



**Australian Government**  
**Australian Radiation Protection  
and Nuclear Safety Agency**



# Regulatory Guide

## UV emitting apparatus case studies







## **Regulatory Guide**

# **UV EMITTING APPARATUS**

## **Case Studies**

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## Introduction

This document is provided to assist applicants and licence holders assess UV emitting apparatus. It may also be useful for non-licence holders to gain an understanding of the hazard of some typical UV emitting apparatus. It contains case studies of apparatus that have been assessed by ARPANSA.

The guide demonstrates how [Regulatory Guide: Determining whether a UV source is a controlled apparatus](#) is implemented. If you have any questions on how to evaluate your specific apparatus please contact your regulatory officer or send an e-mail to [licenceadmin@arpansa.gov.au](mailto:licenceadmin@arpansa.gov.au).

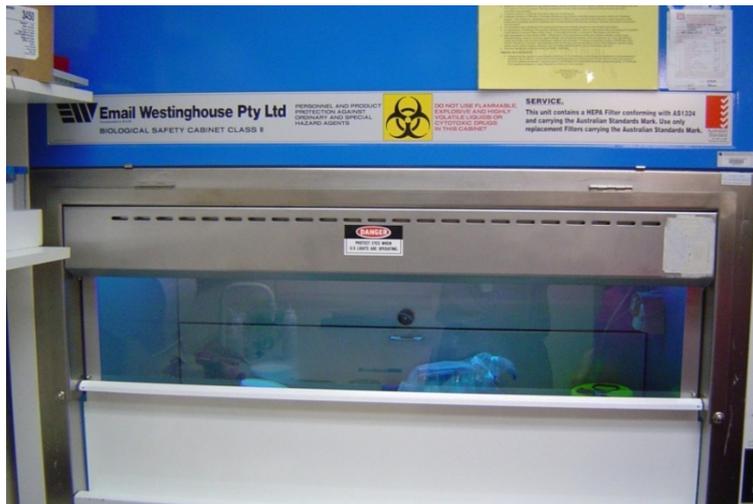
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# 1. Biological safety cabinet – Example 1



## Details of the apparatus

- The biological safety cabinet emits at a wavelength of 254 nm, which is in the UVC region (180 – 280 nm). It is a germicidal lamp which means that the emission levels will be well above the exposure limits.
- The lower access panel can be taken off while the UV lamp is energized.
- There is no interlock or the interlock can be overridden.

## Assessment

During intended operations or procedures the exposure limits will not be exceeded as the window and access panel will protect the user. The UV light is only used between procedures for disinfecting. It should not be used while samples are being handled.

It is reasonably foreseeable that a person could remove the access panel while the UV light is on and receive an exposure.

⇒ ***This biological safety cabinet is classed as controlled apparatus***

## 2. Biological safety cabinet – Example 2



Source: <http://www.edwardsco.com.au/store/catalogsearch/result/?q=Safemate+Vision+1.5m+Class+II+Biological+Safety+Cabinet+Ea>

### Details of the apparatus

- The biological safety cabinet emits UV light at 254 nm (UVC). It is a germicidal lamp which means that the emission levels will be well above the exposure limits.
- The fluorescent lamps and UV light cannot work simultaneously as they are electronically interlocked.
- While the unit is in UV mode the sliding window cannot be opened.
- UV light cannot be turned on while the sliding door is open.
- If a fault occurred and the window could be opened electronically or manually, an interlock will cut the UV emission. The interlock is failsafe (meaning that if it should fail the UV emission will terminate) and hard to override.

### Assessment

During intended operations or procedures the exposure limits will not be exceeded.

Due to the robust interlock there is no reasonably foreseeable abnormal event that would expose a person to levels above the exposure limits.

As the interlock is failsafe there is no reasonably foreseeable single element failure that would expose a person to levels above the exposure limits.

⇒ ***This biological safety cabinet is not classed as controlled apparatus***

### Comment

This assessment is based on the above criteria for a biological safety cabinet. Most standard older biological safety (laminar flow/biohazard) cabinets containing a UV source are classed as controlled apparatus. Please contact an ARPANSA regulatory officer to discuss if you have a biological safety cabinet that you believe is not classed as controlled apparatus on the same grounds as in the example above.

