

**Protocol for a Study of the Health of
UK Participants in the UK Atmospheric
Nuclear Weapon Tests**

Edited by J.A.Reissland

**National
Radiological
Protection
Board**

The National Radiological Protection Board was established by the Radiological Protection Act 1970 and is responsible for carrying out research and development and providing information, advice and services to those with responsibilities for radiological protection.

Any questions relating to this report should be addressed to the Publications Officer, National Radiological Protection Board, Chilton, Didcot, Oxfordshire, England.

Further copies of this report are available from Her Majesty's Stationery Office

UNITS

As from 1 April 1978 NRPB adopted the International System of Units (SI). The relationship between the new SI units which are used in this report and the previous units are shown in the table below.

Quantity	New named unit and symbol	In other SI units	Old special unit and symbol	Conversion factor
Exposure	—	C kg ⁻¹	röntgen (R)	1 C kg ⁻¹ ~ 3876 R
Absorbed dose	gray (Gy)	J kg ⁻¹	rad (rad)	1 Gy = 100 rad
Dose equivalent	sievert (Sv)	J kg ⁻¹	rem (rem)	1 Sv = 100 rem
Activity	becquerel (Bq)	s ⁻¹	curie (Ci)	1 Bq ~ 2.7 x 10 ⁻¹¹ Ci

PROTOCOL FOR A STUDY OF THE HEALTH OF UK PARTICIPANTS
IN THE UK ATMOSPHERIC NUCLEAR WEAPON TESTS

J A Reissland (Editor)

ABSTRACT

Between 1952 and 1967 the United Kingdom conducted an atmospheric nuclear weapon test programme which consisted of a series of nuclear weapon tests, experiments in which radioactive materials were dispersed in the atmosphere and subsequent clean-up operations. Claims have been made that the personnel participating in these activities suffered adverse health effects as a result of the tests. The National Radiological Protection Board will conduct a mortality study to compare patterns of mortality among those known to have participated in any part of the programme and similar groups who were not involved with the programme. The radiation dose records of those present will be used to see if there are associations between recorded exposures and causes of death. Subject to acceptance of the Study by the Central BMA Ethical Committee, cancer registration data will also be inspected to see whether or not there is any evidence of differences in cancer morbidity between those involved in the nuclear weapon test programme and similar groups who were not involved.

The Study will be conducted using the facilities provided by the National Health Service Central Register for the tracing and subsequent acquisition of death notification forms and cancer registration abstracts.

Study Team:

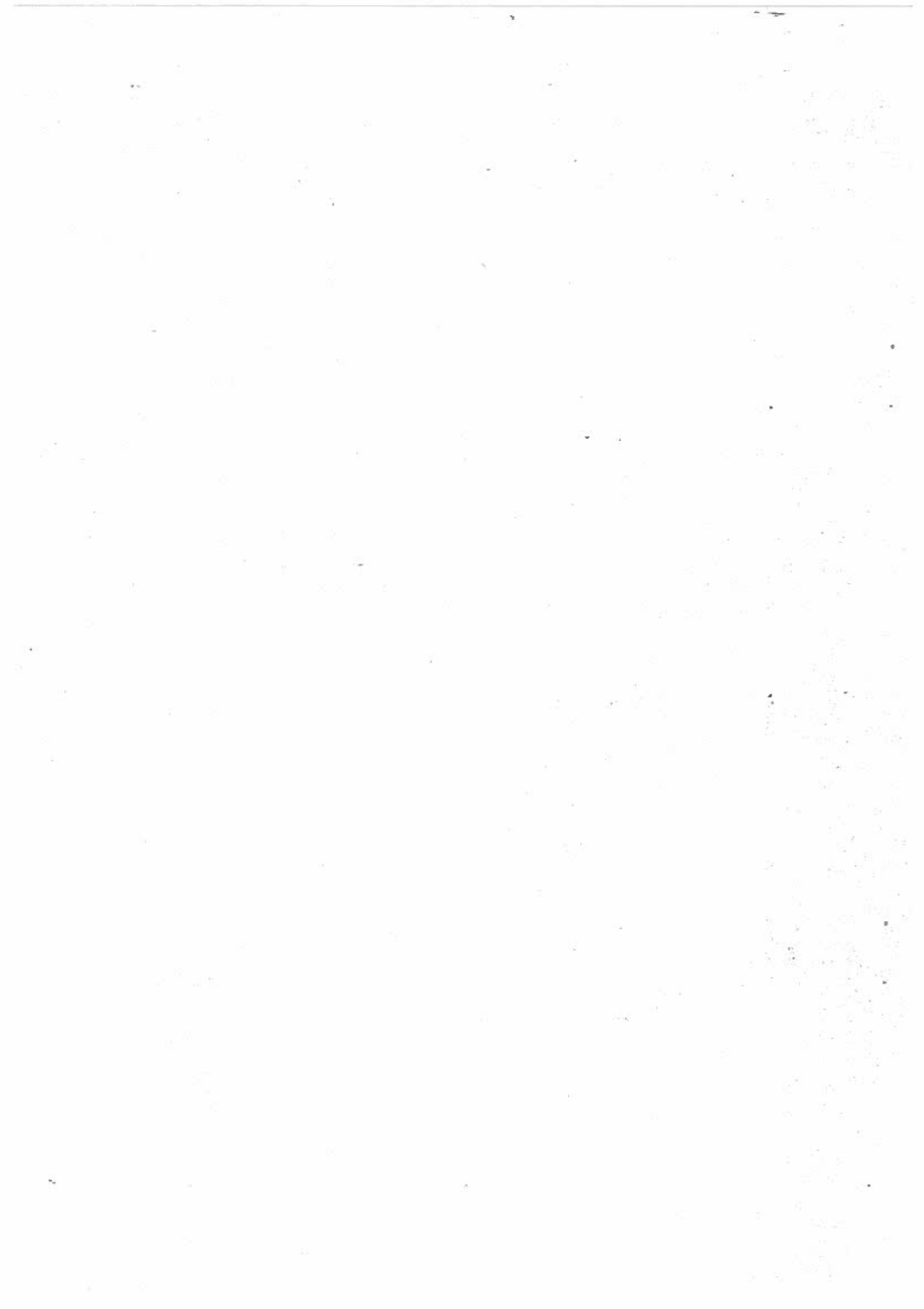
Mr S F Barry
Dr A P Brown
Dr S C Darby
Dr G M Kendall
Dr J A Reissland
Mrs G M A Saw
Clerical

