AUSTRALIAN RADIATION PROTECTION AND NUCLEAR SAFETY AGENCY

Resource Guide for UVR Protective Products

This document is produced by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) which is part of the Health and Aged Care Portfolio of the Commonwealth of Australia. The publication has been approved for release by John Loy, the CEO of ARPANSA.

ISBN 0-642-70473-2

ARPANSA
Lower Plenty Road
Yallambie VIC 3085
AUSTRALIA
Phone: +61 3 9433 2211
Fax: +61 3 9432 1835

Important Copyright Notice And Disclaimer

This Guide is issued by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) to provide information about personal UV protection and to assist consumers in locating suppliers of products that claim to offer protection against solar ultraviolet radiation. It does not claim to be a comprehensive list of such products. Further, any claims made in this Guide with respect to the performance characteristics of the products listed, or of the products themselves and their availability, are those of the suppliers and are not claims of ARPANSA or the Commonwealth of Australia.

ARPANSA and the Commonwealth of Australia give no warranty that the information contained in this book is accurate or correct and, to the extent permitted by law and subject to the Trade Practices Act 1974, shall not be held responsible for any errors or omissions that have occurred in this guide.

Resource Guide for UVR Protective Products

Solar Ultraviolet Radiation

What is Solar Ultraviolet Radiation (UVR) ?
Solar radiation at the earth's surface consists mainly of visible radiation (light) and infrared radiation (heat). Our eyes respond to visible light and infrared (IR) can be felt on the skin as heat. Ultraviolet radiation (UVR) is also present at the earth's surface but cannot be seen and cannot be felt by the skin.

UVR is classified as UVA, UVB and UVC. UVB and UVC are potentially the most dangerous to humans. Ozone and oxygen in the atmosphere absorb all the UVC and most of the UVB before it reaches the earth's surface. UVB is more damaging to the skin and eyes than UVA, however, both UVB and UVA are implicated as causes of skin cancers and some eye disorders.

Health effects of UVR
Over-exposure to solar ultraviolet radiation can cause sunburn, skin damage and an increased risk of developing skin cancer. UVR exposure also places our eyes at risk of photokeratitis, photoconjunctivitus and cataracts. The most obvious short-term effect of over-exposure to UVR is sunburn. The more UVR received, the worse the sunburn becomes. Continued over-exposure for many years, especially in children, can increase a person's risk of developing skin cancer in later life. Skin cancers affect people of all skin types and can also develop on people who do not have a history of severe sunburn. A person’s cumulative exposure to UVR along with the number of severe sunburns they have received, especially during childhood, increases their risk of developing skin cancer.

Common misconceptions about UVR
When people state that the sun has "sting in it" they are confusing infrared (IR) radiation with UVR. The skin detects IR radiation as a sensation of heat but it does not detect UVR. If enough UVR exposure has occurred to cause sunburn, the damaged skin may become more sensitive to IR.

Temperature and UVR
Solar UVR levels are generally not related to temperature. There can be high UVR levels even on cool days. UVR and temperature usually reach their maximums at different times of the day. UVR is usually highest around midday but the temperature is often highest later in the afternoon.

Windburn and UVR
There is no such thing as "windburn". The wind may dry the skin but it does not burn it. Overexposure to UVR can increase the skins sensitivity. What is described as "windburn" is actually sunburn.

Cloud Cover and UVR
The level of UVR can be high enough to cause sunburn on a cloudy day. The amount of UVR is affected by the cloud density. Scattered cloud has a variable effect on UVR levels, which rise and fall as clouds pass in front of the sun.

How to reduce your solar UVR exposure
Many forms of protection are available to reduce your exposure to solar UVR. The best protection is to avoid going outdoors during the middle of the day. When outdoors, wear clothing, a hat, sunglasses and a sunscreen. The following strategies can reduce your UVR exposure:

- Avoid going outdoors when the sun is at its highest. UVR peaks between 10am and 2pm (11am to 3pm during daylight-saving time). This practice can dramatically reduce your UVR exposure;
- Wear clothing designed to cover the arms and legs as well as the body;
- Wear a broad-brimmed or legionnaire style hat to shade the eyes, face, ears and back of

the neck;

- Apply at least SPF 15 sunscreen to all areas of your body not covered by clothing. Reapply sunscreen every two hours, even on cloudy days. Reapply sunscreen after swimming or perspiring as it can wear off;
- Wear sunglasses when outside. Choose a style of glasses that prevent UVR reaching the eyes. Wrap around styles can also block UVR entering the eyes from the sides;
- Choose shaded areas where you cannot directly see the open sky. Even if you are out of the direct sun, UVR can still reach you from the open sky. UVR can also reflect back from some surfaces increasing the amount of UVR exposure of the skin. Surfaces such as beach sand, white paint, light coloured concrete, snow, water and to a lesser extent soil can reflect UVR onto your skin;
- Remember that if the temperature drops it does not mean that the UVR level has also decreased; and
- Protect young children from excessive sun exposure with shade, suitable clothing, hats, sunglasses and sunscreens. They are unaware of the dangers. Apply sunscreen liberally and often to children following the directions on the container. Use pram covers and shades for babies. Model behaviour for children.