### 3. High-performance liquid chromatography (HPLC)



#### Details of the apparatus

- The UV light source is completely enclosed
- Low UV emission

#### Assessment

During intended operations or procedures the exposure limits will not be exceeded.

It is not reasonably foreseeable that a person could access the UV source and receive exposures above the exposure limit.

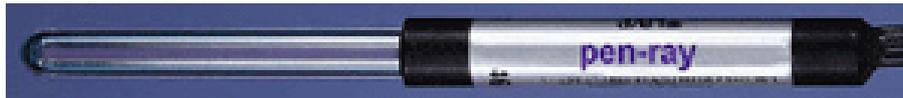
A person cannot remove access panels without use of tools or specialised equipment.

⇒ ***The apparatus is not classed as controlled apparatus***

#### Comment

If a unit is a standard HPLC with properties similar to the one above it is automatically classed as not controlled. There is no need to assess it against the regulatory guide.

## 4. Pen-Ray Mercury lamp



Source: <http://uvp.com/mercury.html>

### Details of the apparatus

- UV lamp used in a number of applications in laboratories (sterilisation, fluorescent inspection, wavelength calibration etc.)
- Lamp emits Mercury spectral lines with the primary emission at 254nm.
- Typical intensity:
  - 254 nm @ 20 mm distance =  $4700 \mu\text{W}/\text{cm}^2 = 47 \text{ W}/\text{m}^2$  (UVC)
  - 365 nm @ 20 mm distance =  $215 \mu\text{W}/\text{cm}^2 = 2.15 \text{ W}/\text{m}^2$  (UVA)

### Assessment

#### Skin and Eye UVR exposure:

Calculate the effective irradiance according to RPS 12:

At 20 mm:

$$E_{eff} = \sum E_{\lambda} S_{\lambda} \Delta_{\lambda} = 47 \frac{\text{W}}{\text{m}^2} \times 0.5 + 2.15 \frac{\text{W}}{\text{m}^2} \times 0.0001 = 23.5 \text{ W}/\text{m}^2$$

the contribution from 365 nm

is negligible

$$\rightarrow \text{Maximum exposure time at 20 mm} \quad t_{PET} = \frac{30 \text{ J}/\text{m}^2}{23.5 \text{ W}/\text{m}^2} = 1.3 \text{ s}$$

At 20 cm:

$$\text{Inverse square law} \rightarrow \text{distance} \times 10 \rightarrow \text{intensity} / 100 \rightarrow t_{PET} = \frac{30 \text{ J}/\text{m}^2}{0.235 \text{ W}/\text{m}^2} = 130 \text{ s} \approx 2 \text{ min}$$

It is reasonably foreseeable that someone would be exposed for more than 2 minutes at 20 cm distance or more than 1.3 seconds at 20 mm distance. This means that the UVR exposure limit could be exceeded.

#### Eye UVA (315 – 400 nm) exposure:

$$\text{At 20 mm:} \quad E_{365\text{nm}} = 2.15 \text{ W}/\text{m}^2$$

$$t_{PET} = \frac{10\,000 \text{ J}/\text{m}^2}{2.15 \text{ W}/\text{m}^2} \approx 4650 \text{ s} \approx 77 \text{ min}$$

At 50 cm:

Inverse square law  $\rightarrow$  distance  $\times (50/20) = 25 \rightarrow$  intensity  $/ 625 \rightarrow$

$$E_{365\text{nm}} = \frac{2.15 \text{ W}/\text{m}^2}{625} = 0.00344 \text{ W}/\text{m}^2$$

The exposure limit at 50 cm

$$t_{PET} = \frac{10\,000 \text{ J/m}^2}{0.00344 \text{ W/m}^2} \approx 2\,900\,000 \text{ s} \approx 800 \text{ hours}$$

Maximum UVA exposure for the eyes will not be exceeded. The exposure to the skin will be the limiting factor.

It is reasonably foreseeable that a person could be exposed to levels above the exposure limit.

