

**NRL C13**  
Version 1.1  
**ISSN 0110-9316**

**CODE OF SAFE PRACTICE FOR USE OF  
STRONTIUM-90 OPHTHALMIC APPLICATORS**

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**September 1997  
Revised June 2001**

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**Ministry of Health**

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## 1. INTRODUCTION

**1.1** This Code of Safe Practice has been produced by the National Radiation Laboratory (NRL) in order to ensure the safe use of strontium-90 applicators that are used for treatment of pterygium and other eye conditions.

**1.2** “Safe use” includes both the safety of anyone intentionally or unintentionally coming into contact with the radioactive material, and safety of patients through assurance that an appropriate therapeutic dose is accurately delivered.

**1.3** Where compliance with this Code is a requirement (Section 2.1), **clauses in the Code using the word “shall” are mandatory**. Other clauses and notes are recommendations and for information.

**1.4** As well as compliance with this Code, the user must satisfy the requirements of the radiation protection legislation (Section 2.1).

## 2. LICENSING

### 2.1 Legislation

**2.1.1** The safe use of radioactive materials is regulated by the Radiation Protection Act 1965 and the Radiation Protection Regulations 1982. No person may use radioactive materials unless he or she has an appropriate licence under the Act, or is acting under the supervision or instructions of such a licensee.

**2.1.2** The safety of the use of any Sr-90 ophthalmic applicator **shall** be the responsibility of a person who has been granted a licence under the Act for the purpose Medical Therapy or Medical Superficial Therapy.

**2.1.3** To be eligible an applicant for a licence must be on the New Zealand Medical Register, and have special knowledge in the safe use of radioactive material for the treatment of ophthalmic disease. When any question arises as to whether an applicant has the required special knowledge, this will be referred to the Radiation Protection Advisory Council.

## **2.2 Use under the supervision or instructions of a licensee**

**2.2.1** The Radiation Protection Act permits the use of radioactive material by persons operating under the instructions or supervision of a licensee. The responsibility remains with the licensee for any decisions affecting the radiation safety of patients treated or other staff handling the applicator.

**2.2.2** One medical practitioner may act under the supervision of another who holds a licence, but only if that practitioner is subject to the general oversight of the licensee. However, any clinician who holds vocational registration under the Medical Practitioners Act 1995 in the branches of Ophthalmology or Radiotherapy would be considered to be acting independently and not under supervision or instructions. Such a person **shall not** treat patients with a Sr-90 applicator unless he or she has been granted a separate licence.

**2.2.3** Any licensee **shall** ensure that the requirements of the Act, Regulations, and this Code are satisfied at all times by any other person acting under his or her supervision or instructions. Any other such person using the applicator in any way (eg, cleaning, inspecting) **shall** be familiar with the contents of this Code.

## **2.3 Multiple licences**

**2.3.1** When one Sr-90 applicator is used by several licensees, one **shall** be designated by the owner as the “principal licensee” for that applicator.

**2.3.2** The principal licensee **shall** ensure compliance with this Code at all times that the applicator is not under the direct control of another licensee.

## **3. HAZARDS FROM SR-90 RADIATION**

### **3.1 The types of radiation emitted**

Strontium-90 decays into yttrium-90 which is also radioactive. Both of these radionuclides emit beta rays. These beta rays do not penetrate more than a centimetre or so through tissue, and are fully absorbed by 1.2 centimetres of

perspex. They are almost entirely directed outwards in a broad beam from the surface of the applicator, and travel more than a metre in air.

Depending on the absorbing material, when betas interact they may generate “bremsstrahlung”. This radiation is the same as x-rays and is much more penetrating than beta rays, but it is not generated very efficiently, particularly in materials of low atomic number, and the radiation dose rate is no more than a percent or so of that from the beta rays. The radiation emitted from the shielded box containing the applicator, or through the other side of a thick perspex shield is bremsstrahlung.

