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PM	Caveat	
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Prepared By	Number of Sheets
1 2	5 8

Note: See coding sheet for Protective Marking (PM), Caveat and Prepared By codes.

CINO 0417 TO CINO 0419

1 x BLACK SHEET

For use with Documents with Protective Markings up to and including
[redacted]

CINO 0417

GRAP.....100..... is duplicate of GRAP.....55.....

TITLE .....BLOOD COUNTS & RADIATION HAZARDS.....

CLASSIFICATION .....U/C.....

T. Sol No .....774.....

[redacted].....

CINO 0417

774 pt

GRA/PNO 55

Our Ref: SSPT/Trials/28
Your Ref: GRA/104/6/Org

7th July, 1958

I agree that your letter of 2nd July gives a correct summary of our discussion with regard to Film Badges and although this is not the complete solution it is accepted here as a practical compromise.

With regard to blood counts, I have sought the best medical and health physics advice available to me and I must advise the implementation as far as possible of a universal blood count for all members of the Task Force. We did agree that it was not possible to cover everyone for the next trial but that all replacements at Christmas Island and all those whose work is in the 'forward' area should be "blood counted" and I strongly recommend that you adhere to this.

It is recognised that from a purely medical and perhaps also from a logical aspect, [redacted] and [redacted] right. However, apart from safety, which I believe is adequately covered in any case, our main concern is to avoid subsequent claims and legal battles and even more important the consequential unwelcome publicity. If a man has a tendency towards leukaemia, anaemia or any similar condition associated with a low blood count, (the incidence of these diseases in a normal population is sufficiently high to make it likely that one or more will appear from time to time in a sample of 4500) it matters little to the newspapers if, at Christmas Island, he worked at the Port or in the measurements area. The only real safeguard is to make as sure as possible that such men are not included in the Task Force.

It may be that the advice given by [redacted] and [redacted] was affected by the difficulties of undertaking the "universal blood count": if so, and you should decide in favour of its being undertaken for the future, it is possible that our Medical Division here may be able to give some assistance.

Air Vice-Marshal J. Grandy, C.B., D.S.O., R.A.F.,
Headquarters Task Force Grapple,
Air Ministry,
Whitehall Gardens,
London, S.W.1.

[redacted]

From: [redacted]

UNCLASSIFIED

Headquarters Task Force Grapple,
Air Ministry,
Whitehall Gardens,
London S.W.1

GRA/104/6/Org

9th July, 1958

[redacted]

Thank you for the letter SSPT/Trials/27 which you gave me yesterday in which you strongly recommend that we should institute blood counts at Christmas Island for all future replacements and that those whose work is in the forward area should be given blood counts before going there.

The R.A.F. medical authorities do not support this view. I attach a copy of a letter received from Air Commodore Stamm, the Consultant in Pathology and Tropical Medicine and some notes prepared for me by Group [redacted]

We must reach an agreed policy on this and there is some urgency as time is getting short. If you still do not feel able to accept the R.A.F. medical view I propose we should meet next Tuesday afternoon (July 15th) at A.W.R.E. and flog it out. I would like [redacted] and [redacted] to attend, and I suggest A.W.R.E. medical representation as well. I think it as well to keep the meeting as small (but well informed) as possible as there seem to be so many differing views on this.

Yours sincerely

[redacted]

[redacted]
S.S.T.D.,
A.W.R.E.,
Aldermaston,
Berks.

Copies to: [redacted]
C.M.E.,
Kelvin House,
London W.C.2

[redacted]
M.A.4, Air Ministry,
Tavistock Sq.,
London W.C.1

EXT 8

R.A.F. Institute of Pathology and
Tropical Medicine,
HALTON

Ref: CP/70

4th July, 1958

Sir,

Blood Counts and Radiation Hazards

I have the honour to forward my views on the above subject in response to Air Ministry request under reference C.95567/57/MA5.

2. I have attended several lectures and symposia on the laboratory aspects of radiation hazards and at all these the conclusion has been reached that significant changes in blood counts from exposure to radiation are not signs of impending danger but of gross overdosage already received. The routine use of blood counts is therefore not only futile but is actually dangerous in that it tends to produce a feeling of false security in the uninitiated and to engender slackness in the sue of monitoring methods on which reliance should be placed.

3. It is sometimes argued that pre-employment counts should be performed to exclude from employment anyone whose blood picture already shows pathological abnormalities. The validity of this argument in both its professional and administrative of medico-legal aspects is open to question. So far as I am aware there is no evidence that a person with anaemia, leucopenia or any other blood abnormality is any more suseptible to the effects of radiation than the normal subject. From the medico-legal angle a normal pre-employment count merely strengthens a claim that a subsequent abnormality has been caused by radiation. It is true that an already incipient leukaemia might conceivably be picked up by the pre-employment count, but the chances of this happening must be in the region of 1/1,000,000 or even less, so that in practice to do routine counts for this reason alone is equivalent to spending £1 to save a penny.

4. It would be helpful if a report could be obtained from the scientists at Aldermaston stating their views and their reasons for wanting routine blood counts.

SGD. [redacted],
Consultant in Pathology and
Tropical Medicine.

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[redacted]

[redacted]

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Blood Counts
Notes for T.F.C. [redacted] (D of H & R)

1. Several must be done in the same individual under standard conditions to establish their "normal" count.

2. A single low count in an otherwise normal individual would in itself be of little significance.

3. If it were really significant, in the overwhelming majority of cases he would have been accepted as a sick man already.

4. In view of this we must consider "the logistics" involved in wholesale blood counts on say 4,000 people (R.N., Army and R.A.F.) on the island.

5. I estimate that for a single blood count, a minimum time of 20 minutes must be allowed - this takes no account of cleaning pipettes, slides, preparing diluent fluids, and keeping the microscope properly serviced.

6. However, assuming a continuous supply of fresh pipettes and slides, to complete one examination on 4,000 people would take a minimum of $\frac{4000}{3}$ hours = 1,333 hours approximately, and assuming an 8 hour working day this figure becomes $\frac{1,333}{8}$ = 166 days.

7. In practice one would find this period very much extended due to many factors concerned with the "minor administrative contretemps" inseparable in real life from mustering 4,000 men of different arms and units and running them through a "blood counting gauntlet " even if perfectly organised. For these I should allow at least a further 50 days.

8. One now begins to wonder how reliable the figures would be from a technician, however skilled, if subjected to such satiation.

9. Further, suppose some apprently normal men - as would inevitably happen, particularly on a single examination - were found to have unusually low or high counts, what policy would be adopted with regard to them. Would they have to be sent off the island for a prolonged period, and kept under observation? If so, where?

10. Such wholesale blood examinations would inevitably raise alarm among many, and others would interpret them as a lack of confidence in the safety arrangements.

11. In Atomic Energy Establishments where any counts considered necessary can be conveniently staggered throughout the year, very special counting devices have been devised to eliminate the human "error" inseparable even from the most practised technician.

12. In view of all the above I have no hesitation in concluding that the Royal Air Force should not accept any such commitment - at best it would accumulate merely a mass of "normal" figures and at worst introduce more factors of confusion and uncertainty to the Trials Administration, which is already sufficiently loaded with responsibilities for individual safety.

[redacted]

FYT 10

SSPT/Miles/28.

Air Ministry,
Whitehall Gardens,
London S.W.1

GRA/104/6/Org

2nd July, 1958

[redacted]

We discussed two aspects of health physics yesterday and I think it appropriate to record our views.

Film Badges

Should film badges be issued to those serving at Christmas Island? It has not been thought necessary to issue film badges to date. Since radio-activity and contamination at the Island may occur only in certain areas the policy has been to define these areas and control entry and exit thereto, admitting only personnel both service and civilian (A.W.R.E.) whose duty necessitates their working in these areas. These personnel have been given appropriate medical examinations (blood count) and are provided with film badges.

The remainder of the Island is not subject to contamination or radio-activity. However, as a wise insurance policy, counts are taken in all areas to ensure that backgrounds remain within limits. In lay language the count could be regarded as a communal film badge.

As we are now, for the first time, about to undertake balloon supported firings at Christmas Island, health physics for all at the Island comes under fresh examination in view of the possible differences between this type of firing and the high altitude air burst from the general radio-activity and contamination aspect. First thoughts suggest issue of film badges to all personnel. Further examination, however, indicates the wisdom of this policy to be questionable to say the least. If all personnel are to be issued with film badges, natives, both female and children, civilian merchant navy men in merchant ships and those in a similar category at the Island will have to be included. The administrative task (which of course must be met if essential) is considerable bearing in mind that the badge has to be issued, a record kept and the badge rechecked subsequent to examination for contamination after the holder has left the Island. Issue of badges at this stage may well provoke anxiety. What right have we to subject native populations and civilians to the possibility of contamination which, however remote, the issue of a badge to individuals would suggest is a likely possibility? Why should our present system of controlled areas not be extended to cover the requirements of balloon supported firings? Would this be adequate and safe?

First consideration of a film badge issue was provoked by the lego-medical aspect of disability claims. A case is now about to start and there may be some difficulty in disproving such claims. We discussed all this at some length at our meeting yesterday and our conclusion was that it would not be necessary for a general issue of film badges for Grapple Z, and that the present system of controlled areas would be safe and should continue. The Task Force will take the necessary steps to ensure that such areas are clearly

../marked....