National Radiological Protection Board
Chilton
Didcot
Oxon

September 1983

HMSO, £2.00

ISBN 0 85951 210 X



CONTENTS

	<u>Page No.</u>
1. INTRODUCTION	1
1.1 Background	1
1.2 Medical considerations	1
2. OBJECTIVES	1
2.1 Immediate objectives	1
2.2 Longer-term possibilities	2
3. GENERAL PLAN	2
4. DEFINITION OF THE STUDY POPULATION	3
4.1 Study Group	3
4.2 Adequacy of the blue book sample	5
4.3 Control Group	5
5. DATA AND DATA HANDLING	7
5.1 Data to be collected	7
5.2 Data handling	7
5.3 Coding on death notification	8
6. METHODS OF ANALYSIS	8
7. TIMESCALE	9
7.1 Immediate objectives	9
7.2 Longer-term possibilities	10
8. ACKNOWLEDGEMENTS	10
9. REFERENCES	10
TABLES (see list below)	11

TABLES

1. UK nuclear weapon tests in Australia and the South Pacific, October 1952 - September 1958	11
2. Maralinga experimental programme	12
3. The information included wherever practicable in the blue book	13
4. Information to be assembled for study of personnel involved in UK atmospheric nuclear weapon test programme	14

1. INTRODUCTION

1.1 Background

Between 1952 and 1958, the United Kingdom conducted 21 atmospheric nuclear weapon tests at the Monte Bello Islands off the coast of Western Australia, at Emu Field and Maralinga in South Australia, and at Malden Island and Christmas Island in the South Pacific. In addition, between 1953 and 1963, experiments in which some radioactive materials were dispersed into the environment were carried out in South Australia. Clean-up operations were carried out in 1963, 1964 and 1967. Claims has been made that personnel who participated in these activities have suffered a higher rate of illness than the population generally. The Ministry of Defence (MOD) has commissioned the National Radiological Protection Board to carry out a Study of the health of the UK participants in the UK atmospheric nuclear weapon test programme.

1.2 Medical considerations

It is known from observations on people exposed to substantial radiation doses that high levels of ionising radiation may result in injury or disease. Very high doses may result in almost immediate effects and will often cause early death. It is also generally accepted that effects may be experienced as a result of exposure to lower levels of radiation and that these effects may cause illness, most notably cancer, after the passage of many years. Therefore this Study will be restricted to an examination of the subsequent pattern of malignant diseases among those who took part in the test programme.

However, radiation is not the only cause of cancer; nor in the case of test personnel are the tests the only possible source of radiation exposure. Malignant diseases occur in all populations and, therefore, any effects induced by radiation from the tests must be resolved from those which have other causes. Since malignant neoplasms are responsible for about 20% of all deaths in the western world, the reliable identification of a small excess number attributable to radiation requires a very careful study. To this end, the Ministry of Defence has been asked to provide information on a 'Control Group' defined by the Study team to have similar characteristics to the 'Study Group' other than involvement in the nuclear weapon test programme. The composition of these two groups is described in Section 4.

2. OBJECTIVES

2.1 Immediate objectives

The immediate objectives of the Study are as follows.

Primary

- (i) Mortality study. To identify a Study Group which is as large a sample as practicable of those UK nationals who took part in the tests and to determine whether or not there is evidence of differences in the causes of and the age at death between this Group and a Control Group

which did not participate in the atmospheric nuclear weapon test programme.

- (ii) Morbidity study. (Subject to acceptance of the Study by the Central BMA Ethical Committee). To investigate whether or not cancer registrations for the Study and Control Groups provide evidence of adverse health consequences associated with the weapon test programme.

Secondary

- (iii) Relationship to known radiation exposure. To determine whether or not there is evidence of differences in the causes of and the age at death for those with recorded radiation exposures as a result of the tests and for those with no such recorded exposures. If significant differences are found, to determine whether or not they are correlated with the levels of recorded radiation exposures. (In addition to recorded external radiation exposures there is a possibility that doses from internal contamination by radioactive materials were incurred.)
- (iv) (Subject to acceptance of the Study by the Central BMA Ethical Committee). To investigate whether or not cancer registration data have any association with the levels of recorded radiation exposure.

2.2 Longer-term possibilities

The expectation is that less than 20% of the Study Group and of the Control Group will have died by the time the first analysis is complete. It may, therefore, be desirable to continue the monitoring of the histories of these groups so that the comparisons identified in Section 2.1 above can be made on a periodic basis and so that any special enquiries suggested by the results of these comparisons can be carried out expeditiously.

3. GENERAL PLAN

The Ministry of Defence will provide the Study team with a list of personnel who participated in the UK atmospheric nuclear weapon test programme in Australia and the South Pacific (the Study Group) and another list of personnel who have similar characteristics to the individuals in the Study Group but who did not participate in the test programme (the Control Group). The sources which were drawn upon to create these lists and, hence, the definition of the Study population are outlined in Section 4. The information to be supplied for each individual is discussed in Section 5. This information must allow the individual to be identified on the records of the National Health Service Central Register (NHSCR) and must provide sufficient data for the epidemiological aspects of the Study.

