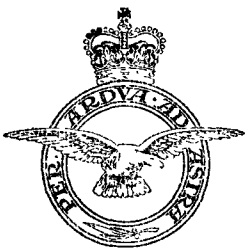
AIR PUBLICATION

4687A

VOLUME 2



ROYAL AIR FORCE

RADIATION SAFETY

IONIZING AND

NON-IONIZING RADIATION

ORDERS AND INSTRUCTIONS

MINISTRY OF DEFENCE

March 1966

AIR PUBLICATION
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ROYAL AIR FORCE

RADIATION SAFETY

IONIZING AND
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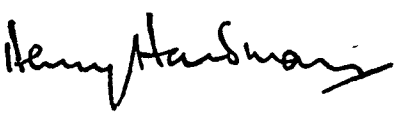
ORDERS AND INSTRUCTIONS

By Command of the Defence Council



MINISTRY OF DEFENCE
March 1966

(AL 15, May 76)

NOTE TO READERS

The subject matter of this publication may be affected by Defence Council Instructions (Royal Air Force) or "General Orders and Modifications" leaflets in the associated publications listed below or even in some others. If possible, Amendment Lists are issued to correct this publication accordingly, but it is not always practical to do so. When an Instruction or leaflet contradicts any portion of this publication, the Instruction or leaflet is to be taken as the overriding authority.

The inclusion of reference to items of equipment does not constitute authority for demanding the items.

LIST OF ASSOCIATED PUBLICATIONS AND DIAGRAMS

	Publication
Radiation Safety – Hazards from Ionizing Radiation and Principles of Protection	AP110A-0601-1
Radiac Sources, Containers and Calibration Jigs	AP112T-0165-0
Radiation Monitor Type 1320X	AP112G-1302-0(R)
Radiation Monitor Type 0030	AP112G-1303-0(R)
Radiation Monitor Type 1257C	AP112G-1305-0(R)
Radiation Monitor Type 1650A	AP112G-1306-0(R)
Radiation Dosimeters and Charging Units	AP112G-1307-123A5F6
Meter Doserate Portable Trainer No 1	AP112G-1308-0(R)
Meter Survey Radiac No 2	AP112G-1309-0(R)
Meter Survey Radiac No 3 and 4	AP112G-1310-0(R)
Meter Contamination No 1	AP112G-1311-0(R)
Monitor Air Sampling Type L10B	AP112G-1312-0(R)
Radiation Monitor Type NIS 322XA	AP112G-1313-0(R)
Radiation Monitor Type NIS 295B	AP112G-1314-0(R)
Radiation Monitor Type 617	AP112G-1315-0
Royal Air Force Special Safety Organization	AP110A-0103-1
The Nuclear Handbook for Instructors and Staff Officers	AP3321
Radiation Safety Air Diagrams	AD
Full Protective Clothing – Dressing and Undressing Sequences	8021A
Contaminated Crash/Fire Protective Clothing, Undressing Sequence	8021B
Radiation Detectors – Principles of Operation	8022
Monitor Type 1257C	8022B
Monitor Type 1320X	112G-1302-DI(R)
Dosimeter Quartz Fibre and Ancillary Equipment	112G-1307-DI
Monitor, Radiac Survey Meter No 2	112G-1309-0(R)
Monitor Type 1650A	8022J

PREFACE

1. AP 4687A, Volume 2 gives orders and instructions to Royal Air Force personnel responsible for the control and supervision of work involving ionizing and non-ionizing radiation. It should be read in conjunction with AP 110A-0601-1 which gives information on the hazards from radiation and the principles of protection.

2. At the top of each leaflet is shown the authority and date of issue.

LIST OF SECTIONS AND PRELIMINARY MATTER

PRELIMINARIES

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NON-IONIZING RADIATION – ORDERS AND INSTRUCTIONS

PART 1

RADIATION SAFETY

ORGANIZATION AND ADMINISTRATION

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DEFINITIONS, EXEMPTIONS AND AUTHORIZATIONS

SECTION A

DEFINITIONS, EXEMPTIONS AND AUTHORIZATIONS

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DEFINITIONS AND EXEMPTIONS

(AF/CX 384/74 MA4a(RAF) MAY 1976)

Introduction

1. This volume contains the basic safety regulations controlling the use in the Royal Air Force of any source of radiation in such circumstances that it presents a potential human hazard.

Sources of Radiation

2. The term "Sources of Radiation" includes any source of ionizing or non-ionizing radiation as radio frequency radiation (RF), microwave radiation employed as in microwave ovens, or laser radiation.

Ionizing Radiation

3. There are 2 principal groups of ionizing radiation sources in the Royal Air Force, radioactive substances and electronic apparatus (including X-ray equipment).

4. **Radioactive Substances.** A radioactive substance for the purpose of this air publication is one that contains or consists of any natural or artificial radioactive chemical element whose specific activity exceeds 0·002 of a microcurie of parent radioactive chemical element per gram of substance.

5. **Radioactive Sources.** A radioactive source is a quantity of radioactive substance used as a source of ionizing radiations. Sources may be sealed or unsealed. A sealed source is any radioactive substance sealed in a container (otherwise than solely for the purpose of storage, transport or disposal) or bonded wholly within a solid substance and includes the immediate container or the bonding. An unsealed source is any radioactive substance that is not a sealed source.

6. Radioactive sources coming within the terms of these instructions are classified as:

a. **Primary Sources.** These are sources that provide ionizing radiation for specific purposes. They may be associated with specific items of equipment for servicing purposes, but are not essential to the functioning of the equipment. Examples are sources used for industrial radiography, Nuclear, Biological and Chemical (NBC) defence training, and most sources used for checking radiac instruments.

b. **Demountable Sources.** These are sources that are associated with specific items of equipment and are essential to their function. They may be removed from the equipment during servicing or when it is not in use. Certain atmospheric ionization detection instruments incorporate this type of source.

c. **Integral Sources.** Like demountable sources, these sources are necessary for the functioning of specific items of equipment, but they are incorporated in the equipment during manufacture and not normally removed during servicing; however, they may be exposed and act as unsealed sources in an accident or during major servicing, repair, or modification of the parent equipment. Examples are priming sources in electronic valves and fire detectors, priming and check sources found in some radiac instruments, and radioactive luminizing in luminous markers, watches, clocks and other instruments used in aircraft, land vehicles, marine craft *etc.*

d. **Radioactive Materials.** These include certain luminizing materials, paints containing radioactive substances, and quantities of other radioactive elements, compounds, solutions, and mixtures that are indeterminate in amount and physical shape and size.

7. **Contaminated Articles.** Under certain circumstances, a wide variety of items may become contaminated with radioactive material, *eg* airframe surfaces, engine components, working clothing, *etc.* These items are invariably to be treated as radioactive sources, although they are not used as sources of ionizing radiations; however, they are not to be recorded in the registers of sources referred to in Leaflet B1. Other leaflets in this volume contain detailed instructions concerning specific items in this category.

8. **Electronic Sources.** Ionizing radiations are produced by any apparatus in which charged particles are accelerated through potentials greater than 5 kilovolts. These sources may be divided into 2 groups:

a. *Primary,* where there is a controlled deliberate release of x-radiation, *eg* medical, dental, scientific or industrial radiography apparatus; and

b. *Secondary,* where there is an incidental production of x-radiation, suitable screening normally preventing its release, *eg* radar sets, klystrons, *etc.*

Radio Frequency Radiation

9. Radio frequency radiation consists of electromagnetic waves in the frequency range 3 KHz to 3000 GHz propagated in space without artificial guide. The term microwaves is sometimes used synonymously with radio frequency as in the instance where this type of radiant energy at about 2·45 GHz is used for the rapid heating of food in a microwave oven.

Laser Radiation

10. Laser radiation is coherent electromagnetic radiation of wavelength about 0·2 to 340 micrometers ($\mu m = 10^{-6} m$). This spectral band includes the visible radiation wavelengths as well as part of those of ultra-violet and infra-red radiation as shown below:

Radiation	**Wavelength**
ultra-violet	0·2–0·4 μm
visible	0·2–0·7 μm
near infra-red	0·7–1·4 μm
infra-red	greater than 1·4 μm

Characteristically lasers produce beams of small cross-section and high energy intensity. The radiation from a laser is monochromatic and particular to that laser system. The radiation output may be continuous or pulsed, the durations of the latter being from a few nanoseconds ($ns = 10^{-9} s$) to a few milliseconds ($ms = 10^{-3} s$). Laser radiation may be absorbed, reflected or refracted by a medium. When absorbed, its energy is converted to heat.

Exemptions – Ionizing Radiation

11. **Nuclear Weapon Components and Assemblies.** Nuclear weapon components and assemblies may in certain circumstances be exempt from the provisions of these instructions. Such exemption is valid only when the provisions of these instructions conflict with, or are rendered redundant by, weapon clearances, approved servicing schedules or the nuclear weapon regulations.

12. **Television Apparatus.** Any apparatus intended only for the purpose of receiving visual images sent by television is exempt as follows:

a. When operated at a voltage of not more than 20 kilovolts in the course of its manufacture, repair, maintenance or testing; or

b. In any other circumstances, when the dose rate at or near the surface of the apparatus does not exceed 0·5 millirems per hour.

13. There are certain other partial or complete exemptions from these regulations for specific sources. Details of these exemptions will be found in the appropriate leaflets.

AUTHORIZATION OF THE USE OF SOURCES OF RADIATION AND WORKING PROCEDURES INVOLVING RADIATION

(AF/CX 384/74/MA4a(RAF) MAY 1976)

IONIZING RADIATION

1. No source of radiation or working procedure involving the use of sources of radiation may be introduced into use in the Royal Air Force, or any significant change effected in the use of an existing source or procedure, without the approval of the Royal Air Force Radiation Health and Safety Committee. (*see* Leaflet B1).

2. Any sponsoring branch considering the initial or significantly modified use of such a source or a procedure that will incidentally produce a radiation hazard or modify an existing hazard (*eg* a new aircraft surface cleaning technique) is to give adequate notice of intent to the Committee.

3. Sponsoring branches are responsible for preparing and publishing the relevant safety instructions, including disposal details when these are necessary. These instructions are to be approved by Ministry of Defence (MA4a(RAF)) before the source or procedure is used. These branches are also responsible for notifying any appropriate Government department (*eg* The Department of the Environment) and obtaining any necessary authorization.

4. The sponsoring branch invariably is to submit a formal application to the Committee when the safety instructions have been approved. The committee monitors current working procedures and the continuing use of sources, and may withdraw its approval at any time. Such a decision will be notified to the sponsoring branch for any necessary action.

5. **Medical Use of Radionuclides.** The use of any radionuclide for diagnostic or therapeutic purposes requires the prior approval of the Medical Research Council. This is invariably to be obtained before formal application is made to the Committee, as well as action being taken in accordance with para 1–4.

Exemptions

6. **Secondary Electronic Sources.** The introduction or modified use of these sources does not require formal approval by the Committee. However, sponsoring branches are to take the action detailed in para 3.

NON-IONIZING RADIATION

7. When sources of non-ionizing radiation, *ie* sources of radio-frequency or laser radiation, or working procedures involving such radiations are introduced into the Royal Air Force, or when such existing involvement with non-ionizing radiation is significantly modified the sponsor branch concerned is to give adequate notice of intent to the MOD(RAF) Radiation Health and Safety Committee. Sponsor branches are also responsible for notifying the appropriate Government departments and for obtaining any necessary authorization.

8. Sponsor branches are responsible for preparing and publishing the relevant safety instructions; these instructions are to be approved by MOD MA4a(RAF) before the source of radiation or procedure is brought into use.

SECTION B

RESPONSIBILITIES AND APPOINTMENTS

SECTION B

RESPONSIBILITIES AND APPOINTMENTS

CONTENTS LIST

RESPONSIBILITIES AND APPOINTMENTS - SOURCES OF RADIATION

(AF/CX 384/74 MA4a(RAF) MAY 1976)

Introduction

1. The Royal Air Force is becoming increasingly involved in the use of sources of radiation *ie* ionizing radiation and non-ionizing radiation as radio-frequency radiation, microwaves and laser radiation; each of these sources of radiation is potentially harmful. This publication is concerned with the necessary safety regulations and also with programmes of medical surveillance of those persons who might be exposed to such radiant energy; more general and descriptive information on sources of ionizing radiation is contained in AP 110A-0601-1.

2. It is neither practicable nor desirable to legislate in this volume for every possible situation and these essentially basic instructions should be supplemented where necessary by the appropriate service technical publication or authorized civil code of practice or guide. Local orders and instructions are to be initially approved and regularly checked thereafter by a qualified radiation safety officer (RSO) and also, where appropriate, by the specialist officer concerned.

Civil Legislation

3. **Health and Safety at Work etc Act 1974.** The Health and Safety at Work *etc* Act 1974 makes provision for securing the health, safety and welfare of persons at work, protects others against risks to health and safety in connection with the activities of persons at work and controls the keeping and use of dangerous substances; the Act applies to the Crown and to persons in the public service of the Crown unless specifically exempted by the Secretary of State.

4. **Ionizing Radiation.** The Radioactive Substances Act 1960 governs the storage, use and disposal of radioactive material in the United Kingdom; it is also the authority for many associated statutory regulations. The Crown is exempt from the provisions of this Act; however, the MOD(AFD) implements the spirit of it and the ionizing radiation regulations and instructions in this volume conform to its essential requirements.

5. Detailed regulations for the supervision of civilian workers who are occupationally exposed to ionizing radiations are contained in the Ionizing Radiations (Sealed Sources) Regulations 1969 and the Ionizing Radiations (Unsealed Radioactive Substances) Regulations 1968. These regulations derive their authority from the Factories Act 1961, which applies to Crown premises. The relevant instructions in this volume are compatible with the equivalent detailed statutory instructions.

6. **Radio-Frequency Radiation.** Safety regulations for the protection of personnel against the effects of RF radiation are contained in the HMSO Publication 1960 (Safety Precautions Relating to Intense Radio-Frequency Radiation), and the Mintech Intense Radio Frequency Radiation Code of Practice (1968 Edition). These Codes of Practice, which were adopted for mandatory use throughout the Royal Air Force in 1960 and 1968 respectively, are to remain in force until further notice.

7. The Codes of Practice deal with RF radiation hazards to personnel at frequencies above 30 MHz and quote the nationally accepted standard of $100W/m^2$ as a maximum permissible RF power density for continuous daily whole body exposure at these frequencies. Very high powered emissions at frequencies below 30 MHz can also be injurious to health but, because of the difficulty of measuring RF power density at these lower frequencies, the Medical Research Council has advised that an electric field strength of 1000 volts/metre is a permissible safe limit for whole body exposure at frequencies below 30 MHz. This limit has been accepted by the Director of Health and Research (RAF) for application within the Royal Air Force.

8. **Lasers.** This AP contains instructions for the protection and medical surveillance of personnel who might be exposed to laser radiation; additional information on this subject is contained in the British Standards Institution publication, Guide on the Protection of Personnel Against Hazards from Laser Radiation, BS 4083:1972. This BSI is under review.

ADMINISTRATIVE RESPONSIBILITIES

Ministry of Defence (Air Force Department)

9. **General Responsibilities.** The Director of Health and Research (RAF) is responsible to the Director General of Medical Services (RAF) for the co-ordination of all aspects of peace-time radiation health and safety; this responsibility covers ionizing radiation and non-ionizing radiation including laser radiation. DHR(RAF) has no responsibility for matters relating to the electromagnetic compatibility of materials.

10. DHR(RAF) will give advice and assistance to branches sponsoring the use of particular sources of radiation and will define the necessary radiation safety criteria. In particular DHR(RAF) will:

a. Sponsor programmes of medical research into ionizing, non-ionizing and laser radiation.

b. Sponsor programmes of medical surveillance of personnel who may be exposed to any such radiations.

c. Sponsor training programmes in radiation safety for medical officers, radiation safety officers and other personnel nominated by MOD.

11. Responsibility for nuclear defence planning, training and wartime safety levels and some instrumentation belongs to the Director of Ground Defence (DGD) (RAF) who also shares responsibility for the Special Safety Organization with the Director of Operations (Strike) (D of Ops(S)) (RAF). The Director of Weapon and Support Engineering (RAF), DWSE(RAF) is responsible for some aspects of instrumentation and other Directorates have responsibilities as sponsors or handlers of equipment using or producing ionizing or non-ionizing radiation.

12. **The Royal Air Force Radiation Health and Safety Committee.** The approving and advisory authority for all human aspects of radiation health and safety is the Royal Air Force Radiation Health and Safety Committee under the chairmanship of DHR(RAF).

13. All proposals for the introduction of sources of potentially harmful radiations, or the significantly modified use of exisiting sources, are to be submitted to the Committee for consideration. The Committee's recommendations will be implemented through its members, who represent branches that have administrative responsibility for the use of potentially harmful radiations. All matters for the attention of the Committee are to be forwarded through the appropriate staff channels to MOD (MA4a(RAF)).

14. **Branch Responsibilities.** Branches sponsoring the use or service involvement with sources of radiation are responsible for issuing appropriate radiation safety instructions and for ensuring that personnel are adequately trained in radiation safety matters. Such branches will also ensure that details of the hazard, together with safety precautions necessary to meet the particular safety criteria contained in this AP, are included in the servicing policy documents for each equipment – and also in the training syllabi for servicing and operating personnel. These radiation instructions are to be approved by DHR(RAF) and the publications concerned are to be listed in this AP and are to contain suitable cross reference.

15. Branches sponsoring the development of equipment employing or producing radiation, and this applies particularly to equipment employing a laser, are responsible for:

a. The concurrent appraisal of risks of injury to personnel involved in inspection, maintenance, operation and development of the equipment, or to any other personnel not so involved, being included in the development contract.

b. The parallel development of safety precautions and safety equipment.

c. The incorporation of these precautions in manuals and publications, and the training syllabi for maintenance and operating personnel.