Clothing as UVR Protection

Sun protective garments are not usually specially treated. Most rated garments rely on the fabric's natural ability to block UVR. Laboratory testing determines how effective the fabric is at blocking UVR and this is often stated on the garment label as a UPF (Ultraviolet Protection Factor) rating.

The UPF rating of a fabric, can be determined by placing a sample of the fabric under an ultraviolet lamp and measuring the amount of UVR that passes through the fabric. Several measurements are made with the UVR lamp positioned directly above the fabric. This allows the UPF to be calculated under conditions where the fabric is least protective against UVR.

The UPF rating indicates how much UVR is absorbed by the fabric. For example, a fabric with a UPF rating of 20 only allows 1/20th of the hazardous UVR falling on the surface of the fabric to pass through it. This means that this fabric will reduce your skins UVR exposure by twenty times where it is protected by the fabric.

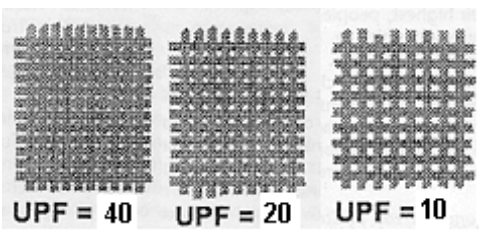
The UVR protection offered by different types of fabrics varies considerably and depends on the factors listed below.

What makes a good sun protective garment?

Several factors determine how effective garments are at reducing UVR:

Composition of the fabric: Different materials such as cotton, polyester and nylon have different natural UVR-absorbing properties.

Weave density: Less UVR passes through tightly woven or knitted fabrics. As shown below the smaller the spacing between the individual fibre strands the higher the protection.



Colour: Many dyes absorb UVR. Darker colours of the same fabric type (black, navy, dark red) will usually absorb UVR more strongly than light pastel shades and consequently will have a higher UPF rating.

The following table shows the effect of colour on the UPF of some fabrics with identical weave and weights. This should be taken as a guide only as specific fabrics may have different characteristics.

Cotton	**UPF**	**Polyester**	**UPF**
White	12	White	16
Sky Blue	18	Light Green	19
Black	32	Dark Red	29
Navy	37	Black	34

Tension: Stretching a fabric may cause a decrease in the UPF rating. This is common in knitted or elasticised fabrics and care should be taken to select the correct size for the wearer.

Moisture content: Many fabrics have lower UPF ratings when wet. The drop in UPF rating depends on the type of fabric and the amount of moisture it absorbs when wet.

Design: As well as considerations of fashion and comfort, selecting garments that are sensibly designed for sun protection can make a large difference to your overall UVR exposure. Garments that provide more body coverage offer more protection. A shirt with long sleeves and a high collar offers more protection than a short sleeve shirt without a collar. Loose fitting garments give better protection than garments that are worn close to the skin and also may be more comfortable to wear on hot days. A legionnaire style cap with a flap protects the ears and back of the neck. A broad-brimmed hat shades the face and neck.

Condition: Unless otherwise stated, UPF ratings are performed on fabrics that are in new condition. The UPF rating of many cotton based fabrics can improve over the "new" rating after they have been washed at least once. Shrinkage in the fabric closes small gaps between the threads and allows less UVR to pass through. However, old, threadbare or faded garments may have a lower UPF rating.

UVR absorbers: Some fabrics are treated to improve the UPF rating. This is usually done if the base fabric has a low natural resistance to UVR. Treatment with a UVR inhibitor, generally during manufacture, can result in a fabric with a higher UPF rating that still retains the comfort properties of the original fabric.

Many dyes absorb UVR and therefore increase the UPF rating of the fabric. Some UVR absorbers behave like colourless dyes. They bond to the fabric in a similar way, and have a comparable permanency to coloured dyes. Recently there has been interest in adding UVR absorbers to commercial washing powders.

Sources of UVR Exposure

Solar UVR can reach you on the ground from three sources:

- Directly from the sun.
- Scattered from the open sky.
- Reflected from the environment.