When the lists, and any additional information required by the Study team, are available, they will be computerised and cards will be printed for NHSCR to begin the tracing procedure. For each individual successfully traced on the

NHSCR, a copy of the death notification will be supplied to the Study team if the individual has died; if the individual is still alive, a marker will be inserted in the Register so that a copy of the death notification will be automatically made available when death occurs. Additionally, for each traced surviving individual, the Study team will be notified of any cancer registration known to the NHSCR.

The information available about the Study Group is unlikely to enable every individual to be traced on the NHSCR and, in those cases where tracing is unsuccessful at the first attempt, further enquiries will be made to locate additional identifying information. At this stage, it is not possible to estimate the extent of these further enquiries or to predict how large a number of the Study Group will remain untraced but it is expected that it will be a small proportion of the whole.

The causes of and age at death from the death notification forms and the data extracted from the cancer registrations will be entered on the computer file for analysis in accordance with the procedures described in Section 6. The first analysis will begin as soon as the tracing at the NHSCR is complete for all members of both the Study Group and Control Group.

The data collected will be treated as confidential. No report or publication will permit any individual to be identified; all results will be presented in statistical terms.

4. DEFINITION OF THE STUDY POPULATION

The Study population consists of the Study and Control Groups.

4.1 Study Group

At the time of the UK atmospheric nuclear weapon test programme, no comprehensive list of those who participated was compiled. Civilian and HM Forces personnel were employed in the test areas to carry out a variety of functions. The UK civilians were largely drawn from the Atomic Weapons Research Establishment, Aldermaston, and the UK Forces personnel were from all three Services. In addition, Australian civilians and Servicemen participated in the test activities in Australia and a small number of nationals from other countries also took part. Other nationals are not included in this Study, however those from Australia have been the subject of a corresponding study by the Australian authorities.

During recent years, the Ministry of Defence have examined archival material relating to the test programme to compile as complete a list as possible of all persons for whom there is evidence of participation in the programme. This list comprises about 12,000 names, of which about 6000 are from the Royal Navy, 2000 from the Army, 3000 from the Royal Air Force and 1000 are UK civilians. While there is confidence that this listing, which will be referred to as the 'blue book' data, includes almost all, if not all, personnel who were monitored and shown to have been exposed to radiation above the threshold of measurement, it is

clear that it does not include everyone who took part in the atmospheric nuclear weapon test programme. It is likely that there are a substantial number who took part who have not yet been identified for inclusion in the blue book.

The blue book lists UK personnel who participated in the following operations.

- (a) Atmospheric nuclear weapon test explosions in Australia and the South Pacific. The code names, dates and locations of these tests are given in Table 1.
- (b) Experimental work, not involving nuclear test explosions, in the Maralinga area of Australia. These experimental programmes with dates are shown in Table 2.
- (c) Re-visits to the Monte Bello Islands in the period 1953-56.
- (d) UK support for the US test series in the Christmas Island area in 1962.
- (e) The clean-up operations at Maralinga in 1964 and 1967 and at Christmas Island in 1963 and 1964.

The blue book data on Servicemen were compiled by consulting the Naval, Army and Air Historical Branches for the names of HM Ships, Army units and RAF Squadrons and Flights which participated in the above operations. The names of individuals serving with their military units were then obtained from various sources, for example, ships' ledgers. Additional information on participating Servicemen and also on civilians was obtained from planning documents and trials reports in AWRE archives, from information held at AWRE and in Australia, and from AWRE overseas travel registers. Data in the blue book will be checked against Service documents by the Board for completeness and accuracy.

For each individual identified as a member of the Study Group, the blue book data include, whenever possible, the types of information listed in Table 3. In many cases, however, it was not possible when compiling the blue book to retrieve all of this information and, for some entries, the only identification is a surname. Further, as individuals were listed in the blue book under each operation, it is clear that some individuals appear more than once because they took part in more than one operation or made separate visits to the site of an operation. Therefore, Service personnel from the blue book will be included in the Study Group only when their Service record has been uniquely identified according to criteria determined by the Board. AWRE and UKAEA civilians listed in the blue book will be included in the Study Group only when a superannuation number or other unique identifier has been established. The blue book also includes civilians who were not employees of AWRE or UKAEA. The extent to which they can now be identified from records is currently being investigated and a decision on whether they should be included in the Study Group will be made later.

4.2 Adequacy of the blue book sample

Although the list of personnel involved in the UK atmospheric nuclear weapon test programme is not complete, certain groups of people for whom coverage is complete, or virtually complete, can be identified. These are as follows.

- (i) Participants in the tests listed in Table 1 who were issued with personal dosimeters which gave readings above the measurement threshold. A summary list of these participants was kept by AWRE which provided the health physics coverage for these tests.
- (ii) Participants in the Maralinga Experimental Programme shown in Table 2 who were issued with personal dosimeters which gave readings above the measurement threshold. Records on these participants were kept by the Australian authorities who provided the health physics coverage for this programme.
- (iii) Ministry of Supply and UKAEA civilian participants (Note: AWRE was part of the Department of Atomic Energy of the Ministry of Supply until 1954 and of the UKAEA between 1954 and March 1974).
- (iv) The companies of ships which participated in operations. These are listed in ships' ledgers.
- (v) The members of at least one RAF Squadron.
- (vi) Possibly the members of two Army Regiments and one Army Construction Unit which were stationed on Christmas Island for the tests.

In addition to the information in the blue book, the MOD have information on several hundred individuals who have been self-identified or have been identified by third parties as having been engaged on the atmospheric nuclear weapon test programme. Correspondence relating to these individuals was stimulated by TV and radio programmes and the Press. All such information will be made available to the Study team and will be surveyed alongside the population defined by the blue book. Anecdotal material and analyses based on another set of responses received by the BBC were published in the Lancet⁽¹⁾. This analysis covered 330 responses and was invited only from those involved in the South Pacific tests. Since these samples are small and they are entirely self-selected, there is a strong possibility for the introduction of bias. The likelihood of response from those who have suffered effects thought to be related to radiation exposure is greater than from those who have not suffered such effects. On the other hand, the samples may exclude some who have already died. Therefore they will be examined separately from the blue book sample.