RAF Institute of Aviation Medicine

16. On behalf of DHR(RAF), the RAF Institute of Aviation Medicine is responsible for conducting research into the biological effects of laser radiation and for giving advice to MOD and others on matters relating to laser safety.

17. In particular it will:

a. Conduct research to determine safe exposure levels for use with laser equipments under development and in-service.

b. Provide assistance to commanders investigating reports of over-exposure of personnel to laser radiation.

c. Arrange for the medical examination of all personnel thought to be victims of accidental laser over-exposure.

d. Maintain records of clinical data collected during investigations of reported over-exposure of personnel to laser radiation.

Consultant in Radiobiology

18. The consultant radiobiologists are medical officers with academic qualifications and practical experience in the assessment of risks from exposures to radiations. They are to co-operate with medical and non-medical specialists in the prevention of radiation hazards to personnel, in the assessment of potential hazards and in the application of appropriate protective measures where hazards are found to exist. They will also provide specialist advice, ~~and assistance in the investigation of radiation accidents and~~ in the treatment of radiation injuries; research work in support of these responsibilities is part of their duties.

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19. The consultant radiobiologists are directly responsible to MOD(DHR(RAF)). Commanders may seek their advice on matters not involving MOD(AFD) policy at the addresses and telephone numbers given below. For administrative convenience their advisory responsibilities to RAF commands are allotted as indicated. In the absence of a particular radiobiologist, those responsibilities will be discharged by the other radiobiologist deputizing by prior arrangement.

20. The consultant radiobiologists are normally to be ex officio members of the Command Radiation Health and Safety Committees; their normal locations are as follows:

a. The RAF Consultant in Radiobiology
Building A72
AWRE
Aldermaston
Berkshire
RG7 4PR
Telephone No: Tadley 4111, extension 7553
RAF Commands: Strike Command
RAF Germany

b. The RAF Consultant in Radiobiology
Institute of Naval Medicine
Alverstoke
Gosport
Hampshire
PO12 2DL
Telephone No: Portsmouth 22351, extension 41405/41383
RAF Commands: Training Command
Support Command
Near East Air Force

Command Headquarters

21. A senior staff officer will be appointed to be responsible for all aspects of peace-time radiation health and safety within the command; he will work in close consultation with other appropriate specialist staffs. The Command Ground Defence Staff Officer has specific responsibilities for radiation matters; these are related to nuclear defence (*ie* war-time operations) and the Special Safety Organization only.

22. A Command Radiation Health and Safety Committee should be formed to provide an effective means for the exchange of information, formulation of local policy and co-ordination of radiation safety activities; the appointed senior staff officer will normally be chairman of this committee.

23. A Command Radiation Safety Officer (CRSO) and a deputy are to be appointed; the details are to be promulgated in Command Routine Orders. Both the CRSO and his deputy are to be qualified in accordance with Leaflet M1 and are additionally required to attend the RAF Institute of Aviation Medicine Course on Laser Hazards for Medical and Safety Officers; this course is currently of 1 day's duration and applications for vacancies should be submitted to MOD MA1 (RAF) through normal channels. These responsibilities are secondary duties and are usually associated with a primary appointment on the staff of the senior officer appointed in accordance with para 21.

24. The CRSO is to maintain an effective liaison with all headquarters staffs responsible for sources of radiation or working procedures involving radiation. He is to advise these staffs on the preparation of radiation safety orders and emergency instructions and procedures and formally approve those in force at units. He is to ensure the effective distribution of all relevant radiation safety information, co-ordinate peace-time radiation safety training and supervise personal monitoring and surveillance activities throughout the command.

25. The CRSO is to supervise and co-ordinate the activities of station Radiation Safety Officers (RSOs) and afford them all possible assistance. He is to maintain an up-to-date register of unit RSOs and those Competent Persons (CPs) appointed to carry out certain RSO duties (para 31 refers).

EXECUTIVE RESPONSIBILITIES AT STATIONS AND OTHER ESTABLISHMENTS

26. Strict compliance with the instructions in this section may not always be feasible at some small units or establishments. However, variations that meet the essential requirements may be introduced subject to their approval by the CRSO. Similar approved variations will cater, where necessary, for the particular needs of medical, scientific and teaching units and establishments.

The Commanding Officer

27. The CO, who is responsible for health and welfare of all persons under his command, is to promulgate the necessary orders controlling the use of radiation sources at his station. He is to ensure that adequate notice is given to the medical officer of the introduction of any source of radiation or working procedure involving radiation, and of any intended significant change in the use of such sources of working procedures.

28. He is also to make all the necessary appointments detailed in this leaflet and to promulgate the appropriate details in Unit Routine Orders.

29. He may form a Radiation Health and Safety Committee to co-ordinate radiation health and safety activities.

The OC Engineering Wing or Quality Assurance Officer

30. The OC Engineering Wing or Quality Assurance Officer (QAO) as appropriate is directly responsible to the Commanding Officer for the radiation safety aspects of all sources of radiation; this includes the direct control of all sources of radiation except those sources on charge to OC Supply Squadron (OCSS) and secondary electronic sources. Where sources of radiation are held and no RSO is appointed, the OC Engineering Wing or Quality Assurance Officer may delegate the administration and documentation of personal monitoring and surveillance (Film Badges – Health Register *etc*) to the appointed Competent Person.

31. Radiation hazards due to ionizing radiation, radio-frequency radiation, or coherent light (lasers) arise from the RAF use or involvement with a wide variety of sources including the following:

a. Radars, flight simulators and other electronic apparatus.
b. Medical, dental and veterinary uses of radiation.
c. Gamma and x-ray industrial type radiography employed in non-destructive testing (NDT).
d. Radioactive sources used in training or for calibration purposes.
e. Microwave ovens.
f. Devices emitting laser radiation.

The OC Engineering Wing or QAO will consider the extent of the radiation hazard on his station arising from the foregoing or other uses of radiation and, where the degree of hazard justifies such a course, he will advise the CO to appoint one or more RSOs. When a station is involved in the use of only one or two varieties of such sources, the OC Engineering Wing or QAO may consider that the radia-

tion hazard is small and that the appointment of a RSO is not justified; in this instance if the senior CP has attended and qualified on the CP course at INM Alverstoke, he will be nominated as CP/RSO and advised of his special duties as stated in para 55. Attendance on this course should, if necessary, be arranged before such nomination.

32. The OC Engineering Wing or QAO will also appoint a technically qualified officer to be responsible for the radiation safety practices for specific radio frequency or laser sources of radiation. This officer, who may or may not be an appointed RSO, is to be qualified in accordance with either Leaflet R4 (for those officers with responsibilities for laser radiation sources) or Leaflet S6 (for those officers with responsibilities for radio frequency radiation sources).

33. The advice of the CRSO and/or the appointed consultant in radiobiology should be sought if doubt exists concerning the necessity or otherwise of appointing a Station RSO.

34. The OC Engineering Wing or QAO may, for administrative, security or safety reasons accept responsibility from OCSS for the storage of sources that are neither in use, nor undergoing modification, servicing or repair.

35. He is to ensure that a register of all sources of radiation (except secondary electronic sources) that are under his control (*see* Leaflet D1, para 1) is maintained and also that a record is kept of the details for all such sources that are under the control of OCSS.

36. He is to ensure that the necessary standing radiation safety orders and emergency procedure instructions are prepared for all sources of radiation and working procedures involving radiation. These orders are to be promulgated after formal approval by the Command RSO.

37. He is to provide safe storage facilities for all sources of radiation in his control and is to obtain all monitoring and associated technical equipment necessary for maintaining these safe conditions. Although he is responsible for the condition and safe custody of sources under his control, he may delegate these responsibilities to one or more CPs.

38. He is to inform the appropriate civilian contractors of any radiation hazard, or significant change in the existing hazard, that may be associated with any article or equipment that they are required to operate, use, maintain, service or repair.

OC Supply Squadron (OCSS)

39. The OCSS is responsible for providing safe storage facilities for all sources of radiation in his control, or for arranging for these to be provided by the OC Engineering Wing on his behalf, when he will only be responsible for accounting action. He is also to notify details of sources in his charge in accordance with para 35.

40. He is to comply with all relevant technical and radiation safety orders and emergency procedure instructions for sources in his charge.

41. He is to ensure that all relevant instructions in this volume and other official publications are implemented when sources are consigned from the station. He is also responsible for the safe disposal of any radioactive source and for the safety of personnel under his command who are involved – see also Leaflet J1, para 5.

The Officer in Medical Charge (OIMC)

42. The OIMC is responsible for all medical and health aspects of the use of sources of radiation or working procedures involving radiation and he is to implement all current medical instructions.

43. He is also responsible for notifying the competent medical authority in the event of any proven or suspected unacceptable radiation exposure or release of a radionuclide.

The Radiation Safety Officer (RSO)

44. The CO is to appoint a Radiation Safety Officer or Officers and a deputy when, in his opinion, the radiation hazard on his station justifies such a course; he should be guided in this matter by the OC Engineering Wing or the QAO. Where a RSO or RSOs are appointed the particular post or posts concerned are to be suitably annotated in the LUE; details of these appointments are to be promulgated in SROs.

45. The RSO has specific advisory duties and has direct access to the CO in discharging these duties.

46. The RSO is to be qualified in accordance with Leaflet M1 unless a specific waiver is authorized by the CRSO.

47. The RSO is responsible to the OC Engineering Wing or the QAO for the routine administration of all radiation safety procedures on the station and for the supervision of all ionizing radiation safety practices. He may not delegate his responsibilities to an unqualified person unless delegation is approved by the CRSO and authorized by the Commanding Officer.

48. The training of RSOs required under Leaflet No M1 ensures that the RSO has a working knowledge of ionizing radiation principles and safety precautions and a knowledge of non-ionizing radiation safety regulations. Where an appointed RSO does not possess professional knowledge of laser or radio-frequency radiation, his responsibilities for such a source will be limited to ensuring that a Competent Person (CP/L) or (CP/RF) is appointed and that the relevant administrative instructions contained in this AP and local orders are complied with.

49. The RSO is to ensure that he is familiar with the specific radiation hazards on his station, the appropriate methods of monitoring and personal protection and all relevant emergency procedures.

50. He also has the following specific duties:

a. To provide advice on radiation safety to the CO and any other involved person.

b. To co-ordinate all radiation safety practice and procedures except as in para 48 above, to supervise CPs and maintain a close and effective liaison with the Officer-in-Medical-Charge and other specialist officers.

c. To obtain and distribute all necessary radiation safety information.

d. To advise on the preparation of all necessary standing radiation safety orders and emergency procedure instructions prior to their submission for approval by the CRSO.

e. To co-ordinate all investigations into any proven or suspected unacceptable exposure to radiation, and any proven or suspected release of a radionuclide; in addition he is to ensure that any such incident is reported in accordance with the instructions in his volume. This instruction also applies to any loss or significant damage to a radioactive source.

f. To supervise the radiation safety of visiting NDT teams.

g To maintain an up-to-date register of all sources of radiation (except secondary electronic sources) and the related CPs.

h. To co-ordinate all peace-time radiation safety training.

Competent Persons (CPs)

51. When sources of radiation are held or used on a RAF station the CO is to appoint one or more CPs to exercise detailed supervision of the use of specific sources or working procedures that involve radiation. Details of such appointments and of the relevant sources of radiation are to be promulgated in SROs.

52. Competent Persons have varied duties and responsibilities in accordance with the circumstances as follows:

a. *Competent Person (CP)*. Appointed by CO in accordance with Ionizing Radiations (Sealed Sources) Regulations (1969) with responsibility for sources of ionizing radiation; responsible to RSO for radiation safety administration and practice.

b. *Competent Person (CP/RF)*. Appointed by CO with responsibilities for radio-frequency radiation safety matters. Responsible to RSO for radiation safety administration matters and to the technical officer appointed by OC Eng Wing or QAO, for technical practices.

c. *Competent Person (CP/L)*. As "b" above with laser responsibilities.

d. *Competent Person (CP) (CP/RF) (CP/L)*. Any Competent Person who has attended the CP course at INM Alverstoke may be appointed as CP (RSO duties) in the circumstances outlined in para 31 above.

53. The appointed CP has the following specific duties:

a. To prepare the radiation safety orders and instructions and emergency procedure instructions for the routine use of his particular source(s) of radiation or working procedure(s) and to submit these for approval to the RSO and, if appropriate, the specialist officer nominated in accordance with para 32.

b. To ensure that the source(s) of radiation and procedure(s) for which he is responsible are only used under the direct supervision of an appointed Competent Person.

c. To ensure that all persons using such sources or procedures are aware of all relevant safety orders and emergency procedure instructions, and of their personal responsibilities.

d. To ensure that all necessary warning notices and/or barriers are provided and used in accordance with the appropriate instructions *eg* when sources are moved, energized, exposed or placed in storage.

e. To ensure that the classification and surveillance of all persons using the sources or procedures for which he is responsible are in accordance with current instructions.

f. To control the use of such sources or procedures so that all human exposure is kept to the minimum, and to ensure that no persons are unnecessarily exposed.

g. To be responsible for the administration (as delegated to him) of personal monitoring and surveillance (including any relevant documentation) in accordance with current instructions for all personnel using such sources or procedures.

h. To report the facts to the RSO and Officer in Medical Charge immediately he is aware of the loss of a source, or of proven or suspected untoward radiation exposure, or proven or suspected release of a radionuclide.

j. To ensure that, when necessary, suitable and serviceable monitoring instruments are provided and used to maintain adequate control over the use of any source or procedure.

k. To ensure the safe custody at all times of all radioactive sources in his charge.

l. To carry out snap checks of radioactive sources (ionizing radiation) in his charge on appointment, handing over and at irregular intervals not exceeding three months; these checks are to be limited to an examination for damage or corrosion. He should report any suspicious findings to the RSO; all details are invariably to be recorded in the register referred to in Leaflet D1.

54. A CP is to be qualified in accordance with Leaflet M1 and is to be trained and experienced in the use of the particular source of radiation or working procedure for which he has been appointed. He is responsible for carrying out the instructions of the OC Engineering Wing, QAO or RSO and is to comply with the relevant safety orders and instructions for the specific source of radiation or working procedure.

Competent Persons – RSO Duties

55. When the radiation safety status of a station permits, the CO may decide not to appoint an RSO: in such circumstances the senior INM Alverstoke qualified CP of any CPs appointed, will be indicated and detailed in SROs to carry out additional duties that would otherwise fall to the RSO. These additional duties are to be selected from the duties of an RSO as given above to ensure that all necessary radiation safety measures are taken to meet the station's responsibilities for the sources of radiation held or used. A CP appointed to these additional responsibilities will normally report to the OC Engineering Wing or QAO on radiation safety matters.

The Individual

56. Any person who is aware, or has been so advised, that he is likely to be exposed to ionizing, radiofrequency, microwave, or laser radiation from any source (except when administered to him for personal diagnostic or therapeutic purposes) has the following responsibilities:

a. To acquaint himself with all relevant safety orders and instructions and to comply with them.

b. To be aware that he has a duty to protect himself and others from any unnecessary exposure to radiation, and to take all necessary practical steps to that end.

c. To present himself, when so instructed, for any necessary medical examination.

d. To report immediately to the RSO or Officer in Medical Charge if he suspects that he or any other person, has been exposed to an unacceptable dose of radiation or that there has been a release of any radionuclide.

CHANNELS OF COMMUNICATION

57. The effective control of numerous and diverse sources of radiation and working procedures involving radiation in the Royal Air Force requires an organizational system that may in some circumstances cut across the accepted command channels of communication. However, these conventional reporting channels are to be used for all action that is not primarily concerned with radiation safety administration, unless specific contrary instructions are given in this volume.

SELECTION OF PERSONNEL

58. The selection of individuals to fill appointments with responsibility for radiation safety is to take account of the particular requirements in each instance. For this reason, apart from obvious appointments described in this leaflet, no hard and fast rules are laid down about choice of individuals or their branches. However, all individuals appointed are to be qualified in accordance with leaflet M1.

RADIATION SAFETY – INCIDENTS

(D/DDC Med(RAF)/13/1/3B/MA4a(RAF) – April 1980)

1. Incidents involving the accidental release of radioactive substances or exposure to ionizing, radio-frequency, microwave or laser radiation are to be resolved to the satisfaction of the qualified Radiation Safety Officer or reported in accordance with the following instructions.

2. If a Unit or Board of Inquiry is convened to enquire into the circumstances of a radiation incident, the President is to obtain the advice of an RAF Consultant in Radiobiology. The request for this advice is to be made as in sub-paras 5a and b. A copy of the proceedings of the Board is to be forwarded to MOD MA4a(RAF). A final report of lesser, but significant, occurrences for which a Unit or Board of Inquiry was not considered necessary is to be compiled by the RSO and submitted to the Command RSO for onward transmission to MOD MA4a(RAF).

IONIZING RADIATION

Initial Reporting

3. Any incident involving the uncontrolled exposure of radiation sources or materials or any incident involving radioactive material or associated equipment which could produce a radioactive hazard is to be reported immediately to the Unit Radiation Safety Officer or his authorized deputy. The Unit RSO is to take action to remove any hazard from the incident if it is within his capacity to do so. Any significant occurrence is to be reported to the Command Radiation Safety Officer through normal channels; such incidents are subsequently to be reported to MOD MA4a(RAF). If the Unit RSO is unable to resolve the incident the circumstances are to be reported to the Command Radiation Safety Officer, his deputy or if necessary, to the Duty Staff Officer.

Further Reporting

4. Unresolved incidents reported to commands by units are to be investigated immediately, and if possible, remedial action is to be taken; the Command Radiation Safety Officer is to report the incident to MOD MA4a(RAF). Notification to, and subsequent liaison with, other Government Departments will, if necessary, be performed by, or on the advice of, MOD MA4a(RAF). If beyond resolution by Command, or when the incident involves suspected significant contamination or over-exposure of personnel, an RAF Consultant in Radiobiology is to be informed so that he may provide emergency health physics and radiobiological advice. Subsequently, direct liaison should be established between the Unit and MOD in these circumstances.

