



REGULATORY GUIDE: DETERMINING WHETHER A UV SOURCE IS A CONTROLLED APPARATUS UNDER THE ARPANS REGULATIONS

This document is provided to assist controlled persons to determine whether an ultraviolet (UV) source is classed as *controlled apparatus* under the [Australian Radiation Protection and Nuclear Safety Act 1998](#). In particular, it clarifies the conditions specified in Regulation 4 of the [Australian Radiation Protection and Nuclear Safety Regulations 1999](#).

This document is valid for both pulsed and continuous sources of UV radiation where the exposure duration is not less than 0.1 μ s. It does not apply to UV lasers.

REFERENCE DOCUMENT

[Radiation Protection Standard for Occupational Exposure to Ultraviolet Radiation \(2006\), ARPANSA Radiation Protection Series No. 12](#). Extracts from this document can be found in Appendix 1.

DEFINITIONS

Exposure limit: the exposure which it is believed that nearly all workers can be repeatedly exposed to without adverse effect.

Permissible exposure time, t_{PET} : the time it takes to reach the exposure limit (calculated according to RPS12).

PROCEDURE

This procedure (as illustrated by the flow chart on page 3) will assist you to determine whether your apparatus is controlled or not.

1. If the apparatus is a transilluminator, germicidal lamp or a standard UV tube in a biohazard/laminar flow cabinet, it is controlled apparatus.
2. If the apparatus is a fluorescence microscope, a spectrophotometer or a high-performance liquid chromatography (HPLC) where the light source is completely enclosed, it is not controlled apparatus.
3. For all other apparatus, determine if the source emits UV radiation that could lead to a person being exposed to radiation levels in excess of the exposure limits using the *Radiation Protection Standard for Occupational Exposure to Ultraviolet Radiation* as reproduced in Appendix 1. This can be done by calculating the radiation levels at a distance of 20 cm from the source, not taking into account any shielding. Assume that the exposure time is 8 hours. If the radiation levels are below the exposure limits then the apparatus is not controlled apparatus. If the radiation levels are above the exposure limits then the intended operations and procedures have to be taken into consideration.

4. Taking into account the intended operations and procedures, calculate the **permissible exposure time**, t_{PET} . This means that the distance to the source when the unit is in operation should be taken into account. Using the inverse square law the radiation level is calculated at the position where the closest person is situated. If the unit is handheld and no distances are specified: assume that the skin and eyes are 20 cm and 50 cm, respectively, from the source.

The attenuation provided by any engineered shields should be taken into account when calculating t_{PET} .

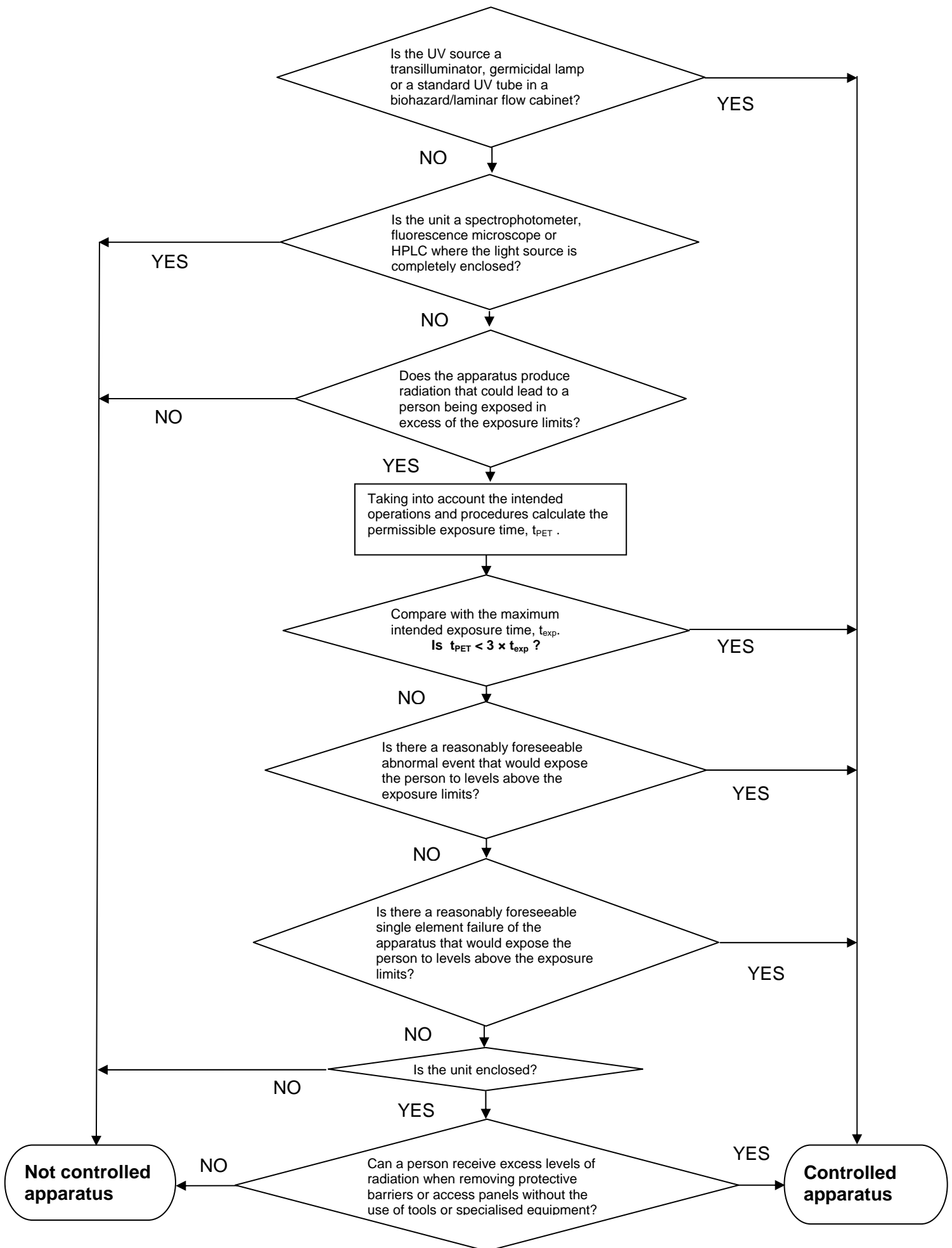
The use of any personal protective equipment (PPE) should be taken into account when calculating t_{PET} .