4.3 Control Group

The Control Group will be approximately the same size as the Study Group, and will contain individuals who have characteristics similar to the individuals in the Study Group, except that they have not been involved in the programme. The individuals in the Control Group will be identified by MOD staff according to

criteria laid down by the Board. The principles for the identification of the Control Group are outlined below.

For the Royal Navy, for each ship known to have taken part in an operation, a similar ship that was serving in the tropics at the time of the operation will be identified. The ship's ledger will then be consulted for the names of individuals in the ship's crew and their Service records will be located using the same criteria for unique identification as is used for the Study Group. When a Service record is found, it will be scanned for evidence that the individual was involved in any part of the atmospheric nuclear weapon test programme and, if such evidence is found, the individual will not be included in the Control Group, although he will be noted for possible study at a later date.

For the Army, the Service records of soldiers are stored according to their Arm/Corps. The records for each Arm/Corps are stored according to year of discharge, and then within each year of discharge records are stored alphabetically according to the name of the individual. Many of these individuals would have been National Servicemen who served in the Army for a short period only, usually two or three years. For each soldier in the Study Group who was discharged alive, the Service records stored following his record will be searched, and the first record which corresponds to an individual with the same year of birth who was discharged alive, who is not in the Study Group and has not already been identified for the Control Group will be examined. The individual will be identified for the Control Group provided that his service included a posting in a tropical or desert area, and that his record contains no evidence that he was involved in any part of the atmospheric nuclear weapon test programme. If there is evidence of involvement in these operations the individual will not be included in the Control Group, although his name will be noted for possible study at a later date. For individuals in the Study Group whose names are towards the end of the alphabet the search will go back to the beginning of the alphabet for people within the Arm/Corps year-of-discharge group, if necessary.

For Army officers, the Service records are stored in Service number order. Adjacent Service numbers will, in most cases, indicate similar dates of entry to the Service. For each individual in the Study Group, the records stored following his record will be searched, and the first record corresponding to an officer from the same Arm/Corps will be examined. He will be selected for the Control Group provided that his service included a posting in a tropical or desert area, and that his record contains no evidence that he was involved in any part of the atmospheric nuclear weapon test programme. If there is evidence of involvement the individual's name will be noted for possible study at a later date.

RAF Service records are stored in Service number order and the procedure for selection of controls will be the same as that for Army officers.

As the Control Group for the Services is selected, its structure will be checked for similarity to the Study Group when the individuals are classified according to all the following characteristics simultaneously.

- (i) Service and, where appropriate, Arm/Corps or Branch
 - (ii) National Service/Regular Service
 - (iii) Rank
 - (iv) Nature of job carried out in the Service
 - (v) Date of enlistment
 - (vi) Date of birth

If the structure of the Control Group differs substantially from the structure of the Study Group, the Control Group will be adjusted to provide the appropriate content.

For civilian staff employed by AWRE, the Control Group will be selected from other AWRE employees at the time of the operations. The Control Group will be chosen to have a similar age distribution at the time of the tests, and have similar proportions of industrial/non-industrial and radiation/non-radiation workers, but would exclude any participants in tests.

5. DATA AND DATA HANDLING

5.1 Data to be collected

The Ministry of Defence have been requested to provide full names, date of birth and sex for each person that they can identify as having participated in part of the atmospheric nuclear weapon test programme. The same data are required for each member of the Control Group. This is the minimum information which will permit NHSCR staff to carry out their tracing procedure. Additional information that could help this procedure, includes town of birth, a dated address, doctor's name and address, or best of all, a National Health Service Number. A National Insurance Number is also useful. Preliminary discussions have concluded that it is unlikely that many of these additional pieces of information are available for the majority of the Study population.

The information that is desirable for the epidemiological aspects of the study is summarised in Table 4.

5.2 Data handling

It is important that the data stored on the computer is secure against accidental loss and against unauthorised access. Nevertheless, it must be easy for the Study team to interrogate and update the files. The data will be stored on the Board's computer, a VAX 11/780 from Digital Equipment Corporation. Powerful file protection facilities are available as a standard feature of the operating system. Nevertheless, extra security features have been implemented. These are used to protect the database for the National Registry for Radiation Workers⁽²⁾, and the same methods will be used for the present study.

The data will be stored with a single record for every individual. Each individual will have a unique Study number but it is expected that corrections to

the data will require the records to be accessed by name. The name field will thus be used as the primary key and the file will be sorted alphabetically on this field. If it proves desirable, alternative keys may be introduced.

To simplify access to the data, information will be stored in character form, usually in fixed length fields. This will mean that the data are stored less compactly than would otherwise be possible. However, the capacities of modern computer systems are such that this is a minor consideration by comparison with the advantages of simpler access to the data.

5.3 Coding on death notification

The period in which deaths of the Study population will have occurred extend across the 6th, 7th, 8th and 9th revisions of the International Classification of Diseases Codes. Some of the differences in these revisions affect the classification of malignancies. Provision will have to be made to permit the comparisons of malignancy rates with the national figures, and also within the Study population. This will be achieved by coding all the death certificates according to one of the revisions, either the 8th or the 9th revision to be agreed by the Coding Office of the Office of Population, Censuses and Surveys (OPCS). Death notification forms give primary cause of death and contributing causes. It is desirable to have all these coded and for the codes to be entered on the file.

6. METHODS OF ANALYSIS

The analysis will consist of three parts.

