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RADIATION SAFETY REGULATIONS

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MARALINGA RANGE

(PROVISIONAL)

Issued by

Senior Superintendent, Trials Division

A.W.R.E.

Second (Provisional) Edition

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USEFUL TELEPHONE NUMBERS

- Health Physics Advisor
Group Leader Health Physics Group
Health Physics Representative
Safety Officer
Fire Officer
Medical Officer
Security Officer
Fire Station
Ambulance
Health Physics
Trials H.Q.

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RADIATION SAFETY REGULATIONS

MARLINGA RANGE

1. INTRODUCTION

- 1.1 Radiation which may be encountered on the Range may be α particles, β particles, γ rays and neutrons. Under properly controlled conditions work involving exposure to these radiations can be carried on in perfect safety.

Excessive exposure however may result in serious damage to the human body.

The danger is particularly insidious because the effects are not immediately felt and damage may only become apparent after a period of years. Damage may arise not only from external exposure but from irradiation of internal organs as a result of ingestion, inhalation, injection into the bloodstream through cuts and abrasions, or even by absorption through an intact skin.

- 1.2 The object of these regulations is to ensure complete protection both of workers on the Range and of the general public, whilst imposing the minimum interference with work.

- 1.3 In order to assist in the implementation and interpretation of these and other Radiation Safety Regulations a Health Physics Advisor to the Trials Superintendent, nominated by SH/PR A.F.R.E. will be appointed for each trial. In the period between trials a Health Physics Representative appointed by the Australian Authorities will be present at the Range.

2. MAXIMUM PERMISSIBLE LEVELS

- 2.1.1 The maximum permissible levels of the various radiations and radioactive substances are based on the recommendations of the International Commission on Radiological Protection and of the International Commission on Radiological Units, and have been approved by the Minister of Supply and other Authorities concerned. These are the levels to be used throughout the Range.

- 2.1.2 It is emphasized that these are maxima and every endeavour must be made to keep the average exposure as low as possible.

2.2 EXTERNAL RADIATIONS

For external radiation the maximum permissible levels will be:-

(i) β and γ Radiation

- (a) A normal working rate of 0.6 Rep/week of which the radiation component must not exceed 0.3 R/week.

A relaxation in the case of β particles is permitted for the hands, wrists, forearms, head, neck, feet and ankles, for which the β dose must not exceed 1.5 Rep/week.

The β dose to the eyes must not exceed 0.3 Rep/week.

- (b) A lower integrated dose of 15 Rep of which the γ radiation component must not exceed 3 R.

No further exposure will be permitted during the operation except as under (c) below. Authority to work at this level will be given by the Health Physics Advisor.

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- (c) A high integrated dose of 50 Rep. a week to the Y component must not exceed 10%. No further exposure will be permitted during the next 12 months. Authority to work at this level will be given by the Trials Superintendent after consultation with the Health Physics Advisor and Medical Officer.

(iii) Neutron Radiation

The dose to the tissue 2 cm below the skin surface must be less than 30 millirads per week.

This figure is given by the neutron fluxes below:

Neutrons of energy 0.25 eV - 2000 neutrons/cm²/sec
Neutrons of energy 10 eV - 2000 neutrons/cm²/sec
Neutrons of energy 10 MeV - 1000 neutrons/cm²/sec
Neutrons of energy 0.1 MeV - 200 neutrons/cm²/sec
Neutrons of energy 0.5 MeV - 80 neutrons/cm²/sec
Neutrons of energy 1 MeV - 60 neutrons/cm²/sec
Neutrons of energy 2 MeV - 40 neutrons/cm²/sec
Neutrons of energy 3-10 MeV - 30 neutrons/cm²/sec

(iv) α Radiation

α particles present no external hazard as they are unable to penetrate the outer layers of undamaged skin.

2.3 INTERNAL RADIATIONS

The maximum permissible levels of ingestion, inhalation and injection are based on the equivalent doses to tissue, but are dependent on biological factors which vary with the material.

2.3.1 The Maximum permissible levels will be:-

- (a) For individual isotopes or mixtures of isotopes except weapon debris

The concentrations shall be those laid down in Appx. I for the materials concerned.

- (b) For Weapon Debris

- (i) In water 10^{-7} $\mu\text{c}/\text{cc}$

- (ii) In Air (a) α emitters

The concentration shall be that laid down in Appx. I for the most hazardous material likely to be found

- (b) β -Y emitters

The concentrations shall be those given by the expression $3.0 \times 10^{-6} T$ $\mu\text{c}/\text{cc}$

Where T is the time after the explosion in hours for times between T = 0.25 and T = 5040 (210 days).

For times after 210 days the value given for Sr⁹⁰ shall be used, namely 6×10^{-6} $\mu\text{c}/\text{cc}$.

If the type of the debris is in doubt, the value adopted must be that applicable to the greatest possible area.