## **3.2 Organs at risk**

The greatest hazard from handling a Sr-90 applicator is to the skin and eyes from the beta rays. It is important to be aware of the “beam” of betas radiating out from the active surface, and not to point it at any unprotected skin or eyes. (However, it is safe to view the active surface through at least 1.2 centimetres thickness of perspex.)

The bremsstrahlung from the applicator when in storage irradiates the whole of the body. Even though the radiation dose rate is low, exposure to this should be minimised.

## **3.3 Damage to the source – leakage of radioactive material**

If the active surface is not cared for correctly, there is a possibility that the metal foil coating may become broken, and the active material may rub off the surface. Then there is a hazard from the spread of radioactive contamination onto the treated area of the patient’s eye, as well as onto cleaning materials.

## **3.4 Obsolescence**

**3.4.1** Because the intense radiation degrades the encapsulation of Sr-90, the manufacturer will typically not recommend continued use after more than 10 years from the date of manufacture. However, if regular checks indicate

there is no visible degradation of the active surface and no removable contamination, the working life may be extended.

**3.4.2** If the person who has inspected an applicator in accordance with Section 6.2 has good reason to believe that there is a significant risk that the active surface, because of its age and condition, will not remain safe until the next wipe test, then the applicator **shall** be withdrawn from use and disposed of in an approved manner (see Section 9).

## **4. GENERAL PRECAUTIONS**

**4.1** The Sr-90 applicator **shall** be removed from its shielded container only by a person who is trained in its safe use, and who is familiar with the requirements of this Code of Safe Practice.

**4.2** When used for treating a patient, the applicator should be moved to and from the treatment position as quickly as practical.

**4.3** The active surface of the applicator **must not** be touched with the fingers.

**4.4** The active surface **must not** be viewed with the naked eye.

**4.5** The applicator **shall** always be stored in its shielded container when not in use.

**4.6** If the applicator is provided with a protective cap **make sure this is removed** for treatments.

**4.7** If any person receives a radiation dose of greater than 0.5 Gy for any reason other than medical therapy, then this is an over exposure in terms of the Radiation Protection Regulations 1982. If anyone has reason to believe that this has happened, the licensee responsible **shall** be informed immediately, or failing that, the Director of NRL. The licensee **shall** report all pertinent details of the case to the Director of NRL as soon as possible.

## 5. CORRECT TREATMENT TIMES

**5.1** A Sr-90 applicator **shall not** be used unless there is on hand a certificate of measurement by a recognised authority stating the surface radiation dose rate at a reference date, or a copy or authorised reference to such a certificate.

**5.2** Sr-90 decays with a half-life of 29.12 years. The surface dose rate **shall** be corrected for decay at intervals not exceeding 2 years. After 2 years the uncorrected dose rate is in error by more than 5%. A chart of correct treatment times for standard doses **shall** be kept with the applicator. (See Appendix A for details of dose units and treatment times.)

**5.3** The timing of dose delivery **shall** be accurate within 5% of the prescribed time, or 1 second, whichever is greater. In practice the prescribed time will be given to the nearest second, and accuracy within a second can easily be achieved using a digital timer.

## 6. CARE OF THE APPLICATOR

### 6.1 Cleaning

After each use the applicator should be cleaned by wiping with a swab moistened in antiseptic solution, or alcohol. To check the surface it may be viewed through a perspex sheet at least 1.2 cm thick and 10 x 10 cm<sup>2</sup> in area. If this is not available a mirror may be used. Keep the applicator at arms' length as much as possible.

All care **shall** be taken to keep the fingers away from the active surface

*Note:* As long as wipe tests are clear, materials used for cleaning the applicator will not be radioactive, so no special precautions are needed for disposal.

## 6.2 Wipe testing and inspecting

**6.2.1** The applicator **shall** be wipe-tested and inspected visually at intervals of no greater than two years for the first 10 years after manufacture, and from then on, no greater than one year. (See also 6.2.5.)

**6.2.2** Every wipe test **shall** be performed by a person or service approved by the NRL.

**6.2.3** The method used for the wipe test **shall** conform to International Standard ISO 1677-1977.

**6.2.4** If a wipe test indicates that the removable contamination on the surface of the applicator is greater than 185 Bq it **shall** be withdrawn from use. (See Section 9 for disposal instructions.)