Firstly, the observed numbers of deaths in both Study and Control Groups will be compared with expected values based on national mortality rates^(3,4). These expected values will be calculated by multiplying the national rates by the person-years at risk in the Study subdivided into appropriate categories by age and calendar-year. It is unlikely that the numbers of observed deaths in either Study or Control Group will equal those expected according to the national rates. However, by appropriate sub-grouping, these comparisons will indicate the extent to which the mortality of the Study population has been influenced by factors such as the healthy worker effect through selection for employment and survival in the Services or at AWRE⁽⁵⁾. The results of these comparisons will provide a guide to the degree of subdivision necessary for the second part of the analysis on factors such as time since entering the Study. They should also provide a rough check on the appropriateness of the Control Group, for example, by highlighting any unusual mortality patterns.

Following the comparison based on national mortality rates, a second analysis will be carried out in which mortality rates in the Study Group are compared with those in the Control Group, after allowing for the influence of age, calendar-year, and factors identified in the first part of the analysis^(3,4,6). Initially, the Study Group as a whole will be considered, but

the analysis will be repeated with the group subdivided according to various other groupings. Further analyses will be made which are limited to those sections of the Study population for whom coverage is complete or virtually complete, see Section 4.2.

The third part of the analysis will be restricted to those members of the Study Group who wore personal dosimeters and whose dosimeters gave a reading above the minimum detectable threshold. In this analysis the observed death rates will be tested for evidence of a trend with increasing radiation exposure, after allowing for the influence of age, calendar-year and factors identified in the first part of the analysis^(4,6), see Section 4.2.

Because it is known that this Study does not have 100% coverage of the participants in the atmospheric nuclear weapon test programme, greatest weight will be given to the analysis of health effects among those sub-groups for which coverage is virtually complete (see Section 4.2). The main conclusions concerning association between effects and radiation will be based on the third part of the analysis.

The analyses will be carried out for all causes of death combined, all neoplasms, all solid malignant tumours, leukaemia, multiple myeloma, other lymphomas and, if there are sufficient numbers of deaths, other specific cancer sites. Lung cancer will be considered separately since it is expected to be the largest single contributor to the total number of deaths due to malignancies; however, interpretation of any findings will be difficult since it is likely that both the Study and the Control Group will contain large numbers of heavy smokers.

The methods of analysis for the information derived from the cancer registrations have not yet been decided. Such data present problems in interpretation and may not provide a reliable measure of differences between the Study and Control Groups. The data will, however, be inspected to determine how they might be used to derive further information relevant to the hypothesis that the Study Group was exposed to increased cancer risks.

7. TIMESCALE

7.1 Immediate objectives

In view of public concern, it is considered that this investigation should be completed as early as possible. This will be achieved by basing the Study on the population defined by the blue book. From the time all the information required from MOD has been received, it is estimated that a period of about 18 months will be required to carry out the flagging with NHSCR, data validation and the mortality analysis, assuming that NHSCR can devote adequate resources to their tracing procedures. Any analysis of information on cancer registrations will be undertaken following completion of the primary mortality study.

7.2 Longer-term possibilities

When the Study is complete recommendations will be made on the value of increasing the population covered. Consideration will also be given to using data compiled during the Study for purposes such as a more detailed look at the particular types of cancers involved. These could begin immediately the Study is complete. If it is decided to leave the Study population as an on-going study, that is collecting data on new deaths as they occur, then analyses will be carried out periodically.

8. ACKNOWLEDGEMENTS

The Study team would like to record their gratitude to Sir Richard Doll, Dr Michael Alderson, Prof John Fox and Mr Peter Smith for reading earlier drafts of this Protocol and for their constructive comments.

9. REFERENCES

1. Knox, E G, Sorahan, T and Stewart, A M, Letter to the editor: Cancer following nuclear weapon tests. *Lancet*, 1, No 8328, 815 (1983).
2. Darby, S C (editor), Protocol for the National Registry for Radiation Workers. Harwell, NRPB-R116 (1981) (London, HMSO).
3. Berry, G, The analysis of mortality by the subject-years method. *Biometrics*, 39, 173 (1983).
4. Darby, S C and Reissland, J A, Low levels of ionizing radiation and cancer - are we underestimating the risks? *J. R. Stat. Soc.*, A114, 298 (1981).
5. Fox, A J and Collier, P F, Low mortality rates in industrial cohort studies due to selection for work and survival in the industry. *Br. J. Prev. Soc. Med.*, 30, 225 (1976).
6. Darby, S C and Reissland, J A, Exposure to ionising radiation and cancer mortality among workers at the Hanford Plant. IN Quantification of Occupational Cancer. Cold Spring Harbor Laboratory, Banbury Report 9 (1981).

Table 1

UK nuclear weapon tests in Australia

and the South Pacific, October 1952 - September 1958

Operation	Type*	Date of firing	Yield**	Site
Hurricane 1	S	3 October 1952	K	Monte Bello Islands, (Lagoon) Western Australia
Totem	1 T	14 October 1953	K	Emu Field, South Australia
	2 T	26 October 1953	K	Emu Field, South Australia
Mosaic	1 T	16 May 1956	K	Monte Bello Islands, (Trimouille Island) Western Australia
	2 T	19 June 1956	K	Monte Bello Islands, (Alpha Island) Western Australia
Buffalo	1 T	27 September 1956	K	Maralinga, (One Tree) South Australia
	2 S	4 October 1956	L	Maralinga (Marcoo), South Australia
	3 A	11 October 1956	L	Maralinga (Kite), South Australia
	4 T	21 October 1956	K	Maralinga (Breakaway), South Australia
Grapple	1 A	15 May 1957	M	Off Malden Island, South Pacific
	2 A	31 May 1957	M	Off Malden Island, South Pacific
	3 A	19 June 1957	M	Off Malden Island, South Pacific
Antler	1 T	14 September 1957	K	Maralinga (Tadje), South Australia
	2 AB	25 September 1957	K	Maralinga (Biak), South Australia
	3 A	9 October 1957	K	Maralinga (Taranaki), South Australia
Grapple X	A	8 November 1957	M	Christmas Island, South Pacific
Grapple Y	A	28 April 1958	M	Christmas Island, South Pacific
Grapple Z	1 AB	22 August 1958	K	Christmas Island, South Pacific
	2 A	2 September 1958	M	Christmas Island, South Pacific
	3 A	11 September 1958	M	Christmas Island, South Pacific
	4 AB	23 September 1958	K	Christmas Island, South Pacific