The maximum permissible levels applicable to inhalation hazards are based on a regular exposure of 56 hours/week. If these hours are not applicable the levels should be altered proportionately.

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2.4 Contamination Levels

Contamination can be fixed or loose.

2.4.1 In the case of benches, clothing, etc., contamination can be regarded as fixed when a smear test (See Appendix II) gives values below the maximum permissible levels. In the case of hands and body it is defined as that which remains after washing in accordance with the instructions laid down in Appendix III.

2.4.2 The maximum permissible levels of final surface contamination will be as follows:-

	<u>Microcuries/cm²</u>
<u>f - Y</u>	
6,000 disintegrations/min on both sides of one hand	1×10^{-5}
400 disintegrations/min/cm ² , clothing, benches, equip. etc.	2×10^{-5}
400 disintegrations/min/cm ² , floor, cupboards	3×10^{-5}
<u>z</u>	
600 disintegrations/min on both sides of one hand	10^{-5}
20 disintegrations/min/cm ² , clothing, benches, equip. etc.	10^{-5}
400 disintegrations/min/cm ² , floor, cupboards	2×10^{-4}

2.4.3 The maximum permissible level for loose contamination will be:-

<u>f - Y</u>	20 disintegrations/min $\approx 3 \times 10^{-5} / \text{cm}^2$
<u>z</u>	5 disintegrations/min $\approx 1.5 \times 10^{-6} / \text{cm}^2$

3. NOMENCLATURE

3.1 All parts of the Range will be classified according to the nature of the work which may be done in that particular part.

3.2 The system of classification and nomenclature which will be used is as follows:-

3.2.1 NON-ACTIVE Areas

A NON-ACTIVE area is one in which the maximum radiation levels must be less than 1/10 of those laid down in part 2 for Active areas and there is no detectable loose activity. No special radiation precautions will be necessary.

3.2.2 ACTIVE Areas

Those in which there may be some radiation risk and where precautions appropriate to the degree of risk must be taken. There will be three categories:-

- BLUE Area - Risk of penetrating radiation but not of inhalation, ingestion or injection. No special clothing.
- RED Area - Risk of penetrating radiation and of slight inhalation, ingestion, and injection. Protective clothing will be worn in accordance with Health Physics recommendations for the particular area.
- YELLOW Area - Risk of a serious inhalation, ingestion, injection or penetrating radiation hazard. Fully protective clothing must be worn.

3.2.3 The classification of an area will be laid down by the Health Physics Advisor who must be informed prior to any proposed change in the work which might affect the classification. The Health Physics Advisor will review the classifications periodically.

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- 3.2.4 Signs showing the classification and having a patch of the appropriate colour will be displayed at all entrances to any ACTIVE area.

All areas not classified in this way will be NON-ACTIVE areas and these will not have any special marking.

- 3.3.7 No person will be allowed to enter RED or BLUE areas without permission of the Scientist, or other Officer, in charge of the area concerned. No person will be allowed to enter a YELLOW area without permission of the Health Control Officer in charge.

When it is necessary to carry out any building, engineering or other maintenance work in any ACTIVE area, a Permit to Work Certificate must first be raised through the Trials Room, who will consult the Health Physics Advisor, or Representative, where necessary.

4. FILM RIDGES

All personnel will wear a personal monitoring film at all times.

5. PROTECTIVE CLOTHING

- 5.1 (a) All radiation protective clothing will be white, and will be distinguished by red epaulettes or a red triangle as appropriate.
(b) The wearing of the approved protective clothing with film badges and dosimeters as specified in the appropriate part of the regulations is compulsory.
(c) To assist the rigid enforcement of these rules under no circumstances will radiation protective clothing be issued for other purposes.

5.2 Degree of Protection

- (a) Workers in BLUE areas - No special protective clothing necessary.
(b) Workers in RED areas - Approved Lab-coats or overalls, shoes or overshoes. The above is general for all RED areas but in certain special cases additional clothing will be specified by the Health Physics Advisor. When worn in ACTIVE areas Lab-coats and overalls must be kept fastened at all times.
(c) Workers in YELLOW areas - Complete change of all clothing into the fully protective items provided.

5.3 Laundering and Disposal

- 5.3.1 Once an article becomes unserviceable it will not be returned to stores but will be disposed of as contaminated waste.

- 5.3.2 Protective clothing will be sent only to the special laundry provided, gloves and shoes will not be sent to the laundry. Gloves and shoes from YELLOW areas will be cleaned by the Decontamination Group, those from RED areas will be cleaned by the users.

6. USE AND STORAGE OF RADIOACTIVE MATERIALS

- 6.1 No radioactive material will be used in NON-ACTIVE areas. Sealed sources may be used in carrying out calibrations provided the Health Physics Advisor has been informed and Dose Rate warning signs have been erected.
6.2 Materials which are completely sealed so as to prevent any escape of active materials may be used, or stored, in any ACTIVE area. Adequate precautions must be taken to ensure that the dose received by workers in that area is within the limits laid down and to prevent the dose-rate at any point outside the ACTIVE area from exceeding one tenth of the maximum permissible.