5. Reporting, as required by paras 2 and 4, is to be made as follows:

a. *During normal working week (Mon-Fri: 0900-1700 hours)*

(1) By telephone to MOD MA4a(RAF), using the Royal Air Force General Purpose Telephone Network (RAF GPTN) – dial Access Code as shown in AP 3435 for LACON HOUSE exchange, followed by extension number 5509 (or 5555 for operator assistance). In the event of difficulty callers may revert to the Public Switched Telephone Network, Tel: 01-430 5509 (or 01-430 5555 for operator assistance).

(2) By telephone to an RAF Consultant in Radiobiology (*see* leaflet B1).

b. *Outside the normal working week.* By telephone to the Institute of Naval Medicine, Alverstoke, Tel: Portsmouth 22351 (STD Code 0705), Ext 4530 for Duty Officer; the Duty Officer should be requested to inform the RAF Consultant in Radiobiology. The Consultant will inform MOD MA4a(RAF).

6. If difficulty is experienced in contacting the above officer outside normal working week times, Units may, on Command instructions and as a last resort contact AWRE Aldermaston as follows:

Tel: Tadley 2945 (STD Code 073–56)

The caller is to state his identity and telephone number and request assistance from a Senior Health Physicist; the circumstances are to be reported in accordance with paras 4 and 5 as soon as possible.

RADIO–FREQUENCY RADIATION INCLUDING MICROWAVE RADIATION

7. Any individual who is over-exposed or suspected of being over-exposed to RF radiation is to be referred to the Unit Medical Officer who is to arrange for the individual to be seen by an RAF Consultant in Ophthalmology as soon as possible.

8. Any accident or occurrence in which a person is over-exposed to RF radiation is to be reported to MOD DHR(RAF) and the Command Radiation Safety Officer by signal; an immediate follow-up report is to contain the following information:

a. An account of the accident or occurrence including details of frequencies, exposure times and an assessment of power densities.

b. Details of the immediate medical findings.

Subsequent reporting is to detail the action required to eliminate the hazardous situation or to prevent recurrence.

9. The incident is also to be reported to the MOD or INM Alverstoke by telephone in accordance with sub-paras 5a and 5b above. Last resort contacting of AWRE as detailed in para 6 does not apply to RF radiation incidents.

LASER RADIATION

10. Any suspected case of over-exposure to laser radiation is to be referred at once to the Unit Medical Officer, who is to arrange for his transfer as soon as possible to a consultant in ophthalmology.

11. The officer in charge of the operation of the laser equipment involved in a case of suspected over-exposure will take the following immediate action:

a. Suspend all operation in the laser hazard area.

b. Ensure that the accident conditions are left unaltered pending the subsequent investigation.

c. Ensure that the medical officer has all the information necessary for the proper care of the person(s) exposed.

d. Notify the circumstances of the accidental over-exposure to the Officer Commanding

Duties of Officer Commanding

12. The Officer Commanding is to institute a full investigation of the circumstances of all accidents involving over-exposure to laser radiation. In this respect, expert advice will be made available to the Officer Commanding from the RAF Institute of Aviation Medicine on receipt of information by signal via the Director General of Medical Services (RAF).

13. The incident is also to be reported to the MOD or the INM Alverstoke by telephone in accordance with sub-paras 5a and 5b above. Last resort contacting of AWRE as detailed in para 6 does not apply to laser incidents.

PART 2

IONIZING RADIATION

ORDERS AND INSTRUCTIONS

SECTION C

THE CLASSIFICATION, MEDICAL SUPERVISION AND DOCUMENTATION OF PERSONNEL WORKING WITH SOURCES OF IONIZING RADIATION

SECTION C

THE CLASSIFICATION, MEDICAL SUPERVISION AND DOCUMENTATION OF PERSONNEL WORKING WITH SOURCES OF IONIZING RADIATION

CONTENTS LIST

MAXIMUM PERMISSIBLE DOSES OF IONIZING RADIATION

(AF/662/66/MA4a(RAF)—August 1972)

Dose Limitation

1. The normal annual maximum permissible dose to the reproductive organs (gonads) and the blood-forming organs, essentially the whole body, from occupational exposure to ionizing radiations is 5 rem in any calendar year. It shall not be held to include the dose from any exposure to medical procedures or from natural background radiation. Additionally the normal quarterly dose limit is 3 rem in any calendar quarter. This quarterly quota may be repeated in each quarter of the year provided that the total dose accumulated at any age over 18 years does not exceed 5(N-18) rem where N is the age in years which the individual will reach by the end of the year in question.

2. An individual is to be assumed to have received a whole body dose at the rate of 5 rem/year during any period in which he has been engaged on duties involving exposure to ionizing radiations and accurate or reliable details of this exposure are not available.

3. The dose received by skin, thyroid, and bone shall not exceed 30 rem/year of which not more than 15 rem shall be received in any calendar quarter.

4. The dose received by the hands, forearms, feet and ankles shall not exceed 75 rem in any calendar year of which not more than 38 rem shall be received in any calendar quarter.

5. The dose received by the lens of the eye or any other single organ shall not exceed 15 rem/year of which not more than 8 rem shall be received in any calendar quarter.

6. Women of reproductive capacity should be occupationally employed only under conditions where the dose to the abdomen is limited to 1·3 rem in a quarter. If pregnancy is diagnosed the foetal dose during the remainder of the pregnancy shall be limited to 1 rem.

7. The annual dose limits for members of the public shall be one-tenth of the corresponding annual occupational maximum permissible doses given in paragraphs 1, 3, 4 and 5, except in the case of children below the age of 16 years where the dose to the thyroid is limited to 1·5 rem.

8. These limitations of exposures to ionizing radiations are summarized in Table C1.1:

TABLE C.1.1.: MAXIMUM PERMISSIBLE DOSES

Part of Body Exposed	Occupationally Exposed Persons	Individual Members of the Public
Whole body, blood forming organs, gonads	5 rem/year (3 rem/Calendar quarter)	0·5 rem/year
Skin, Thyroid, bone	30 rem/year (15 rem/Calendar quarter)	3 rem/year (1·5 rem/year to thyroid of children below 16 years of age)
Other single organs, lens of eye	15 rem/year (8 rem/Calendar quarter)	1·5 rem/year
Hands, forearms, feet and ankles	75 rem/year (38 rem/Calendar quarter)	7·5 rem/year

Dose Equivalent

9. Radiation dose records shall be expressed in terms of the dose equivalent, the unit of which is the rem. The dose equivalent is defined as the product of the absorbed dose (in rad) multiplied by the 'quality factor' (QF) of the radiation concerned.

DE (in rem) = D (in rad) × QF

10. The advantages of the use of the rem in radiation protection are that it is a unit which expresses biological damage and that doses from mixed radiations expressed in rem are additive. For practical purposes the millirem (1 mrem = 10^{-3} rem) is often used.

11. The quality factor is a special case of the concept of relative biological effectiveness used in radiation protection for exposures within the range of the maximum permissible levels. Quality factors, as detailed in Table C1.2, cannot be used to convert larger exposures as additional modifying factors must be considered.

TABLE C.1.2: QUALITY FACTORS

TYPE OF RADIATION	QUALITY FACTOR (QF)
X, gamma, electron and beta radiation	1
Thermal neutrons	3
Fast neutrons, protons, and alpha particles	10
Heavy recoil nuclei	20

Accidental Exposures

12. All doses from accidental exposures shall be recorded and clearly distinguished from routine exposures. If the dose exceeds twice the annual limit the matter shall be referred for review to the Ministry of Defence (DHR(RAF)). The individual may still be allowed to continue in radiation work provided there is no objection from the medical standpoint and due account has been taken of his previous exposure, age and health.

THE CLASSIFICATION OF PERSONNEL OCCUPATIONALLY EXPOSED TO IONIZING RADIATION

(AF/662/66/MA4a(RAF)—August 1972)

Classification of Exposed Personnel

1. Personnel, who, in the course of their routine duties, are likely to be exposed to ionizing radiations are known as radiation workers; every effort is to be made to keep their numbers as low as possible. Radiation workers are to be classified into two groups, according to their probable radiation exposure:

a. *Class A Radiation Workers*—Those receiving, or likely to receive, a whole body dose of more than 1.5 rem per year (3/10ths of the maximum permissible dose) but within the maximum permissible. They may receive up to a maximum of 3 rem in any one calendar quarter.

b. *Class B Radiation Workers*—Those receiving, or likely to receive, a whole body dose of less than 1.5 rem per year. They may receive up to a maximum of 1 rem in any one calendar quarter.

2. Individuals who are not routinely exposed to ionizing radiations in the course of their duties, but are occasionally so exposed, are known as incidentally exposed workers. They may receive a body dose not exceeding 0.5 rem per year and do not require any routine surveillance except occasional verification, usually by environmental monitoring, that the body dose received is likely to be less than 0.5 rem per year. They are to be classified as radiation workers if this dose is, or is likely to be, exceeded.

3. The medical supervision required for all radiation workers is described in Leaflet C3.

Assessment of Classification

4. The officer in medical charge is to classify workers, in consultation with the Radiation Safety Officer and the appropriate specialist officers responsible for each particular source of ionizing radiation. They are to consider the following factors when making a provisional assessment of the dose that any individual is likely to receive:

a. The type and activity (where applicable) of each source of ionizing radiation.

b. The periods of exposure to each source.

c. The proximity of the individual to each source of ionizing radiation.

d. The safety precautions applicable to each task or procedure.

5. This provisional assessment is then to be verified, using personal dosimeters or other appropriate monitoring equipment. Film badges are usually employed for this purpose, although direct-reading quartz fibre dosimeters may be adequate. Advice on the most appropriate method of dose verification may be obtained from MOD (MA4a(RAF)).

6. Exposed personnel are to be assigned to the appropriate class when the probable dose has thus been determined. Workers are to be reclassified, subject to the exceptions given in para 8 below, when there is any significant alteration in their exposure.

7. No individual under the age of 18 is to be employed on any duty that would entail his classification as a Class A radiation worker.

8. **Exceptions.** The Director of Health and Research (RAF) may, at his discretion, assign certain individuals or groups of workers to specific classes. Such action is currently in force for the following group of workers:

a. All personnel, who use any form of industrial radiographic or fluoroscopic equipment, who are to be assigned to Class A (but *see* sub para 8c).

b. All personnel, except those dental officers and airmen at dental centres not located at hospitals, who use medical or dental radiographic equipment, who are to be assigned to Class A.

c. All operators of the Rapidex X–50 hand baggage security X-ray equipment and all those dental personnel excluded from sub para 8b above, who are to be assigned to Class B.

d. All personnel directly involved in the handling of sources used in the radioactive miss-distance indicator system, who are to be assigned to Class B.

e. All personnel who are employed on decontamination programmes or tasks including training involving the use of unsealed sources, who are to be assigned to Class B.

9. **Personnel Employed with High-Voltage Electronic Equipment.** Precautions against ionizing radiation for operators, servicing personnel and other persons employed with high-voltage electronic equipment are promulgated by the sponsor branch concerned, *eg* MOD Sigs 55 (Air) for Ground Radar, MOD SE5(RAF) for Flight Simulators. The issue of these instructions does not lessen the responsibility of the local Officer in Medical Charge or the Radiation Safety Officer to assess and classify workers and any difficulty experienced in agreeing classification or precautionary procedures should be reported.

(*Note:* In this context high-voltage equipment is that in which charged particles are accelerated through potentials in excess of 5 kilovolts).

10. **Radiation from Contaminated Surfaces.** Personnel are to be categorized as Class A radiation workers if they work for more than 2,000 hours per year in close contact with extensive surfaces bearing loose radioactive contamination greater than:

a. 10^{-4} μCi/cm^2 of any beta emitter or low toxicity alpha emitter, or

b. 10^{-5} μCi/cm^2 of any other alpha emitter

averaged over an area not exceeding 1000 cm^2.

11. These levels of activity may be increased by a factor not exceeding X10, in direct proportion to any decrease in the number of hours exposure per year.

12. Workers are to be assigned to Class B if their exposure period does not, or is unlikely to, exceed three-tenths of that permitted to a Class A worker.

13. Classification should be determined in accordance with the provisions of para 1 above when the contamination is fixed or when the likelihood of close contact with loose contamination is remote.

THE MEDICAL SUPERVISION OF PERSONNEL OCCUPATIONALLY EXPOSED TO IONIZING RADIATION

(AF/662/66/MA4a(RAF)—August 1972)

Medical Examinations

1. All Class A (*see* Leaflet C2) radiation workers are to be medically examined on the following occasions:

a. In the 4-week period before they commence radiation work for the first time, or recommence such duties after an absence of 4 months or longer.

b. Annually thereafter, as long as they are so employed.

c. When they cease to be so classified (including termination of service).

d. At the discretion of the officer in medical charge.

The officer in medical charge is responsible for making arrangements for the medical examinations for all Class A radiation workers and is to ensure that these are carried out at the appropriate intervals.

The results of such examinations, in the form of a certificate of fitness for employment as a Class A radiation worker (where appropriate), are to be forwarded on RAF Form 624 to the RSO. F/Med/291A is also to be annotated and signed by the medical officer (*see* also Leaflet C5).

2. The initial medical examination is to include a blood examination, carried out at an approved laboratory, consisting of or including the following:

a. Red and white cell counts.

b. Differential white cell count.

c. An estimate of the haemaglobin in g/100 ml.

d. A measurement of the packed cell volume.

e. A search for any abnormal cells: any found are to be described and enumerated.

These estimations will provide a base line for each individual and assist in interpretation of any later findings that may be attributed to the effects of radiation exposure.

3. No individual is to be rejected for radiation duties solely on the results of a blood examination unless it reveals unequivocal pathological abnormalities. Any difficulties in the application of the results of clinical or haematological examination in the context of radiation work are to be referred to a RAF consultant in radiobiology.

4. Repeat blood examinations, which are to include the above-listed estimations, are only required when indicated on clinical grounds, when an over-exposure is suspected, or when an individual ceases to be categorized as a Class A radiation worker.

5. Any Royal Air Force Hospital laboratory or National Health Service pathological laboratory may be regarded as an approved laboratory.

6. All clinical examinations are to be recorded on F/Med/291C consisting of two flimsies and one card. Blood examinations are to be requested on Fs/Med/12 (Revised 1969), which are to be disposed of in accordance with paragraph 0545 of AP 1269 (6th Edition), except that the report is to be transcribed on to F/Med/291C when the blood examination is part of a full examination. (*see* also Leaflet C5).

7. The chest X-ray required in block 21 of F/Med/291C should be that of the most recent routine X-ray; there is no RAF requirement for a special X-ray examination solely for the purposes of this radiation medical examination. X-rays of the chest may be carried out at the professional discretion of the examining medical officer.

8. Class B radiation workers do not require examinations other than at the discretion of the officer in medical charge.

IONIZING RADIATION—PERSONAL DOSIMETRY

(AF/662/66/MA4a(RAF)—August 1972)

Personal Monitoring

1. All radiation workers are to wear film badges when on duty. They are also to wear direct-reading quartz fibre dosimeters whenever they are exposed, or are likely to be exposed, to X- or gamma radiation of an intensity greater than 75 mrad per hour. Other personnel are to wear film badges or other dosimeters when so required by a medical officer or RSO.

2. Film badges are supplied and processed by the Admiralty Radiation Records Centre (ARRC), located at:

The Institute of Naval Medicine
Alverstoke
Gosport
Hants
PO12 2DL
Tel: Portsmouth 22351, Ext 41544

The RAF element at the Institute, under the charge of a RAF consultant radiobiologist, supervises the RAF participation in this service.

3. RSOs are responsible for the co-ordination of all arrangements for personal monitoring. They are to ensure that:

a. Film badges are worn for periods of 4 to 5 weeks. The change-over of films is normally to be made on the first Monday or each month, or the next working day when the first Monday falls on a public holiday.

b. Used films and correctly completed Radiation Film Invoices are returned promptly to the ARRC for processing.

c. All personal documentation is maintained in accordance with current instructions.

d. Films are returned for processing immediately there is any suspicion that the wearer has received whole body radiation at a rate exceeding 1.0 rem in 4 weeks. The returned film is accompanied by a statement giving details of the circumstances in which the dose was received and all relevant data appertaining to the source of ionizing radiation.

e. Film badges are used correctly and not subjected to abuse, *see* Annex A to this leaflet.

4. Any films that are surplus to requirement, or have not been used and are out of date, are not to be destroyed locally, but returned to ARRC.

5. Special circumstances may arise requiring the use of neutron track plates or thermoluminescent devices; requests for such dosimeters are to be made through normal channels to the RAF consultant radiobiologist at the Institute of Naval Medicine. Instructions are given, in writing, to users when thermoluminescent devices are issued by the ARRC.

Supply of Film Badges

6. The RSO is to demand from the ARRC his requirements for radiation monitoring films. He shall issue and recall the film badges as required, filling in the details of individuals to whom badges are issued, in accordance with the instructions on the Radiation Film Invoice. If a film has been lost or damaged the Invoice shall be annotated accordingly and where it is possible to make an estimate of the dose received by the individual during the currency of the film, that estimate shall be forwarded to the ARRC together with the Invoice.

7. In the case of individuals subject to photodosimetry for the first time in the establishment, and who are not visitors for whom records need not be kept, the appropriate information is to be entered on the Personal Details Form (F/Med/291/E), *see* Leaflet C5, and this form forwarded to the ARRC with the Radiation Film Invoice.

8. Orders for films will be treated as monthly standing orders until countermanded. RSOs are to give one month's written notice, whenever possible, of all changes in demands, which are to be scrutinized carefully to prevent wastage of costly films. RSOs are to inform the ARRC whenever any radiation worker leaves a unit, ceases to be employed as a radiation worker, or is reclassified, by suitable annotation of the Invoice.

