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Milan, 31/05/2023

IN VITRO METHOD for the DETERMINATION of SUNSCREEN UVA PHOTOPROTECTION and CRITICAL WAVELENGTH VALUES ISO 24443:2021 Method

METHOD: Ref. E16C rev. 6

- CUSTOMER: THE NUDE ALCHEMIST 24c Essex St. Phillipstown Christchurch 8011 (New Zealand)
- PRODUCT: SPF30 THE NUDE ALCHEMIST

Ref. LAB: 139/23/01 – 151/23

STARTING DATE OF THE STUDY: 31/05/2023

COMPLETION DATE: 31/05/2023

ETHICAL AND QUALITY CRITERIA

The current study was carried out in compliance with the quality assurance system requirements.

REFERENCES

The data given in this report are exclusively related to the tested sample. This report can be only in full reproduced only with the permission.



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1. SAMPLE DATA SHEET

SAMPLE REF.: SPF30 THE NUDE ALCHEMIST

Ref. LAB: 139/23/01 - 151/23

SAMPLE ARRIVAL DATE:	10/05/2023
EXECUTION DATE:	31/05/2023

PRODUCT:

- PHYSICAL FORM:	cream
- COLOUR:	white

QUALITATIVE FORMULA:

- Known / yes /

- Other information / /

OTHER INFORMATION RELATED TO THE PRODUCT SAFETY: None.

IN VIVO TEST INFORMATION:

SPF result:	33.7 (30/05/2023)
Method:	ISO 24444:2019
Test type:	FULL TEST

FILE: 1 sample with the code number **Ref. LAB: 139/23/01 – 151/23** and the study findings will be kept in our files for one year and ten years respectively. After these periods, the sample and the findings report will be discarded, unless otherwise required by the client.



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IN VITRO METHOD for the DETERMINATION of SUNSCREEN UVA PHOTOPROTECTION and CRITICAL WAVELENGTH VALUES ISO 24443:2021 Method (REF. E16C)

2. PRINCIPLE OF THE METHOD

The aim of the method is to provide an *in vitro* test to measure the UVA protection provided by sunscreen products as well as their critical wavelength.

The method provides the *in vitro* UVA protection factors (UVAPF), which are shown to correlate with *in vivo* UVA protection factors determined by the Persistent Pigment Darkening (PPD) method.

The test is based on the assessment of UV-transmittance through a thin film of sunscreen sample spread on a roughened substrate (PMMA plate), before and after exposure to a controlled dose of UV radiation (290-400 nm) from a defined UV source. All the sunscreen transmission data are adjusted by first converting to absorbance data (before and after UV exposure) and then by multiplying by the same coefficient.

The coefficient (coefficient C) is iteratively determined from the non-exposed sample's absorbance data to provide a calculated *in vitro* SPF value equal to the *in vivo* measured SPF.

The sunscreen sample is exposed to an irradiation dose proportional to the initial UVA protection factor UVAPFO, calculated from the adjusted absorbance data of the non exposed sample.

Using this method, the UVA protection factor (UVAPF), the UVAPF/SPF_{label} ratio and the Critical Wavelength of the tested sunscreen product can be obtained.

All these parameters are calculated from the absorbance data of the sample exposed to UV rays.



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3. INSTRUMENTS AND MATERIALS

PMMA plates (PolyMethylMethacrylate), square shaped (50x50 mm), with one side roughened and one side smooth are used as a substrate. The product is applied to the rough side of the plates. For this method, both moulded and sandblasted PMMA are accepted and the topographic parameters of the plates are described below:

```
Moulded PMMA plate

Ra (\mum) = 4,853 ± 0,501

Rv (\mum) = 13,042 ± 0,989

Rdq (°) = 11,122 ± 2,032

A1 (\mum<sup>2</sup>/mm) = 239,750 ± 70,165

Ssc (1/\mum) = 0,033 ± 0,021

Vvv (mm<sup>3</sup>/mm<sup>2</sup>) = 1,044,10-4 ± 9,76,10-5

Sandblasted PMMA plate

Ra (\mum) = 4,188 ± 0,514

Rv (\mum) = 11,402 ± 2,499

Rdq (°) = 11,004 ± 1,938

A1 (\mum<sup>2</sup>/mm) = 238,252 ± 72,663

Ssc (1/\mum) = 0,032 ± 0,015

Vvv (mm<sup>3</sup>/mm<sup>2</sup>) = 8,701,10-4 ± 2,325,10-4
```

In the present study the <u>HD6 PMMA plates</u> were used (see page 16).