- 6.3.1 Use or storage of radioactive materials other than as stated above is permitted only in RED or YELLOW areas.

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6.3 In N.D. areas no radiation will be released intentionally to the air of the Laboratory.

6.4 Details of special precautions required for particular materials and areas will be laid down as appropriate by the Health Physics Advisor.

7. TRANSIT OF RADIOACTIVE MATERIALS

7.1 Transit of radioactive materials through internal N.D.-L.D.N.D. areas is permitted, provided they are in properly designed and sealed containers which will effectively contain the material and shield themselves externally, cloth, and that the Health Physics Advisor has been informed. The transit should be uninterrupted and adequate precautions must be taken to ensure that the Y-ray dose does not exceed 20 milliroentgen/hour at the surface, nor 10 milliroentgen/hour at one metre, and the neutron dose rate does not exceed 30 neutrons/cm²/sec. at the surface. Transit of containers where the dose rate exceeds any one of those is to be prohibited only with prior approval of the Health Physics Advisor.

7.2 Transit of radioactive materials outside the area is governed by any International, U.K. and International Government Legal Memorandum in force, by the Regulations of any other Government concerned, and by any Instructions, currently in force, issued by the N.D., or the Health Physics Advisor. (See also H. D.).

8. LABORATORY WASTE

8.1 All solid waste will be segregated into four main categories:

(i) Highly active waste i.e. above one million curie.

(ii) Low activity waste non-combustible.

(iii) Low activity waste combustible.

(iv) Used Paper, Tissues.

Category (i) waste must be sealed in rigid-suit incinerators held over by the scientist until proper arrangements have been made for its disposal.

Bins suitably labelled will be kept in all laboratories and workrooms where categories (ii) and (iv) are likely to arise. Low activity articles too large to be placed in the bins will be wrapped in impervious material in such a way as to prevent the escape of radioactive material, and will have their contents and approximate levels of activity marked on the outside.

9. MONITORING

9.1 The object of radiation monitoring is to ensure the protection of workers and to prevent interference with scientific work due to contamination.

Health Physics will provide complete monitoring facilities for external use.

A Health Physics Officer will be available to all "active" buildings to advise and assist where called upon.

9.2 PERSONAL MONITORING

9.2.1 Personal monitoring must primarily be the individual's responsibility.

9.2.2 Gamma-ray dosage will be measured by means of film badges which will be worn by all persons at all times.

9.2.3 All persons, before leaving an N.D.-L.D. will monitor the clothes by means of film in brackets provided, to ensure that the count in the lead laid down is not exceeded.

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9.2.4 For special operations, where high dose-rates are anticipated personal ionization chambers will be worn. Special film badges will be worn when required by the Health Physics Advisor, (or Representative).

9.3 Area Monitoring

9.3.1 Air sampling will be carried out in all laboratories and work rooms where there is normally a potential inhalation risk. For special operations or where an unusual inhalation risk is anticipated additional samples will be taken.

9.3.2 Neutron and gamma-ray levels will be measured by fixed instruments installed where necessary.

9.3.3 The Officer-in-Charge will ensure that regular contamination checks are made to ensure that levels of activity are below the maximum values laid down.

In addition periodic surveys will be made by Health Physics surveyors.

9.4 Monitoring of Active Waste

Solid wastes containing radium will be monitored until decontamination is necessary before being taken from an ACTIVE area.

9.5 Monitoring of Equipment

All equipment will be monitored until it is contaminated if necessary before being taken out of an ACTIVE area.

Equipment will not be moved into a less active area unless it is monitored, discontaminated if necessary, and given a Health Physics clearance certificate. Articles must not be moved into a CLEAN or a NON ACTIVE area if there is any detectable loose activity.

10. MEDICAL SURVEILLANCE

The Medical Officer must be consulted in all medical aspects of Radiation Safety.

No person will be allowed to work in an ACTIVE area, or with radioactive materials, who has not previously been cleared for such work by a special medical examination either immediately prior to the Trial concerned, or immediately prior to his first exposure during that Trial.

11. ACCIDENTS AND FIRST AID

11.1 If anyone thinks he may have inhaled, ingested or otherwise absorbed (e.g. through cuts etc.) any radioactive material he must report to his officer-in-charge, the Health Physics Advisor (or Representative) and the Medical Officer, and take emergency action.

11.2.1 If the skin is accidentally cut, or scratched, during work in ACTIVE areas the cut should be placed, if possible, under running water within 15 seconds and held there whilst the whole wound area is scrubbed with a soaped brush for at least five minutes. The flow of blood should be encouraged by mild pressure above the wound. The surrounding skin should be monitored and washed continually until this is inactive.

11.2.2 A sterile dressing, not a strip of dressing of the Elastoplast type may be used as a temporary cover until qualified medical attention has been received.