⇒ ***The apparatus is classed as controlled apparatus***

## 5. Spectrophotometer



### Details of the apparatus

- The UV light source is enclosed during operation
- Low UV emission

### Assessment

During intended operations or procedures the exposure limits will not be exceeded.

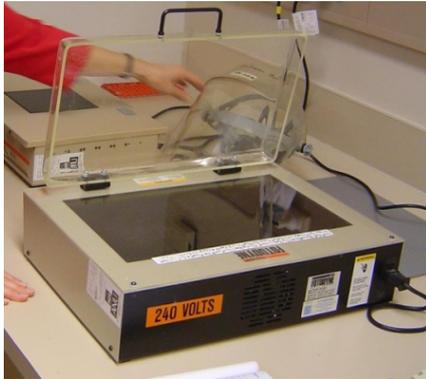
It is not reasonably foreseeable that a person could access the UV source and receive exposures above the exposure limit.

⇒ ***The apparatus is not classed as controlled apparatus***

### Comment

If a unit is a standard spectrophotometer with properties similar to the one above it is automatically classed as not controlled. There is no need to assess it against the regulatory guide.

## 6. Transilluminator



### Details of the apparatus

- The emission of transilluminators is typically 254 nm, 312 nm or 366 nm.
- Transilluminators are powerful sources of UV radiation. Emission levels are above exposure limits. Transilluminators, used in research can be a significant source of occupational exposure to UVR. Hands, arms, face and eyes are likely sites of injury. Working unprotected for even a few minutes can cause injury.

### Assessment

Reasonably foreseeable abnormal events where exposure limits could be exceeded are:

- shielding is removed or non-existent
- PPE is not worn or is not appropriate

⇒ ***Both transilluminators are classed as controlled apparatus***

### Comment

There have been a number of incidents where the user of a transilluminator developed erythema because appropriate PPE was not used and a shield was not present.

## 7. UV light box



### Details of the apparatus

- Homemade units
- Manual switches turns UV source on and off
- Intensity levels unknown
- There is no interlock or fixed shielding

### Assessment

It is reasonably foreseeable that someone might place their hand in the box while the UV source is on. If the levels are high enough the exposure levels could be exceeded.

⇒ *The apparatus is classed as controlled apparatus*

### Comment

If emission levels are measured and found to be low (no reasonably foreseeable abnormal event where a person would be exposed to levels above the exposure limit) the apparatus is not controlled.

## 8. Water steriliser – Example 1



### Details of the apparatus

- Water steriliser where UV lamp is used to kill bacteria as the water flows past.
- Germicidal action which means that emission levels are high (primarily UVC – 254 nm).
- UV light is leaking out from the back of the unit. The unit is completely enclosed apart from this opening. The emission levels of the escaping UV light have not been quantified.
- The enclosure is interlocked.

### Assessment

We can assume that the intensity of the escaping light is low so that during intended operations or procedures the exposure limits will not be exceeded (a person will not normally be close to the unit).

It is reasonably foreseeable that a person could hold their hand close to the unit and be exposed to the escaping light. As we do not know the intensity of the escaping light we make the conservative assumption that the exposure limit can be exceeded.

⇒ *The apparatus is classed as controlled apparatus*

## 9. Water steriliser – Example 2



### Details of the apparatus

- Water steriliser where UV lamp is used to kill bacteria as the water flows past.
- The emission of the UV light is at 254 nm (UVC). Germicidal action which means that emission levels are high.
- The unit is fully enclosed and the housing is not interlocked.
- A screwdriver is needed to open the housing.

### Assessment

During intended operations or procedures the exposure limits will not be exceeded as the source is completely enclosed.

A reasonably foreseeable abnormal event that would expose a person to levels above the exposure limit could be exposure during maintenance when the UV lamp is replaced. The standard operating procedure for changing the lamp illustrates that the lamp is completely enclosed in a special housing, and that the power has to be switched off before you can access the UV lamp. From this it is concluded that there is no risk of exposure during the process of changing the lamp.

Excess levels of radiation are not accessible under a reasonable foreseeable single element failure of the apparatus and the source cannot be accessed without the use of tools or specialised equipment.

⇒ ***The apparatus is not classed as controlled apparatus***