Compare with the **intended exposure time**, t_{exp} .

If $t_{PET} < 3 \times t_{exp}$ then the apparatus is classed as controlled apparatus.

If $t_{PET} > 3 \times t_{exp}$ then steps 5, 6, 7 and 8 have to be excluded before the decision is made that the apparatus is not classed as controlled apparatus.

5. If there is a reasonably foreseeable abnormal event involving the apparatus that would lead to a person being exposed to excess levels of radiation, the apparatus should be classed as controlled apparatus. Examples of this are: forgetting or using the wrong PPE, possible exposure during normal maintenance, not using prescribed shielding to cover a sample, easy overriding of an interlock etc.
6. If there is a reasonably foreseeable single element failure of the apparatus that would lead to a person being exposed to excess levels of radiation, the apparatus should be classed as controlled apparatus. An example of this is a malfunctioning interlock. A *failsafe* interlock would not lead to a person being exposed as no UV is emitted if the interlock fails.
7. If the above evaluation has been done on an apparatus that is enclosed then the possibility of removal of the access panels has to be assessed. If there is no enclosure then the evaluation is complete and the apparatus is not classed as controlled apparatus.
8. If a person can receive excess levels of radiation when removing protective barriers or access panels that do not require the use of tools or other specialized equipment, then the apparatus should be classed as controlled apparatus. Assume that the person is exposed for 10 minutes while the access panels or protective barriers are removed.



Appendix 1

Extracts from Schedule 1, *Radiation Protection Standard for Occupational Exposure to Ultraviolet Radiation (2006)*, ARPANSA, Radiation Protection Series No. 12

EXPOSURE LIMITS (EL) FOR UVR FROM ARTIFICIAL SOURCES²

- S1.1 The EL for occupational exposure to UVR incident upon the skin or eye where irradiance values are known and the exposure duration is controlled are as below. Note that S1.2 and S1.3 must both be satisfied independently.
- S1.2 For the UV-A spectral region 315 to 400 nm, the total radiant exposure on the unprotected eye must not exceed 10 kJ.m⁻² within an 8 hour period and the total 8 hour radiant exposure incident on the unprotected skin must not exceed the values given in Table 1. Values for the relative spectral effectiveness are given up to 400 nm to expand the action spectrum into the UV-A for determining the EL for skin exposure.
- S1.3 In addition, the ultraviolet radiant exposure in the actinic UV spectral region (UV-B and UV-C from 180 to 315 nm) incident upon the unprotected skin and unprotected eye(s) within an 8 hour period must not exceed the values given in Table 1.
- S1.4 For broadband sources emitting a range of wavelengths in the ultraviolet region (ie most UVR sources), determination of the effective irradiance of such a broadband source is done by weighting all wavelengths present in the emission with their corresponding spectral effectiveness by using the following weighting formula:

$$E_{\text{eff}} = \sum E_{\lambda} \cdot S_{\lambda} \cdot \Delta\lambda$$

where:

E_{eff} = Effective irradiance in W.m⁻² (J.s⁻¹.m⁻²) normalised to a monochromatic source at 270 nm

E_{λ} = Spectral irradiance in W.m⁻².nm

S_{λ} = Relative spectral effectiveness (unitless)

$\Delta\lambda$ = Bandwidth in nanometres of the calculated or measurement intervals

- S1.5 Permissible exposure time in seconds for exposure to actinic UVR incident upon the unprotected skin or eye may be computed by dividing 30 J.m⁻² by E_{eff} in W.m⁻². The maximum exposure duration may also be determined using Table 2 of this Schedule which provides representative exposure durations corresponding to effective irradiances in W.m⁻² (and $\mu\text{W.cm}^{-2}$).