11.2.3 The object causing the wound will be kept and tested for contamination.

11.3 If anyone spills any radioactive material he must, unless in a CLEAN area,

- (i) Ask all staff to vacate the area.
- (ii) Limit the spread of contamination.
- (iii) Report immediately to Health Physics.

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In a YELLOW area he must mark the boundaries of the spill and report to Health Physics.

12. STORAGE AND USE OF PERSONAL EFFECTS

Eating, smoking, drinking and the storing of food, drink and tobacco anywhere in ACTIVE areas, other than BLUE areas is forbidden.

13. HAZARDS EXTERNAL TO THE RANGE

13.1 There will be certain radiological hazards external to the Range associated with explosion clouds or fall-out from the clouds. The Health Physics Advisor will obtain from the Radiation Measurements Group and the Meteorological Service all data in order to maintain a record of the tracks of such clouds and of the ground fall-out pattern to the extent necessary to ensure that no hazard exists to personnel or animals.

13.2 All aircraft and vehicles used in connection with the Range will be governed by such instructions as may be issued by the Health Physics Advisor with regard to radiological safety. If a vehicle or personnel have been in or near likely fallout areas and/or they may have been subjected to a hazard, all areas of contact must be swept over by health physics, who will in turn check, how far contaminated if necessary and relevant clearance taken with the exception of areas to be necessary.

13.3 Advice on other matters concerning Radiological fall-out outside the Range will be called for from the Health Physics Advisor as necessary.

14. RESPONSIBILITIES

14.1 The individuals.

Any person coming into contact with radioactive materials or entering active areas is personally responsible for complying with these regulations.

14.2 The Officer in Charge of any task in the range.

14.2.1 That these regulations together with any additional requirements applicable to his task are brought to the notice of all his staff, and that they clearly understand the hazards involved in any work that they have to do.

14.2.2 That these regulations are rigorously adhered to.

14.2.3 That the Health Physics Advisor and the Medical Officer is informed in advance of any proposed work which may affect the Radiological Safety arrangements in any way.

14.2.4 That any accidents or abnormal circumstances are reported immediately to the Trials Superintendent, the Health Physics Advisor, the Medical Officer and where applicable the O.C's Construction Work and Maintenance Party and the O.i/c Range.

14.3 The Health Physics Advisor is responsible for:

14.3.1 Radiological control of all movements, in, out of or within YELLOW areas, and radiological surveillance in all ACTIVE areas.

14.3.2 Maintenance of records of individual exposures, and of the locations of ACTIVE Areas.

14.3.3 Prompt investigation of all unusual and abnormal circumstances reported to him.

14.3.4 Advice on all aspects of radiological control, on behalf of the Trials Superintendent of special interest to him.

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14.4 The Trials Superintendent of each trial will ensure that:

14.4.1 These regulations, to other with any instructions issued by his Health Physics Advisor under the authority para. 14.3 above, are enforced and are brought to the notice of all staff employed at the Range, including Construction Force and Maintenance Party Staffs and to the notice of all visitors to the range.

14.4.2 Test explosions involving Radioactive materials are carried out only under Meteorological conditions, such that upon debris falls within the permissible firing area trial area for the trial or test concerned.

14.5 Official Commanding Service Units

The senior officers of the various Service units engaged in the trial and the Senior Service Representative will ensure that these Regulations, and any instructions issued by the Health Physics Advisor, are brought to the notice of all personnel under their command and will ensure that they are enforced.

14.6 The Officer in Charge of the Range will ensure that all staff employed at the range in the inter-trial period, and all visitors to the range in these periods, have the Regulations and instructions brought to their notice, and will ensure that they are enforced.

14.7 The Health Physics Representative during inter-trial periods will advise and assist the Officer in Charge of the Range in the implementation and interpretation of these regulations, and advise him on all matters of radiological safety. He may seek the advice of S.C.I.R./C.R.D. where necessary and should render regular reports on the conditions on the Range to the Officer in Charge of the Range, who should forward copies of the reports to S.C.I.R./C.R.D., through the usual channels. If it is convenient the Officer in Charge of the Range may, in fact, also be directly in charge of Health Physics during the inter-trial periods.

15. SHORT TITLE AND ABBREVIATION

15.1 The short title for these Regulations shall be the Radiation Safety Regulations.

15.2 The authorised abbreviation for use in References shall be R.S.R.I.R/55(2), where the number in parentheses refers to the Edition and the number preceding it refers to the year of issue.

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APPENDIX A

MAXIMUM PERMISSIBLE CONCENTRATIONS

1. The concentrations shown below, shall be the maximum permissible levels for the various isotopes mentioned, when found at the Hiralinga Range. The values are based on recommendations of the International Commission on Radiological Protection and of the International Commission on Radiological Units.
2. When using these levels it must be remembered that the inhalation levels are based on a working week of 56 hours spent in the active areas. For differing exposure times the levels will be inversely proportional to the exposure times etc. for a 24 hour daily exposure the level in air for Sr⁹⁰ will be 2×10^{-10} $\mu\text{g/cc}$, instead of 6×10^{-10} $\mu\text{g/cc}$.