Labsphere UV-2000S Ultraviolet Trasmittance Analyzer operates by measuring the diffuse transmittance of a carefully prepared sample as a function of wavelength in the ultraviolet spectrum (290-400 nm).

The UV-2000S takes advantage of an optical device known as an integrating sphere and its ability to collect light transmitted in all directions after passing through a sample substrate.

Atlas Sun Test CPS+ is used as a light source for the UV-irradiation (filters for the irradiance 56052371 e 56052059 – total UV irradiance: 40 - 200 W/m² in the wavelengths range 290-400nm).

The **analytical balance (ME204T/00, Mettler Toledo or Radwag Mod. AS 220.X2 PLUS)** is used to weight the product. It determines up to 4 decimal numbers and has a sensitivity of 0.1 mg.



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4. METHOD

STEP 1: *in vitro* transmission measurement of the sunscreen product spread on PMMA plate, prior to any UV irradiation. A standard dose of the product (equal to 1.3 mg/cm² for HD6 and 1.2 mg/cm² for SB6) is applied on the substrate, a PMMA plate.

The sunscreen is spread onto at least four PMMA plates for each sunscreen sample and then at least 5 transmission measurements are performed for each plate.

Acquisition of initial UV transmission spectrum with $A_0(\lambda)$ data.

STEP 2: mathematical adjustment of the initial UV spectrum using coefficient 'C' to achieve an *in vitro* SPF equal to the *in vivo* SPF. It is recommended that C falls within a range between 0.6 and 1.6. Initial **UVAPF**₀ is calculated using $A_0(\lambda)$ and C.

STEP 3: a single UV dose D is calculated, proportional to UVAPF₀.

STEP 4: UV exposure of the samples, according to the calculated UV dose D.

STEP 5: *in vitro* transmission measurement of the sunscreen product after UV exposure. Acquisition of second UV spectrum with $A(\lambda)$ data.

STEP 6: mathematical adjustment of the second spectrum (following UV exposure) according to the same C coefficient, previously determined in step 2. Calculation of the *in vitro* UVA protection factor **UVAPF** after irradiation using $A(\lambda)$ and C. Calculation of Critical Wavelength value.



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5. REFERENCE SUNSCREEN

The method must be checked regularly by the use of a reference sunscreen formulations to verify the test procedure.

The formulations used are described in Annex E of ISO 24443:2021.

Product reference sunscreen	Mean	Mean	Acceptance limits					
Formulation	SPF	UVAPF	Lower limit	Upper limit				
S2	16,0	12,7	10,7	14,7				
P8	63,1	21,1	19,1	23,1				

If the UVA-PF of the standard formulation does not fall in the reference range of values the test is deemed invalid and must be repeated.

Reference P8 sunscreen formula should be used when expected UVA-PF is of 20 or more.

In the present study the standard S2 was used.

6. CALCULATIONS

1. Calculation of the *in vitro* SPF

	400 nm	
	$\int E(\lambda) \times I(\lambda) \times d\lambda$	
<i>in vitro</i> SPF =	290 nm	
	400 nm	
	$\int E(\lambda) \times I(\lambda) \times 10^{-AO(\lambda)} \times d\lambda$	
	290 nm	

where:

 $E(\lambda)$ = erythema action spectrum (CIE-1987)

 $I(\lambda)$ = spectral irradiance received from the UV source (290-400 nm)

 $A_0(\lambda)$ = mean monochromatic absorbance of the test product layer before UV exposure

 $d\lambda$ = wavelength step (1 nm)



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2. Calculation of the **coefficient C**