* S: Surface detonation at sea or ground level
 T: Near-surface detonation on a tower, at about 30 m above ground level
 A: Airburst, of device dropped by aircraft
 AB: Airburst, of device borne by a tethered balloon system

**L: Low-yield range (1-20 kt)
 K: Kiloton-yield range (1-1000 kt)
 M: Megaton-yield range (a few hundred kt to several Mt)

Table 2

Maralinga experimental programme

Months are shown for operations in each year

Operation	1955	1956	1957	1958	1959	1960	1961	1963	1964	1967
Kittens	4-6	3	3-7		4-5		5			
Tims	7		3-7 9-11	4-7 9-11	5-11	4-10	8-12	3-4		
Rats				4-7 10-11	3-7	9-11				
Vixen A					6-8	5-8	3-4			
Vixen B						7-10	3-6 9-11	4-5		
Ayres						2-3				
Ayres 2								3		
Hercules									8-11	
Brumby										3-6

Table 3

The information included wherever practicable
in the blue book

- (1) Name - Surname followed by initials of forenames
- (2) Employer, ie, Civil or Service
- (3) Grade or Rank; Staff, Service or Personnel Number; and Regiment for Army Personnel
- (4) Nationality
- (5) The name of the operation(s) in which the person was involved
- (6) The organisational group(s) in which the person worked during the operation
- (7) Dates on which the person arrived at and left the site of the operation
- (8) Details of personal radiation exposure
- (9) The sources from which the information was obtained

Table 4

Information to be assembled for study of personnel involved
in UK atmospheric nuclear weapon test programme

1. Service Personnel - Study Group
 1. Surname
 2. Forenames (initials if these are unavailable)
 3. Previous surname)
 4. Previous forenames) if any
 5. Service Number
 6. Service: eg. Royal Navy/Royal Marines/Army/Royal Air Force
 7. National Service or Regular
 8. Rank at the time of test: Officer/Serviceman
 9. Role in Service: Officer: Specialisation or Arm/Corps
Servicemen: Branch, Arm/Corps or Trade
 10. Date of enlistment
 11. Date of discharge
 12. Vital status at discharge: dead/alive
 13. Date of birth
 14. Place of birth (Town and Country)
 15. Nationality
 16. Last recorded civilian address and date of currency
 17. National Insurance Number
 18. National Registration Number/National Health Service Number
 19. Serial number(s) of entries in blue book corresponding to this individual
 20. Confirmation of blue book data from Service records

2. Service Personnel - Control Group

- A Army/Royal Air Force: (i) serial number of individual in Study Group for whom this person is a control
(ii) overseas posting on which control group selection is based: place and dates

Royal Navy/Royal Marines: name, initial, Service, rank, Service number, ship and dates. (Provided from ship's ledger)

B Items 1 - 18 as for Study Group

C Confirmation of no evidence of involvement in atmospheric nuclear weapon test programme from Service record

3. Civilian Personnel - Study Group

1. Surname
2. Forenames
3. Previous surname)
4. Previous forenames) if any
5. Superannuation or other unique number
6. Serial numbers of entries in blue book corresponding to this man
7. Employer
8. Industrial/non-industrial
9. Radiation/non-radiation worker
10. Date of commencement of his employment
11. Last date of leaving if not employed on 31.12.83
12. Date of birth
13. Place of birth
14. Nationality
15. Last recorded address and date
16. National Insurance Number
17. National Registration Number/National Health Service Number
18. For radiation workers; annual dose history

4. Civilian Personnel - Control Group

As for Study Group, but with 6 omitted.