9. Units may communicate directly with ARRC only on matters relating to the administration of this service; all other queries are to be submitted through the appropriate administrative or technical channels.

10. ARRC will allocate a personal serial number to each radiation worker. RSOs are to ensure that any radiation worker leaving a unit is advised in writing of his serial number; also RSOs are to notify the serial number to the RSO at the receiving unit when the new unit is known. The ARRC personal number will be given when a badge is demanded for any individual who has been a radiation worker previously or otherwise subject to photodosimetric surveillance using film badges supplied by the ARRC.

Dose Reports

11. ARRC will send monthly unit dose reports and quarterly individual dose reports direct to units, who are to maintain personal records, *see* Leaflet C5. Additionally in the instance of hospitals and medical units the ARRC will produce a consolidated return to the RAF consultant adviser in radiology. ARRC will also take all necessary action to notify any excessive radiation doses to units and competent medical authorities. Advice on the action to be taken will be given by the RAF consultant radiobiologist.

USE AND CARE OF FILM BADGES

1. The film shall be carefully placed in the holder which is worn so that the surface carrying the word "BACK" faces the body of the wearer. If the number stamped on the white side of the film is showing in full in the open window of the front of the holder, it is correctly positioned. Once a film has been placed incorrectly in the holder and has been issued in that condition it shall be left that way and the Radiation Film Invoice appropriately annotated.

2. Normally film badges for measuring dose to the whole body shall be worn on the chest outside all clothing. Film badges worn to measure dose to other body areas, such as wrists and eyes, are to be so indicated on the Radiation Film Invoice.

3. Metallic objects, luminized watches or other luminized articles are not to be worn or carried near the film badge.

4. Film badges are to be protected by encapsulation in polythene when:
   a. the possibility of significant contamination exists
   b. in humid and damp environments
   c. if exposure to corrosive or chemically reactive gases or vapours is likely.

5. The Radiation Safety Officer shall ensure that any special instructions issued by ARRC with regard to the use and care of film badges are carried out.

IONIZING RADIATION—PERSONAL DOSIMETRY—DOCUMENTATION

(AF/662/66/MA4a (RAF)—August 1972)

Documentation

1. Special forms are provided for the compilation of the various records and reports required. These forms, together with details of their use, are described below.

2. The forms are:

F/Med/291/A (Radiation History Envelope)
F/Med/291/C (Radiation Medical Examination Form)
F/Med/291/D (Radiation Record Summary Card)
F/Med/291/E (Personal Details Form)
ARRC Monthly Dose Record (for each unit)
ARRC Quarterly Dose Record (for each individual)
DEP Form 2066 (Department of Employment and Productivity Transfer Record)
Radiation Health Register (no standard form).

F Med 291A

3. F Med 291A is graded "Staff in Confidence". For each individual allocated an ARRC number (*see* Leaflet C4, para 10) an envelope F Med 291A shall be used by the ARRC to hold all relevant data on the individual's exposure to ionizing radiation and associated radiation medical records.

4. The RSO of the unit shall keep a F Med 291A for each radiation worker. The outside of the envelope has spaces for certain administrative and personal data. The unit copy will contain the quarterly ARRC dose reports and is to be made available to the officer in medical charge whenever medical examinations are carried out for purposes of medical supervision of radiation work. On posting, the unit copy of the F Med 291A shall accompany the individual to his new unit if he is to continue in employment as a classified radiation worker. On cessation of radiation duties, or on discharge, death or release from the Service, the unit copy is to be returned to the ARRC.

5. If a unit copy of the F Med 291A is lost or destroyed, application is to be made to ARRC for the issue of a complete duplicate copy. The application is to give an explanation of the reasons for the request and is to be submitted through the Command RSO.

6. When the unit copy of F Med 291A is full and no more entries can be made on the outside panel, or it is damaged and unusable, it is to be sent complete with its contents to the ARRC with a request for the issue of a new envelope. ARRC will issue a new envelope, containing basic essential data and will retain the old envelope and contents for checking and disposal.

F Med 291C

7. F Med 291C is graded as "Medical in Confidence" when partially or fully completed. It consists of 2 flimsies and one card. Blood examinations recorded on F Med 12 (Revised 1969) are to be entered in the appropriate space (block 1a) on this form, *see* also Leaflet C3, paragraphs 6 and 7. The disposal of copies is:

a. Card copy to MOD (MA7(RAF)).
b. One flimsy to F Med 4.
c. One flimsy to ARRC for inclusion in master F Med 291A.

F Med 291D

8. F Med 291D is a small personal card that is issued to radiation workers on posting or proceeding on short periods of detachment from the parent unit. The RSO of the dispatching (parent) unit is to complete the administrative details and also columns 1 and 2 inside the form. The RSO at the unit of detachment is responsible for completion of the other columns.

9. This form is to be used by a radiation worker on posting as a means of identification on allocation to radiation duties until his unit copy of the F Med 291A is received. The F Med 291D is to be handed to the RSO who may use it as a temporary record of radiation dosage pending the receipt of the F Med 291A, in which it is to be enclosed.

10. When a radiation worker who has been on detachment returns to his parent unit, the F Med 291D is to be enclosed in the F Med 291A.

F Med 291E

11. This Personal Details Form is to be raised when an individual is first classified as a radiation worker. Full instructions are given on the form, which shall be sent to the ARRC when completed.

Radiation Dose Records

12. The ARRC Monthly Dose Record is to be scrutinized, on receipt, by the RSO and the officer in medical charge. It is to be retained for 12 months in the Radiation Health Register.

13. The ARRC Quarterly Dose Record is important because it provides the up-to-date dose record of the radiation workers exposure to ionizing radiation. After scrutiny, it is to be enclosed in the individual's F Med 291A.

Transfer Record (DEP Form 2066)

14. The Department of Employment and Productivity Form 2066 is to be raised by ARRC at the request of the unit RSO for issue to any Class A radiation worker. Service or civilian, who is leaving the Service or AFD employment. This issue is mandatory irrespective of the dose record of the individual worker. ARRC will issue one copy to the radiation worker concerned, will send one copy to HM Factory Inspectorate, and will retain a file copy.

Radiation Health Register

15. The RSO is to maintain an up-to-date written record of the state of fitness for radiation duties of all Class A radiation workers at the unit. This record will be known as the Radiation Health Register. The medical officer is to be responsible for informing the RSO, on RAF Form 624, of the results of all medical examinations. The RSO is to be responsible for making the appropriate entries in the Radiation Health Register.

Supply of Forms

16. Units are to obtain supplies of Fs Med 291 C and D from their usual stationery supply source. The other forms mentioned have a limited distribution to ARRC.

Inquiries and Past Records

17. All inquiries for radiation dose histories are invariably to be forwarded to the RAF element at the Institute of Naval Medicine. The majority of radiation dose records are available to the RAF element from ARRC and in addition the RAF element has access to records held by other organizations responsible in the past for the health surveillance of RAF personnel engaged on certain radiation tasks.

SECTION D

REGISTRATION OF RADIOACTIVE SOURCES

SECTION D

REGISTRATION OF RADIOACTIVE SOURCES

CONTENTS LIST

REGISTER OF RADIOACTIVE SOURCES

(C.133061/60/Mech Eng 10 (RAF)—1st December 1965)

Register

1. A single register is to be kept by the radiation safety officer of all primary sources, radioactive materials and demountable sources held on the establishment. The register is to show the following particulars when applicable.

   a. Serial number, type, section and reference number or other particulars sufficient to identify the source and, when applicable, its container.

   b. The nature of the source and its nominal activity.

   c. Consignor, date of receipt, and signature of recipient.

   d. Dates of all internal issues and receipts with signatures of recipients.

   e. Details and dates of changes of location on the establishment and temporary movements off the establishment.

   f. Date of disposal by the establishment, consignee, method of packaging and identification markings.

2. The register is also to contain:

   a. A graph showing initial and current nominal source activities as derived from the nominal strength at activation, date of activation and half-life of the element concerned. This is not applicable to radium, uranium and plutonium or other long-lived sources, which may be specified subsequently.

   b. ~~Annual~~ Quarterly and consignment certificates of inspection (*see* Leaflet J 1 paragraph 1).

3. The register is to be kept for three years from the date of the last entry.

4. When a source is taken from the establishment temporarily, a sub-register is to be maintained by the Competent Person supervising the use of the source, showing the information required by paragraphs 1 a. and b. and 2a. above. The sub-register must show details of all movements of the source, including changes of location within the establishment in which it is temporarily located.

SECTION E

STORAGE OF RADIOACTIVE SOURCES

SECTION E

STORAGE OF RADIO ACTIVE SOURCES

CONTENTS LIST

GENERAL STORE INSTRUCTIONS

(D/DDC Med(RAF)/13/12/3, MA4a(RAF)—June 1978)

Safeguards

1. Radioactive sources, either "sealed" or "unsealed", are to be regarded as "attractive items" and are to be safeguarded as such. Sealed and unsealed sources are defined in Leaflet No A 1, para 4.

2. The overriding principle for the storage of radioactive materials is that there shall be no hazard to personnel. Whenever radioactive materials are stored in bulk, monitoring instruments are to be available and are to be used periodically for checking radiation levels.

3. Personnel whose duties entail the use or handling of radioactive sources are to be classified in accordance with Section C.

Marking

4. Details of the marking of radioactive sources, or their containers and equipment incorporating the sources, are shown in Leaflet No F 1, paras 5 to 7.

Storage

5. Radioactive material is not to be placed within 30 yards of any sensitive photographic material.

6. When special containers are provided for radioactive sources, the sources are to remain in those containers during storage and when not actually and necessarily in use. Radioactive materials as defined in Section A are to be treated as unsealed sources and are to be provided with an outer impervious covering (*see* Leaflet F 1, para 11).

7. If special containers are not provided, then sources, radioactive materials and demountable sources when not in their parent equipments are to be placed in a steel box or cupboard to prevent loss and reduce the chance of damage.

8. Sources are to be stored in a building shielded as necessary to ensure that the radiation at any point on the outside of the building or part of it used as a radioactive storage area does not exceed 0.75 mr/hour.

9. The building or part of it used as a radioactive storage area is to be not less than 20 yards from places occupied or frequented by the general public, work places occupied by other personnel, or living accommodation.

10. The building is to be constructed of non-flammable material and is to be well ventilated by natural means. The floor should be at or above ground level if possible. If the floor is below normal ground level, it must be dry and not liable to flooding.

11. No corrosive, flammable or explosive substance is to be taken into any building used as a radioactive storage area.

12. Any room or compartment used as a radioactive storage area is not to contain anything other than the sources, their containers and any necessary shielding material.

13. To avoid the risk of corrosion and the possible spread of contamination, radioactive sources are to be stored in buildings and not in outdoor pits or trenches.

14. Radioactive sources in containers are to be stored in stacks in the shape of a pyramid. There is no restriction on the number of sources contained within a stack, but the dose rate of a stack is not to exceed 40 mr/hour at 1 foot. Stacks may consist of sources of different types, but are to be restricted as far as possible to one type of s

15. Each stack is to be positioned so that there is 16 feet clear on all sides. When this distance is not available inside a building a suitable barrier is to be erected around the building at a distance where the dose-rate falls to 0.75 mr/hour, and the barriers prominently marked in accordance with para 16.

16. All entrances and exits are to be marked with the "Trefoil" sign indicating a radiation hazard shown in Annex A to this leaflet, and are also to be marked by notices in black letters at least 2 inches high, on a yellow background.

WARNING—RADIOACTIVITY—NO ADMITTANCE TO UNAUTHORIZED PERSONS—NO LOITERING

A yellow paint approximating to BS 2660 Colour No 0–001 may be obtained by local purchase.

17. Doors are to be kept locked and keys are to be under control of the officer responsible for safe custody of sources. The location of the keys is to be indicated on the building for fire purposes.

When sources are stored within an explosive storage area the safety distances given in

18. ~~When sources have to be stored within an explosives area the safety distances given in AP 2608A (2nd Edn), Part 2, Leaflet E 1, Appendix A, columns 11 and 13 are normally to be applied.~~ They are not to be stored in an underground explosives storage area without prior reference to the Ministry of Defence (DD Wpn Eng(RAF)).

19. Fire orders are to give the locations of all radioactive storage areas on the establishment. They are to include a warning that smoke and effluent from fires involving radioactive substances should be avoided and also require that the radiation safety officer, senior medical officer and the appropriate officer in charge of radioactive sources should be consulted before salvage work is undertaken.

20. A source is only to be removed from and replaced in a radioactive storage area under the direct supervision of a Competent Person trained in the use of that source. No person is to be permitted to enter such a storage area unless authorized by the officer in charge of radioactive sources and under the control of a Competent Person.

21. Instructions for the storage of equipment incorporating integral sources are shown in Section H.

22. **Transport.** Transport of radioactive sources is to be in accordance with Section K. The regulations therein postulate the marking and packing requirements.

23. **Packaging.** Packaging of radioactive sources is to be as given in DEF 1234A but *see* Leaflet K3 for packaging for transport.

STORAGE AND SAFETY PRECAUTIONS FOR RADIOACTIVE VALVES

(AF/C. 3210/64/E 14a (RAF) dated 8th November 1966 and
AF/5989/66/Elect Eng 13 dated 14th December 1966)

Introduction

1. Certain valves fitted to electronic equipment contain radioactive substances, and special precautions are necessary to prevent injury to the health of personnel. These precautions are given in the Code of Practice relating to Joint Service Radioactive Valves upon which this Leaflet is based.

2. Valves containing radioactive substances are to be treated as "sealed" radioactive sources (*see* Leaflet No E 1) which are to be subjected to normal equipment accounting procedures. They do not need to be registered in accordance with Leaflet No D 1.

3. They are classified in accordance with the Code of Practice as Class 1, Class 2 or Hazard Grade.

Marking of Radioactive Valves

4. The approved marking of radioactive electronic valves is shown in Annex A to this Leaflet.

5. Containers for radioactive valves are fitted with protective markings, and will be similarly marked. Action is being taken to introduce these markings retrospectively on stocks of valves and containers held by maintenance units and user units.

Valves Held in Store and In Use

6. Radioactive valves are not considered to constitute a serious radiation hazard to personnel when properly stored or handled; *eg*, during fitment to equipment. Nevertheless, depending upon the valve classification and quantity involved, a radiation hazard can exist, particularly if they are broken.

7. If a radioactive valve is broken it immediately becomes an "unsealed" source and there is a danger from:

a. Radioactive contamination of a cut or abrasion.

b. The inhalation of radioactive particles or gas.

c. The consumption of contaminated food or drink.

8. To reduce this hazard to a minimum, the following general rules are to apply especially to bulk storage of such items:

a. Valves are only to be stacked when stored in the manufacturer's, or similar, cartons. Valves devoid of such protection are to be stored "one high".

b. Class 1 and 2 valves are to be segregated from other stores and are to be kept at least 6 feet from photographic or X-ray films. They may be stored in the main equipment storage building provided that the storage area has barriers or signs to indicate locations where the radiation levels exceed 0.75 mr per hour.

c. Hazard grade valves are to be kept in a store set apart for this purpose and treated as radioactive sources. The contents of Leaflet No E 1 will apply to the storage of these items.

d. Stocks of radioactive valves are to be kept to a minimum (a method of limiting the total quantity of valves in a stack is by setting a stack surface dose rate).

9. Great care must be taken to avoid breaking radioactive valves and the following precautions are to be taken by personnel when handling them:

a. Valves are not to be removed from their cartons until immediately prior to fitting.

b. Valves are not to be carried in a pocket or elsewhere about the person, or in a manner likely to cause them to break.

c. Valves removed from apparatus are to be placed as soon as possible in a suitably marked protective container and, in the instance of Class 2 and Hazard Grade valves, stored in a steel cupboard set aside for this purpose.

d. Valves are to be carefully handled while being fitted to, or removed from, equipment.

Precautions to be Taken When Valves are Broken

10. The following precautions are to be taken when valves are broken:

a. Well-ventilate the area but avoid causing draughts.

b. Do not eat, drink or smoke in the contaminated area.

c. Avoid breathing the vapour or dust released by the breakage.

d. Before handling the debris, don gloves.

Method of Dealing with Broken Valves

11. Broken valves are to be dealt with as follows:

a. Sprinkle moist sawdust or other dust settling compound over the contaminated area.

b. Use forceps to pick up as many fragments as possible and place them in a suitable container; *eg*, a glass jar or metal can with replaceable lid.

c. Use a damp cloth and with very light strokes brush the remaining fragments on to a base of cardboard or stiff paper, and place the cloth, cardboard or paper and fragments into the container mentioned in sub-para b.

d. Use a clean damp cloth and wipe across the contaminated area using light, straight strokes to avoid rubbing the particles into the surface being cleaned. Fold the cloth in half after each stroke and keep the clean side out. When the available wiping surface of the cloth becomes too small, replace with a clean cloth. Monitor the affected area with a Radiation Monitor Type NIS 295B (6Z/1116865) or other approved instrument if the presence of loose (smearable) contamination is suspected. When the affected area is completely clean, place all the cloths in the container with the other accumulated debris and dispose of in accordance with para 13.

e. Monitor the gloves with a Beta/Gamma probe before removal. Contaminated rubber gloves are to be disposed of in accordance with para 13. Contaminated cotton gloves are to be dealt with in accordance with Leaflet P 2.

f. Personnel engaged in this task are to wash their hands thoroughly when the work is completed, and also before eating, drinking or smoking in break periods.

First Aid

12. Any cuts or abrasions caused by the breakage, or sustained during the cleaning-up process, must be reported to the Medical Officer immediately. The Medical Officer is to be informed that the injury might be contaminated with a radioactive substance, and if possible the radioactive nuclide involved is to be stated. If he is not immediately available, wash the wound with soap and copious quantities of running water, stimulate mild bleeding by applying manual pressure around the wound and cover it with a plain dry dressing which should be made waterproof wherever possible.