[redacted]
S.S.T.D.,
A.W.R.E.,
Aldermaston,
Berks.

UNCLASSIFIED

[redacted]

marked in appropriate languages, controlled and defined in orders and that such orders are frequently repeated. Finally, all personnel who may have to enter these controlled areas are to be examined and issued with a personal film badge.

Blood Counts

At the moment the vast majority of service personnel at Christmas Island are not medically examined (blood counts) either prior to or after serving on the Island. However, contamination levels have been calculated on the assumption that all serving at the Island could be regarded as occupational workers and this category of personnel at Aldermaston have medical tests (blood count). Those at the Island, other than A.W.R.E., however, do not.

We discussed this matter at length and were of the opinion that measures should be put into effect at the earliest opportunity to ensure that all service personnel going to Christmas Island from now on were subject to medical examination (blood count). We also thought that medical test facilities should be set up at the Island immediately so that all personnel could be examined prior to the first Grapple Z firing. I have today put these two points verbally to [redacted] and [redacted] of the H & R Medical Branch, Air Ministry. They are not in favour of instituting a universal medical examination (blood count) and consider that our present system of controlled areas is adequate. They do believe, however, that it would be a wise precaution to institute a medical examination (blood count) for those Army and other personnel who are required to take part in rehabilitation work after balloon firings at the southeast end.

I would be grateful if you would confirm or otherwise the points I have made above as far as our meeting yesterday was concerned. I will then write to the H & R department asking them to confirm their advice on the medical examination (blood count) aspect for service personnel, and ask them to provide facilities for examination of those we propose to employ on rehabilitation. If the War Office and Admiralty accept the R.A.F. view, and I will put it to them, then I think we will be clear to go ahead.

[redacted]

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[redacted]

From: [redacted]

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FYT '10

Headquarters Task Force Grapple.
Air Ministry,
Whitehall Gardens,
London S.W.1

SSPT/Guide/28.

GRA/104/6/Org

2nd July, 1958

[redacted]

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../marked....

[redacted]
S.S.T.D.,
A.W.R.E.,
Aldermaston,
Berks.

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[redacted]

[redacted]

UNCLASSIFIED

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EXT. 10

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Yours

[redacted]

UNCLASSIFIED

[redacted]

Rad. Safety Rep.
Christmas Island
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RADIOLOGICAL SAFETY REGULATIONS

CHRISTMAS ISLAND

OFFICIAL USE ONLY

RSRC/58(1)

RADIOLOGICAL SAFETY REGULATIONS

CHRISTMAS ISLAND

The Radiological Safety Regulations, Christmas Island, are issued by the Director, Atomic Weapons Research Establishment, on behalf of the Minister of Supply and have been agreed by the United Kingdom authorities concerned.

Enforcement of these regulations will be the overall responsibility of the Commander, Task Force Grapple.

Trials Planning Branch,
A.W.R.E. Aldermaston,
Berks.

March, 1958.

OFFICIAL USE ONLY

RADIOLOGICAL SAFETY REGULATIONS

CHRISTMAS ISLAND

RADIOLOGICAL SAFETY REGULATIONS

CHRISTMAS ISLAND

1. INTRODUCTION

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

Excessive exposure, however, results in damage to the human body.

The danger is insidious because the effects are not immediately felt and damage may become apparent only 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 or abrasions, or even by absorption through an intact skin.

1.2 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 UKAEA and other Authorities concerned. These are the levels to be used throughout a Trial.

1.3 The object of these regulations is to ensure complete protection both of staff and of the general public, whilst imposing the minimum interference with work. To this end, the regulations will, at all times, apply to all who are concerned with the Christmas Island Trials, both Servicemen and Civilians wherever stationed.

1.4 Advice on the applicability and interpretation of these regulations will be prepared by the Health Physics Adviser for the Scientific Director, who is responsible for advising the Commander, Task Force Grapple, on whom rests overall responsibility for all matters of radiological safety. For implementation, a Health Physics Controller will be appointed by DAWRE to work under control of the Scientific Director.

If necessary, a Health Physics Representative will be provided by AWRE during inter-trials periods.

2. SPECIFICATION OF MAXIMUM PERMISSIBLE LEVELS

It is emphasized that these levels are maxima and every endeavour must be made to keep all exposures as low as possible.

2.1 External Radiations

For external radiation the maximum permissible levels will be:-

2.1.1 β and γ Radiation

(a) A normal working rate as defined in the current 'Recommendations of the International Commission on Radiological Protection'.

1·5 rep/week of which the γ radiation component must not exceed 0·3r/week.

The dose to the eyes must not exceed 0·3 rep/week.

(b) A lower integrated dose of up to 15 rep of which the γ radiation components must not exceed 3r.

This dose will be allowed only with the express permission of the Health Physics Controller which will be given only when he regards it as necessary for the smooth running of the Operation.

Except as provided for under (c) or (d) below, personnel who have received this dose will not be subjected to further exposure until their average exposure is below 1·5 rep/week of which the γ component shall not exceed 0·3r/week.

(c) A higher integrated dose of up to 50 rep of which the γ radiation component must not exceed 10r.

This dose will be allowed only where it is necessary in order to recover important records and information which might otherwise be lost, and will require the personal permission of the Scientific Superintendent after consultation with the Health Physics Adviser and Medical Adviser.

Except as provided for under (d) below, personnel who have received this dose will not be subjected to further exposure until their average exposure is below the level given in (b).

Personnel who, having been given permission to receive up to 10r, accidentally exceed this figure, will not be permitted to receive further exposure within 3 years except under the conditions of (d) below.

(d) A special higher integrated dose of up to 75 rep of which the γ radiation component must not exceed 25r.

This dose will be allowed only if essential to the success of the trial, and only to personnel who are not normally exposed to radiation, and then only with the personal permission of the Scientific Director after consultation with the Health Physics Adviser and the Medical Adviser.

(e) Personnel who have received over 10r but not more than 25r will not be subjected to further exposure during a period of three years except under the condition of (d) above.

(f) No person will be allowed to receive more than 50r before age 30, his full radiation history being taken into account.

(g) If doses are received longer than are authorised for the individual, a special enquiry into the circumstances must be held by the Scientific Director.

2.1.2 Neutron Radiation

The maximum permissible levels will be as defined in the current recommendations of the 'International Commission on Radiological Protection'.

The dose to the tissue 2 cm below the skin surface must be less than 30 millirads/week. This figure, for a 40 hour week is given by the neutron fluxes below:-

Neutrons of energy 0·25eV	2000 neutrons/cm^2/sec
Neutrons of energy 10eV	2000 neutrons/cm^2/sec
Neutrons of energy 10keV	1000 neutrons/cm^2/sec
Neutrons of energy 0·1MeV	200 neutrons/cm^2/sec
Neutrons of energy 0·5MeV	80 neutrons/cm^2/sec
Neutrons of energy 1MeV	60 neutrons/cm^2/sec
Neutrons of energy 2MeV	40 neutrons/cm^2/sec
Neutrons of energy 3-10MeV	30 neutrons/cm^2/sec

2.1.3 α Radiation

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

2.2 Internal Radiations

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

2.2.1 The maximum permissible levels for inhalation and ingestion will be:-

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

The concentrations shall be those in Appendix I for the materials concerned.

(b) For Weapon Debris

(i) In Water

(a) α emitters 10^{-7} μc/cc for debris less than 30 days old.

(b) β-γ emitters 6×10^{-4} μc/cc for debris less than 30 days old.

β-γ emitters 1×10^{-6} μc/cc for debris more than 30 days old.

These levels are based upon the ingestion of 2 litres/day.

(ii) In Air

(a) α emitters. The concentrations shall be that in Appendix I for the most hazardous material likely to be found.

(b) β-γ emitters. The concentrations shall be those given by the expression.

$$\frac{3 \cdot 0 \times 10^{-6}}{T} \quad \mu c/cc$$

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 or if the age of the debris is in doubt, the value given for Sr 90 shall be used, namely 6×10^{-10} μc/cc.

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 varied in inverse proportion to the duration of exposure.

2.3 Contamination Levels

2.3.1 Buildings and Installations

Contamination can be fixed or loose.

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 washings in accordance with the instructions laid down in Appendix III.

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

α	μc/cm²
600 disintegrations/min on both sides of one hand	1×10^{-6}
20 disintegrations/min/cm², clothing, benches, equipment, etc.	1×10^{-5}
400 disintegrations/min/cm², fume cupboards	2×10^{-4}
β-γ	
6000 disintegrations/min on both sides of one hand	1×10^{-5}
400 disintegrations/min/cm², clothing, benches, equipment, etc.	2×10^{-4}
8000 disintegrations/min/cm², fume cupboards	4×10^{-3}

The maximum permissible levels for loose contamination will be:-

α	μc/cm²
5 disintegrations/min/'smear'	$1{\cdot}5 \times 10^{-8}$
β-γ	
20 disintegrations/min/'smear'	6×10^{-8}

2.3.2 Fall-out Areas

The maximum permissible level (MPL) of contamination by fall-out of fission products in uncontrolled areas depends upon its physical state, (whether it is soluble or insoluble, finely divided or in pellet form), and upon the age of the products.

The Health Physics Controller will determine the boundaries of the Controlled Area according to the circumstances.