This means that even if you are shaded from the direct sun you can still receive substantial UVR exposure from the open sky and reflective ground surfaces. Reflective surfaces can reduce the effect of protective measures. For example, a person wearing a hat may still receive UVR exposure to their face if they are near or in water.

Factors that affect solar UVR levels

1. **Sun Height:** The most important factor affecting the level of solar UVR at the earth's surface is the height of the sun above the horizon in the sky. When the sun is high in the sky, the UVR has less atmosphere to travel through so less is absorbed.
2. **Geographical Position:** Australia has high levels of solar UVR in comparison with Europe and North America due mainly to its geographical position close to the equator.
3. **Cloud Cover:** Solar UVR can penetrate through light cloud cover, and on lightly overcast days the UVR level can be similar to that of a cloud-free day. Heavy cloud can reduce the intensity of UVR. Scattered cloud has a variable effect on UVR levels, which rise and fall as clouds pass in front of the sun.
4. **Ozone:** This is a form of oxygen that occurs naturally in the upper atmosphere and has the ability to absorb UVB radiation. Atmospheric absorption prevents most of the UVB from reaching ground leve. Ozone levels rise and fall naturally from day to day and seasonally. Ozone over Australia is generally lowest in March. Discovery of an ozone "hole" over Antarctica has increased general awareness and caused concern about possible increases in UVR levels in southern Australia. The ozone "hole" does not extend as far north as Australia but stratospheric winds can occasionally carry ozone-depleted air towards Australia causing a short term rise in UVB levels. Ozone depletion and the associated increase in solar UVR reaching the earth is a major environmental issue but other factors such as sun height and variations in cloud cover may have more local influence on the intensity of UVR reaching the ground.
5. **Scattering:** Due to scattering of solar UVR by molecules and particles in the atmosphere there is about as much UVB received from the open sky as there is from the direct sun. If you are in the shade but can see a lot of blue sky you are still exposed to UVR scattered from the sky. At times the amount of scattered solar UVR that reaches your skin may exceed that from the direct sun.
6. **Environment:** A highly reflective environment can also increase exposure by reflecting UVR onto the skin. Some ground and building surfaces are quite reflective to UVR. These include white paint, light coloured concrete, snow, water and to a lesser extent soil.
7. **Altitude:** The intensity of UVR increases by about 4% for every 300 metres increase in altitude. At higher altitudes there is less atmosphere for the UVR to pass through before it reaches the ground so less is absorbed. Consequently, people at higher altitudes can be exposed to more UVR than those at sea level. In the Australian ski fields, at an altitude of around 2000 metres, the UVR levels on clear days can be substantially higher than at sea level. The fact that snow is extremely reflective to UVR is an additional hazard.

Monitoring UVR Levels

ARPANSA has measured solar UVR levels using a network of detectors in Australian capital cities and at other sites since 1986. The information is analysed by computer then distributed daily to news services and other interested organisations.

Reporting UVR Levels

ARPANSA has been reporting solar UVR levels for Australian capital cities since 1990. UVR levels are reported as a Solar UV-Index, which is a measure of the highest level of UVR each day. The UV-Index allows for cloud cover and other environmental factors and is used worldwide for reporting UVR levels.

UV-Index

UV-Index values are related to UVR exposure as shown in the table below. Following some simple precautions shown in the table you can reduce your risk of sun related damage.

UV-Index	Exposure Category	Precautions
Less than 3	Moderate	hat, sunscreen, sunglasses
3 to 6	High	hat, sunscreen, sunglasses, shady area
7 to 10	Very High	hat, sunscreen, sunglasses, shady area, stay indoors between 10-2pm (11-3pm daylight savings)
Greater than 10	Extreme	Stay indoors as much as possible otherwise use all precautions above

The UV-Index exposure categories are based on the response of fair-skinned people to UVR. People who have skin types that are less likely to burn should note that although they may not sunburn easily, they can still receive high UVR exposures which can increase their long-term risk of skin cancer.

Skin Types

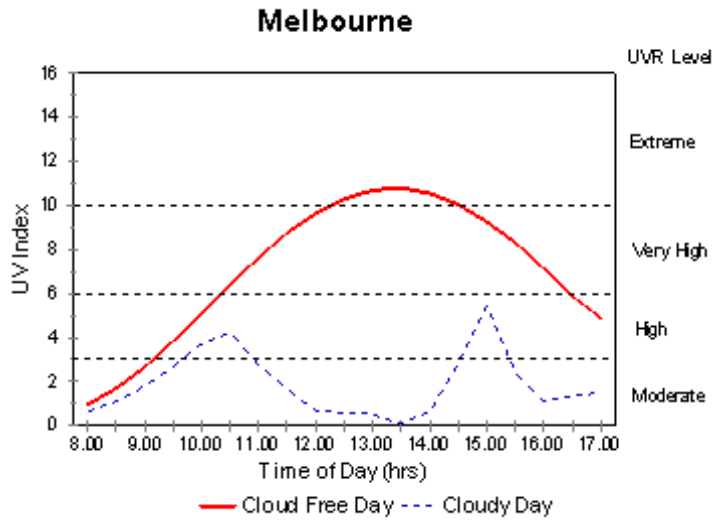
Human skin is classified by sensitivity to UV radiation as follows:

Skin Type	Appearance (unexposed)	Response to UV Radiation
I	White	Burns easily, never tans
2	White	Burns easily, sometimes tans
3	White	Burns moderately, average tans
4	Light Brown	Burns slightly, tans easily
5	Moderate Brown	Rarely burns, heavy pigmentation
6	Dark brown-black	Never burns, heavy pigmentation

Based on a Table from M.A. Pathak. *"Intrinsic Photoprotection in Human Skin"*, p45 (N.J. Lowe (ed.) Physicians Guide to Sunscreens), Marcel Dekker, Inc., 1991.

Variation in UVR intensity during the day

This graph shows the UV Index for Melbourne on a cloud free day (solid line)
and a day when there was heavy cloud and rain (dotted line) which reduced the UVR.



Australian and New Zealand Cancer Authorities

For further information, services and products related to personal UVR protection contact your local state cancer authority:

Anti-Cancer Council of Victoria .....(03) 9635 5000
New South Wales State Cancer Council.....(02) 9334 1982
Queensland Cancer Fund .....(07) 3258 2200
Anti-Cancer Foundation of the Universities of S.A.....(08) 8291 4111
Cancer Foundation of Western Australia .....(08) 9381 4515
ACT Cancer Society Incorporated .....(02) 6262 2222
Northern Territory Anti-Cancer Foundation.....1800 188 070
Cancer Council of Tasmania.....(03) 6233 2030
Cancer Society of New Zealand Inc.....+61 4 494 7270

Further information about solar UVR

Contact: Information Officer
Australian Radiation Protection and Nuclear Safety Agency
Lower Plenty Road
Yallambie VIC 3085
Australia
Tel: +61 3 9433 2211
Fax: +61 3 9432 1835
E-mail: arpansa@health.gov.au

UV Protection Information on the Internet

ARPANSA:	www.arpansa.gov.au
Anti-Cancer Council of Victoria:	www.accv.org.au
Australian Bureau of Meteorology:	www.bom.gov.au
World Health Organisation:	www.who.int
Australian Academy of Science:	www.science.org.au

Some Ultraviolet Radiation Terms

UVR - Ultraviolet Radiation. Refers to all ultraviolet radiation in the range 100 nanometres to 400 nanometres. Solar UVR that reaches the earth's surface contains radiation in the range 290 to 400 nanometres due to atmospheric absorption of the shorter wavelengths below 290 nanometres.

UVA - Ultraviolet radiation in the range 315 nanometres to 400 nanometres which generally contribute to premature aging and wrinkling of the skin.

UVB - Ultraviolet radiation in the range 280 nanometres to 315 nanometres and are much stronger than UVA. Much more dangerous to the skin and eyes than UVA and is the most common cause of sunburning. UVB is implicated as a major cause of skin cancer. Only a small amount of UVB reaches the earth's surface due to absorption by the atmosphere.

UVC - Ultraviolet radiation in the range 100 nanometres to 280 nanometres. Very dangerous to the skin and eyes. No UVC reaches the earth's surface due to absorption in the atmosphere. It can be generated by some industrial electronic processes and by arc welding.

UPF - Ultraviolet Protection Factor. This value is a measure of the UVR protection provided by a fabric. A UPF rating of 20 indicates that only 1/20th of the biologically effective UVR striking the sur-

face of the fabric actually passes through it. UPF ratings are determined by testing fabrics in a laboratory in accordance with Australian Standard AS/NZS4399: 1996.

SPF - Sun Protection Factor. Applied to sunscreens and is a measure of the amount of protection against UVR provided by a sunscreen. Sunscreen SPF ratings are determined by testing sunscreens on the skin of human volunteers in accordance with Australian Standard AS2604: 1998.

EPF - Eye Protection Factor. A rating scale (1 to 10) applied to sunglasses. EPF 10 glasses offer the highest protection.

Erythema - Reddening of the skin, as in sunburn.

MED - Minimal Erythemal Dose. The amount of UVR exposure required to cause perceptible reddening of the skin of fair-skinned people.