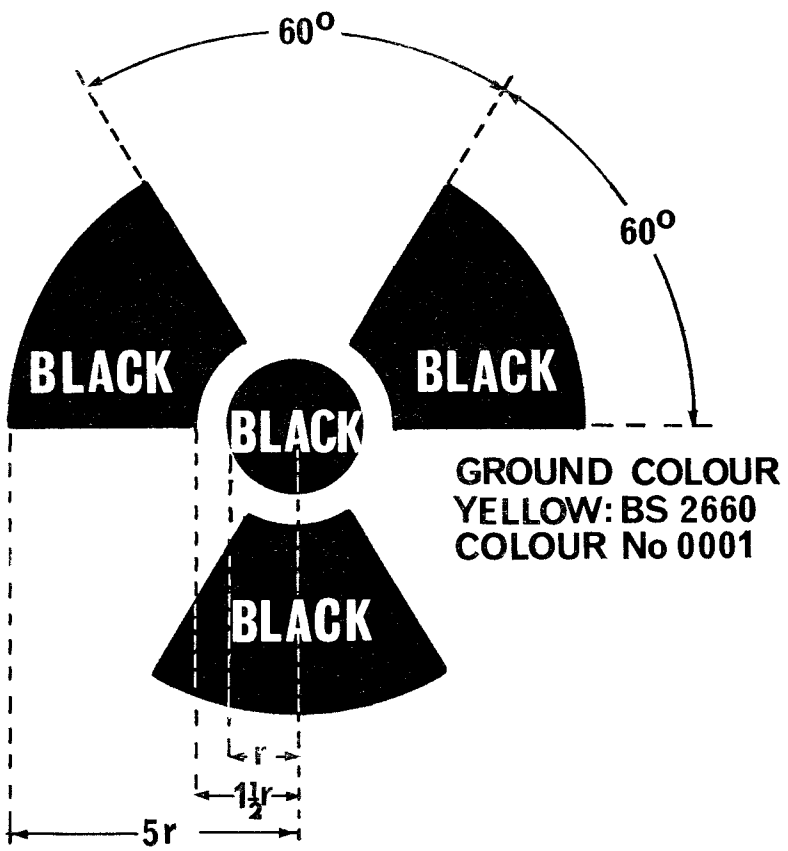
Disposal of Unserviceable Radioactive Valves

13. Unserviceable radioactive valves, whether broken or not, are to be disposed of in accordance with the appropriate "N" Leaflet.

Comprehensive List of Radioactive Valves in Service Use

14. Annex B lists the British and American valves in current Service use. The list will be amended from time to time and is intended to act only as a reference.

IDENTIFICATION SYMBOL FOR RADIOACTIVE SUBSTANCES



MARKING OF RADIOACTIVE VALVES

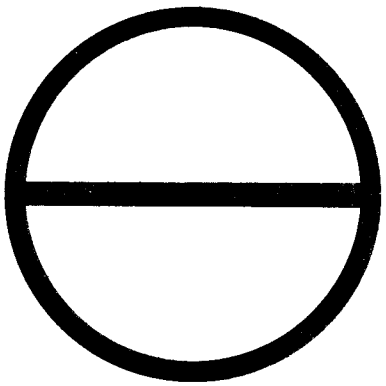


Figure 1
Theta Marking for Class 1 Radioactive Valves
COLOUR OF SYMBOL — BLACK

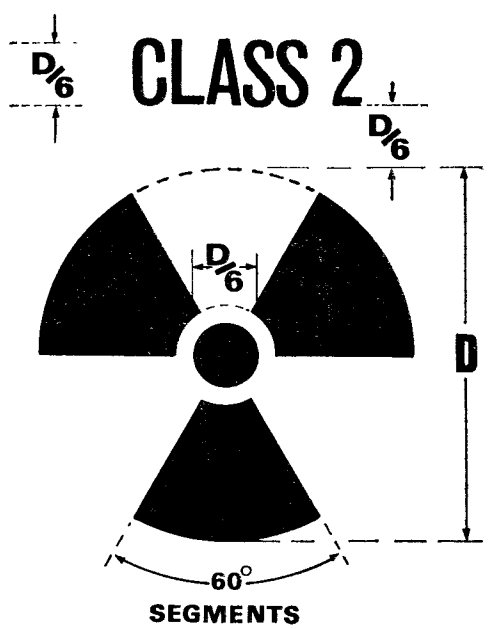


Figure 2
Marking for Class 2 Radioactive Valves
COLOUR OF SYMBOL — BLACK ON YELLOW BACKGROUND

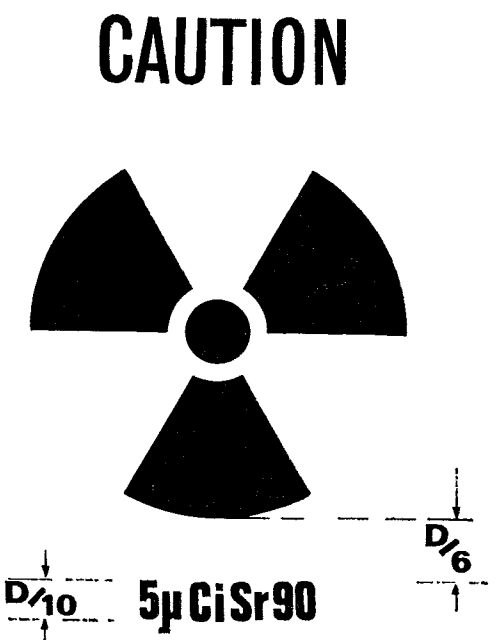


Figure 3
Marking for Hazard Grade Radioactive Valves
COLOUR OF SYMBOL — BLACK ON YELLOW BACKGROUND

TABLE 1 — UK MANUFACTURED RADIOACTIVE VALVES

NATO STOCK NUMBER 5960–99–	CV NO	MANUFACTURER	RADIONUCLIDE	RADIOACTIVE CLASS
000–0188	CV188	Mullard	Tritium	CLASS 1
–0216	CV216	,,	,,	
–0284	CV284	EEV	,,	
–0287	CV287	,,	,,	
–0431	CV431	Mullard	,,	
–0449	CV449	Mullard	,,	
		EEV	,,	
–0460	CV460	EEV	Nickel 63	
–0461	CV461	,,	,,	
–0462	CV462	,,	,,	
–0463	CV463	,,	,,	
–1070	CV1070	Mullard	Tritium	
–1832	CV1832	Mullard	,,	
		EEV	,,	
–1833	CV1833	Mullard	,,	
–1923	CV1923	EEV	,,	
–1992	CV1992	Mullard	,,	
–2012	CV2012	EEV	,,	
–2225	CV2225	Mullard	,,	
		EEV	,,	
–2236	CV2236	Mullard	,,	
–2248	CV2248	Ferranti	,,	
–2249	CV2249	,,	,,	
–2250	CV2250	,,	,,	
–2251	CV2251	,,	,,	
–2252	CV2252	,,	,,	
–2255	CV2255	Mullard	,,	
–2271	CV2271	,,	,,	
–2274	CV2274	EEV	Nickel 63	
–2308	CV2308	,,	,,	
–2309	CV2309	,,	,,	
–2325	CV2325	Mullard	Tritium	
–2351	CV2351	EEV	,,	
–2374	CV2374	Ferranti	,,	
–2375	CV2375	,,	,,	
–2434	CV2434	Mullard	,,	
–2482	CV2482	EEV		
		Nore Electric	,,	
–2483	CV2483	Nore Electric	,,	
–2573	CV2573	Mullard	,,	
–3539	CV2329	EEV	,,	

NATO STOCK NUMBER 5960–99–	CV NO	MANUFACTURER	RADIONUCLIDE	RADIOACTIVE CLASS
000–3960	CV3960	Mullard	Tritium	CLASS 1
–3987	CV3987	,,	,,	
–4020	CV4020	Mullard	,,	
		EEV	,,	
–4028	CV4028	Mullard	,,	
–4048	CV4048	EEV	Uranium oxide (U308)	
		Mullard	Tritium	
–4052	CV4052	EEV	Uranium oxide (U308)	
–4053	CV4053	,,	,,	
–4054	CV4054	EEV	,,	
		Mullard	Tritium	
–4066	CV4066	Mullard	,,	
–4080	CV4080	,,	,,	
037–2254	CV4100	Mullard	,,	
		EEV	,,	
–2268	CV4101	Mullard	,,	
–2292	CV4104	,,	,,	
000–4516	CV4516	,,	,,	
–5122	CV5122	,,	,,	
–5132	CV5132	,,	,,	
–5162	CV5162	EEV	,,	
–5173	CV5173	,,	,,	
037–2076	CV5229	Ferranti	,,	
037–2185	CV5278	Mullard	Tritium	
		ITT	Krypton 85	
–	CV5285	EEV	Uranium oxide (U308)	
037–2266	CV5312	Ferranti	Tritium	
–2324	CV5351	ITT	Krypton 85	
–2344	CV5373	EEV	Tritium	
–2345	CV5374	EEV	,,	
–2346	CV5375	EEV	,,	
–2358	CV5384	Hivac	,,	
–2904	CV5820	Mullard	,,	
–2162	CV6028	Nore Electric	,,	
		EEV	,,	
–2297	CV6070	EEV	Nickel 63	
–2432	CV6086	EEV	Tritium	
		Nore Electric	,,	
–2435	CV6089	Nore Electric	,,	
–3120	CV6110	,, ,,	,,	HAZARD GRADE
–3518	CV6129	MOV	,,	CLASS 1
		EEV	,,	
–3302	CV8090	Mullard	,,	
–3317	CV8105	Ferranti	,,	
–3370	CV8161	EEV	,,	
–3514	CV8323	Ferranti	,,	

NATO STOCK NUMBER 5960–99–	CV NO	MANUFACTURER	RADIONUCLIDE	RADIOACTIVE CLASS
037–3573	CV8380	Ferranti	Tritium	
–3663	CV8462	Mullard	,,	
–3711	CV8482	Mullard	,,	
–3487	CV8572	Mullard	Tritium	
		ITT	Krypton 85	
–3945	CV8670	MOV	Thorium	
		EEV	Tritium	
–3946	CV8671	MOV	Thorium	
		EEV	Tritium	
–	CV8679	Mullard	,,	
–4032	CV8766	EEV	,,	
–4240	CV8958	MOV	Thorium	
		EEV	Thorium/Tritium	
–4578	CV9316	Mullard	Tritium	CLASS 1
		ITT	Krypton 85	
–4856	CV9732	ITT	Krypton 85	
	CV10054	Mullard	Tritium	
–5079	CV10079	,,	,,	
–5664	CV10816	,,	,,	
038–0248	—	EEV	,,	
–0328	—	,,	,,	
–0329	—	,,	—	
–0330	—	,,	—	
–0399	—	Ferranti	Tritium	
–0400	—	Ferranti	,,	
–0505	—	EEV	,,	
–0514	—	,,	Tritium (1000 μCi)	CLASS 2
–0523	—	,,	Tritium	CLASS 1

Note: CV2248 to 2252 inclusive, CV2375 and CV5229 made before April 1961 contain Radium Bromide and are to be disposed of as HAZARD GRADE VALVES.

TABLE 2 — US MANUFACTURED RADIOACTIVE VALVES (IN MANUFACTURER'S TYPE NO ORDER)

USA TYPE NO	UK CV NO	NATO STOCK NUMBER 5960–99–	MANUFACTURER	RADIOACTIVE SUBSTANCE		RADIO-ACTIVE CLASS
				ISOTOPE	QTY PER TUBE (MICROCURIES)	
0A2	1832	188–3564	Raytheon	Co60	0.0067	1
0A2WA	4020	503–4880 or	Hy	Ni63	0.01–0.05	1
		617–6367	Raytheon	Co60	0.0067	1
0B2	1833	166–7648	,,	Co60	0.0067	1
0B2WA	4028	262–3763 or	Hy	Ni63	0.01–0.05	1
		624–4718	Raytheon	Co60	0.0067	1
1B22	761	—	Bomac	—	—	—
1B23	539	188–3533	,,	Co60	0.15	2
			Cent	Co60	0.5 to 1.0	2
1B24	725	188–3533	Westinghouse	Ra226	2.0	HAZARD
			Bomac	Co60	0.15	2
1B24A	3548	193–5091	Microwave Ass	,,	0.5	2
			Sylvania	,,	1.0	2
			Westinghouse	Ra226	2.0	HAZARD
1B26	576	—	Bomac	Co60	0.15	2
1B27	713	193–5092	,,	,,	0.15	2
1B35A	3628	262–1356	,,	,,	0.4	2
			Sylvania	,,	1.0	2
1B36	577	—	Bomac	,,	0.25	2
1B38	3549	237–2413	,,	,,	0.9	2
1B40	2914	237–2414	,,	,,	0.2	2
			Sylvania	,,	1.0	2
1B41	3550	262–0123	Bomac	,,	0.25	2
			Westinghouse	Ra226	2.0	HAZARD
1B49	508	—	,,	Ra226	2.0	,,
1B56	3877	192–5094	Bomac	Co60	0.45	2
1B58	3745	—	GE	,,	0.475	2
			Bomac	,,	0.15	2
1B63A	2862	188–3534	Microwave Ass	,,	0.5	2
			Sylvania	,,	1.0	2
313C	2615	—	Western	Ra226	0.01	HAZARD
346A	2626		Electric			

USA TYPE NO	UK CV NO	NATO STOCK NUMBER 5960–99–	MANUFACTURERS	RADIOACTIVE SUBSTANCE		RADIO-ACTIVE CLASS
				ISOTOPE	QTY PER TUBE (MICROCURIES)	
346B	—	—	Western Electric	Ra226	1.0	HAZARD
446	—	—	AE	C14	1.0	1
724B	1793	—	Bomac	Co60	0.15	2
5651	2573	167–0389	Raytheon	,,	0.0067	1
5651WA	5186	262–0286 or 892–0814	Ch Raytheon	Ra226 Co60	0.045–0.055 0.0067	1 1
5783	3933	230–5253	,,	,,	0.0067	1
5783WA	3960	284–7166	,,	,,	0.0067	1
5787	—	262–3771	,,	,,	0.0067	1
5787WA	5113	272–8545	—	—	—	—
5791	—	—	—	—	—	—
5791/ X6007	—	—	Sylvania	Co60	1.0	2
5841	5062	057–7127 or 819–1154	—	—	—	—
6024/ ATR387	3539	—	Bomac	Co60	0.45	2
6117	—	272–9196	—	—	—	—
BL63	—	—	—	—	—	—
VDX 1017	—	134–0912	Varian	Pm147	10	1
VDX 1031	—	134–0913	,,	,,	10	1
576R 496 HO1	—	778–5237	Westinghouse	Cs137	0.9	2
577R 353 HO1	—	855–1091	,,	Co60	0.2	2
577R 353 HO3	—	134–0914	,,	,,	0.2	2
577R 353 HO4	—	134–0912	,,	,,	0.2	2
577R 660 HO1	—	896–5549	,,	Cs137	0.9	2
579R 545 HO1	—	856–7639	,,	Co60	0.2	2
579R 545 HO2	—	134–0913	,,	,,	0.2	2
580R 697 HO1	—	900–7653	,,	Cs137	0.9	2

TABLE 3 — US MANUFACTURED RADIOACTIVE VALVES (IN NSN ORDER)

NATO STOCK NUMBER 5960–99–	USA TYPE NO	UK CV NO (if applicable)	MANUFACTURER	RADIOACTIVE SUBSTANCE		RADIO-ACTIVE CLASS
				ISOTOPE	QTY PER TUBE (MICROCURIES)	
057–7127	5814	5062	—	—	—	—
134–0912	—	—	Westinghouse	Co60	0.2	2
134–0913	—	—	,,	,,	0.2	2
			Varian	—	10	—
134–0914	—	—	Westinghouse	Co60	0.2	2
			Varian	—	10	—
166–7648 167–0389	OB2 565	1833 2573	Raytheon	Co60	0.0067	1
188–3533	1B24	725	Westinghouse	Ra226	2.0	HAZARD
188–3534			Microwave Ass	Co60	0.5	2
			Sylvania	,,	1.0	2
188–3535	1B23	539	Bomac	,,	0.15	2
			Cent	,,	0.5 to 1.0	2
188–3564	OA2	1832	Raytheon	,,	0.0067	1
193–5091	1B24A	—	Bomac	,,	0.15	2
			Microwave Ass	,,	0.5	2
			Sylvania	,,	1.0	2
			Westinghouse	Ra226	2.0	HAZARD
193–5092	1B27	713	Bomac	Co60	0.15	2
193–5094	1B56	3877	,,	,,	0.45	2
230–5253	5783	3933	Raytheon	,,	0.0067	1
237–2413	1B38	3549	Bomac	,,	0.9	2
237–2414	1B40	2914	Sylvania	,,	1.0	2
			Bomac	,,	0.2	2
262–0123	1B41	3550	Westinghouse	Ra226	2.0	HAZARD
			Bomac	Co60	0.25	2
†262–0286	5651WA	5186	Ch	Ra226	0.045–0.055	1
			Raytheon	Co60	0.0067	1
262–1356	1B35A	3628	Bomac		0.4	2
			Sylvania		1.0	2
†262–3763	OB2WA	4028	Hy	Ni63	0.01–0.5	1
			Raytheon	Co60	0.0067	1

NATO STOCK NUMBER 5960–99–	USA TYPE NO	UK CV NO (if applicable)	MANUFACTURER	RADIOACTIVE SUBSTANCE		RADIO-ACTIVE CLASS
				ISOTOPE	QTY PER TUBE (MICROCURIES)	
262–3771	5787	3897	Raytheon	Co60	0.0067	1
272–8545	5787WA	5113	—	—	—	—
272–9196	—	—	Bomac Microwave Ass Sylvania	Co60 ,, ,,	0.45 0.5 1.0	2 2 2
284–7166	5783WA	3960	Raytheon	,,	0.0067	1
†503–4880	0A2WA	4020	Hy Raytheon	Ni63 Co60	0.01–0.05 0.0067	1 1
624–4718	0B2Wa	4028	Hy Raytheon	Ni63 Co60	0.01–0.05 0.0067	1 1
778–5237	—	—	Westinghouse	Cs137	0.9	2
†819–1154	5841	5062	—	—	—	—
855–1091	—	—	Westinghouse	Co60	0.2	2
855–7639	—	—	,,	,,	0.2	2
†892–0814	5651WA	5186	Ch Raytheon	Ra226 Co60	0.045–0.055 0.0067	1 1
896–5549	—	—	Westinghouse	Cs137	0.9	2
900–7653	—	—	,,	,,	0.9	2

† Valves which have been allocated two NSNs. *See* Table 2 for both NATO Stock Numbers.