Insoluble Products

MPL for products of any age = 430 $\mu c/m^2$

Soluble Products

MPL for products aged up to $4^1/2$ months = 430 $\mu c/m^2$

MPL for products aged $4^1/2$ months to 12 years = $2{\cdot}7 \times 10^3 \, t^{-1{\cdot}2} \mu c/m^2$

(t = age in months)

MPL for products of age unknown or greater than 12 years = 7 $\mu c/m^2$

Pellets

MPL for insoluble pellets = 5 μc/pellet of any age

MPL for soluble pellets = 5 μc/pellet up to age 1 month, $5t^{-1{\cdot}2}$ μc/pellet aged 1 month to 12 years

(t = age in months)

and $1{\cdot}3 \times 10^{-2}$ μc/pellet of age unknown or over 12 years.

Note: 430 $\mu c/m^2 \sim$ 2 mr/h

2.3.3 When contamination levels exceed those given in paras 2.3.1 and 2.3.2 the Health Physics Controller will lay down the conditions under which work may proceed in the areas affected.

3. CLASSIFICATION OF AREAS

3.1 All parts of the Test Area 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 Controlled Areas: are those where the levels laid down in Section 2 are exceeded and where precautions appropriate to the degree of risk must be taken.

3.2.2 There will be three categories:-

(a) BLUE Area - Risk of penetrating radiation but not of inhalation, ingestion or injection. No special clothing.

(b) RED Area - Risk of penetrating radiation and of slight inhalation, ingestion or injection. Clothing as specified by the Health Physics Controller will be worn.

(c) 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 Adviser who must be informed prior to any proposed change in the work which might affect the classification. He will review the classifications periodically.

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

3.3 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 Physics Control Officer in charge.

When it is necessary to carry out building, engineering or other maintenance work in any Controlled Area, a Permit to Work Certificate must first be obtained from the Health Physics Adviser or Representative.

4. FILM BADGES

All personnel who have duties in a Controlled Area will wear a Personal Monitoring Film at all times.

5. PROTECTIVE CLOTHING

5.1 Wearing of Clothing

5.1.1 The type of radiation protective clothing required in Controlled Areas depends upon the degree of hazard prevailing and will be specified by the Health Physics Controller accordingly.

5.1.2 All protective clothing will be white and will be distinguished by red epaulettes or a red triangle as appropriate.

5.1.3 The wearing of the approved protective clothing with film badges and dosimeters, as specified in the appropriate parts of the regulations, is compulsory.

5.1.4 To assist the rigorous enforcement of these rules, radiation protective clothing will not be issued for other purposes.

5.2 Laundering and Disposal

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

5.2.2 Protective clothing will be sent only to the special laundry provided. Rubber gloves from RED areas will not be sent to the laundry but will be cleaned by the users.

6. USE AND STORAGE OF RADIOACTIVE MATERIALS

6.1 No radioactive material will be used outside Controlled Areas. Sealed sources of radiation may be used in carrying out calibrations provided the Health Physics organization has been informed and BLUE Area 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 Controlled Area. Adequate precautions must be taken to ensure that the dose

received by workers in that area is within the limits laid down.

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

6.4 In RED Areas no radioactive material will be exposed unnecessarily to the air of the laboratory.

6.5 Details of special precautions required for particular materials and areas will be laid down as appropriate by the Health Physics Controller, who will maintain a record of all radioactive sources and materials in use or in store.

7. TRANSIT OF RADIOACTIVE MATERIALS

7.1 Transit of radioactive materials outside Controlled Areas is permitted, provided they are in properly designed and sealed containers which will effectively prevent escape of the material and which are themselves externally clean, and that the Health Physics organization has been informed previously. The transit should be uninterrupted and adequate precautions must be taken to ensure that the γ-ray dose rate does not exceed 200 mr/h at the surface and 10 mr/h at one metre, and the neutron dose rate does not exceed 30 neutrons/cm^2/sec. at the surface. Transit of containers where the dose rate exceeds any one of these limits will be permitted only with prior Health Physics approval.

7.2 Transit of radioactive materials to and from the Test Area is governed by any International UK and Australian Government Regulations currently in force, by the Regulations of any other Government concerned, and by any Instructions, currently in force, issued by DAWRE, RAF/AWRE, the Health Physics Adviser (See Appendix IV), or the Scientific Director.

8. LABORATORY WASTE

8.1 All solid waste will be segregated into the following four categories:-

(i) Highly active waste, i.e., above one millicurie.

(ii) Low activity waste non-combustible.

(iii) Low activity waste combustible.

(iv) Used paper towels.

Category (i) waste must be sealed in rigid containers and retained by the originator until proper arrangements have been made for its disposal. The contents and the approximate levels of activity must be marked on the outside.

Bins suitably labelled will be kept in all laboratories and workrooms where categories (ii), (iii), 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 active 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 personnel and to prevent interference with scientific work due to contamination.

The Health Physics organisation will provide complete monitoring facilities for personal use.

A representative of Health Physics will be available in all Controlled Areas to advise and assist when called upon.

9.2 Personal Monitoring

9.2.1 It is the responsibility of each individual to ensure that he is monitored before leaving a Controlled Area. Instruments will be provided for this.

9.2.2 γ-ray dosage will be measured by means of film badges which will be worn as laid down in section 4.

9.2.3 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 organization.

9.3 Area Monitoring

9.3.1 Air sampling will be carried out in all laboratories and workrooms 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 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 the Health Physics organization.

9.4 Monitoring of Active Waste

Solid waste containers will be monitored and decontaminated if necessary before being taken from a Controlled Area.

9.5 Monitoring of Vehicles and Equipment

All equipment and vehicles, including ships and aircraft, will be monitored and decontaminated, if necessary, before being taken out of a Controlled Area. Special arrangements have been made for the movement from and to Australia of aircraft which have undertaken sampling duties and may, therefore, be contaminated, and this section does not apply to such aircraft.

Equipment will not be moved into a less active area unless it is monitored, decontaminated, if necessary, and given a Health Physics Clearance Certificate. Articles must not be moved into a BLUE or a non-controlled area if there is any detectable loose activity. Again, this section does not apply to sampling aircraft for which special arrangements are made.

10. MEDICAL SURVEILLANCE

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

No person will be allowed to work in a Controlled 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, or immediately prior to his first exposure during the 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 at once:-

(i) Take emergency action. (See 11.2 below)

(ii) Report to the Health Physics Controller and the Medical Officer (through his Officer-in-Charge if the accident occurs on duty).

11.2 If the skin is accidentally cut, or scratched, during work in a Controlled Area 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 washing continued until this is inactive.

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.

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 YELLOW area:-

(i) Ask all staff to vacate the area.

(ii) Limit the spread of contamination.

(iii) Report immediately to the Health Physics organization.

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

12. STORAGE AND USE OF PERSONAL EFFECTS

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

13. HAZARDS FROM WEAPON DEBRIS

13.1 The Health Physics Adviser will obtain from the Radiation Measurements Group, The Theoretical Predictions Group and the Meteorological Service all data required to maintain effective control over the hazards due to fall-out.

13.2 The use of all aircraft, vessels and vehicles, in connection with the Operation will be governed by such instructions as may be issued. Where aircraft, vehicles or personnel have been, or are likely to go, into areas which may have been contaminated, all personnel concerned must report at once to a Health Physics representative, who will arrange with the appropriate authority for the checking, decontamination if necessary and the granting of clearances and who will give such other advice as may be necessary.

13.3 Advice on other matters concerning Radiological Safety outside the Test Area will be called for from the Health Physics Adviser 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 and other relevant regulations and instructions.

14.2 The Officer-in-Charge of any Task is responsible for ensuring:-

(i) That these regulations and other relevant regulations and instructions 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.

(ii) That these regulations are rigorously observed.

(iii) That the Health Physics Adviser and the Medical Officer are informed in advance of any proposed work which may affect the Radiological Safety arrangements in any way.

(iv) That any accidents or abnormal circumstances are reported immediately to the Scientific Director, the Health Physics Adviser, the Medical Officer and, where applicable, to Officers Commanding Service Units.

(v) That Health Physics Controller is kept fully informed of of all radioactive materials being used by his staff or under his control.

14.3 Officer Commanding Service Units, etc.

The Officers in Command of the various service units, ships, aircraft and detachments and groups involved will ensure that these regulations and all other relevant regulations and instructions issued by the Health Physics Adviser with the approval of the Scientific Director, under the Task Force Commander's Authority, are enforced and are brought to the notice of all personnel under their command and to their visitors.

14.4 The Health Physics Adviser is responsible for:-

(i) Advice to the Scientific Director on radiological safety. Issue of instructions on behalf of the Scientific Director requires the authority of the Commander, Task Force Grapple.

(ii) The activities of the Health Physics Controller (see Section 14.5).

14.5 The Health Physics Controller is responsible to the Health Physics Adviser for:-

(i) Delineation of all Controlled Areas.

(ii) Radiological control of all movements into, out of, and within Yellow areas and radiological supervision in all other Controlled Areas.

(iii) Maintenance of records of individual radiation doses received by all personnel and location of all radiation sources used in the Test Area.

(iv) Provision of instruments and equipment necessary for Health Physics control.

15. AMENDMENTS

DAWRE will issue any amendments necessary to keep these regulations consistent with current Regulations, Instructions and Codes of Practice issued by various Government, International and other organizations concerned.