UV-Index - A measure of the highest UVR level reached each day at a particular location. The higher the UV-Index the greater the amount of skin damaging UVR present and the less time it takes for skin damage to occur. This method of reporting UVR levels is being adopted worldwide.

Australian Standards related to UVR Protection

UVR Protection Issues

Increasing public awareness and interest in UV protection is due in part to the requirements for occupational protection of outdoor workers as well as the provision of UVR protection for the recreational market. In 1989 the National Health and Medical Research Council (NHRMC) issued a standard for occupational exposure limits to ultraviolet radiation.

Behaviour outdoors can significantly affect exposure to solar UVR and use of items of personal protection can provide a substantial reduction in the UVR dose received. This is important because in Australia in summer around noon, outdoor workers would exceed the NHRMC guidelines in 10 to 15 minutes and thus require occupational protection against solar UVR.

The protective properties of sunscreens, sunglasses, hats and clothing against UVR have been the subject of considerable research. Over the last few years interest has extended to shade structures and the UVR protection offered by commonly used materials such as shadecloth, plastic roofing materials, glass, windscreens and window tinting films. Research publications are available free from the ARPANSA Information Officer.

Clothing

In July 1996 Australia became the first country to have a standard formalising the UV protection claims of clothing and the test methods used to evaluate and classify them (AS/NZS 4399:1996 Sun protective clothing - Evaluation and classification). The standard uses the term Ultraviolet Protection Factor (UPF) to designate the amount of protection, up to a maximum of UPF 50+, and also has broad protection categories. The table below shows how well fabrics of various UPF ratings block UV.

The UPF rating scheme is described in the Australian/New Zealand Standard on sun protective clothing AS/NZS 4399:1996.

Protection Category	UPF Ratings	UV Blocked
Excellent protection	40, 45, 50, 50+	more than 97.5%
Very Good protection	25, 30, 35	95.9% to 97.4%
Good protection	15, 20	93.3% to 95.8%

An information bulletin titled "**Clothing and Solar UV Protection**" is available free from the ARPANSA Information Officer.

Sunglasses
Australia is one of the few countries along with the UK, Germany, France and USA to have a standard for sunglasses. Sunglasses purchased overseas may not necessarily comply with the Australian standard AS 1067.1: 1990 Sunglasses and fashion spectacles Part 1: Safety Requirements.

The Australian sunglass standard is quite demanding and is the only mandatory sunglass standard in the world. All sunglasses sold in Australia must comply with the standard.

The standard defines three types of glasses: fashion spectacles, general purpose sunglasses and specific purpose sunglasses. The UV and optical transmittance requirements of AS 1067 are least stringent for fashion spectacles and most stringent for specific purpose sunglasses. All sunglasses sold must be labelled to indicate which AS 1067 category they comply with. An information bulletin **"Sunglasses and Protection from Solar Ultraviolet Radiation**" is available free from the ARPANSA Information Officer.

A related standard is AS/NZS 1337:1992 Eye protectors for industrial applications.

Sunscreens
The current Australian standard (AS/NZS 2604:1998 Sunscreen products - Evaluation and classification) limits the maximum protection claimed for sunscreen products to SPF 30+.

Broad spectrum sunscreens offer protection against UVA as well as UVB. Sunscreens should be applied before going out into the sun and reapplied regularly to maintain the protection. Reapplication does not give additional protection but ensures the stated protection is achieved.

For example, an SPF 15+ sunscreen that has been effectively applied will give a fair-skinned person about two and a half hours sun protection before they start to sunburn whilst SPF 30+ sunscreen gives about five hours sun protection.

Reapplying the sunscreen will not give extra hours of protection, but it will ensure that the sunscreen provides the full amount of protection. Application of sunscreen ineffectively or too sparingly may considerably reduce the level of protection for the wearer.

Sunscreens of less than SPF 15 offer only moderate to low protection.

List of Standards related to UVR Protection

AS 4174: 1994 Synthetic shadecloth.
AS 2635: 1983 The installation, maintenance and operation of solaria for cosmetic purposes.
AS/NZS 2604: 1998 Sunscreen products - Evaluation and classification
Also relevant AS/NZS 1337: 1992 Eye protectors for industrial applications.
AS 1067.1: 1990 Sunglasses and fashion spectacles
AS/NZS 4399: 1996 Sun protective clothing - Evaluation and classification

Official Guidelines on UVR Protection

National Health and Medical Research Council. Occupational standard for exposure to ultraviolet radiation. Radiation Health Series No.29. Canberra: NHMRC; 1989

Australian standards are available from:

Standards Australia
1 The Crescent,
Homebush NSW 2120,
Australia.
Phone: 1300 654 646