Maximum Permissible Concentration

Radio Isotope	Water ($\mu\text{g/cc}$)	Air ($\mu\text{g/cc}$)
C ¹⁴	0.1	1.5×10^{-5}
C ¹⁴ (CO ₂)	1×10^{-3}	3×10^{-5}
H ²⁴	8×10^{-3}	3×10^{-5}
I ¹³¹	3×10^{-4}	1.5×10^{-6}
Ca ⁴⁵	10^{-5}	2.4×10^{-5}
Sr ⁸⁹	7×10^{-3}	6×10^{-8}
Sr ⁹⁰ + 90	6×10^{-7}	6×10^{-10}
T ⁹¹	3×10^{-4}	2.7×10^{-8}
Ru ¹⁰⁶ + Rh ¹⁰⁶	10^{-5}	6×10^{-8}
I ¹³¹	6×10^{-3}	1.5×10^{-6}
C ¹⁵⁷ + Br ¹⁵⁷	2×10^{-3}	6×10^{-7}
Ba ¹⁴⁰ + La ¹⁴⁰	2×10^{-4}	5×10^{-8}
Os ¹⁴⁴ + Pr ¹⁴⁴	10^{-4}	6×10^{-9}
Po ²¹⁰	3×10^{-6}	3×10^{-10}
Rn ²²²	-	3×10^{-7}
Ra ²²⁶ + 55% dr.	4×10^{-8}	2.4×10^{-11}
Io ²²⁷ + dr	5×10^{-7}	1.2×10^{-11}
Th Natural	4×10^{-7}	9×10^{-11}
Th ²³⁴ + Pa ²³⁴	2×10^{-4}	3×10^{-7}
U Natural	2×10^{-5}	9×10^{-11}
U ²³³	3×10^{-5}	9×10^{-11}
Pu ²³⁹	3×10^{-5}	6×10^{-12}
Weapon Detris	See note 1 below	See note 1 below
Any fission mixture (except from weapons) and any mixture of $\beta - \gamma$ emitters	10^{-7}	3×10^{-9} See note 5 below
A mixture of α emitters	10^{-7} (See note 3 below)	1.5×10^{-11} (See note 3 & 10.)

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Notes:- 1. Canyon Debris - The maximum permissible levels are to be:

- (a) In water - (i) α emitters 10^{-7} $\mu\text{c}/\text{cc}$
(ii) $\beta + \gamma$ emitters 10^{-7} $\mu\text{c}/\text{cc}$

- (b) In Air - (i) α emitters

The concentration shown above for the most hazardous material likely to be found.

- (ii) $\beta + \gamma$ emitters

$$15 \text{ mins} = 210 \text{ sec. yr m.p.l.} = 1.0 \times 10^{-6} \frac{\mu\text{c}}{\text{cc}}$$

Where T = Time in hours since the explosion

$$\text{Above } 210 \text{ sec. } 3 \times 10^{-10} \mu\text{c}/\text{cc}$$

2. The figure given refers to the parent element. Here there is a daughter element, if it is assumed that it is safe equilibrium with the parent after it is taken into the body. However, the figure of 3×10^{-7} $\mu\text{c}/\text{cc}$ for Radon is safe to the daughter product in the inhaled air and is thus an exception to the above rule.

3. The curie of natural Thorium is considered to correspond to 3.7×10^{10} dis/sec. from U^{238} , 4.7×10^8 dis/sec. from U^{234} and 9×10^6 dis/sec. from Th^{232} . It is considered that none of the other daughter products of U^{238} is present at the time of ingestion or inhalation.

4. The curie of natural Thorium is considered to correspond to 3.7×10^{10} dis/sec. from Th^{232} and 3.7×10^8 dis/sec. from Ra^{226} . It is considered that none of the other daughter products of Th^{232} is present at the time of ingestion or inhalation.

5. The last two values listed are for "unidentified beta or gamma emitters" and "unidentified alpha emitters". They are safe for use over short periods of time (a few months) regardless of their radioactive constituents. They are safe for individual use with the following exceptions:

- 10^{-7} $\mu\text{c}/\text{cc}$ of water is safe for any mixture of beta-gamma emitters and all alpha emitters except Ra^{226} .
- 3×10^{-9} $\mu\text{c}/\text{cc}$ of air is safe for any mixture of beta-gamma emitters except Sr^{90} .
- 1.5×10^{-11} $\mu\text{c}/\text{cc}$ of air is safe for any mixture of alpha emitters except Pu^{239} and Ce^{227} .
- Fission products arising from nuclear explosions are covered under Note 1 above.