MAXIMUM PERMISSIBLE CONCENTRATIONS

1. The concentrations shown below shall be the maximum permissible levels for the various isotopes mentioned, when found during the Trial. The Values are based on recommendations and 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, e.g. for a 24 hour daily exposure the level in air for Sr90 will be 2×10^{-10} µc/cc, instead of 6×10^{-10} µc/cc.

Maximum Permissible Concentrations

Radio Isotopes	Water (µc/cc)	Air (µc/cc)
H^3	0.2	3×10^{-5}
$C^{14}(CO_2)$	3×10^{-3}	3×10^{-5}
Na^{24}	8×10^{-3}	3×10^{-6}
A^{41}	5×10^{-4}	1.5×10^{-6}
Ca^{45}	10^{-4}	2.4×10^{-8}
Sr^{89}	7×10^{-5}	6×10^{-8}
$Sr^{90} + Y^{90}$	8×10^{-7}	6×10^{-10}
Y91	3×10^{-4}	2.7×10^{-8}
$Ru106 + Rh^{106}$	10^{-4}	6×10^{-8}
I^{131}	6×10^{-5}	1.8×10^{-8}
$Cs^{137} + Ba^{137}$	2×10^{-3}	6×10^{-7}
$Ba^{140} + La^{140}$	2×10^{-4}	5×10^{-8}
$Ce^{144} + Pr^{144}$	10^{-4}	6×10^{-9}
Po^{210}	3×10^{-6}	3×10^{-10}
Rn^{222}	-	3×10^{-7}
Ra^{226} + 55% d.p.	4×10^{-8}	2.4×10^{-11}
Ac^{227} + d.p.	5×10^{-7}	1.2×10^{-11}
Th Natural	4×10^{-7}	9×10^{-11}
$Th^{234} + Pa^{234}$	2×10^{-4}	3×10^{-8}
U Natural	2×10^{-6}	9×10^{-11}
U^{233}	3×10^{-6}	9×10^{-11}
Pu^{239}	3×10^{-6}	6×10^{-12}
Weapon Debris	See note 1 below	See note 1 below
Any fission mixture (except from weapons) and any mixture of $\beta\gamma$	10^{-7}	3×10^{-9} See note 5 below
A mixture of emitters	10^{-7} See note 5 below	1.5×10^{-11} See note 5 below

NOTES

(a) The figures given refer to the parent element. Where there is a daughter element, it is assumed that it reaches equilibrium with the parent after it is taken into the body. However, the figure of 3×10^{-7} µc/cc for radon refers to Rn + daughter products in the inhaled air and is thus an exception to the above rule.

(b) The curie of natural uranium is considered to correspond to 3.7×10^{10} dis/sec. from U^{238}, 3.7×10^{10} dis/sec. from U^{234} and 9×10^{8} dis/sec. from U^{235}. It is considered that none of the other daughter products of U^{238} is present at the time of ingestion or inhalation.

The curie of natural thorium is considered to correspond to 3.7×10^{10} dis/sec. from Th^{232} and 3.7×10^{10} dis/sec. from Th^{238}. It is considered that none of the other daughter products of Th^{232} is present at the time of ingestion or inhalation.

(c) 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 the radioactive contaminants. They are safe for indefinite use with the following exceptions:-

(i) 10^{-7} µc/cc of water is safe for any mixture of beta gamma emitters and all alpha emitters except Ra^{226}.

(ii) 3×10^{-9} µc/cc of air is safe for any mixture of beta gamma emitters except Sr^{90}.

(iii) 1.5×10^{-11} µc/cc of air is safe for any mixture of alpha emitters except Pu^{239} and Ac^{227}.

APPENDIX II

METHOD OF MAKING SMEAR TESTS

A Whatman No. 1 (5.5 cm) filter paper is used for this test.

The paper is slightly bent around the second finger by the two adjacent fingers so that a small area in the centre of the paper is brought into contact with the surface. It is then rubbed lightly over the area or object being checked.

For Flat Surfaces

Rub paper in a circular motion covering an area of approximately six inches diameter, i.e. approximately 180 to 200 cm^2.

For Irregular Shaped Objects: Door Handles, Telephones, etc.

Lightly rub paper over whole surface (if small enough), otherwise take a series covering the whole surface.

These "smears" are then placed in a standard type alpha or beta/gamma counter and counted.

Results are usually expressed as disintegrations/minute having applied the necessary factors for counter efficiency.

APPENDIX III

REMOVAL OF RADIOACTIVE CONTAMINATION FROM HANDS

In many cases contamination will be removed by a normal washing of the hands in tepid water using a mild soap.

DO NOT RINSE HANDS IN WASHINGS AS THIS IS LIABLE TO BE CONTAMINATED.

If this procedure is not enough to remove contamination then scrubbing is necessary.

For this you should use the special brush provided in active change rooms.

A convenient routine for scrubbing hands is to start by scrubbing one thumb, being sure to brush all surface; proceed to the space between the thumb and first finger and similarly to each finger and the webs between the fingers.

Close fingers tightly together and scrub in a downward direction from approximately one inch above the wrist, giving attention to the back and palm of the hand, and finally additional scrubbing of the nails and cuticles.

Rinse hands, as before, in fresh water direct from the tap.

This nail brush is most effective when used lightly; any extra pressure of this brush on the hands will only result in bending the bristles out of shape.

Always scrub in a direction away from the body into the basin. This is to prevent splashing of possibly contaminated liquid on your clothes or the floor.

IN ORDER TO PREVENT THE TRANSFER OF ACTIVITY FROM ONE SECTION OF THE HAND TO ANOTHER. THE BRUSH SHOULD BE WASHED IN WARM WATER AND FRESH SOAP APPLIED AT LEAST THREE TIMES DURING THE SCRUBBING OF EACH HAND.

If the above procedure is not successful, then it should be repeated.

It is advisable to rub a small quantity of [illegible] No.4 on the hands after a vigorous scrubbing to soften the hands and prevent chapping.

DO NOT USE THIS CREAM BEFORE YOU HAVE SATISFIED YOURSELF THAT YOUR HANDS ARE FREE FROM CONTAMINATION.

It will probably not be necessary to use any more than the above scrubbing, but if contamination is very persistent more drastic techniques are available.

Whether these are used should be decided jointly by the Medical Officer and the Health Controller.

ANNEX A

CARRIAGE OF RADIOACTIVE MATERIAL

1. 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 A.E.R.E. Harwell have, however, been adopted by the authorities concerned in the U.K. All regulations and Codes of Practice extant in the U.K. are given in para. 3 below. Health Physics must be consulted about the arrangements for each consignment and will issue any necessary certificates.

2. Where consignments do not comply with the regulations or Codes of Practice, special arrangements must be made with the carrier concerned. Such consignments invariably require one or two escorts. The Health Physics authorities at the Establishment originating the consignment must be consulted about the arrangements for all such consignments, and will, in consultation with the consignor and the carrier, issue written 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 interim measure, the railways are accepting 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 per 24 hours, 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 railways and 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. Packages are signed for at the consigning station, and should only be sent by direct through routes to their destination.

Arrangements must be made for the immediate collection 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.

/(ii) TRANSPORT

(iv) TRANSPORT OF RADIOACTIVE MATERIALS BY ROAD (Code of Practice)

(a) The radiation level at the driver's seat, or at any seat occupied by a passenger, must be below 100 milliroentgens per eight hours (12½ mr/h).

(b) The radiation level at any point on the outside of the car must be below [illegible] milliroentgens per hour.

(c) A notice should be carried in the car stating that radioactive materials are being transported, and are packed in [illegible] containers (or appropriate wording as applicable). An [illegible] and telephone number should be given, in order that the public may contact the owner of the vehicle immediately if there is an accident. As an example, the following is a copy of the notice [illegible] by A.E.R.E. [illegible]

WARNING
THIS CAR IS CARRYING
RADIOACTIVE MATERIAL
THE MATERIAL IS PACKED IN SEALED CONTAINERS
THE CONTAINERS ARE SAFE TO HANDLE FOR
SHORT PERIODS PROVIDED THEY ARE UNDAMAGED
IN CASE OF ACCIDENT TO THIS CAR
COMMUNICATE AT ONCE WITH

Telephone Number :

(v) TRANSPORT OF RADIOACTIVE MATERIALS BY SEA (Code of Practice)

(a) Detailed regulations covering the transport of radioactive materials by sea have not yet been published but [illegible] are granted subject to the approval of the U.K. Ministry of Transport and [illegible] the Department of Defence Production and the State [illegible] concerned.

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

(b) Applications to the Ministry 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.

[illegible] are classed [illegible] defined [illegible] Rules, 1952 [illegible] provisions of [illegible] by the [illegible] Minister of Transport [illegible] goods [illegible] on board any ship unless the [illegible] has been supplied with a declaration of [illegible] the shipper. [illegible] of [illegible] form of declaration has been agreed by the U.K. Ministry of Transport.

[illegible] the undersigned has [illegible] paragraph 2(1) of the [illegible] 1952 [illegible] that the packing and marking of the goods are in accordance with [illegible] of the Rules which are reproduced in paragraph [illegible] below.

[illegible]

(d) Paras. 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 to which this Rule applies for carriage in the ship unless the shipper of the goods has furnished the owner or master of the ship with a statement in writing of the identity of the goods and of the nature of the danger to which the goods give rise, indicating to which of the following categories the goods belong:

(i) Explosives.
(ii) Compressed, liquified and 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 agents.
(viii) Substances which are liable to spontaneous combustion.
(ix) Laboratory chemicals and medicinal preparations in limited quantities.
(x) Other dangerous goods.