SPF	in	vitro	adi	= '	SPF	in	vivo	=
JEI		VILIO,	auj		JEI		<i>viv</i> 0	_

400 nm $\int E(\lambda) \times I(\lambda) \times d\lambda$ 290 nm 400 nm $\int E(\lambda) \times I(\lambda) \times 10^{-A0} (\lambda) \times C \times d\lambda$ 290 nm

3. Calculation of the $UVAPF_0$ before UV exposure

	400nm ∫ P(λ) x I(λ) x dλ
UVAPF ₀ =	320 nm
	400nm
	$\int P(\lambda) \times I(\lambda) \times 10^{-A0} \lambda^{(\lambda) \times C} \times d\lambda$
	320 nm

 $P(\lambda) = PPD$ action spectrum

 $I(\lambda)$ = spectral irradiance received from the UV source (UVA 320-400 nm) $A_0(\lambda)$ = mean monochromatic absorbance of the test product layer before UV exposure C = coefficient C $d\lambda$ = wavelength step (1 nm)

4. Calculation of the UV exposure dose D

The single UVA dose **D** is proportional to the UVAPF₀ value. The irradiation with the dose D allows to achieve a good correlation between the *in vitro* UVAPF and *in vivo* PPD values.

 $D = UVAPF_0 \times D_0 J/cm^2$

 D_0 = unit UVA dose per unit UVAPF₀ = 1.2 J/cm⁻² UVA



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5. Calculation of **UVAPF** of plates after UV irradiation of the sample

	400nm ∫ P(λ) × I(λ) × dλ
UVAPF =	320 nm
	400nm
	$\int P(\lambda) \times I(\lambda) \times 10^{-A(\lambda) \times C} \times d\lambda$
	320 nm

 $A(\lambda)$ = mean monochromatic absorbance of the test product layer after UV exposure.

6. Calculation of **UVAPF** of the product

It is the mean of the UVAPF's of at least four individual plates. If the confidence interval exceeds 17% of the mean UVAPF value, then further plates have to be prepared until the statistical requirement is reached.

7. Calculation of the ratio UVAPF/SPF

UVAPF Ratio = -----SPF_{label}

8. Calculation of Critical Wavelength value

It is that wavelength where the area under the absorbance spectrum for the irradiated product from 290 nm to λc is 90% of the integral of the absorbance spectrum from 290 nm to 400 nm.



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7. RESULTS AND GRAPH

Substrate: 4 PMMA plates HD6 by Helioscreen, batch 637 date 27/03/2022 Coefficient of calibration radiometer versus spectroradiometer: 2.04 Exposure temperature (at plates level): 29°C Raw UVA irradiance: 25.88 W/m² UV Dose: 14.06 J/cm² UVAPF obtained for S2 reference standard: 13.4 <u>+</u> 0.2 (05/05/2023)

Table 1: results of the in vitro test.

UVAPF values for the 4 plates	11.5	11.6	11.7	11.3				
UVAPF mean value (post-irradiation)	11.5							
Standard deviation		<u>0</u>	.2					
95% CI (<17%)	2.4%							
UVAPF ₀ mean value (pre-irradiation)	11.7							
SPF _{in vivo}	33.7							
SPF _{label}	30							
UVAPF / SPF _{label} (> 0.33)	0.38							
Coefficient C (0.6-1.6)	1.0							
λ _c (nm >370)		37	75					

Graph 1: the graph represents the mean values of the absorbance readings of the 4 plates, before and after UV irradiation.



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8. CONCLUSIONS

The evaluation of the UVA photoprotection of the product **SPF30 THE NUDE ALCHEMIST, Ref. LAB: 139/23/01 – 151/23** was performed under the experimental conditions described above in this report.

Such evaluation was conducted in accordance with Labanalysis' analysis criteria and its specific knowhow and follows accepted international guidelines for cosmetic evaluation.

Observations

The European Commission in their Recommendation of September 22nd 2006 on the efficacy of sunscreen products and claims (2006/647/EC) include a requirement for UVA protection comprising both:

- the mean UVA-PF of a solar product must be at least 1/3 of the labelled SPF
- the Critical Wavelength must be at least 370 nm

On the basis of the obtained results we can draw the following conclusions:

The product passes the test.