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ADVICE ON MAIL IV

The only published regulations in the United Kingdom governing the carriage of Radioactive material are those made by the Ministry of Civil Aviation, which are in close agreement with the International recommendations. Regulations governing other forms of Transport have not yet been made. Codes of Practice recommended by I.A.E.A. have however been adopted by the authorities concerned in the U.K. All regulations and Codes of Practice exist in the U.K. are given in para 3 below. Health Physics must be consulted about the various elements for each consignment and will issue any necessary certificate.

In Australia the Atomic Energy Commission of Australia is the body which gives advice on the handling and movement of Radioactive materials.

Where consignments do not comply with the regulations or Codes of Practice, special arrangements must be made with the carrier concerned. Such consignments involve carrying a special escort. The Health Physics authorities of the British Railways in fixing the consignment must be consulted about the items involved, and will issue detailed instructions governing the carriage of the particular items.

3. (i) TRANSPORT OF RADIOACTIVE MATERIALS BY RAIL (Code of Practice)

The basic requirement for rail transport is that the radiation at any point on the outer surface of the container may not exceed certain limits; as an interior source, the railway are carrying packages which fall into two classes:

Class I. Radiation at any point on the surface not greater than 10 milliroentgens per 24 hours.

Class II. Radiation at any point on the surface greater than 10 milliroentgens and less than, but not exceeding 100 milliroentgens per eight hours.

Special labels are used to designate these two classes. A Class I package does not have to be separated from other freight carried in passenger trains, and is treated by the railways as an ordinary package, except that prior notice must be given to the railway authorities at the station from which it is to be consigned.

Class II packages have to be stowed in passenger trains at least 4 feet from any other goods. The label is designed so that this requirement is brought to the notice of all railway officials handling the package. Prior notice must be given to the railway station on some routes at least 48 hours' notice is required.

In order that an adequate check may be kept on the transport of these materials they are usually classed as "Insured Goods" under a special rate. Packets are signed for at the consignment station, and should only be sent by direct through-route to their destination.

Arrangements must be made for the driver to collect at the destination, and railways will not in any circumstances transport radioactive materials by their own vans. This means that the person to whom the isotopes are consigned should be notified in advance of the time of arrival of the train, and must be able to collect the material at this time from the station.

3. (ii) TRANSPORT OF RADIOACTIVE MATERIALS BY ROAD (Code of Practice)

(a) The radiation level in the driver's seat, or in any seat occupied by a passenger, must not be more than 10 milliroentgens per eight hours (100 mR/hr).

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- (b) The radiation if at any point on the outside of the car must be below 200 milliroentgens per hour.
- (c) A notice should be carried in the car stating that radioactive materials are being transported, and are packed in containers in the luggage compartment (or equivalent wording as applicable). An address and telephone number should be given, in order that the police may contact the owner of the vehicle immediately if there is an accident. In addition, the following is a copy of the notice carried by the R.A.C. cars:

NOTICE
THIS C. I. M. CARrying
RADIOACTIVE MATERIAL
THE AMERICAN IRONWORKS COMPANY INC.
HAS CONTRACTED THE SHIP TO TRANSPORT
SHORTE-LIVED RADIOPRODUCTS
IN CONTAINERS FROM THE U.S.
TO U.K. ON 10.3.55

Telephone: [unclear]

(iii) REPORT OF RADIOACTIVE MATERIALS SHIPMENT (Copy of Notice)

- (a) Detailed regulations covering the transport of radioactive materials by sea have not yet been established but limits are permitted subject to the approval of the U.K. Ministry of Transport, or the Australian Department of Transport and the State Government Commissions.

Gamma radiation should not exceed 200 milliroentgens per hour at any point on the surface of the outside shipping container and 10 milliroentgens per hour at a distance of 1 yard from the container.

- (b) Application to the ship's Captain, should include the following information:
- (a) Details of radioactive material including half-life.
 - (b) Details of packing used.
 - (c) Radiation at surface of container in milliroentgens per hour.
 - (d) Radiation at 1 yard from surface of container, in milliroentgens per hour.
- (c) Radioactive materials are classified in the U.K. as "Category X-Other-Dangerous Goods", as defined in the Merchant Shipping (Dangerous Goods) Rules, 1972. The provisions of Schedule Instrument 1972 No. 1977, issued by the U.K. Minister of Transport make it unlawful for dangerous goods to be taken on board any ship unless the owner or master of the ship has been supplied with a declaration of identity, packing and marking of the goods by the shipper. The use of the following standard form of declaration has been agreed by the U.K. Ministry of Transport.
- "The herein-mentioned hazardous cargo is declared and classified as set out in part 1 (i) of the Merchant Shipping (Dangerous Goods) Rules, 1972 and we declare that the marking and packing of the goods are in accordance with parts 3 and 4 of the Rules which are reproduced in subpart (iii) (2) below.
- (d) Part 2, 3 and 4 of the Merchant Shipping (Dangerous Goods) Rules
2. - (1) It shall be unlawful for dangerous goods to be taken on board any ship under this Rule without the consent in writing of the master of the ship, or of the responsible person in charge of the ship, or of the responsible agent in charge of the ship, to take the goods ashore, including those which are to be taken off board the ship before-

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- (i) Explosives.
- (ii) Compressed, liquefied or dissolved gases.
- (iii) Corrosives.
- (iv) Poisons.
- (v) Substances giving off inflammable vapours.
- (vi) Substances which become dangerous by interaction with water or air.
- (vii) Strong oxidising agent.
- (viii) Substances which are liable to spontaneous combustion.
- (ix) Laboratory chemicals and medicinal preparations in limited quantities.
- (x) Other dangerous goods.