For the purpose of these Rules a laboratory chemical or medicinal preparation shall be treated as 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 Department Committee appointed by the Minister of Transport to consider the Existing Rules relating to the Carriage of Dangerous Goods and Explosives in Ships, dated 13th November, 1951.

(2) The master of the ship shall cause a list to be carried in the ship setting forth, in accordance with the information furnished under the foregoing provisions of this Rule, the dangerous goods carried in the Ship on the voyage in which she is currently engaged.

Marking

(3) It shall be unlawful for dangerous goods, being goods contained in a vehicle, receptacle or package, 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 for 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 provisions 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

Packing and Carriage in Bulk

4. - (1) It shall be unlawful for dangerous goods being goods which are not loaded in bulk, to be taken on board any ship to which this Rule applies for carriage in that ship if the owner of 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 withstand 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 th provisions of this paragraph, it shall be a good defence to prove that before the goods were taken on board the ship:

(a) 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

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

(2) It shall be unlawful for dangerous goods to be loaded in bulk into any ship to which this Rule applies for carriage in that ship if the owner of the ship or any 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 BY AIR - MINISTRY OF CIVIL AVIATION REGULATIONS

The following conditions have been adopted by the United Kingdom to govern the carriage of radioactive materials in aircraft. These conditions are basically the same as the conditions recommended by the International Air Transport Association and adopted by the majority of 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 materials 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 subject to compliance with the undermentioned conditions.

(b) Radioactive materials are defined as any material or combination of materials which spontaneously emit 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 or beta radiation or both).

/(c) A Unit

(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 mrhm), 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 ½ inch of lead.

(d) The maximum quantity of radioactive materials 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 sealed inner metal containers. Where the material is liquid it must in addition be packed in tight glass, earthenware, or other suitable inside containers surrounded on all sides, and within the shield, by sufficient absorbent material to absorb the entire contents. The outside shipping container must be a strong, rigid container having a minimum dimension of 4 inches on any one side, and of such design that the gamma radiation will not exceed 200 milliroentgens per hour or equivalent at any point of readily accessible surface.

(f) Radioactive material consignments must be shielded in such a manner that the shield will maintain its efficiency under conditions normally incident to carriage as follows:

(i) Group I. The shield must be lead or other suitable material of such thicknesses that at all times gamma radiation at 1 metre does not exceed 10 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 mrhm of gamma radiation, or its physical equivalent in electrically charged corpuscular radiation, or neutron radiation which is the physical equivalent of 2 mrhm of gamma radiation. Where more than one type of radiation is 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 must not exceed 10 milliroentgens per 24 hours, at any time during carriage.

(g) The following statement signed by the shipper 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 material published by .... (carrier(s)) .... and otherwise comply with such regulations. This consignment is within the limitations prescribed for passenger-carrying aircraft."

/(h) All

(h) All packages of radioactive materials in Groups I and II shall have attached a label worded as follows.

"Do not place undeveloped film within 15 feet of this container.
Radioactive material.
Group I or II.
No person shall remain within 3 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 these circumstances, where the number of units is one or under, the words "15 feet", "3 feet" and "40 units" may be replaced by "5 feet", "1 foot" and "1 unit" respectively. Where the number of units is over one but does not exceed four, the words "15 feet", "3 feet" and "40 units" may be replaced by "10 feet", "2 feet" and "4 units" respectively.

+Note: In Australia aircraft of the internal airlines may carry a maximum of two packets containing R.A. materials.

(k) All packages of radioactive materials in Group III shall have attached a label worded as follows:

"Handle carefully
Radioactive material
Group III
Contents .....
Emitting corpuscular rays only."

WING TIP SERVICE

Limited amounts of gamma emitting radioactive materials can be transported without lead shielding, in the wing tips of DC4 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 millicuries. A standard size cylindrical wing-tip container, 1.7 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. Nevertheless, small amounts of radioactive materials can be transported long distances by wing-tip service at a lower cost than that involving the orthodox use of lead pots and wooden boxes.

Special handling procedures are used in the wing-tip service. Aircraft are loaded and unloaded by the airlines or their agents, but users must possess a suitable shielding container into which the wing-tip cylinder containing the radioactive material can be loaded at airport of arrival and transported safely to its final destination.

(V) POSTAL TRANSPORT OF RADIOACTIVE MATERIALS (Code of Practice)

(i) The packages used must have been approved by the G.P.O. Engineering Section.

(ii) That the radiation at any point on the surface of the package is not greater than 10 milliroentgens per 24 hours.

REFERENCE WORKS

(a) Published in the United Kingdom

(1) A.E.R.E. Radioactive Materials and Stable Isotopes. Catalogue No.3, July 1954 - A.E.R.E. Harwell, Berks.

(2) Merchant Shipping (Dangerous Goods) Rules, 1952. Statutory Instrument 1952 No.1977 - H.M.S.O., London.

(3) The Carriage of Dangerous Goods and Explosives in Ships (The Blue Book) - Ministry of Transport & Civil Aviation, London.

(4) Conditions Governing the Carriage of Radioactive Materials in Aircraft - Ministry of Transport & Civil Aviation, London.

(5) Recommendations of the International Commission on Radiological Protection (Revised December, 1954) - Published in the British Journal of Radiology, Supplement No.6, 1955 - British Institute of Radiology, London.

(b) Published in Australia

(1) Technical Communication No.58 of the Commonwealth X-Ray and Radium Laboratory - CX and RL, Melbourne.

(2) Air Navigation Order, Part 33 - Department of Civil Aviation, Melbourne.

(3) Instructions for the Storage and Handling of Radioactive Sources - Defence Standards Laboratory, Melbourne.

(c) Published Elsewhere

(1) Ensuring Public Safety in Continental Weapons Tests (13th Semi Annual Report of the United States Atomic Energy Commission)

(2) The Effects of Nuclear Weapons - U.S.A.E.C., June 1957.

OFFICIAL USE ONLY

RSRC/58(1)

RADIOLOGICAL SAFETY REGULATIONS

CHRISTMAS ISLAND

The Radiological Safety Regulations, Christmas Island, are issued by the Director, Atomic Weapons Research Establishment, on behalf of the Minister of Supply and have been agreed by the United Kingdom authorities concerned.

Enforcement of these regulations will be the overall responsibility of the Commander, Task Force Grapple.

Trials Planning Branch,
A.W.R.E. Aldermaston,
Berks.

March, 1958.

RADIOLOGICAL SAFETY REGULATIONS

CHRISTMAS ISLAND

RADIOLOGICAL SAFETY REGULATIONS

CHRISTMAS ISLAND

1. INTRODUCTION

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

Excessive exposure, however, results in damage to the human body.

The danger is insidious because the effects are not immediately felt and damage may become apparent only 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 or abrasions, or even by absorption through an intact skin.

1.2 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 UKAEA and other Authorities concerned. These are the levels to be used throughout a Trial.

1.3 The object of these regulations is to ensure complete protection both of staff and of the general public, whilst imposing the minimum interference with work. To this end, the regulations will, at all times, apply to all who are concerned with the Christmas Island Trials, both Servicemen and Civilians wherever stationed.

1.4 Advice on the applicability and interpretation of these regulations will be prepared by the Health Physics Adviser for the Scientific Director, who is responsible for advising the Commander, Task Force Grapple, on whom rests overall responsibility for all matters of radiological safety. For implementation, a Health Physics Controller will be appointed by DAWRE to work under control of the Scientific Director.

If necessary, a Health Physics Representative will be provided by AWRE during inter-trials periods.

2. SPECIFICATION OF MAXIMUM PERMISSIBLE LEVELS

It is emphasized that these levels are maxima and every endeavour must be made to keep all exposures as low as possible.

2.1 External Radiations

For external radiation the maximum permissible levels will be:-

2.1.1 β and γ Radiation

(a) A normal working rate as defined in the current 'Recommendations of the International Commission on Radiological Protection'.

1·5 rep/week of which the γ radiation component must not exceed 0·3r/week.

The dose to the eyes must not exceed 0·3 rep/week.

(b) A lower integrated dose of up to 15 rep of which the γ radiation components must not exceed 3r.

This dose will be allowed only with the express permission of the Health Physics Controller which will be given only when he regards it as necessary for the smooth running of the Operation.

Except as provided for under (c) or (d) below, personnel who have received this dose will not be subjected to further exposure until their average exposure is below 1·5 rep/week of which the γ component shall not exceed 0·3r/week.

(c) A higher integrated dose of up to 50 rep of which the γ radiation component must not exceed 10r.

This dose will be allowed only where it is necessary in order to recover important records and information which might otherwise be lost, and will require the personal permission of the Scientific Superintendent after consultation with the Health Physics Adviser and Medical Adviser.

Except as provided for under (d) below, personnel who have received this dose will not be subjected to further exposure until their average exposure is below the level given in (b).

Personnel who, having been given permission to receive up to 10r, accidentally exceed this figure, will not be permitted to receive further exposure within 3 years except under the conditions of (d) below.

(d) A special higher integrated dose of up to 75 rep of which the γ radiation component must not exceed 25r.

This dose will be allowed only if essential to the success of the trial, and only to personnel who are not normally exposed to radiation, and then only with the personal permission of the Scientific Director after consultation with the Health Physics Adviser and the Medical Adviser.