Note: When applying the EL to the skin for the case when there is continuous exposure for a period longer than 8 hours (such as a double shift for indoor workers) special care needs to be taken. This is because the EL is based on a normal 24 hours cycle of light and dark where cellular repair takes place mainly when the exposure is discontinued.

² These exposure limits are intended to be used as guidelines only for Solar UVR exposure.

Table 1: Ultraviolet radiation exposure limits and Relative Spectral Effectiveness

Wavelength ^a (nm)	Exposure Limit (J.m ⁻²)	Exposure Limit (mJ.cm ⁻²)	Relative Spectral Effectiveness S _λ
180	2 500	250	0.012
190	1 600	160	0.019
200	1 000	100	0.030
205	590	59	0.051
210	400	40	0.075
215	320	32	0.095
220	250	25	0.120
225	200	20	0.150
230	160	16	0.190
235	130	13	0.240
240	100	10	0.300
245	83	8.3	0.360
250	70	7.0	0.430
254 ^b	60	6.0	0.500
255	58	5.8	0.520
260	46	4.6	0.650
265	37	3.7	0.810
270	30	3.0	1.000
275	31	3.1	0.960
280 ^b	34	3.4	0.880
285	39	3.9	0.770
290	47	4.7	0.640
295	56	5.6	0.540
297 ^b	65	6.5	0.460
300	100	10	0.300
303 ^b	250	25	0.120
305	500	50	0.060
308	1 200	120	0.026
310	2 000	200	0.015
313 ^b	5 000	500	0.006

Table 1: Ultraviolet radiation exposure limits and Relative Spectral Effectiveness (continued)

Wavelength ^a (nm)	Exposure Limit (J.m ⁻²)	Exposure Limit (mJ.cm ⁻²)	Relative Spectral Effectiveness S _λ
315	1.0 × 10 ⁴	1.0 × 10 ³	0.003
316	1.3 × 10 ⁴	1.3 × 10 ³	0.0024
317	1.5 × 10 ⁴	1.5 × 10 ³	0.0020
318	1.9 × 10 ⁴	1.9 × 10 ³	0.0016
319	2.5 × 10 ⁴	2.5 × 10 ³	0.0012
320	2.9 × 10 ⁴	2.9 × 10 ³	0.0010
322	4.5 × 10 ⁴	4.5 × 10 ³	0.00067
323	5.6 × 10 ⁴	5.6 × 10 ³	0.00054
325	6.0 × 10 ⁴	6.0 × 10 ³	0.00050
328	6.8 × 10 ⁴	6.8 × 10 ³	0.00044
330	7.3 × 10 ⁴	7.3 × 10 ³	0.00041
333	8.1 × 10 ⁴	8.1 × 10 ³	0.00037
335	8.8 × 10 ⁴	8.8 × 10 ³	0.00034
340	1.1 × 10 ⁵	1.1 × 10 ⁴	0.00028
345	1.3 × 10 ⁵	1.3 × 10 ⁴	0.00024
350	1.5 × 10 ⁵	1.5 × 10 ⁴	0.00020
355	1.9 × 10 ⁵	1.9 × 10 ⁴	0.00016
360	2.3 × 10 ⁵	2.3 × 10 ⁴	0.00013
365 ^b	2.7 × 10 ⁵	2.7 × 10 ⁴	0.00011
370	3.2 × 10 ⁵	3.2 × 10 ⁴	0.000093
375	3.9 × 10 ⁵	3.9 × 10 ⁴	0.000077
380	4.7 × 10 ⁵	4.7 × 10 ⁴	0.000064
385	5.7 × 10 ⁵	5.7 × 10 ⁴	0.000053
390	6.8 × 10 ⁵	6.8 × 10 ⁴	0.000044
395	8.3 × 10 ⁵	8.3 × 10 ⁴	0.000036
400	1.0 × 10 ⁶	1.0 × 10 ⁵	0.000030

^a Wavelengths chosen are representative; other values should be interpolated at intermediate wavelengths.

^b Emission lines of a mercury discharge spectrum.