**6.2.5** The visual inspection **shall** be done using a perspex screen of at least 1.2 centimetres thickness and 10 x 10 cm<sup>2</sup> in area. If there is any pitting, cracking, or other degradation of the active surface, wipe tests **shall** be done annually, irrespective of the age of the applicator.

**6.2.6** Records of the results of wipe tests and visual inspections **shall** be kept as detailed in Section 10.

## 6.3 Storage

**6.3.1** When not in use, the applicator **shall** be kept in the shielded box in which it was supplied, in a locked storage place to minimise the possibility of theft.

**6.3.2** The applicator **shall** not be stored within 3 metres of any place that is continuously occupied, unless there is extra shielding provided to reduce the radiation to what it would otherwise be at 3 metres from the storage box.

## **7. USE OF AN APPLICATOR AT A NUMBER OF LOCATIONS**

**7.1** If an applicator is to be used at more than one location, then the licensee (or principal licensee if there is more than one) **shall** maintain a log system that allows an unambiguous determination of where the applicator is at any time.

**7.2** The licensee (or principal licensee) **shall** ensure that the requirements for treatment records in Section 10.3 are satisfied in each of the locations.

## **8. TRANSPORT OF SOURCES**

### **8.1 Regulations**

Transport of radioactive material within New Zealand must comply with the IAEA *Regulations for the safe transport of radioactive materials*. It is the responsibility of the licensee to ensure that all the requirements are satisfied.

### **8.2 Packaging**

A Sr-90 applicator must be transported in a Type A package as defined in the IAEA Transport Regulations. The requirements for Type A packages are quite detailed and are not covered fully here. The package in which the applicator was originally delivered will comply with the requirements, and it should be kept intact for subsequent transport. However, if this is no longer available, most applicators are supplied in a shielded wooden lockable box that may satisfy the requirements for a Type A package. If there is any doubt about this, the container should be approved by NRL.

### **8.3 Labelling**

The original package may have labels attached indicating “Type A” and “Radioactive Material, Type A Package, UN 2915”. If so, and if they are in good condition, they should be left as they will still be valid. If they are not in good condition, or if they are labels with different wording complying with superseded requirements, they should be replaced with new labels with the

above wording. Two Category I, or II labels must be affixed to opposite sides of the package. Which category depends on the radiation dose rate at the surface and at 1 metre from the surface as follows:

Maximum dose rate	At surface	1 m from surface
Category I	5 $\mu\text{Sv/h}$	-
Category II	500 $\mu\text{Sv/h}$	10 $\mu\text{Sv/h}$

If the radiation dose rate has changed from the original consignment, new labels will be required. The labels must show the activity in becquerel units and the Transport Index. The Transport Index is determined by taking the maximum radiation dose rate at any point 1 metre from the surface of the package in  $\mu\text{Sv/h}$  and dividing by 10 (ie, the dose rate in mrem/h). Labels are available from NRL.