(e) Personnel who have received over 10r but not more than 25r will not be subjected to further exposure during a period of three years except under the condition of (d) above.

(f) No person will be allowed to receive more than 50r before age 30, his full radiation history being taken into account.

(g) If doses are received longer than are authorised for the individual, a special enquiry into the circumstances must be held by the Scientific Director.

2.1.2 Neutron Radiation

The maximum permissible levels will be as defined in the current recommendations of the 'International Commission on Radiological Protection'.

The dose to the tissue 2 cm below the skin surface must be less than 30 millirads/week. This figure, for a 40 hour week is given by the neutron fluxes below:-

Neutrons of energy 0·25eV	2000 neutrons/cm^2/sec
Neutrons of energy 10eV	2000 neutrons/cm^2/sec
Neutrons of energy 10keV	1000 neutrons/cm^2/sec
Neutrons of energy 0·1MeV	200 neutrons/cm^2/sec
Neutrons of energy 0·5MeV	80 neutrons/cm^2/sec
Neutrons of energy 1MeV	60 neutrons/cm^2/sec
Neutrons of energy 2MeV	40 neutrons/cm^2/sec
Neutrons of energy 3-10MeV	30 neutrons/cm^2/sec

2.1.3 α Radiation

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

2.2 Internal Radiations

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

2.2.1 The maximum permissible levels for inhalation and ingestion will be:-

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

The concentrations shall be those in Appendix I for the materials concerned.

(b) For Weapon Debris

(i) In Water

(a) α emitters 10^{-7} μc/cc for debris less than 30 days old.

(b) β-γ emitters 6×10^{-4} μc/cc for debris less than 30 days old.

β-γ emitters 1×10^{-6} μc/cc for debris more than 30 days old.

These levels are based upon the ingestion of 2 litres/day.

(ii) In Air

(a) α emitters. The concentrations shall be that in Appendix I for the most hazardous material likely to be found.

(b) β-γ emitters. The concentrations shall be those given by the expression.

$$\frac{3{\cdot}0 \times 10^{-6}}{T} \quad \mu c/cc$$

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 or if the age of the debris is in doubt, the value given for Sr 90 shall be used, namely 6×10^{-10} μc/cc.

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 varied in inverse proportion to the duration of exposure.

2.3 Contamination Levels

2.3.1 Buildings and Installations

Contamination can be fixed or loose.

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 washings in accordance with the instructions laid down in Appendix III.

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

α	μc/cm²
600 disintegrations/min on both sides of one hand	1×10^{-6}
20 disintegrations/min/cm², clothing, benches, equipment, etc.	1×10^{-5}
400 disintegrations/min/cm², fume cupboards	2×10^{-4}
β-γ	
6000 disintegrations/min on both sides of one hand	1×10^{-5}
400 disintegrations/min/cm², clothing, benches, equipment, etc.	2×10^{-4}
8000 disintegrations/min/cm², fume cupboards	4×10^{-3}

The maximum permissible levels for loose contamination will be:-

α	μc/cm²
5 disintegrations/min/'smear'	$1{\cdot}5 \times 10^{-8}$
β-γ	
20 disintegrations/min/'smear'	6×10^{-8}

2.3.2 Fall-out Areas

The maximum permissible level (MPL) of contamination by fall-out of fission products in uncontrolled areas depends upon its physical state, (whether it is soluble or insoluble, finely divided or in pellet form), and upon the age of the products.

The Health Physics Controller will determine the boundaries of the Controlled Area according to the circumstances.

Insoluble Products

MPL for products of any age = 430 $\mu c/m^2$

Soluble Products

MPL for products aged up to $4^1/2$ months = 430 $\mu c/m^2$

MPL for products aged $4^1/2$ months to 12 years = $2{\cdot}7 \times 10^3\ t^{-1{\cdot}2} \mu c/m^2$

(t = age in months)

MPL for products of age unknown or greater than 12 years = 7 $\mu c/m^2$

Pellets

MPL for insoluble pellets = 5 μc/pellet of any age

MPL for soluble pellets = 5 μc/pellet up to age 1 month, $5t^{-1{\cdot}2} \mu c$/pellet aged 1 month to 12 years

(t = age in months)

and $1{\cdot}3 \times 10^{-2}$ μc/pellet of age unknown or over 12 years.

Note: 430 $\mu c/m^2 \sim$ 2 mr/h

2.3.3 When contamination levels exceed those given in paras 2.3.1 and 2.3.2 the Health Physics Controller will lay down the conditions under which work may proceed in the areas affected.

3. CLASSIFICATION OF AREAS

3.1 All parts of the Test Area 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 Controlled Areas: are those where the levels laid down in Section 2 are exceeded and where precautions appropriate to the degree of risk must be taken.

3.2.2 There will be three categories:-

(a) BLUE Area - Risk of penetrating radiation but not of inhalation, ingestion or injection. No special clothing.

(b) RED Area - Risk of penetrating radiation and of slight inhalation, ingestion or injection. Clothing as specified by the Health Physics Controller will be worn.

(c) 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 Adviser who must be informed prior to any proposed change in the work which might affect the classification. He will review the classifications periodically.

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

3.3 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 Physics Control Officer in charge.

When it is necessary to carry out building, engineering or other maintenance work in any Controlled Area, a Permit to Work Certificate must first be obtained from the Health Physics Adviser or Representative.

4. FILM BADGES

All personnel who have duties in a Controlled Area will wear a Personal Monitoring Film at all times.

5. PROTECTIVE CLOTHING

5.1 Wearing of Clothing

5.1.1 The type of radiation protective clothing required in Controlled Areas depends upon the degree of hazard prevailing and will be specified by the Health Physics Controller accordingly.

5.1.2 All protective clothing will be white and will be distinguished by red epaulettes or a red triangle as appropriate.

5.1.3 The wearing of the approved protective clothing with film badges and dosimeters, as specified in the appropriate parts of the regulations, is compulsory.

5.1.4 To assist the rigorous enforcement of these rules, radiation protective clothing will not be issued for other purposes.

5.2 Laundering and Disposal

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

5.2.2 Protective clothing will be sent only to the special laundry provided. Rubber gloves from RED areas will not be sent to the laundry but will be cleaned by the users.

6. USE AND STORAGE OF RADIOACTIVE MATERIALS

6.1 No radioactive material will be used outside Controlled Areas. Sealed sources of radiation may be used in carrying out calibrations provided the Health Physics organization has been informed and BLUE Area 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 Controlled Area. Adequate precautions must be taken to ensure that the dose

received by workers in that area is within the limits laid down.

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

6.4 In RED Areas no radioactive material will be exposed unnecessarily to the air of the laboratory.

6.5 Details of special precautions required for particular materials and areas will be laid down as appropriate by the Health Physics Controller, who will maintain a record of all radioactive sources and materials in use or in store.

7. TRANSIT OF RADIOACTIVE MATERIALS

7.1 Transit of radioactive materials outside Controlled Areas is permitted, provided they are in properly designed and sealed containers which will effectively prevent escape of the material and which are themselves externally clean, and that the Health Physics organization has been informed previously. The transit should be uninterrupted and adequate precautions must be taken to ensure that the γ-ray dose/rate does not exceed 200 mr/h at the surface and 10 mr/h at one metre, and the neutron dose rate does not exceed 30 neutrons/cm^2/sec. at the surface. Transit of containers where the dose rate exceeds any one of these limits will be permitted only with prior Health Physics approval.

7.2 Transit of radioactive materials to and from the Test Area is governed by any International UK and Australian Government Regulations currently in force, by the Regulations of any other Government concerned, and by any Instructions, currently in force, issued by DAWRE, RAF/AWRE, the Health Physics Adviser (See Appendix IV), or the Scientific Director.

8. LABORATORY WASTE

8.1 All solid waste will be segregated into the following four categories:-

(i) Highly active waste, i.e., above one millicurie.

(ii) Low activity waste non-combustible.

(iii) Low activity waste combustible.

(iv) Used paper towels.

Category (i) waste must be sealed in rigid containers and retained by the originator until proper arrangements have been made for its disposal. The contents and the approximate levels of activity must be marked on the outside.

Bins suitably labelled will be kept in all laboratories and workrooms where categories (ii), (iii), 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 active 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 personnel and to prevent interference with scientific work due to contamination.

The Health Physics organisation will provide complete monitoring facilities for personal use.

A representative of Health Physics will be available in all Controlled Areas to advise and assist when called upon.

9.2 Personal Monitoring

9.2.1 It is the responsibility of each individual to ensure that he is monitored before leaving a Controlled Area. Instruments will be provided for this.

9.2.2 γ-ray dosage will be measured by means of film badges which will be worn as laid down in section 4.

9.2.3 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 organization.

9.3 Area Monitoring

9.3.1 Air sampling will be carried out in all laboratories and workrooms 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 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 the Health Physics organization.

9.4 Monitoring of Active Waste

Solid waste containers will be monitored and decontaminated if necessary before being taken from a Controlled Area.

9.5 Monitoring of Vehicles and Equipment

All equipment and vehicles, including ships and aircraft, will be monitored and decontaminated, if necessary, before being taken out of a Controlled Area. Special arrangements have been made for the movement from and to Australia of aircraft which have undertaken sampling duties and may, therefore, be contaminated, and this section does not apply to such aircraft.