- R95 The Effects of Actinide Separation on the Radiological Consequences of Geologic Disposal of High-Level Waste. M. D. Hill et al. ISBN 0 85951 122 7 Price £1.50
- R97 A Methodology for the Evaluation of the Collective Dose from Radioactivity in Terrestrial Food Chains. J. R. Simmonds and G. S. Linsley. ISBN 0 85951 124 3 Price £1.00
- R98 The Consequences of a Reduction in the Administratively Applied Maximum Annual Dose Equivalent Level for an Individual in a Group of Occupationally Exposed Workers. N. T. Harrison. ISBN 0 85951 125 1 Price £3.00
- R99 The NRPB Nuclear Emulsion Dosimeter. D. T. Bartlett et al. ISBN 0 85951 127 8. Price £2.00
- R100 The Radiological Consequences of Notional Accidental Releases of Radioactivity from Fast Breeder Reactors: The Influence of the Meteorological Conditions. C. R. Hemming et al. ISBN 0 85951 128 6. Price £3.00
- R101 FSCLOUD: A Computer Program to Calculate the Air Concentration, Deposition Rate and External Dose Rate from a Continuous Discharge of Radioactive Material to Atmosphere. J. A. Jones. ISBN 0 85951 132 4. Price £3.00
- R102 Calculation of the Incidence of Stochastic Health Effects in Irradiated Populations. R. H. Clarke and H. Smith. ISBN 0 85951 133 2. Price £2.00
- R103 An Evaluation of the Eastman Kodak Type 2 Film. T. O. Marshall et al. ISBN 0 85951 134 0. Price £2.00
- R104 A Frequency Survey of Radiological Examinations Carried Out in National Health Service Hospitals in Great Britain in 1977 for Diagnostic Purposes. G. M. Kendall et al. ISBN 0 85951 135 9. Price £3.00
- R105 Current Levels of Gonadal Irradiation from a Selection of Routine Diagnostic X-ray Examinations in Great Britain. B. F. Wall et al. ISBN 0 85951 136 7. Price £3.00
- R106 The Genetically Significant Dose from Diagnostic Radiology in Great Britain in 1977. S. C. Darby et al. ISBN 0 85951 137 5. Price: £3.00
- R108 An Assessment of the Radiological Consequences of Disposal of High-Level Waste in Coastal Geologic Formations. M. D. Hill et al. ISBN 0 85951 139 1. Price £4.00
- R109 A Model to Calculate Exposure from Radioactive Discharges into the Coastal Waters of Northern Europe. M. J. Clark et al. ISBN 0 85951 140 5. Price £3.00
- R110 The Development of Models for the Transfer of ^{137}Cs and ^{90}Sr in the Pasture-Cow-Milk Pathway using Fallout Data. S. M. Haywood et al. ISBN 0 85951 141 3. Price £3.00
- R111 Emergency Exposure Levels for Natural Uranium. N. L. Spoor and N. T. Harrison. ISBN 0 85951 142 1. Price £2.00
- R113 Statistical Aspects of the Interpretation of Counting Experiments Designed to Detect Low Levels of Radioactivity. T. J. Sumerling and S. C. Darby. ISBN 0 85951 148 0. Price £3.00
- R114 Radiation Exposure from the Normal Movement of Irradiated Fuel Elements by Road and Rail from Magnox Power Stations. S. A. Beach and J. H. Mairs. ISBN 0 85951 149 9 Price £2.00
- R116 Protocol for the National Registry for Radiation Workers. S. C. Darby (editor). ISBN 0 85951 151 0 Price £2.00
- R118 The Radiation Exposure of the UK Population from Airborne Effluents Discharged from Civil Nuclear Installations in the UK in 1978. G. N. Kelly et al. ISBN 0 85951 156 1 Price £4.00
- R119 The Radiation Exposure of the UK Population from Liquid Effluents Discharged from Civil Nuclear Installations in the UK in 1978. W. C. Camplin et al. ISBN 0 85951 157 X Price £4.00
- R120 Optimisation of the Radiological Protection of the Public. M. J. Clark et al. ISBN 0 85951 158 8 Price £3.00
- R122 The Second Report of a Working Group on Atmospheric Dispersion: A Procedure to Include Deposition in the Model for Short and Medium Range Atmospheric Dispersion of Radionuclides. J. A. Jones - Secretary of the Working Group. ISBN 0 85951 162 6 Price £2.00
- R123 The Third Report of a Working Group on Atmospheric Dispersion: The Estimation of Long Range Dispersion and Deposition of Continuous Releases of Radionuclides to Atmosphere. J. A. Jones - Secretary of the Working Group. ISBN 0 85951 163 4 Price £2.00
- R124 The Fourth Report of a Working Group on Atmospheric Dispersion: A Model for Long Range Atmospheric Dispersion of Radionuclides Released over a Short Period. J. A. Jones - Secretary of the Working Group. ISBN 0 85951 164 2 Price £2.00
- R126 An Assessment of the Radiological Consequences of Disposal of Intermediate Level Wastes in Argillaceous Rock Formations. M. D. Hill et al. ISBN 0 85951 166 9 Price £3.00
- R127 MARC - The NRPB Methodology for Assessing Radiological Consequences of Accidental Releases of Activity. R. H. Clarke et al. ISBN 0 85951 167 7 Price £2.00
- R129 Gut Uptake Factors for Plutonium, Americium and Curium. J. D. Harrison. ISBN 0 85951 172 3 Price £2.00
- R130 Assessment of Intakes of Radionuclides: A Summary of Investigations, 1975-1980. F. A. Fry. ISBN 0 85951 173 1 Price £2.00
- R131 Radiation Hazards to Collectors of Geological Specimens Containing Natural Radioactivity. D. W. Dixon. ISBN 0 85951 174 X Price £2.00
- R132 Evaluating Future Detriment from Radioactive Discharges: Judgement and Implications for Optimisation of Protection. A. B. Fleishman et al. ISBN 0 85951 175 8 Price £3.00
- R133 Accidental Releases of Radionuclides: A Preliminary Study of the Consequences of Land Contamination. J. R. Simmonds et al. ISBN 0 85951 176 6 Price £4.00
- R134 Environmental Radioactivity Surveillance Programme: Results for the UK for 1981. F. A. Fry et al. ISBN 0 85951 181 2 Price £3.00
- R135 An Assessment of the Radiological Impact of the Windscale Reactor Fire, October 1957. M. J. Crick et al. ISBN 0 85951 182 0 Price £3.00

