inlet air temperature	155°C
Steam	90s±10s
Total drying time	8 minutes
Final temperature on the fabrics	135-140°C

* * * * * * * * * * * * * * * * END OF REPORT * * * * * * * * * * * * * * * *

TERMS AND CONDITIONS OF BUSINESS

1. GENERAL
Work done or services undertaken are subject to the terms and conditions detailed below and all other conditions, warranties and representations, expressed or implied are hereby excluded.

2. PRICES
Prices are based on current material and production costs, exchange rates, duty and freight and are subject to change without notice.

3. DELIVERY ESTIMATES
Delivery estimates are made in good faith and date from receipt of a written order and full information to enable us to proceed. While SATRA or its subsidiaries (hereafter referred to as "SATRA") make every effort to fulfil them, such estimates are subject to unforeseen events and if not maintained, cannot give rise to any claim. Offers "ex stock" are subject to prior sale.

4. CANCELLATION AND RETURNS
Cancellation of orders for goods, services, training or consultancy is only acceptable by prior agreement of SATRA and a charge will normally be made.

5. CLAIMS
Claims for errors, shortages etc should be notified within 10 days of date of receipt. In the event of goods damaged in transit, packing materials should be retained for examination; otherwise no liability can be accepted.

6. PAYMENT TERMS
Payment terms are net 21 days from date of invoice. Failure to comply with the terms of payment may result in delayed delivery of goods and services and a review of the Customer's credit account. Should the customer become subject to an administration order, or becomes bankrupt or goes into liquidation, SATRA has a right to cancel any contract and discontinue any work. SATRA reserves the right to adjust US Dollar and Euro sales price where customer exceeds credit terms and where the exchange rate has moved more than 10% since invoicing.

7. RETENTION OF TITLE
All goods remain the property of SATRA until paid in full. Under no circumstances will a customer's purchase order override SATRA's Retention of Title clause. In the case of software, the ownership of the software remains with SATRA. Payment of invoices in full will entitle the customer to use the software under licence until (a) they cease to be a member of SATRA or (b) they cease trading. In both instances, the licence shall then revert to SATRA.

8. GUARANTEE
All goods manufactured by SATRA are guaranteed both as regards material and workmanship. Any part returned carriage paid, within twelve months from date of supply and found defective, will be repaired or replaced at SATRA's option free of charge. SATRA admits no liability for loss, damage or delay consequent on any defect in any goods supplied by SATRA.

9. TEST REPORTS
Results given in test reports refer only to samples submitted for analysis and tested by SATRA. A satisfactory test report in no way implies that the product tested is approved by SATRA and no warranty is given as to the performance of the product tested. SATRA shall not be liable for any subsequent loss or damage incurred by the Customer as a result of information supplied in a test report.

10. TEST SAMPLES

Unless otherwise agreed in advance, test samples will be disposed of 6 weeks after the date of the final report. If required, samples can be returned at the Customer's expense.

11. RESPONSIBILITY
Every effort is made to ensure accuracy in description, drawings and other information in correspondence, catalogues, etc but no warranty is given in this respect and SATRA shall not be liable for any error therein. SATRA carries out all tests and/or advises only on the basis that the same are carried out, made or given without any responsibility whether for negligence or otherwise. SATRA and its servants or agents will not be liable for any damage or loss direct or indirect of whatsoever kind, whether or not the same results directly or indirectly from negligence on the part of SATRA or its servants or agents.

12. CONFIDENTIALITY
Unless specifically excluded in the terms of an individual contract between SATRA and its Customer, the following shall apply to all reports, advice, drawings, photographs, specifications or data:

i. The above shall not be disclosed to third parties or used in litigation without the consent of SATRA.
ii. Where SATRA has given consent to disclosure, the Customer shall draw the attention of the third party to these terms of business and the basis on which SATRA undertakes test, reporting and advising. The Customer shall indemnify SATRA for any failure to do so.
iii. The above items are submitted to the Customer as confidential documents. Confidentiality shall continue to apply after completion of the business, but shall cease to apply to information or knowledge which may come into the public domain.

13. CONSTRUCTION AND ARBITRATION
The laws of England shall govern all contracts and the parties submit to exclusive jurisdiction of the courts of England, unless otherwise agreed.

Issue Date: 1st October 2009