Equipment will not be moved into a less active area unless it is monitored, decontaminated, if necessary, and given a Health Physics Clearance Certificate. Articles must not be moved into a BLUE or a non-controlled area if there is any detectable loose activity. Again, this section does not apply to sampling aircraft for which special arrangements are made.

10. MEDICAL SURVEILLANCE

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

No person will be allowed to work in a Controlled 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, or immediately prior to his first exposure during the 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 at once:-

(i) Take emergency action. (See 11.2 below)

(ii) Report to the Health Physics Controller and the Medical Officer (through his Officer-in-Charge if the accident occurs on duty).

11.2 If the skin is accidentally cut, or scratched, during work in a Controlled Area 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 washing continued until this is inactive.

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.

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 YELLOW area:-

(i) Ask all staff to vacate the area.

(ii) Limit the spread of contamination.

(iii) Report immediately to the Health Physics organization.

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

12. STORAGE AND USE OF PERSONAL EFFECTS

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

13. HAZARDS FROM WEAPON DEBRIS

13.1 The Health Physics Adviser will obtain from the Radiation Measurements Group, The Theoretical Predictions Group and the Meteorological Service all data required to maintain effective control over the hazards due to fall-out.

13.2 The use of all aircraft, vessels and vehicles, in connection with the Operation will be governed by such instructions as may be issued. Where aircraft, vehicles or personnel have been, or are likely to go, into areas which may have been contaminated, all personnel concerned must report at once to a Health Physics representative, who will arrange with the appropriate authority for the checking, decontamination if necessary and the granting of clearances and who will give such other advice as may be necessary.

13.3 Advice on other matters concerning Radiological Safety outside the Test Area will be called for from the Health Physics Adviser 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 and other relevant regulations and instructions.

14.2 The Officer-in-Charge of any Task is responsible for ensuring:-

(i) That these regulations and other relevant regulations and instructions 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.

(ii) That these regulations are rigorously observed.

(iii) That the Health Physics Adviser and the Medical Officer are informed in advance of any proposed work which may affect the Radiological Safety arrangements in any way.

(iv) That any accidents or abnormal circumstances are reported immediately to the Scientific Director, the Health Physics Adviser, the Medical Officer and, where applicable, to Officers Commanding Service Units.

(v) That Health Physics Controller is kept fully informed of of all radioactive materials being used by his staff or under his control.

14.3 Officer Commanding Service Units, etc.

The Officers in Command of the various service units, ships, aircraft and detachments and groups involved will ensure that these regulations and all other relevant regulations and instructions issued by the Health Physics Adviser with the approval of the Scientific Director, under the Task Force Commander's Authority, are enforced and are brought to the notice of all personnel under their command and to their visitors.

14.4 The Health Physics Adviser is responsible for:-

(i) Advice to the Scientific Director on radiological safety. Issue of instructions on behalf of the Scientific Director requires the authority of the Commander, Task Force Grapple.

(ii) The activities of the Health Physics Controller (see Section 14.5).

14.5 The Health Physics Controller is responsible to the Health Physics Adviser for:-

(i) Delineation of all Controlled Areas.

(ii) Radiological control of all movements into, out of, and within Yellow areas and radiological supervision in all other Controlled Areas.

(iii) Maintenance of records of individual radiation doses received by all personnel and location of all radiation sources used in the Test Area.

(iv) Provision of instruments and equipment necessary for Health Physics control.

15. AMENDMENTS

D.WRE will issue any amendments necessary to keep these regulations consistent with current Regulations, Instructions and Codes of Practice issued by various Government, International and other organizations concerned.

APPENDIX I

MAXIMUM PERMISSIBLE CONCENTRATIONS

1. The concentrations shown below shall be the maximum permissible levels for the various isotopes mentioned, when found during the Trial. The Values are based on recommendations and 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, e.g. for a 24 hour daily exposure the level in air for Sr90 will be 2×10^{-10} µc/cc, instead of 6×10^{-10} µc/cc.

Maximum Permissible Concentrations

Radio Isotopes	Water (µc/cc)	Air (µc/cc)
H^3	0.2	3×10^{-5}
$C^{14}(CO_2)$	3×10^{-3}	3×10^{-5}
Na^{24}	8×10^{-3}	3×10^{-6}
A^{41}	5×10^{-4}	1.5×10^{-6}
Ca^{45}	10^{-4}	2.4×10^{-8}
Sr^{89}	7×10^{-5}	6×10^{-8}
$Sr^{90} + Y^{90}$	8×10^{-7}	6×10^{-10}
Y91	3×10^{-4}	2.7×10^{-8}
$Ru106 + Rh^{106}$	10^{-4}	6×10^{-8}
I^{131}	6×10^{-5}	1.8×10^{-8}
$Cs^{137} + Ba^{137}$	2×10^{-3}	6×10^{-7}
$Ba^{140} + La^{140}$	2×10^{-4}	5×10^{-8}
$Ce^{144} + Pr^{144}$	10^{-4}	6×10^{-9}
Po^{210}	3×10^{-6}	3×10^{-10}
Rn^{222}	-	3×10^{-7}
Ra^{226} + 55% d.p.	4×10^{-8}	2.4×10^{-11}
Ac^{227} + d.p.	5×10^{-7}	1.2×10^{-11}
Th Natural	4×10^{-7}	9×10^{-11}
$Th^{234} + Pa^{234}$	2×10^{-4}	3×10^{-8}
U Natural	2×10^{-6}	9×10^{-11}
U^{233}	3×10^{-6}	9×10^{-11}
Pu^{239}	3×10^{-6}	6×10^{-12}
Weapon Debris	See note 1 below	See note 1 below
Any fission mixture (except from weapons) and any mixture of β-γ	10^{-7}	3×10^{-9} See note 5 below
A mixture of emitters	10^{-7} See note 5 below	1.5×10^{-11} See note 5 below

NOTES

(a) The figures given refer to the parent element. Where there is a daughter element, it is assumed that it reaches equilibrium with the parent after it is taken into the body. However, the figure of 3×10^{-7} µc/cc for radon refers to Rn + daughter products in the inhaled air and is thus an exception to the above rule.

(b) The curie of natural uranium is considered to correspond to 3.7×10^{10} dis/sec. from U^{238}, 3.7×10^{10} dis/sec. from U^{234} and 9×10^{8} dis/sec. from U^{235}. It is considered that none of the other daughter products of U^{238} is present at the time of ingestion or inhalation.

(c) The curie of natural thorium is considered to correspond to 3.7×10^{10} dis/sec. from Th^{232} and 3.7×10^{10} dis/sec. from Th^{238}. It is considered that none of the other daughter products of Th^{232} is present at the time of ingestion or inhalation.

(d) 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 the radioactive contaminants. They are safe for indefinite use with the following exceptions:-

(i) 10^{-7} µc/cc of water is safe for any mixture of beta gamma emitters and all alpha emitters except Ra^{226}.

(ii) 3×10^{-9} µc/cc of air is safe for any mixture of beta gamma emitters except Sr^{90}.

(iii) 1.5×10^{-11} µc/cc of air is safe for any mixture of alpha emitters except Pu^{239} and Ac^{227}.

APPENDIX II

METHOD OF MAKING SMEAR TESTS

A Whatman No.1 (5.5 cm) filter paper is used for this test.

The paper is slightly bent around the second finger by the two adjacent fingers so that a small area in the centre of the paper is brought into contact with the surface. It is then rubbed lightly over the area or object being checked.

For Flat Surfaces

Rub paper in a circular motion covering an area of approximately six inches diameter, i.e. approximately 180 to 200 cm^2.

For Irregular Shaped Objects: Door Handles, Telephones, etc.

Lightly rub paper over whole surface (if small enough), otherwise take a series covering the whole surface.

These "smears" are then placed in a standard type alpha or beta/gamma counter and counted.

Results are usually expressed as disintegrations/minute having applied the necessary factors for counter efficiency.

APPENDIX III

REMOVAL OF RADIOACTIVE CONTAMINATION FROM HANDS

In many cases contamination will be removed by a normal washing of the hands in tepid water using a mild soap.

DO NOT RINSE HANDS IN WASHINGS AS THIS IS LIABLE TO BE CONTAMINATED.

If this procedure is not enough to remove contamination then scrubbing is necessary.

For this you should use the special brush provided in active change rooms.

A convenient routine for scrubbing hands is to start by scrubbing one thumb, being sure to brush all surface; proceed to the space between the thumb and first finger and similarly to each finger and the webs between the fingers.

Close fingers tightly together and scrub in a downward direction from approximately one inch above the wrist, giving attention to the back and palm of the hand, and finally additional scrubbing of the nails and cuticles.

Rinse hands, as before, in fresh water direct from the tap.

This nail brush is most effective when used lightly; any extra pressure of this brush on the hands will only result in bending the bristles out of shape.

Always scrub in a direction away from the body into the basin. This is to prevent splashing of possibly contaminated liquid on your clothes or the floor.

IN ORDER TO PREVENT THE TRANSFER OF ACTIVITY FROM ONE SECTION OF THE HAND TO ANOTHER. THE BRUSH SHOULD BE WASHED IN FRESH WATER AND FRESH SOAP APPLIED AT LEAST THREE TIMES DURING THE SCRUBBING OF EACH HAND.

If the above procedure is not successful, then it should be repeated.

It is advisable to rub a small quantity of ROSAPEX No.4 on the hands after a vigorous scrubbing to soften the hands and prevent chapping.