Responsible for the laboratory
Dr. Adriana Bonfigli
FUNCILLE Daufigh

Responsible for the evaluation Dr. Monica Prigioni



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9. **BIBLIOGRAPHY**

International Standard ISO 24443:2021: Determination of sunscreen UVA photoprotection in vitro.

Glantz S A. Statistica per discipline bio-mediche. Seconda edizione. McGraw-Hill Libri Italia. 1988.



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12. STANDARD PRODUCT

Standard S2

	ISO 24443 : In vitro determination of the UVA photoprotection (2021)												RE	SET							
Date	05/05/2023		Spectrophotometer	.abrphoro UY2000:		Basella			Plate 2	Plate 3	Plate 4	Plate 5	Plate 6	Plate 7	Plate 8	Plate 9	Plate 10	Mean	SD	ADJUST	MENT: "C"
Operator	Manica		Plato typo	PMMAHD6		nesuic	s per place:	Valid	Valid	Valid	4263							Only Valid	l Results	CALC	ULATION
Product	STD 52		Plato Batch Nb	569			"C" Adjustment coefficient	1,411	1,420	1,502	1,501							1,459	0,050		
Batch			Nbufplatar	4			Raw SPF0	7,1	7,0	6 ,3	6,3							6,7	0,4		
MeasuredSPF	16		Nb of Valid Results	4		results before	Adjusted SPF0	16,0	16,0	16,0	16,0							16,0	0,0		
						exposure	U¥APF0	15,3	15,4	15,3	15,4							15,3	0,0		
Canditianning tomporaturo (°C)	27						Unitical wavelength (nm)	381,7	381,8	381,7	381,9							381,8	0,1		
Exparuro tomporaturo (*0)	27,3						Dx (Jłom²)	18,4	18,4	18,4	18,4							18,4	0,0		
20		mAF	Mean																		
18			2 - Adjusted mAF - BEF	ORE EXPOSURE		_						UV.	xpærure dura	itian (hh:mm	27) I						
16 14 (Vvors) 10 10	_					Salar Simulatar RayUVA irradiance (Wim) "Y" Irradiance Carroctian factar CarroctadUVA Irradiance (Wim)	AS SUNTEST OPS+ 25,59 2,04 52,2034	00:58:38	00:58:50	00:58:43	00:58:49							*****	••••		
6																		-			
4						Result	s per plates:	Plate 1	Plate 2	Plate 3	Plate 4	Plate 5	Plate 6	Plate 7	Plate 8	Plate 9	Plate 10	Mean Only Valid	SD Results	c (=t*s/ CI[×] √n)	95×CI
2						Final	UVAPF	13,2	13,4	13,4	13,6							13,4	0,2	0,3 2,1%	[13,1 - 13,7]
0 290	300 31	0 320 330 34 WAVE	0 350 360 37 LENGTH (NM)	70 380 3	90 400	results	Critical wavelength (nm)	381,1	381,2	381,1	381,2							381,1	0,1		



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13. PLATES QUALITY CERTIFICATE

HelioScreen

Date Control Roughness: July 12, 2022

Quality Certificate Moulded PMMA substrate - HD6[®]

Re	eference: Helioplate® HD6®	Batch Nº: 634-635-636-637	Certificate Nº: 2381	
Beginning	Manufacture: March 27, 2022	Control Manufacture Date: March 27, 2022	Mould N*: 769	-
End	I Manufacture: March 27, 2022	Expiration Date: March 26, 2027	Raw material N*: ZK031255	
DESIGNATION	Moulded PMMA plate on which the cosm • Topographic parameters compliant: ISC • One unit: Overall size 50x50mm - Sprea • Material: PMMA (Polymethylmethacrylal • HS Code: 3906.10.00 - Origin: France -	etic product is applied to assess the in vitro sun protection pe 24443:2021 - FDA 2011 - BOOTS STAR RATING 2011 uding area 47x47mm le) Manufacturer: HelioScreen	rformance	