SECTION F

USE OF RADIOACTIVE SOURCES

USE OF RADIOACTIVE SOURCES

CONTENTS LIST

USE OF RADIOACTIVE SOURCES

(AF/662/66/MA4a(RAF)—31st December 1971)

Supervision

1. No radioactive source is to be removed from a radioactive storage area, exposed, or removed from its proper container, except under the direct and continuous supervision of a Competent Person.

Work Sites

2. When radioactive sources are to be used, a work or training site is to be chosen so that as far as possible it is isolated from living accommodation or other areas where persons may gather. When it is necessary to use a radioactive source for radiography within an enclosed explosives area, the work site is to be situated no nearer to danger buildings or dumps of explosives than the appropriate special inside safety distance prescribed in AP 2608A (2nd Edition) and the explosives are to be removed from the work site during non-working hours.

3. An area round the source or sources is to be enclosed by a continuous physical barrier that ensures that the dose-rates outside the barrier do not exceed 0.75 mr/hr when a source is exposed. Only personnel directly and necessarily involved are to be allowed within the controlled area enclosed by the barrier. The boundary of the controlled area is to be marked with prominently displayed warning notices at all points where unauthorized entry might be effected and such points are to be under surveillance at sufficiently frequent intervals to ensure the exclusion of unauthorized personnel. When defining the controlled area, account is to be taken of accessible areas or rooms both above and below the area selected. A building, or part of a building, with appropriate demarcation may constitute a controlled area. The walls of the building may constitute the boundary, provided that the dose-rate at the outer surface of the wall, attenuated by shielding, as required, does not exceed 0.75 mr/hr.

Shielding

4. Shielding against radiation is to be provided whenever feasible in order to reduce the radiation dose received by personnel. Scattered radiation, from the air and surrounding structures, must be taken into account. Estimated dose-rates behind shielding are therefore to be confirmed by monitoring, and additional shielding provided, as necessary, against scattered radiation.

Marking

5. Radioactive sources, or their containers and equipment incorporating sources, may or may not be marked to indicate that a radioactive substance is present, although the more hazardous sources covered by this instruction are invariably marked. The most usual markings currently found are an orange band or general orange colouration. "RADIOACTIVE" or similar words may appear or alternatively the trefoil sign as shown in the Annex to Leaflet No E 1 to these instructions may be found inverted.

6. Electronic valves display an orange band, or a violet trefoil on a white ground, or a magenta trefoil on an orange or white ground. However some valves containing radioactive material are still in issue without any significant markings.

7. The above-mentioned markings on British equipment are now obsolescent and an internationally-agreed marking is now to be adopted. The international marking consists of a black trefoil, proportioned and orientated as shown in the Annex to Leaflet No E 1 to these instructions, on a yellow ground to British Standard 2660, No 0001.

Handling

8. Radioactive sources are to be carried and transported only in their authorized containers, where such are supplied, and are to be removed only when required for use. When required for use, sources that have to be removed from their containers are to be handled only by means of the direct carrying rods, tongs or jigs supplied for the purpose. Sources supplied in integral containers or jigs are not to be removed without authority.

9. Radioactive materials, as defined in Leaflet No A 1 paragraph 5.d. are to be treated as unsealed sources (*see* paragraph 11) and are to be retained in an outer impervious covering except when access to the material is required.

10. Demountable sources are to be removed and placed in radioactive storage area whenever the parent equipment is being serviced, repaired or modified and the presence of the source is not essential.

Unsealed Sources

11. While the handling of sealed sources requires only that external radiation exposure should be kept to a minimum, unsealed sources are to be handled with additional precautions to reduce the chance of ingestion or inhalation of radioactive substances, as follows:

a. No smoking, eating or drinking during handling and until the hands have been well washed with soap and hot water at the end of the work period.

b. Gloves are to be worn, which, if they cannot be decontaminated after use, are to be disposed of as radioactive waste together with any tools that cannot be safely cleaned.

c. Care is to be taken to avoid dispersal of the fine particles of radioactive substances in the air, especially if radium or plutonium is present.

d. Unsealed sources are to be kept wrapped in an outer layer of impervious material and sealed. Polythene or PVC sheet or bags sealed with self-adhesive tape will normally meet the requirement.

e. Suitable respirators are to be worn when the work involves an inhalation hazard.

Release of Radioactive Substances

12. Most sources used in the Royal Air Force are sealed sources and, unless a source or the equipment in which it is incorporated is damaged, the chance of radioactive substances escaping is small. However, when sources or equipment containing them are physically damaged, and this includes damage resulting from corrosion or immersion, a nominally sealed source may present an ingestion or inhalation hazard and must thereafter be treated as an unsealed source until it is determined that there is no danger of an escape of a radioactive substance.

13. If there has been a release of a radioactive substance and immediate measures to contain it and decontaminate the surfaces affected are not successful, the Ministry of Defence (MA 4a) (RAF) is to be informed by telephone or signal. If immediate measures are apparently successful, reporting action may be confirmed to a brief written statement of the circumstances of the release and the action taken as a result.

NBC Defence Training

14. Sources used for NBC defence training are to be employed in accordance with the provisions of these instructions and using the techniques prescribed during formal courses of instruction at either the Defence NBC School, or the RAF Regiment Depot.

Sources Used in Servicing

15. Sources used in servicing are to be employed in accordance with the provisions of these instructions and the relevant servicing schedules prepared by CSDE.

Weak Sources

16. The sources listed in paragraphs 17 and 18 are exempt from the provisions of this instruction in the following respects:

a. Competent Persons in charge of these sources need not exercise continuous supervision during use, although this in no way relieves them of any responsibility for the correct and safe use of such sources.

b. The sources may be stored outside a radioactive material storage area when in frequent use, provided that they are kept in a steel box marked with the trefoil sign as shown in the Annex to Leaflet No E 1 to these instructions when not in actual use. This container must itself be kept in a locked steel cupboard or other container made of steel, not easily moveable and marked with the trefoil sign. Source 12Z/57 is to be safeguarded and used in accordance with the special instructions issued by the Ministry of Defence (Air Force Department).

c. The sources may be used outside a controlled area as defined in paragraphs 2 and 3.

d. Where weak sources are used for servicing radiac instruments, only those sources authorized in the list of tools and equipment in the servicing schedules of the instruments currently being serviced may be stored in the manner described in 16b.

e. Those radioactive sources listed in paragraphs 17 and 18 that are sources of alpha radiation

are necessarily unsealed but are exempt from the provisions of paragraph 11. However, contact with active surfaces is to be avoided as far as possible.

17. The following are weak sources, *ie* those below 0·1mCi, used for checking radiation monitoring instruments:

12Z/2	Source, radioactive, natural uranium
12Z/48	Source, radioactive, plutonium
12Z/52	Source, radioactive, radium 226
12Z/59	Source, radioactive, uranyl nitrate
12Z/62	Source, radioactive, plutonium
12Z/1148909	Source, radioactive, plutonium
12Z/1933906	Source, radioactive, natural uranium.

18. Weak sources used for various other purposes are:

12Z/41 to 45 Source, radioactive, alpha

12Z/57 Source, radioactive, ground contamination monitoring.

Other Sources

19. The use of sources other than those listed above or provided for purposes other than those already described is to be in accordance with instructions issued by the Ministry of Defence branch sponsoring their use, in consultation with MOD (MA4a(RAF)). No such source is to be used until these instructions have been received.

Checking of Radiation Monitoring Instruments

20. Radiation monitoring instruments are to be checked and serviced in accordance with the appropriate schedules and publications. The Competent Person in charge of any procedure concerned with sources of radiation other than "Weak Sources" (paragraph 17 refers), is personally to check that each monitoring instrument is serviceable both before and during use. When serviceability is in doubt performance is to be checked by comparison with other instruments and against check sources. Monitoring instruments are to be calibrated on receipt and at six monthly intervals thereafter. Quartz fibre dosimeters are to be inspected for serviceability, correctly charged and adjusted to zero immediately before issue. Annual servicing is to be carried out in accordance with AP 112G-1307-O(R). Topic 5, Chapter 2.

Laboratories for Work with Radioactive Substances

21. Requests for the construction of new laboratories or facilities for work with radioactive substances are to be passed to MOD (MA4a(RAF)) for approval. Similarly approval is to be obtained for modifications to existing laboratories or facilities.

HANDLING AND TRANSPORTATION OF RADIOACTIVE SOURCES USED IN NDT INSPECTIONS

(AF/CX 384/74 MA4a(RAF)—July 1974)

Introduction

1. Radioactive sources used in non-destructive testing inspections are generally of greater strength than sources used for other purposes in the Royal Air Force and consequently their use presents a potentially serious hazard to all personnel on establishments where NDT inspections are carried out. Maximum permissible levels of dose rate are defined in Section C but every effort is to be made to keep dose rates below these levels. Radiation Monitor Type EMI 0030 Dose rate Meter (6Z/1086048) and Radiation Monitor Type N1S 295B (6Z/1116865) have been approved for all Gamma Radiography applications. All new gamma radiography procedures are to be examined and agreed for radiation safety by MOD MA4a(RAF) prior to issue. Where references are made in this leaflet to Radiation Safety Officer and Competent Person, these persons are to have received training appropriate to their appointments in accordance with leaflet M1.

General

2. Radioactive sources used in NDT inspections are not to be removed from a radioactive storage area, exposed or removed from their proper containers except under the direct and continuous supervision of a Competent Person trained in accordance with Leaflet M1. All other personnel required to participate in the execution of a NDT inspection involving the use of a radioactive source are to receive training in that specific technique and be issued with an appropriate certificate by the Central Servicing Development Establishment, or, if the task is a DQAS(RAF) responsibility, by MOD, QAS Mech(RAF).

3. a. CSDE is responsible for preparing a Servicing Procedure for each task developed by them requiring the use of radioactive sources. A detailed list of the safety precautions to be observed is to be attached to this Servicing Procedure. CSDE is also responsible for assessing the various mechanical contingencies that may arise during each procedure that could constitute emergency situations, and are to detail the actions that are to be taken and to state by whom in respect of each hypothetical incident and, where such incident is considered to be beyond the capacity of the Competent Person in charge of NDT to rectify, this is to be clearly indicated. These emergency procedures are to be included as an addendum to the Servicing Procedure.

b. Sources required for NDT inspection tasks authorized by DQAS (RAF) are to be used in accordance with Inspection Procedures, Safety Precautions and Emergency Procedures approved by MOD, QAS Mech(RAF).

c. A copy of the Servicing/Inspection Procedure including technique, safety and emergency procedures, is to be handed to the Competent Person in charge of the NDT Team, and to the Radiation Safety Officer at the establishment concerned.

4. All personnel carrying out NDT radiography inspections are to be classified Class "A" Radiation Workers. They are to wear two film badges at all times when using the radioactive source. One is to be worn on the front of the body outside the clothing and one on the wrist of the hand normally used for the manipulation or on that part of the body immediately adjacent to the source container when it is being carried. A quartz fibre dose meter is also to be worn and the Competent Person is responsible for ensuring that all dose meters are serviceable and are charged and zeroed before operations commence, and that a recorded dose is entered on the F/Med 291D at the end of each working day or period.

5. The resident Radiation Safety Officer and the Station Medical Officer of the Unit on which radioactive sources are to be used are to be informed on all occasions when:

a. The radioactive source is brought on to the Unit.

b. It is intended to use a radioactive source for an inspection or handling practice.

c. When a radioactive source is transported from the Unit to another destination.

6. All Station personnel are to be made aware of the initial application of radiography on a Unit through the medium of Station Routine Orders. The Order, which should be repeated at 3 monthly intervals, is to detail the measures taken to prevent intrusion into the Radiation Area, and is to describe the warning signs used.

7. The Competent Person is to ensure that the Station Medical Officer is notified immediately when any individual receives, or is thought to have received, any exposure greater than laid down under current regulations.

8. No individual under the age of 18 is to be employed on any duties that would entail his categorization as a Class "A" Radiation Worker.

9. In the event of an emergency arising during the handling of a radioactive source, *eg* the source becoming trapped in the remote handling gear or becoming detached from its container, the area is to be evacuated of all personnel. The Competent Person in charge of the NDT team is then to initiate recovery action in accordance with paragraph 10 of the "R22B Container and Remote Handling Safety Precautions" issued with the technique. If this recovery action fails to return the source to its container the incident is to be reported to the Radiation Safety Officer who will assume command of the situation. The RSO is then to report the circumstances to the Command Radiation Safety Officer in accordance with Leaflet B3.

Warning Signals

10. Adequate warning to all persons in the vicinity shall be given by appropriate light or audible signals or both:

a. When a sealed source is about to be exposed.

b. While a sealed source is exposed.

The signals given in accordance with the foregoing are to be distinguishable from each other.

Handling

11. The Competent Person is to ensure that all team members are fully conversant with the safety precautions and inspection technique and that they are well practiced in the handling of the source and container with particular regard to emergency procedures. At all times when a radioactive source is in use, at least two persons trained in its use are to be present.

12. Immediately prior to a NDT inspection being carried out the Competent Person is to:

a. Calculate the safety distance with respect to "Incidently Exposed Workers" *ie* dose rate not to exceed 0.25 milli-rem per hour derived from the 0.5 rem per year laid down in Section C.

b. Calculate the maximum permissible handling times for the source in use.

c. Clear the area enclosed within the safety distance of all personnel not actively engaged in the NDT inspection.

d. Proceed with a practice run of the inspection and during this practice monitor the operations to check the dose rates and handling times.

e. With the source exposed, monitor the area to establish limits of the Radiation Area.

13. The Radiation Area is to be that area wherein the dose rate, derived from the maximum 0.5 rem per year (10 milli-rem per week), for incidentally exposed workers, exceeds the following:

a. When the total exposure for the radioactive source will be in excess of 4 hours and not more than 8 hours, 0.25 milli-rem per hour.

b. When the total exposure of the radioactive source will be in excess of 2 hours and not more than 4 hours 0.5 mr/hr.

c. When the total exposure of the radioactive source will be less than 2 hours, 0.75 mr/hr.

At no time is the limit of the Radiation Area to be at a dose rate level in excess of 0.75 mr/hr.

14. The Radiation Area is to be defined by a continuous barrier marked with suitable warning signs. The enclosed area is to be cleared of all personnel not actively engaged in the NDT inspections.

15. It is not to be assumed that walls and other structures within the Radiation Area afford any protection, the area behind the walls or structures is to be monitored and cleared of personnel if the dose-rate exceeds that laid down in paragraph 12. Where exposure is made in a closed room the external walls of the room are to be monitored and the safety barriers erected as necessary. In a multi-storied building, the floors above and below the operating floor are to be monitored.

16. The limits of the Radiation Area are to be calculated by the Competent Person in charge, and submitted to the Unit Radiation Safety Officer for approval prior to the exposure of the source. After approval, monitoring of the exposed source is to take place and safety limits, as defined in paragraphs 11 and 12 above, are to be established. These limits are to be certified as shown in Annex A by the Competent Person in charge and one other member of the team. One copy of the certificate is to be handed to the Radiation Safety Officer and a second copy is to be retained and filed by the NDT team.

Transportation

17. The following instructions are to be strictly complied with when a NDT radioactive source is being transported by road in the UK.

a. The Competent Person as detailed in paragraph 2 is to be present during the whole transportation operation and is to supervise it; he is to use a radiation monitor type EMI 0030 or NIS 295B to determine radiation levels.

b. All personnel directly engaged in the operation are to be Class "A" Radiation Workers.

c. The radioactive source is to be sealed in its proper container and the container is to be placed in an approved transportation box. The source is not to be carried in the same compartment as passengers or unexposed film.

d. The vehicle in which the source is to be carried is to display a warning notice in the driver's cab, the notice is to be of the form shown at Leaflet K4.

e. The supervisor of the operation is to monitor the vehicle and ensure that dose rates do not exceed:

(1) 2.0 mr/hr at the drivers seat

(2) 2.0 mr/hr at the passengers seat occupied nearest the source.

(3) 10 mr/hr at a distance of 2 metres from any external surface of the vehicle.

(4) Not exceeding 200 mr/hr at any accessible surface of the vehicle.

Dose rates are to be kept below these levels, if possible, by the use of extra shielding placed around the transportation box.

f. The resident Radiation Safety Officer, Station Medical Officer and MT Officer of both the parent unit and the unit of destination are to be advised of the intended move, the route to be taken and the expected time of arrival.

g. Throughout the journey the vehicle is to be restricted to a maximum speed of 40 miles per hour.

h. In the event of mechanical breakdown the Radiation Safety Officers and the MT Officers of the units concerned are to be informed; the vehicle is not at any time to be left unattended on the public highway or to be parked anywhere for more than 1 hour unless reasonable steps are taken to ensure that a clear space of at least 6 ft all around the vehicle is maintained during its stay.

j. An accident, including a fire in which the source container is in any way damaged is to be reported to the Civil Police in addition to the Officers mentioned in sub-paragraph f above. Radiation levels are to be checked and the area in which the dose rate exceeds 0.25 mr/hr is to be cleared of all persons whose presence is not essential; however, the presence even of a damaged or leaking radioactive package should not deter necessary rescue or fire fighting work.

k. The supervisor of the operation is to ensure that there is readily available written information which will provide the Police, Fire-brigade or other help, with information they may need about the nature of the radioactive material.

l. Where a journey exceeding 4½ hours is to be undertaken the route is to be planned so that breaks for meals *etc* can be taken at Service units.