DO NOT USE THIS CREAM BEFORE YOU HAVE SATISFIED YOURSELF THAT YOUR HANDS ARE FREE FROM CONTAMINATION.

It will probably not be necessary to use any more than the above scrubbing, but if contamination is very persistent more drastic techniques are available.

Whether these are used should be decided jointly by the Medical Officer and the Health Controller.

CARRIAGE OF RADIOACTIVE MATERIAL

1. 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 A.E.R.E. Harwell have, however, been adopted by the authorities concerned in the U.K. All regulations and Codes of Practice extant in the U.K. are given in para. 3 below. Health Physics must be consulted about the arrangements for each consignment, and will issue any necessary certificates.

2. Where consignments do not comply with the regulations or Codes of Practice, special arrangements must be made with the carrier concerned. Such consignments invariably require one or two escorts. The Health Physics authorities at the Establishment originating the consignment must be consulted about the arrangements for all such consignments, and will, in consultation with the consignor and the carrier, issue written 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 interim measure, the railways are accepting 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 per 24 hours, 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 railways and 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. Packages are signed for at the consigning station, and should only be sent by direct through routes to their destination.

Arrangements must be made for the immediate collection 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.

/(ii) TRANSPORT

(14) TRANSPORT OF RADIOACTIVE MATERIALS BY ROAD (Code of Practice)

(a) The radiation level at the driver's seat, or at any seat occupied by a passenger, must be below 100 millirocntgens per eight hours (12½ mr/h).

(b) The radiation limit at any point on the outside of the car must be below 200 millirocntgens 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 compartments (or appropriate 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. As an example, the following is a copy of the notice carried by A.E.R.E. cars:

WARNING
THIS CAR IS CARRYING
RADIOACTIVE MATERIAL
THE MATERIAL IS PACKED IN SEALED CONTAINERS
THE CONTAINERS ARE SAFE TO HANDLE FOR
SHORT PERIODS PROVIDED THEY ARE UNDAMAGED
IN CASE OF ACCIDENT TO THIS CAR
COMMUNICATE AT ONCE WITH

Telephone Number :

(15) TRANSPORT OF RADIOACTIVE MATERIALS BY SEA (Code of Practice)

(a) Detailed regulations covering the transport of radioactive materials by sea have not yet been published but shipments are permitted subject to the approval of the U.K. Ministry of Transport and in Australia the Department of Defence Production and the State Government concerned.

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

(b) Applications to the Ministry 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 millirocntgens per hour.
(d) Radiation at 1 yard from surface of container in millirocntgens per hour.

(c) Radioactive materials are classified in the U.K. as "Category X-Class Dangerous Goods", as defined in the Merchant Shipping (Dangerous Goods) Rules, 1952. The provisions of Statutory Instrument 1952 No.1219, 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 hereon-mentioned hazardous cargo is described and classified as set out in para.2(1) of the Merchant Shipping (Dangerous Goods) Rules, 1952 and we declare that the marking and packing of the goods are in accordance with Paras.3 and 4 of the Rules which are reproduced in sub-para. (iii) (d) below.

/(i) Paras.

(d) Paras. 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 to which this Rule applies for carriage in the ship unless the shipper of the goods has furnished the owner or master of the ship with a statement in writing of the identity of the goods and of the nature of the danger to which the goods give rise, indicating to which of the following categories the goods belong:

(i) Explosives.
(ii) Compressed, liquified and 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 agents.
(viii) Substances which are liable to spontaneous combustion.
(ix) Laboratory chemicals and medicinal preparations in limited quantities.
(x) Other dangerous goods.

For the purpose of these Rules a laboratory chemical or medicinal preparation shall be treated as 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 Department Committee appointed by the Minister of Transport to consider the Existing Rules relating to the Carriage of Dangerous Goods and Explosives in Ships, dated 13th November, 1951.

(2) The master of the ship shall cause a list to be carried in the ship setting forth, in accordance with the information furnished under the foregoing provisions of this Rule, the dangerous goods carried in the Ship on the voyage in which she is currently engaged.

Marking

(3) It shall be unlawful for dangerous goods, being goods contained in a vehicle, receptacle or package, 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 for 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 provisions 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

Packing and Carriage in Bulk

4. - (1) It shall be unlawful for dangerous goods being goods which are not loaded in bulk, to be taken on board any ship to which this Rule applies for carriage in that ship if the owner of 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 withstand 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 th provisions of this paragraph, it shall be a good defence to prove that before the goods were taken on board the ship:

(a) 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

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

(2) It shall be unlawful for dangerous goods to be loaded in bulk into any ship to which this Rule applies for carriage in that ship if the owner of the ship or any 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 BY AIR - MINISTRY OF CIVIL AVIATION REGULATIONS

The following conditions have been adopted by the United Kingdom to govern the carriage of radioactive materials in aircraft. These conditions are basically the same as the conditions recommended by the International Air Transport Association and adopted by the majority of 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 materials 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 subject to compliance with the undermentioned conditions.

(b) Radioactive materials are defined as any material or combination of materials which spontaneously emit 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 or beta radiation or both).

/(c) A Unit

(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 mrhm), 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 $\frac{1}{2}$ inch of lead.

(d) The maximum quantity of radioactive materials 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 sealed inner metal containers. Where the material is liquid it must in addition be packed in tight glass, earthenware, or other suitable inside containers surrounded on all sides, and within the shield, by sufficient absorbent material to absorb the entire contents. The outside shipping container must be a strong, rigid container having a minimum dimension of 4 inches on any one side, and of such design that the gamma radiation will not exceed 200 milliroentgens per hour or equivalent at any point of readily accessible surface.

(f) Radioactive material consignments must be shielded in such a manner that the shield will maintain its efficiency under conditions normally incident to carriage as follows:

(i) Group I. The shield must be lead or other suitable material of such thicknesses that at all times gamma radiation at 1 metre does not exceed 10 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 mrhm of gamma radiation, or its physical equivalent in electrically charged corpuscular radiation, or neutron radiation which is the physical equivalent of 2 mrhm of gamma radiation. Where more than one type of radiation is 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 must not exceed 10 milliroentgens per 24 hours, at any time during carriage.

(g) The following statement signed by the shipper 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 material published by .... (carrier(s)) .... and otherwise comply with such regulations. This consignment is within the limitations prescribed for passenger-carrying aircraft."

/(h) All

(h) All packages of radioactive materials in Groups I and II shall have attached a label worded as follows:

"Do not place undeveloped film within 15 feet of this container.
Radioactive material.
Group I or II.
No person shall remain within 3 feet of this container u necessari

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 these circumstances, where the number of units is one or under, the words "15 feet", "3 feet" and "40 units" may be replaced by "5 feet", "1 foot" and "1 unit" respectively. Where the number of units is over one but does not exceed four, the words "15 feet", "3 feet" and "40 units" may be replaced by "10 feet", "2 feet" and "4 units" respectively.

+Note: In Australia aircraft of the internal airlines may carry a maximum of two packets containing R.A. materials.

(k) All packages of radioactive materials in Group III shall have attached a label worded as follows:

"Handle carefully
Radioactive material
Group III
Contents .....
Emitting corpuscular rays only."

WING TIP SERVICE

Limited amounts of gamma emitting radioactive materials can be transported without lead shielding, in the wing tips of DC4 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 millicuries. A standard size cylindrical wing-tip container, 1.7 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. Nevertheless, small amounts of radioactive materials can be transported long distances by wing-tip service at a lower cost than that involving the orthodox use of lead pots and wooden boxes.

Special handling procedures are used in the wing-tip service. Aircraft are loaded and unloaded by the airlines or their agents, but users must possess a suitable shielding container into which the wing-tip cylinder containing the radioactive material can be loaded at airport of arrival and transported safely to its final destination.

(V) POSTAL TRANSPORT OF RADIOACTIVE MATERIALS (Code of Practice)

(i) The packages used must have been approved by the G.P.O. Engineering Section.

(ii) That the radiation at any point on the surface of the package is not greater than 10 milliroentgens per 24 hours.

REFERENCE WORKS

(a) Published in the United Kingdom

(1) A.E.R.E. Radioactive Materials and Stable Isotopes. Catalogue No.3, July 1954 - A.E.R.E. Harwell, Berks.

(2) Merchant Shipping (Dangerous Goods) Rules, 1952. Statutory Instrument 1952 No.1977 - H.M.S.O., London.

(3) The Carriage of Dangerous Goods and Explosives in Ships (The Blue Book) - Ministry of Transport & Civil Aviation, London.

(4) Conditions Governing the Carriage of Radioactive Materials in Aircraft - Ministry of Transport & Civil Aviation, London.

(5) Recommendations of the International Commission on Radiological Protection (Revised December, 1954) - Published in the British Journal of Radiology, Supplement No.6, 1955 - British Institute of Radiology, London.

(b) Published in Australia

(1) Technical Communication No.58 of the Commonwealth X-Ray and Radium Laboratory - CX and RL, Melbourne.

(2) Air Navigation Order, Part 53 - Department of Civil Aviation, Melbourne.

(3) Instructions for the Storage and Handling of Radioactive Sources - Defence Standards Laboratory, Melbourne.

(c) Published Elsewhere

(1) Ensuring Public Safety in Continental Weapons Tests (13th Semi Annual Report of the United States Atomic Energy Commission)

(2) The Effects of Nuclear Weapons - U.S.A.E.C., June 1957.