For the purposes of these Rules a laboratory chemical or medicinal preparation shall be taken to be being in a limited quantity if and only if the quantity of that chemical or preparation is a limited quantity for the purposes of Section 10 of the Report of the Departmental Committee appointed by the Minister of Transport to consider the Existing Rules relating to the carriage of Dangerous Goods and is issued in Circular 13th November, 1951.

(2) On a start of the ship shall carry a list to be carried in the ship setting forth, in accordance with the information furnished under the foregoing provision of this Rule, all dangerous goods carried in the ship in the voyage in which she is currently engaged.

Packing

(3) It shall be unlawful for dangerous goods, being goods contained in a vehicle, receptacle or cargo, to be taken on board a ship to which this Rule applies for carriage in that ship unless the vehicle receptacle or package in which the goods are contained is clearly marked with a distinctive label or stencil purporting to indicate the nature of the danger to which the goods give rise, and if the goods are taken on board the ship at any port in the United Kingdom or within the territorial waters of the United Kingdom a label or stencil purporting to indicate the identity of the goods.

Where goods are taken on board a ship together with the vehicle in which they are contained, or where goods are taken on board a ship together with the receptacle in which they are contained, being a receptacle which is an additional body formed a vehicle and is constructed or adapted for the purpose of being taken on or off the vehicle with goods contained therein, nothing in the foregoing provision of this Rule shall be taken to require any such receptacle or any package in which the goods in the vehicle may be contained, or, as the case may be, any package in which the goods in the receptacle may be contained, to be also marked.

Packing and Carriage in Bulk

4. - (i) It shall be unlawful for dangerous goods being goods which are not packed in bulk, to be taken on board any ship to which this Rule applies for carriage in that ship, if the owner or the ship or any of his servants or agents knows or ought to know that the goods are not packed in a manner adequate to withstanding the ordinary risks of handling and transport by sea having regard to their nature.

Provided that in any proceedings against an owner or master in respect of a failure to comply with the provisions of this paragraph, it shall be deemed sufficient to prove that if the goods were taken on board the ship,

(ii) The owner or master was furnished with a statement in writing by the shipper to the effect that the goods were packed in accordance with the requirements of this paragraph, and

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- (b) neither the owner nor any of his servants or agents knew that the goods were not consigned.

(2) It shall be unlawful for dangerous goods to be loaded in bulk into any ship to which this regulation applies or carriage in that ship if the owner of the ship, or one of his servants or agents know or ought to know that the goods cannot safely be carried in bulk to the destination to which they are consigned.

(iv) TRANSPORT OF RADIOACTIVE MATERIALS IN AIRCRAFT in accordance with Civil Aviation Regulations

The following conditions have been agreed by the United Kingdom to govern the carriage of radioactive material in aircraft. These conditions are basically the same as the conditions recommended by the International Air Transport Association and accepted by most airline companies. Radioactive materials are not classed as dangerous goods as defined in the Air Navigation Order 1949 unless the amount of radioactivity exceeds the maxima stated in the conditions below.

Conditions governing carriage of radioactive material in aircraft

(a) The carriage of radioactive materials is permitted in any aircraft in or over the United Kingdom and in any aircraft registered in the United Kingdom when flying outside the United Kingdom in accordance with the undermentioned conditions.

(b) Radioactive materials are defined as any material or combination of materials which spontaneously emits ionizing radiation. For the purpose of these conditions, radioactive materials are divided into three groups by the type of radiation emitted at any time during carriage as follows:-

(i) Group I radioactive materials are those materials which emit any gamma radiation, either alone or with electrically charged particles or corpuscles.

(ii) Group II radioactive materials are those materials which emit neutrons and either or both of the types of radiation characteristic of Group I radioactive materials.

(iii) Group III radioactive materials are those materials which emit only electrically charged particles or corpuscles (i.e. alpha and/or beta radiation).

(c) A unit of gamma radiation mentioned in these conditions means one milliroentgen per hour at a distance of one metre for "hard gamma" radiation (1 mR/h), i.e. the amount of gamma radiation which will have the same effect on sensitive photographic film as 1 milliroentgen per hour at a distance of one metre of "hard gamma" radiation of radium filtered through a inch of lead.