The Service unit at which a stop is intended is to be pre-warned of the parking and security arrangements required.

CERTIFICATION OF THE RADIATION AREA AS DEFINED IN AP 4687A, VOL 2, LEAFLET F2

1. Certified that I have monitored the radiation level of the exposed radioactive source used in technique CSDE/ /GAMMA RAD/ and have established the radiation area in accordance with AP 4687A, Vol 2, Leaflet F2.

.....SIGNATURE

.....RANK

.....DATE

2. I have carried out an independent check of the radiation area defined above and certify that it is in accordance with the prescribed safety limits.

.....SIGNATURE

.....RANK

.....DATE

INSTRUCTIONS FOR THE USE OF RADIOACTIVE SOURCES USED IN THE RADIOACTIVE MISS DISTANCE INDICATOR (RAMDI) SYSTEM

(STC/26734/25042/MEGW, 13 August 1971)

Introduction

1. The radioactive sources used in this RAMDI system and used fitted to the missile, consist of Cobalt 60, as activated Cobalt Chloride, contained in a magnesium container fitted into a stainless steel mounting. For details of the individual sources used on particular missiles, refer to Annex A and B to this Leaflet. A test source used to check the target detecting equipment is also used. For details and instructions relative to the test source, refer to Annex C to this Leaflet.

2. The missile sources after firing or other disposal could present a radiation hazard and therefore they are normally fired over the sea, and, when disposed of as waste, are dumped into the sea. In order to ensure rapid dispersal of the Cobalt 60, the sources are designed to corrode and disperse in salt water in a very short time, the salt water initiating electrolytic action between the magnesium and stainless steel and so disintegrating the magnesium tube.

3. The handling and fitting of the sources to the missile and the presence of the "tagged" missile on the aircraft, present a radiation hazard due to gamma radiation, while the fact that the sources are designed to disintegrate in salt water, gives rise to the possibility of a contamination hazard from an unsealed source.

4. These radioactive sources are expensive and occasions will arise when sorties are abandoned or other circumstances will necessitate that sources, once taken from their container and fitted to the missile, have to be removed from the missile. In the United Kingdom, if the source and its immediate container are fully serviceable, the assembly can be re-used; if corrosion or other causes render it unserviceable it must be disposed of by sea-dumping in a prescribed area. The decision as to whether a source is fit for re-use, rests with the Unit Radiation Safety Officer. Because of the more extreme climatic conditions likely to be experienced in certain overseas areas, it has been decided that the re-use of sources is not permissible overseas and therefore in such areas sources once removed from the storage container must be used or disposed of as radioactive waste: disposal is to be in accordance with AP 4687A, Vol 2, Leaflet N10 and paragraph 29 below.

5. All orders in this publication relating to the control and use of radioactive substances are to be strictly complied with in the handling and use of these sources.

Storage

6. The sources are delivered to the unit in a "sealed" transit and storage container which holds the sources for one missile and this container will be located inside a metal drum "Type A" package; unserviceable sources for disposal are contained in a disposal container pending disposal. The sources and containers are to be stored in the Radiation Storage Area in accordance with Leaflet E1 until required for use or disposal. Particular attention is to be given to ensuring that the storage building is kept dry.

Register of Sources

7. A register of sources is to be maintained in accordance with AP 4687A, Vol 2, Leaflet D1.

Handling and Transportation Procedure

8. Radioactive sources used with the RAMDI system are not to be removed from the Radioactive Storage Area, exposed or removed from the special containers, except under the direct and continuous supervision of a Competent Person trained in accordance with Leaflet M1.

9. All personnel directly involved in the handling of the RAMDI radioactive sources are to be classified as Radiation Workers Class B. They are to wear a film badge when working with or near the sources, the badge is to be worn on the front of the body, outside the clothing.

10. Only personnel who have been authorized by the Radiation Safety Officer for these sources are permitted to carry out any operations or work involved with the RAMDI sources or handling equip-

ment. These personnel are to be familiar with the relevant orders and safety regulations in respect of radioactive sources contained in AP 4687A Vol 2 and local orders, and are to be trained and practiced in the use of the RAMDI sources and handling equipment. One member of the team handling the RAMDI sources is always to be a Competent Person, or NCO rank or equivalent status, qualified in accordance with Leaflet M1.

11. The Competent Person is to ensure that the Station Medical Officer is notified immediately when an individual receives or is thought to have received an exposure greater than that laid down under current regulations. ~~(DCI, S165/1970 (RAF))~~ ie in Section C.

12. In the event of an emergency arising during the handling of a source, *ie* damage to a source, or difficulties encountered in the fitting or removal of a source, the area is to be cleared of personnel and the Radiation Safety Officer or his deputy is to be informed immediately. The RSO will take the appropriate action in accordance with Leaflets B3 and F1.

13. When RAMDI sources are being fitted, or are fitted, to an aircraft missile, a barrier is to be maintained around the aircraft, the barrier is to be positioned at 12 metres for the Firestreak/Red Top missiles and 17 metres in the case of the Sparrow/Sidewinder missiles. Warning notices are to be displayed and the warning notices are to include the trefoil sign. Access to this controlled area is to be strictly limited to those personnel directly involved in the exercise.

14. The RAMDI sources are to be fitted at the last practical moment before take-off. If a sortie is cancelled or the aircraft returns with unexpended missiles, the sources are to be inspected by the Radiation Safety Officer and removed as soon as possible. No aircraft servicing is to be carried out when radioactive sources are fitted to the missile, with the exception of emergency or other essential procedures; such actions are to be monitored by the Radiation Safety Officer or his deputy.

Handling and Transportation Equipment

15. Details of the equipment required to handle and transport the radioactive sources can be found in the annexes to this leaflet. A full description of the equipment and its use is given in AP 116H-0301-14.

Transport of Containers by Hand

16. The sources are delivered to the unit in a sealed transit and storage container which holds the sources for one missile; these containers are retained inside "Type A" packaging. The containers, which may be removed from inside the "Type A" packaging, are to be stored in the Radioactive Storage Area until required for use. When the sources are required for use, the sealing is to be removed from the container and the container is to be fitted into the frame assembly; the containers is then to be transported to the aircraft for fitment of the sources. Carrying handles are to be used with the container and frame assembly when transporting the Firestreak/Red Top sources by hand unless the distance to be travelled is a very short one or the use of the handles is otherwise impracticable.

Transport by Road and Sea

17. Transportation of the RAMDI sources by road and by marine craft or otherwise at sea, is to be carried out in accordance with the relevant instructions in Section K. The Radiation Safety Officer is to issue orders to meet the requirements for local conditions, the instructions contained in Section K being adapted to apply to transport by marine craft, if necessary.

18. RAMDI sources are normally to be transported in their exterior Type A packaging (The Amersham Drum type Type A Package). This package is to be correctly labelled in accordance with Section K.

19. When transport of RAMDI sources is necessary over short distances and in circumstances where the Amersham Drum type Type A Package is not available or is inconvenient to use, a Competent Person is to be present throughout and is to supervise the transportation procedure.

20. In all road transportation of RAMDI sources the following radiation levels are not to be exceeded:
    a. 2.0 mr/hr at the driver's seat and the passenger's seat nearest to the source.
    b. 10 mr/hr at a distance of 2 metres from any external surface of the vehicle.
    c. Not exceeding 200 mr/hr at any accessible surface of the vehicle.

21. No photographic materials, explosives, food or drink, or passengers not involved in the handling of the sources, are to be carried in vehicles transporting these sources.

22. Any accident involving damage to the source container is to be reported immediately to the Radiation Safety Officer.

Detailed Fitting and Removal Procedures

23. Detailed fitting and removal procedures are given in AP 116H-0301-4 as follows:

a. *Section* 1. Handling procedure for radioactive sources used with Red Top and Firestreak missiles.

b. *Section* 2. Handling procedures for radioactive sources used with Sparrow and Sidewinder missiles.

Assessment of Serviceability of Exposed RAMDI Sources (Applicable to United Kingdom Only)

24. The responsibility for deciding whether to re-use a source which has been exposed or to classify it as unserviceable, rests with the local Radiation Safety Officer. The RSO should take the following factors into consideration in making his decision:

a. The sources are designed to disintegrate and disperse in sea water after four hours immersion.

b. Condensation from a salt-laden atmosphere in coastal areas can initiate decomposition of the magnesium container.

c. In the case of a tagged missile which has been airborne, rapid changes of altitude can induce condensation on the source container.

d. The time spent exposed, the prevailing winds and weather, the location of the aircraft *etc*, must also be considered—if the RSO has any reasonable doubt about the serviceability of the source, he should classify it unserviceable: on the other hand, under favourable conditions re-use of the sources can be authorized and this will result in considerable economy.

25. a. Sources removed from the missile or otherwise exposed and subsequently deemed suitable for re-use are to be rinsed in Dehydrated Alcohol (Sect/Ref 6505-99-210-0051) and allowed to dry in air before replacement in the source container.

b. Sources removed from a missile or otherwise exposed and subsequently classified as re-usable are to be returned to their original container; the container is to be clearly marked to show that the sources have been used and also with the date of such use. The container is to be returned to the Storage Area immediately. If sources classified as re-usable are not used within seven days, they are to be transferred, without delay, to a disposal container and are to be disposed of as corroded sources within 30 days of their initial exposure for use.

26. Following transfer of the used sources to the disposal container, the empty source container and handling equipment must be checked for radioactive contamination. If the equipment is contaminated, it is to be decontaminated to an acceptable level. (*See* para 36.)

27. All disposal containers holding sources are to be wire-locked and the container is to be labelled with details of its contents and the final date for disposal.

MOD Instructions for the Disposal of Unserviceable RAMDI Sources in the United Kingdom

28. Sources that are corroded or otherwise unserviceable, are to be disposed of by sea-dumping and this is to be effected within an area of the sea having the following co-ordinates; the disposal is normally to be made from a RAF marine craft.

53° 23′—4N	04° 48′—4W
53° 23′—4N	04° 45′—0W
53° 19′—0N	04° 45′—0W
53° 16′—5N	04° 48′—4W

MOD Instructions for the Disposal of Unserviceable RAMDI Sources Overseas

29. The disposal of unserviceable sources overseas is to be in accordance with local national regulations where such regulations exist. Where local national regulations do not exist the following action is to be taken subject to the agreement of any recognized local authority.

a. The sources for disposal are to be sunk in deep sea water using the procedure and equipment detailed in AP 116H-0301-4.

b. The precise deep sea area in which disposal takes place is to be decided by the Command Engineering Armament Staff in consultation with the local British Naval Authorities.

c. The criteria in selecting the area of sinking is that the radioactive waste will not be washed ashore.

d. Arrangements for the disposal of radioactive waste in commands abroad are to be approved by the Competent Medical Authority.

30. If circumstances are such that disposal as above is not practicable, disposal instructions should be requested from MOD SS6b (RAF) in accordance with Leaflet N10.

Six-Monthly Return of Disposals

31. Radioactive sources, deposited as waste are not to exceed 4·0Ci in one year in any theatre and a return is to be rendered by the 1 January and the 1 July each year to MOD MA4a(RAF), certifying, in respect of the preceeding 6 months:

a. The number of sources disposed of.

b. The estimated total activity.

c. The co-ordinates of the site where the disposals were effected.

Additional Precautions

32. Personnel engaged in handling sources are to refrain from smoking, eating or drinking during any handling procedure and after it until the hands have been washed with soap and hot water.

33. As soon as it is known that there is the possibility of a source becoming unsealed or of contamination arising from any cause, action must be taken in accordance with Leaflet F1 paragraph 11; this entails the use of gloves and other precautions dependent upon the extent of the hazard.

Empty Containers

34. Empty source containers are to be checked for radioactive contamination and decontaminated as soon as possible after the sources have been removed and also immediately prior to return to industry.

Tools and Equipment

35. Tools and all equipment, including stores to which sources have been fitted, are to be checked for contamination and, if necessary, decontaminated as soon as possible after use with sources. All empty RAMDI containers including "Type A" packagings are to be decontaminated to the level stated in paragraph 36 below before despatch from the Unit at which the Radioactive sources were removed; they are to be treated as "empty packages which have contained radioactive material" in accordance with AP 4687A, Vol 2, Section K.

Decontamination

36. Contaminated equipment should be wiped with disposable tissue or washed in detergent until the acceptable level as stated below is reached.

a. There must be no smearable (loose) contamination.

b. Fixed contamination must not exceed that giving 8 CPS above background when using a Radiation Monitor 1320X as instructed in AP 4883, Vol 1, Chapter 1, Paragraph 25, sub-paragraph 3.

37. All decontamination is to be carried out by or under the direct supervision of a suitable Competent Person.

Decontamination in the event of the release of a source

38. Under certain circumstances the activated Cobalt Chloride in the source capsule could be released and it would then present a significant radiation hazard.

Possible circumstancesare as follows:

a. Structural damage to the source capsule caused by mishandling whilst on the missile, in the source container, or elsewhere.

b. Disintegration or corrosion of the source capsule due to unforeseen exposure to salt and/or moisture. This is most likely to happen in the source container.

39. In the event of such a release occuring the incident is to be reported immediately to the RSO and all necessary action is to be taken in accordance with Leaflet Q1.

40. All work carried out is to be done under the direct supervision of the RSO and in accordance with the general provisions of Leaflet Q1 and F1. The precise circumstances of such an incident will vary but the following general principles apply to these sources:

a. The first action by anybody present if such a source is broken is to get up-wind of the source and to avoid inhaling any powder or pellets released.

b. Decontamination is to start as soon as possible and the decontaminating team, who should be the only people in the radiation area, are to wear face masks, headware, gloves, overalls buttoned and tightened at the waist and ankle, overshoes or rubber boots and film badges.

The first step should be intended to contain the activity by covering the ground below and adjacent surfaces with polythene sheeting.

c. The damaged capsule and container should be removed using the normal tool and should be placed in the aluminium can in the disposal container.

d. The residual radioactive material should be removed by swabbing with pads of cotton wool soaked in dehydrated alcohol.

The pads must be applied by some remote handling method, *eg* by lashing them to a stick at least 2 feet long with elastic or by other means.

All radioactive waste so generated must be placed in a polythene bag for disposal.

e. Swabbing in this way should proceed until the dose rate is reduced to a level at which the area can be hand wiped clean using the same materials. Decontamination should proceed until all areas reach the 8 CPS level given in paragraph 36. At the conclusion of this action all clothing and equipment used should be monitored, decontaminated and/or disposed of in accordance with current procedures.

41. If serious contamination involving the release of one or more capsules occurs inside a disposal or source container, the container should be closed, sealed inside a strong polythene bag, (the bag initially supplied could be used) and placed in the radioactive stores for subsequent decontamination at a place to be determined by MOD.

42. All releases are to be reported in accordance with leaflet Q1 and the foregoing is to be considered as supplementary to the action required by leaflet Q1, the details of which are to be complied with fully. Body film badges must be worn by all personnel engaged in this decontamination work and full records of the individuals concerned, procedures and times, are to be maintained by the RSO.

RADIOACTIVE SOURCES USED ON THE RED TOP AND FIRESTREAK MISSILES

General

1. Radioactive sources used in the RAMDI system referred to in this annex are fitted as a set of four to a missile and have a combined nominal activity of 50 mCi. The radioactive material Cobalt 60, as activated Cobalt Chloride, is contained in a magnesium tube fitted into a stainless steel mounting; each source has a nominal activity of 12.5 mCi.

Handling and Transportation Equipment

2. The following equipment is provided with this RAMDI system and only authorized equipment is to be used to handle the sources and source containers. A full description of the equipment and its use is given in AP 116H-0301-14.

a.	Container Source Transportable	Ref 12Z/1427617
b.	Frame Crate Carrying	Ref 12Z/1427612
c.	Handles Carrying	Ref 12Z/1427613
d.	Tool kit comprising: Tool handling Magnetic Tool Drawer Opening	Ref 12Z/0015133
e.	Container disposal outer	Ref 12Z/1427615
f.	Container disposal inner	Ref 12Z/1427614
g.	Disposal tool	Ref 12Z/1141891

3. The Frame Assembly must be fitted when transporting the source container or disposal container.

Detailed Fitting and Removal Procedures

4. Detailed fitting and removal procedures are given in AP 116H-0301-4 as follows:

a. Procedure for fitting the sources to the missile—Section 1, Chapter 2.

b. Procedure for removal of re-usable sources from the missile—Section 1, Chapter 3.

c. Procedure for removal of corroded sources from the missile—Section 1, Chapter 4.

d. Procedure for transferring sources from the source container to the disposal container—Section 1, Chapter 5.

e. Procedure for disposal of corroded sources—Section 1, Chapter 6.

Levels of Radiation

5. Although maximum permissible levels of dose rate for personnel handling these sources have been defined, every effort must be made to keep below those levels. The following list of approximate radiation levels associated with the RAMDI sources is provided as a guide:

Source Container (fully loaded)	—	at 1 metre	0.5 mr/hr
Source Handling Tool (loaded with source)			
Dose Rate to Hand	—		10 mr/hr
Disposal Container (loaded 4 sources)	—	at 1 metre	1.5 mr/hr
Missile fitted with four sources	—	at 1 metre from missile centre	75 mr/hr

RADIOACTIVE SOURCES USED ON THE SPARROW AND SIDEWINDER MISSILES

General

1. Radioactive sources used in the RAMDI system referred to in this annex are fitted one to a missile and have an nominal actively of 50-60 mCi.

The radioactive material Cobalt 60, as activated cobalt chloride, is contained in a magnesium tube fitted into a stainless steel mounting.