The control of the ro (Mountains [®] DIGIT/	Aughness was performed randomly on several plates from the same batch described here above with the appliance AltiSurf® A500 (ALTIMET SAS) and the software AltiMap B AL SURF SARL).
Profilometer characteristic:	 Non-contact surface topographic analysis consisting of an optical sensor, a motion controller, an x-y translation stage, and microtopography software. Optical sensor based on a white light chromatic aberration principle which allows for a high resolution of at least 10 nm vertically and 1 um horizontally.
Measurement	 - A surface area of at least X = 10 mm and Y = 5mm with at least 15-µm intervals, - A speed of at least 1 000 µm/s is recommended according to sensor type and frequency.
Analysis operators:	1 - Fill in non-measured points by a smooth shape calculated from the neighbours. 2 - Leveling method by least square plane by substraction. 3 - Conversion to a serie by extraction west-east of all surface profiles for 2D profile parameters. - Gaussian filters of 0.8 mm should be used according to profilometer characteristics.

	10 The 10				RESULTS		the second s	
Profi	10	Mea	sured v	alue			Specification	
Parameter*	Unit	Mean	±	SD**	ISO 24443:202	1	FDA 2011	Boots Star Rating 2011
Ra	(µm)	4,582	+	0,098	4,853 ± 0,501	OK	1	1
Rv	(µm)	12,302	±	0,193	13,042 ± 0,989	OK	1	1
Rdg	(°)	12,515	±	0,21	11,122 ± 2,032	OK	1	1
A1	(µm²/mm)	215,431	±	12,331	239,750 ± 70,165	OK	1	1
Ssc	(1/µm)	0,023	±	0.004	0.033 ± 0.021	OK	1	1
Vvv	(mm3/mm2)	8,588E-05	*	7.272E-07	1.044,10-4 ± 9.76,10-5	OK	1	1
Sa	(um)	5.77	+	0.06	1	10000	20.70 06	20-50 06

TRs (µn). The mean arithmetic deviation of the roughness profile - (Rv (µn). The maximum depth of profile valleys within a sampling length) - (Rdq (*). The root-mean-square slope of the profile within a sampling length) - (At (µn*.mm-1): The upper area, i.e., the area of the rest overs of the peaks adending above an average profile ± kernel[- (Soc (µµn*1): The withmetic mean summit curvature of the surface, which indicates the meanform of peaks and valleys] - (Vv (m m3.m*2): The volume of word in the valleys, i.e., the volume of rest overs of valleys estending below an average profile ± kernel] *30. Samdade Deviation

he control of the o	ptical properties w	as performed rar	ndomly or	several plates from the s	ame batch described here above with the spectrophotome	er UV-2000S (Labsphere).
pectrophotometer	- Primary waveb	and of 290 nm to	o 400 nm	with a 1 nm increment step	p, including an integrating sphere and a flash lamp	
haracteristic:	- Reading site w	ith at least 0,5 c	m², minim	um required dynamic rang	e of 2,2 and one measurement cycle not exceed 0,2 "Vom ²	
leasurement.	 Approximately 15 mg of vaseline/glycerin is applied and spread over the rough side of the plate to obtain a thin continuous film. 					
reason enneme.	- Measure trans	mittance (290 nm	n to 400 n	m) of the treated plate aga	ainst air (with no plate) as the reference light path.	
					00011170	
					RESULTS	
Transmiss	ion (%T)	Mea	sured va	alue	RESULTS Specification	
Transmiss Wavelength	ion (%T) Unit	Mea: Mean	sured va	slue	RESULTS Specification ISO 24443:2021	Conclusion
Transmiss Wavelength 290 nm	ion (%T) Unit %	Mea Mean 69,7	sured va ±	slue SD** 0,5	RESULTS Specification ISO 24443:2021 > 80%	Conclusion
Transmiss Wavelength 290 nm 300 nm	ion (%T) Unit %	Mea: Mean 69,7 76,0	sured va ± ±	slue SD** 0,5 0,3	Specification ISO 24443:2021 > 60% > 69%	Conclusion OK OK

Conclusion: COMPLIANT

The results of analysis of the profile parameters and optical properties are in compliance with the pre-established specification. Therefore, the batch here above of the Moulded PMMA plate - Helioplate HD6® is officially confirmed.

> Place: CREIL, France Date: December 5, 2022 Name: Sébastien MIKSA

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