(d) The maximum quantity of radioactive material contained in one package for conveyance by either passenger or cargo aircraft shall be 2000 millicuries and the maximum amount of radiation shall be 10 units. Not more than 40 units of radioactive materials Group I and II shall be carried on any one aircraft, provided that no quantity limitation is prescribed for Group III materials.

(e) All radioactive materials must be packed in solid inner metal containers. Where the material is liquid it must in addition be packed in tight glass, earthenware, or other suitable inside container surrounded on all sides, and within the shield, by sufficient absorbent material to absorb the entire contents. The outside shipping container must be strong, and the container having a minimum dimension of 6 inches on each side, so that the gamma radiation will not exceed 100 milliroentgens per hour or equivalent at any point of a distance of 12 inches.

(f) Radioactive material contained in one package in such a manner that the shield will maintain its efficiency in conditions normal.

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incident to carriage as follows:-

- (i) Group I. The shield must be lead or other suitable material of such thickness that at all times gamma radiation at 1 metre does not exceed 40 milliroentgens per hour and must also be sufficient to prevent the escape of primary corpuscular radiation to the exterior of the outside shipping container.
- (ii) Group II. The shield must be such that at all times the radiation measured at right angles to any point on the long axis of the shipping container shall not exceed 10 milliroentgens per hour, or its physical equivalent in electrically charged corpuscular radiation, or neutron radiation which is the physical equivalent of 4 mrem of gamma radiation. There need be one type of radiation if present their total must not exceed the above limits.
- (iii) Group III. The shield must be such as to prevent the escape of primary corpuscular radiation to the exterior of the container, and secondary radiation at the surface of the container but not exceeding 10 milliroentgs per hour, when the cargo is carried.
- (g) The following statement signed by the owner or his authorised agent must accompany each package of radioactive material:
- "This is to certify that the contents of this package are properly described by name and are packed and marked and are in proper conditions for carriage by air according to the regulations relating to the carriage of radioactive materials published by... (carrier(s))... and otherwise comply with such regulations. This consignment is within the limitations prescribed for passenger-carrying aircraft".
- (h) All packages of radioactive material in Groups I and II shall have attached a label worded as follows:-
- "Do not place undeveloped film within 10 feet of this container
Radioactive material
Group I or II
No person shall remain within 5 feet of this container
unnecessarily.
Principal radioactive content.....
Activity of contents..... millicuries
Radiation units in this package.....
Not more than 40 units shall be loaded in one aircraft or held
at one location or point".
- (j) The label may be varied in respect of consignments of Group I material handled solely by either the British Overseas Airways Corporation or the British European Airways Corporation where the total number of units carried in one aircraft does not exceed four. In such circumstances, where the number of units is one or under, the words "15 ft. t.", "3 feet", and 40 units" may be replaced by "5 feet", "1 foot" and "one unit" respectively. Where the number of units is over one but does not exceed four the words "15 ft. t", "3 feet", and "3 units" may be replaced by "10 feet", "2 feet" and "Four units" respectively.
- (k) All packages of radioactive materials in Group III shall have attached a label worded as follows:-
- "Handle carefully
Radioactive material
Group III
Content.....
Primary corpuscular radiation".

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WING AIRLINES

Limited amounts of gamma emitting radioactive materials can be transported, without lead shielding, in the wing tips of D.O.T. aircraft operated by South African Airways to South Africa, and in Argonaut aircraft operated by British Overseas Airways Corporation to the Near East, Middle East, Far East and South America. The maximum amount of radioactivity permitted depends upon the intensity of gamma radiation and flying time involved, but in no case, can it exceed 300 milliroentgen. A standard size cylindrical wing-tip container, 4.7 inches diameter and 5.2 inches length, is in use which automatically restricts the physical quantities of materials which can be transported in this manner. Invariably, small amounts of radioactive materials can be transported less expensively by wing-tip service at a lower cost than first involving the use of lead boxes and wooden boxes.

Special handling procedures are used in wing tip service. Aircraft are loaded and unloaded by the airline or their agents, but ground work consists of suitable shielding containers installed in the wing-tips. A cylindrical container the airline carrier serial can be issued by the port of arrival and transported safely to its final destination.

(v) POSTAL TRAFFIC ON RADIOACTIVE MATERIALS (Post Office Practice)

- (i) The packages will must have been approved by the U. S. Post Office Section.
- (ii) That the radiation at any point on the surface of the package is not greater than 10 milliroentgens per hour.

4. REFERENCES

- (1) A.P.R.C. Radioactive Materials and Stable Isotopes Catalogue No 3 July 1954.
- (2) Merchant Shipping (Dangerous Goods) Rules, 1954. Statutory Instrument 1952 No. 1077.
- (3) Ministry of Transport - The carriage of Dangerous Goods and Explosives in Ships (The Blue Book).
- (4) Ministry of Civil Aviation - Conditions governing the carriage of radioactive materials in aircraft.

(b) Published in Australia.