National Radiological Protection Board

Some Technical Reports Currently Available from HMSO, PO Box 276, London SW8 5DT

Prices as indicated

- | | |
|---|--|
| <p>R18 Measurement of Activity of Surfaces Contaminated by Electron-capture Nuclides. W. J. Iles and D. F. White. ISBN 0 85951 016 6. Price £0.50</p> <p>R22 Determination of the Rates of Clearance of Insoluble Compounds of Plutonium from the Lung. L. Watts. ISBN 0 85951 020 4. Price £0.50</p> <p>R29 Radiological Problems in the Protection of Persons Exposed to Plutonium. G. W. Dolphin et al. ISBN 0 85951 028 X. Price £0.50</p> <p>R39 Radon and its Daughters in Various British Mines. J. C. Strong et al. ISBN 0 85951 037 9. Price £0.50</p> <p>R42 Radiological Protection Tests for Products which can Lead to Exposure of the Public to Ionising Radiation. M. D. Hill et al. ISBN 0 85951 040 9. Price £0.50</p> <p>R44 Concentration of Actinides in the Food Chain. R. A. Bulman. ISBN 0 85951 042 5. Price £0.50</p> <p>R52 Human Exposure to Radiation Following the Release of Radioactivity from a Reactor Accident: A Quantitative Assessment of the Biological Consequences. H. Smith and J. W. Stather. ISBN 0 85951 050 6. Price £0.50</p> <p>R53 An Estimate of the Radiological Consequences of Notional Accidental Releases of Radioactivity from a Fast Breeder Reactor. G. N. Kelly et al. ISBN 0 85951 051 4. Price £3.50</p> <p>R59 The Use of EDTA and DTPA for Accelerating the Removal of Deposited Transuranic Elements from Humans. N. L. Spoor. ISBN 0 85951 057 3. Price £1.50</p> <p>R60 Measurement of Activity of Surfaces Contaminated by Beta-emitting Nuclides and ⁵⁹Fe. W. J. Iles et al. ISBN 0 85951 058 1. Price £0.50</p> <p>R62 Insignificant Levels of Dose: A Practical Suggestion for Decision Making. G. A. M. Webb and A. S. McLean. ISBN 0 85951 062 X. Price £1.00</p> <p>R64 Technical Specification of the NRPB Thermoluminescent Dosimeter Used for the Measurement of Body Dose and Skin Dose. K. B. Shaw and T. O. Marshall. ISBN 0 85951 065 4. Price £1.00</p> <p>R65 Performance Tests on the NRPB Thermoluminescent Dosimeter. K. B. Shaw and B. F. Wall. ISBN 0 85951 066 2. Price £1.00</p> <p>R71 Environmental Radiation Protection Standards: an Appreciation. L. D. G. Richings et al. ISBN 0 85951 086 7. Price £1.00</p> <p>R72 A Limited Survey and Evaluation of Ultraviolet Radiation Hazards in University Laboratories. A. F. McKinlay et al. ISBN 0 85951 089 1. Price £1.00</p> <p>R73 The Influence of the Physico-chemical Form of the Aerosol on the Radiological Consequences of Notional Accidental Releases of Radioactivity from a Fast Breeder Reactor. G. N. Kelly et al. ISBN 0 85951 082 4. Price £3.00</p> <p>R74 The Variation of Organ Doses with the Particle Size and Chemical Form of an Inhaled Radioactive Aerosol. B. W. Hunt et al. ISBN 0 85951 083 2. Price £2.50</p> | <p>R75 Resuspension of the Transuranium Elements - A Review of Existing Data. G. S. Linsley. ISBN 0 85951 090 5. Price £1.00</p> <p>R77 Radiation Exposure of the UK Population. F. E. Taylor and G. A. M. Webb. ISBN 0 85951 092 1. Price £2.50</p> <p>R78 A Calculation of Neutron Cross-sections for the Elements Hydrogen, Carbon, Nitrogen and Oxygen in the Energy Range 20-50 MeV. P. J. Dimbylow. ISBN 0 85951 090 5. Price £2.00</p> <p>R79 An Assessment of the Mancuso Study. J. A. Reissland. ISBN 0 85951 094 8. Price £1.00</p> <p>R80 Technical Specification of the NRPB Nuclear Emulsion Dosimeter. D. T. Bartlett and T. V. Bird. ISBN 0 85951 095 6. Price £1.00</p> <p>R81 An Evaluation of the Foodchain Pathway for Transuranium Elements Dispersed in Soils. G. S. Linsley et al. ISBN 0 85951 096 4. Price £1.50</p> <p>R82 Annual Limits of Intake of Radionuclides for Workers. N. Adams et al. ISBN 0 85951 097 2. Price £1.50</p> <p>R85 The Radiological Testing of Consumer Products: 1976-78. B. T. Wilkins and D. W. Dixon. ISBN 0 85951 105 7. Price £1.00</p> <p>R86 Analysis of the Effect of Variations in Parameter Values on the Predicted Radiological Consequences of Geological Disposal of High-Level Waste. M. D. Hill. ISBN 0 85951 106 5. Price £2.00</p> <p>R87 The Radiological Consequences of Notional Accidental Releases of Radioactivity from Fast Breeder Reactors: Sensitivity to the Dose-Effect Relationships Adopted for Early Biological Effects. G. N. Kelly et al. ISBN 0 85951 110 3. Price £2.00</p> <p>R88 The Radiological Consequences of Notional Accidental Releases of Radioactivity from Fast Breeder Reactors: Sensitivity to the Choice of Atmospheric Dispersion Model. J. A. Jones. ISBN 0 85951 111 1. Price £1.50</p> <p>R89 A General Model for the Transfer of Radioactive Materials in Terrestrial Food Chains. J. R. Simmonds et al. ISBN 0 85951 112 X. Price £1.50</p> <p>R91 A Model for Short and Medium Range Dispersion of Radionuclides as Released to the Atmosphere. R. H. Clarke - Chairman of the Working Group. ISBN 0 85951 117 0. Price £2.00</p> <p>R92 A Calculation of the Photon Depth-dose Distributions in the ICRU Sphere for a Broad Parallel Beam, a Point Source and an Isotropic Field. P. J. Dimbylow and T. M. Francis. ISBN 0 85951 118 9. Price £1.50</p> <p>R93 The Radiological Consequences of Notional Accidental Releases of Radioactivity from Fast Breeder Reactors: Sensitivity of the Incidence of Early Effects to the Duration of the Release. C. R. Hemming et al. ISBN 0 85951 119 7. Price £1.50</p> <p>R94 The Effects of Actinide Separation on the Radiological Consequences of Disposal of High-Level Radioactive Waste on the Ocean Bed. W. C. Camplin et al. ISBN 0 85951 121 9. Price £1.50</p> |
|---|--|

Continued inside