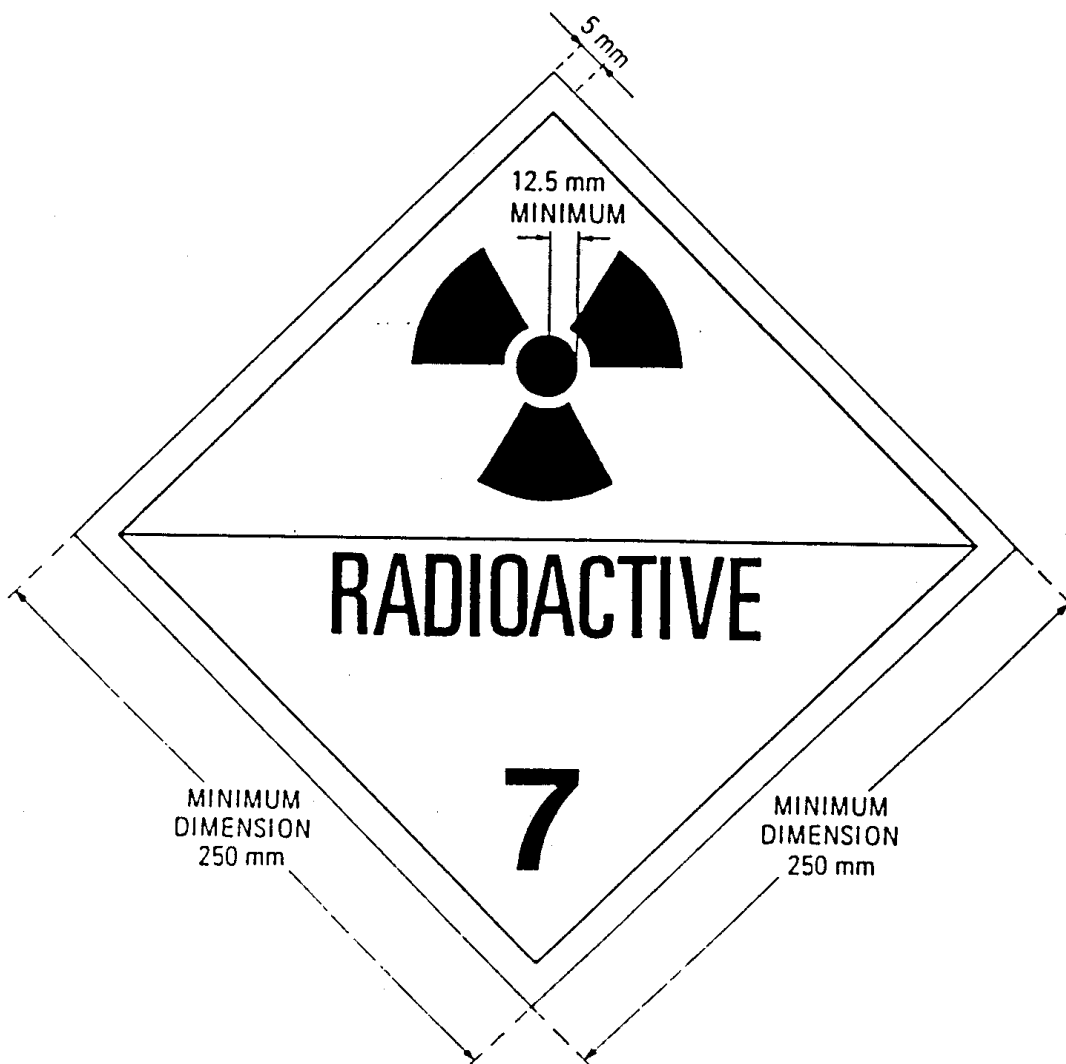
## 8.4 Documentation

For road transport, a “Road/Rail/Marine Shipper’s declaration for Dangerous Goods – Class 7 Radioactive Material” (available from the NRL) **shall** be included with the transport documents. For road transport in a private vehicle, this declaration **shall** be carried in the cab of the vehicle, and a single Shipper’s Declaration may be used for repeat transport of the same source, for not more than one year from its first use.

## 8.5 Vehicle placarding

Any vehicle carrying radioactive materials which require a dangerous goods label (in this case all Sr-90 ophthalmic applicators) must be placarded. The IAEA Regulations specify that the placards be placed according to international practice, that is, at the rear and both sides of the vehicle. New Zealand law allows an alternative placement in line with standard dangerous goods placarding in New Zealand, that is, at the front and the rear of the vehicle.

The placards **shall** be at least 250 millimetres square, and be of the design reproduced below. The upper half of the diamond shall be yellow, and the lower half white.



## **9. DISPOSAL OF UNWANTED SOURCES**

If a Sr-90 applicator has either exceeded its 30-year working life, or has more than 185 Bq of surface contamination (Section 3.3), it **shall** be disposed of in one of the two following ways:

**9.1** NRL can accept applicators for disposal. This will be done only on the understanding that ownership of the applicator has been transferred to NRL on receipt at NRL. It is the responsibility of the owner to meet all relevant transport of dangerous goods requirements, and to meet the costs of transport. (NRL can advise on transport requirements.)

**9.2** Alternatively, an applicator may be exported overseas (to the supplier of a replacement, for example). NRL has no responsibility in these cases, apart from issuing the required export authorisation.

## **10. RECORDS TO BE KEPT**

### **10.1 Certificate of dose rate measurement**

Either the original or a clear copy of the certificate of measurement that was supplied when the applicator was purchased **shall** be kept available for reference for as long as the applicator is used.

### **10.2 Wipe tests and visual inspections**

A record of the results of every wipe test and visual inspection required in Section 6.2, signed by the person who carried out the test **shall** be kept for as long as the applicator is used.

### **10.3 Treatments**

**10.3.1** A record **shall** be kept of every treatment given using an applicator.

**10.3.2** The record **shall** include:

the name of the patient;

the date of treatment;  
the area treated;  
the radiation dose delivered, and treatment time;  
the name of the person who used the applicator.

**10.3.3** A set of such records for a particular applicator **shall** indicate the serial number of the applicator used.

**10.3.4** Such records **shall** be kept available for audit for ten years.

## **11. LOSS OF AN APPLICATOR**

In the event of the loss, or release beyond the control of the licensee, of an applicator, the licensee **shall** take the following action:

**11.1** Take all reasonable steps to recover the material, and issue such warnings as are considered appropriate to minimise the radiation dose that any person might receive as a consequence of that loss or release.

**11.2** Notify the Director of NRL as soon as practicable of the loss or release, of the actions taken to recover the applicator, and of the results of these actions.

## **12. NRL AUDITS**

From time to time every licensee responsible for a Sr-90 applicator will be visited by an officer from NRL to audit compliance with this Code of Practice.

## **APPENDIX A: CALCULATION OF CORRECT TREATMENT TIMES**

The dose to be delivered is typically 10 - 20 grays (or 1000 - 2000 rads; the rad is an old unit for radiation dose. 1 gray = 100 rads).

The measurement certificate will give a doserate in grays per second or rads per second, on a reference date.

To calculate the correct treatment time for a required dose:

1. Determine how many years have elapsed since the reference date on the measurement certificate.
2. Look up the correction factor for source decay from the following table:

<i>Years after reference date on certificate</i>	<i>Correction factor</i>
2	0.95
4	0.91
6	0.87
8	0.83
10	0.79
12	0.75
14	0.72
16	0.68
18	0.65
20	0.62
22	0.59
24	0.56
26	0.54
28	0.51
30	0.49

3. Corrected doserate = (reference doserate) x (correction factor)

$$\text{Treatment time} = (\text{Required dose}) / (\text{corrected doserate})$$

## **APPENDIX B: WIPE TEST METHODS**

International Standard ISO 1677-1977 *Sealed radioactive sources – general*

This gives the following methods:

### *Method 1*

Wipe all exposed external surfaces of the sealed source thoroughly with a piece of filter paper or other suitable material of high absorbent capacity, moistened with a liquid which will not attack the material of which the external surfaces of the capsule are made and which, under the conditions of this test, has been demonstrated to be effective in removing any radioactive material involved. Measure the activity on all of the paper or other material used. If the detected activity is less than 5 nCi (185 Bq), the sealed source is considered to be free from surface contamination.

### *Method 2*

Immerse the sealed source in a liquid which will not attack the material of which the external surfaces of the capsule are made and which, under the conditions of this test, has been demonstrated to be effective in removing any radioactive material involved. Examples of such liquids include distilled water, and weak solutions of detergents or chelating agents. Heat the liquid to  $50 \pm 5^\circ\text{C}$  and hold it at this temperature for four hours. Remove the sealed source and measure the activity in the liquid. If the detected activity is less than 5 nCi (185 Bq) the sealed source is considered to be free from surface contamination.