Handling and Transportation Equipment

2. The following equipment is provided with this RAMDI system and only authorized equipment is to be used to handle the sources and source containers, a full description of the equipment and its use is given in AP 116H-0301-14.

a. Source Handling tool
b. Source Container
c. Disposal Tool 12Z/1141 891
d. Container Disposal Outer 12Z/1427615
e. Container Disposal Inner 12Z/1427614
f. Frame Crate Carrying 12Z/1427612
g. Handles Carrying 12Z/1427613

3. The Frame Assembly must be fitted when transporting the Disposal Container.

Detailed Fitting and Handling Instructions

4. Detailed fitting and removal procedures are given in AP 116H-0301-4 as follows:

a. Procedure for fitting the source to the missile—Section 2, Chapter 2.
b. Procedure of removal of re-usable sources from the missile—Section 2, Chapter 3.
c. Procedure for removal of corroded sources from the missile—Section 2, Chapter 4.
d. Procedure for transferring sources from the source Container to the Disposal Containers—Section 2, Chapter 5.
e. Procedure for disposal of corroded sources—Section 2, Chapter 6.

Levels of Radiation

5. Although maximum permissable levels of dose rates for personnel handling these sources have been defined every effort must be made to keep below those levels. The following list of approximate radiation levels associated with the RAMDI sources is provided as a guide:

Source Container (fully loaded *ie* 1 source)	at 1 metre	1·5 mr/hr
Source Handling Tool (loaded 1 source)	dose rate to hand	60 mr/hr
Disposal Container (loaded 1 source)	at 1 metre	2·0 mr/hr
Missile fitted source	at 1 metre	120 mr/hr

CALIBRATOR RADIAC (12Z/6665 99 107 6547)

General

1. The radioactive source referred to in this Annex is sealed in a shielded container and is described in AP 116H-0301-1. The radioactive material is Cobalt 60 and has a nominal activity of 250 micro Ci. All regulations applicable to sealed sources contained in AP 4687A Vol 2 apply to these sources which, under no circumstances, are to be treated as "weak sources". Attention is drawn specifically to the following.

Storage

2. The calibrator radiac is to be stored in the Radioactive Storage Area in accordance with Leaflet E1 until required for use.

Register of Sources

3. A register of sources is to be maintained in accordance with Leaflet D1.

Handling

4. The calibrator radiac is not to be removed from the radioactive storage area by any person other than a "Competent Person" trained in accordance with Leaflet M1.

5. All personnel carrying out servicing procedures involving the calibrator radiac are to wear a film badge when using the calibrator radiac, the badge is to be worn on the front of the body out side the clothing.

6. The Competent Person is to ensure that the Station Medical Officer is notified immediately when an individual receives or is thought to have received an exposure greater than that laid down under current regulations ~~(DCI S165/70 (RAF) refers~~).

7. An area around the working site of at least 1 metre radius from the calibrator radiac is to be enclosed by a physical barrier. Only personnel directly and necessarily involved are to be allowed within the controlled area enclosed by the barrier. The boundary of the controlled area is to be marked with prominently displayed warning notices (as detailed in Leaflet E1).

8. The calibrator radiac is only to be removed from the radioactive storage area when required for use, and is to be returned immediately after use. The shutter is to be opened only for sufficient time to allow the relevant checks to be carried out.

9. At no time is any person to be allowed to linger within 1 metre of the front face (Trefoil sign) of the calibrator radiac when the shutter is open.

Transportation

10. Transportation of the source is to be in accordance with AP 4687A Vol 2, Section K.

Operating Instructions

11. Detailed operating instructions are given in Radioactive Miss Distance Indicator, CSDE Schedule, Provisional Parts 1-4 and Part 6.

Levels of Radiation

12. Although maximum permissible levels of dose rates for personnel handling radio-active sources have been defined every effort must be made to keep below these levels. The following list of approximate radiation levels associated with the calibrator radiac source is provided as a guide:

Dose rate at surface—shutter closed	1 mr/hr
Dose rate 0·3 m from shutter—shutter open	1·5 mr/hr
Dose rate 0·6 m from shutter—shutter open	0·4 mr/hr

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GASEOUS TRITIUM LIGHT SOURCES (GTLS)

(D/DDC Med(RAF)/13/1/3/MA4a(RAF) – October 1979)

General

1. A Gaseous Tritium Light Source (sometimes known as a Betalight) consists of a sealed glass container filled with gaseous tritium and coated internally with a phosphor. When one or more GTLS is incorporated into an instrument, piece of equipment or a sub-assembly, the whole is known as a Gaseous Tritium Light Device (GTLD).

2. Tritium gas is a pure beta emitter, the energy of the beta particles being such that it is completely dissipated in the walls of the GTLS container. The external dose rate from GTLSs is due solely to bremsstrahlung and, in existing applications, is so low that it may be discounted.

3. Over a period of time the luminance of a GTLS decays such that after six years it is approximately only 50 per cent of its initial value. Since this decay occurs irrespective of whether in use or storage, excess quantities should not be stored.

Defence Standard 62-4 Issue 3

4. This Def Stan specifies the material, manufacturing and other requirements for GTLSs for MOD use. It also lists the safety considerations which must be applied to the introduction, transportation and disposal of GTLSs.

Introduction of GTLSs into RAF Use

5. Proposals to include GTLSs in new or existing RAF equipment must be approved by the MOD (RAF) Radiation Health and Safety Committee (Leaflet B1). The following information will be required by the committee:

a. The number of GTLSs to be used in the available air volume.

b. Details of GTLSs including housing, mounting and individual and aggregate tritium content.

c. Proximity of GTLSs to personnel.

d. Details of normal and available emergency ventilation of the area.

6. Approval for use will normally be based on the following principles:

a. No reasonable or practicable alternative exists.

b. The number of GTLSs and their total tritium content shall be the minima necessary to provide the desired illumination having regard to luminance decay (para 3).

c. The installation shall be such that only very severe damage or misuse could cause the breakage of a GTLS.

Storage

7. Spare GTLSs and/or GTLDs are to be stored within a store of non-flammable construction which is ventilated, dry and adequately secured. Unit Fire Orders should specify that the location of GTLSs should be known to the fire staff in order that closed-circuit breathing apparatus is worn in the event of a fire.

Accidental Breakage

8. If a GTLS containing more than 1.85 gigabecquerels (GBq) (50 millicuries) of tritium gas (typically 1 to 2 mm dia 10 mm long) is accidentally broken in an enclosed space, the following actions are to be taken:

a. Extinguish any smoking materials and naked flames.

b. Open all doors and windows in the room affected and switch on any extractor fan(s).

c. Evacuate the room if it is less than 10 000 cu ft; if the room is larger, evacuate the immediate area. Do not return for 30 minutes.

d. After 30 minutes dispose of the broken GTLS as described in para 9.

Disposal

9. The approved method of disposal for GTLSs is to return them to the manufacturer (Messrs Saunders Roe Developments Ltd, Millington Road, Hayes, Middlesex (Tel 01-573 3800)) who operate a free disposal service. However, in exceptional circumstances and under direct supervision of the RSO, statutory regulations allow individual GTLSs containing not more than 74 GBq (2 Ci) of tritium gas to be disposed of by breaking the sealed glass container in the open air and letting the gas escape. The broken container is to be left untouched for 30 minutes after which time the broken fragments are to be placed in a strong bag, using indirect handling methods, and disposed of with the ordinary refuse. Not more than ten glass containers are to be broken on a premises in any one week.

10. Disposal of GTLSs which individually contain more than 74 GBq (2 Ci) of tritium gas are to be referred to HQ RAFSC (Unit Supply 2) in accordance with Leaflet N3.

Transportation

11. Transportation of GTLSs is to be carried out in accordance with Section K.

Accounting

12. Although GTLSs containing up to 74 GBq (2 Ci) of tritium gas do not require the full source register procedure detailed in Leaflet D1, RSOs are to ensure that a list showing unit holdings of GTLSs is maintained. This list should include the following information:

a. Location.

b. Type, quantity and activity of GTLSs.

c. Date and method of transfer or final disposal.

13. The RSO is to conduct an annual audit to satisfy himself that the accounting is effective.

SECTION G

USE OF X-RAY MACHINES

SECTION G

USE OF X-RAY MACHINES

CONTENTS LIST

INSTRUCTIONS FOR THE USE OF X-RAY MACHINES

(AF/CX 384/74 MA4a(RAF)—January 1974)

Introduction

1. An X-ray machine generates ionizing radiation and can therefore be a source of danger to persons if incorrectly used.

2. Before any apparatus generating and using X-rays is introduced for Service use, action is to be taken by the sponsor to obtain the approval of the MOD(RAF) Radiation Health and Safety Committee for such use. It is also necessary for the sponsor to prepare draft radiation safety instructions for the use of the equipment concerned and, in the instance of portable or transportable X-ray equipment, a draft scheme of work; the drafts are to be submitted to DHR(RAF) for approval before issue. The approved safety precautions and scheme of work are to be made effective at the work site and are to ensure compliance with the general radiation safety criteria and regulations given in this Air Publication and, where appropriate, with the relevant Code of Practice.

3. The instructions contained in this AP are compatible with the Ionizing Radiation (Sealed Sources) Regulations 1969; these regulations govern the use of X-ray machines and should be consulted as necessary.

4. Codes of practice are published detailing the radiation safety precautions necessary with certain specific uses of X-rays and some of these codes are listed below; any incompatibility noted between the requirements of a Code of Practice and this AP should be reported.

a. Code of Practice for the Protection of Persons against Ionizing Radiations arising from Medical and Dental use.

b. Code of Practice for the Protection of Persons exposed to Ionizing Radiations from Veterinary uses.

c. Code of Practice for the Protection of Persons exposed to Ionizing Radiations in Research and Teaching.

General Instructions for the Use of X-ray Machines

5. The following instructions cover the use of X-rays in general and are to be complied with wherever X-rays are used. In specific instances additional instructions will be necessary to cover particular circumstances and local requirements; guidance on these aspects can, if necessary, be obtained from the Code of Practice or through normal channels from DHR(RAF).

6. **The X-Ray Equipment.** The X-ray equipment and, if provided, the walled enclosure or cabinet, or any other form of biological shielding must conform to the recommendations of the Ionizing Radiation (Sealed Sources) Regulations 1969; a statement to this effect must be included in the relevant supply contract. These regulations do not apply to medical X-ray equipments.

a. *Design of Cabinet.* The above regulations include the following:

(1) Where a walled enclosure or cabinet is provided the control panel must be located outside the enclosure or cabinet to ensure that the operator receives a nil dose during exposure procedures.

(2) There must be means of easy exit from the enclosure or cabinet and a means whereby a person concerned can quickly control the source of radiation.

(3) There must be screening inside the cabinet appropriate to the circumstances.

(4) Where necessary suitable means of communication must be provided and maintained to enable a person shut inside a cabinet or wall enclosure to summon help from outside.

(5) Effective devices shall be provided to ensure that if a door or aperture of an enclosure is opened whilst the equipment contained inside is energized, the equipment will be de-energized and cannot be re-energized whilst the door or part is open.

b. *Warning Signals and Notices.*

(1) Adequate warning to all persons in the vicinity shall be given by appropriate light or audible warning signals or both when a machine is about to be energized and also additionally while it is energized; the signals shall be separate and distinguishable for each purpose and shall be arranged to operate automatically.

(2) Suitable warning notices capable of being easily read by persons in the vicinity and also the basic ionizing radiation symbol (to BS3510–1968) shall be displayed when ionizing radiations are about to be used or are being used in an enclosure or marked radiation area.

Operating Precautions

7. The X-ray equipment is to be operated generally in accordance with AP 4687A, Vol 2; attention is particularly drawn to Section C giving instructions for the medical supervision of personnel exposed to ionizing radiations and also to Sections A, B, G and M.

8. **Personnel.** One or more Competent Persons (CPs) qualified in accordance with Leaflet M1 are to be appointed to exercise supervision of X-ray procedures. Operators are to be classified as Radiation Workers in accordance with Section C and are to be adequately trained concerning their duties with the equipment that they operate.

9. **Instrumentation and Monitoring.** All personnel working with X-ray equipment are to be classified as Radiation Workers in accordance with Leaflet C2 and are to wear film badges.

10. A Radiation Monitor Type NIS 295B (6Z/1116865) or other type of monitoring instrument approved for this purpose is to be held or readily available on units where X-ray equipment is in use and the full serviceability of the instrument is to be ensured.

11. A radiation survey is to be carried out by a CP whenever an X-ray machine is installed or whenever there is cause to think that the radiation hazard may have changed, *ie* after repair, adjustment, *etc.*

12. **Radiation Area.** As stated earlier the radiographic set-up must be completed before the source is energized; the doses likely to be received by the operators are to be carefully assessed and the radiation area, *ie* where the dose rate will exceed 0.75 mr/hr is to be defined. When the radiation area has been defined by a barrier and marked with the ionizing radiation symbol, it must be cleared of all personnel not essential for the conduct of the work in hand before the X-ray equipment is energized and the dose rates in the area must be checked using a serviceable dose rate meter; if necessary the barrier position must be adjusted.

13. **Direction and Size of Useful Beam.** The useful beam shall be directed away from adjacent occupied areas; it is to be limited by appropriate means to the minimum size reasonably necessary for the task and where appropriate, suitable means are to be taken to limit scattered radiation. Special care must be taken with portable X-ray machines to ensure that this concept is strictly honoured.

14. **Screening and Protective Clothing.** Effective arrangements are to be provided, maintained and used to prevent the unintentional insertion of any part of the body into a useful beam; where required with specific equipment, protective clothing, screens or other special equipment is to be maintained and used.

15. **Incidents.** In the varied applications of X-ray machines, circumstances will arise in which things will go wrong and apparatus will malfunction. Where appropriate, *eg* in the case of security X-ray systems, the possibility that such incidents will occur should be envisaged and the details of pre-arranged procedures to rectify forseen faults should be readily available and should be used when necessary so that excessive exposures or other difficulties arising from such causes can be avoided. Where pre-arranged rectification procedures are prepared in accordance with the foregoing, they are in all instances, to be approved in writing by a RSO or CP. Attention is drawn to Leaflet B3 giving incident reporting instructions.

16. **Security.** Adequate action is to be taken to ensure that the equipment is secured by lock and key against unauthorized use.

17. **Servicing.** Where possible the equipment is to be maintained by the manufacturer under contract, where this is not so, approved arrangements must be made so that the equipment will be inspected and serviced as necessary with the object of maintaining or improving upon its initial radiation safety status.

SAFETY PRECAUTIONS FOR INDUSTRIAL X-RAY EQUIPMENT USED BY NDT PERSONNEL

(AF/CX 384/74 MA4a (RAF)—September 1976)

1. An X-ray machine generates ionizing radiation and can therefore be a source of danger if incorrectly used due to the adverse effect on the human body of the ionizing radiations which are generated.

2. NDT industrial X-ray equipment, as listed in Annex A, is to be operated only by Competent Persons as defined in Leaflet B1. They are to be qualified as Competent Persons by successful completion of the Central Servicing Development Establishment NDT Technician's Course, or such other approved course as laid down in Leaflet M1.

3. All members of NDT radiographic teams are regarded as Class A Radiation Workers as defined in Leaflet C2. Medical supervision is to be exercised in accordance with Leaflet C3.

4. At Stations where NDT radiography is carried out, personnel are to be made aware of this activity through the medium of Station Routine Orders; the order is to be repeated at 3-monthly intervals. The order is to detail the method to be used for defining the danger area and the warning notices and signals to be displayed.

5. General instructions for the use of X-ray machines are contained in Leaflet G1 and the following safety precautions are to be observed during the operation and testing of all NDT X-ray equipment:

a. A senior NCO is to be specifically detailed to ensure compliance with these precautions at all times when the equipment is in use.

b. Film badges are to be worn by all members of the X-ray team. In addition a radiation monitor NIS 295B (6Z/1116865) or a radiation monitor EMI 0030 (6Z/1036048) is to be available. "Before Use Servicing" on the instrument is to be carried out in accordance with AP 112G-1314 or 1303, as applicable.

c. The control panel is to be positioned a minimum of 60 ft from the tube as follows:

(1) Unidirectional tube—directly behind, or, if impracticable, to the side of the useful beam.

(2) 360 degree emitter—in line with the longitudinal axis, at the cable end of the tube.

d. The operator at the control panel is to have a clear view of the radiation area. Where this is not possible, other team members of local personnel acting as "Safety Men" are to prevent the entry of persons into the radiation area during exposure. They are to be placed outside the radiation area in such a position that they can warn the control panel operator of the presence of persons in or near the radiation area prior to exposure. The control panel operator is not to leave the panel unattended at any time during exposure.

e. Immediately prior to operating the X-ray equipment, the senior NCO IC is to assess the area where the dose rate is liable to be in excess of 0·75 mr/hr. This area is to be designated as the Radiation Area and is to be clearly defined by the erection of a safety barrier marked with the ionizing radiation symbol. Suitable warning notices are to be displayed on or near the barrier.

f. The radiation area is to be cleared of all personnel not actively engaged on the radiographic inspection, paying particular attention to possible "hideaways" *eg* bomb compartments, undercarriage compartments, cockpits *etc.*

g. During the first exposure the senior NCO IC, using a radiation monitor, is to check the radiation level at the control panel, establish the limits of the radiation area (the area where the dose rate will exceed 0·75 mr/hr) and reset the safety barriers as necessary. It is not to be assumed that walls, floor, ceilings and other structures within the radiation area afford adequate protection from ionizing radiations. The area behind walls and structures is to be monitored and cleared of personnel if the dose rate exceeds 0·75 mr/hr. Due attention is to be paid to scattered radiation from the structure being examined, and from the building housing the structure. Under no circumstances is the radiation area limit to be set at a dose rate level in excess of 0·75 mr/hr.

The senior NCO IC must be aware of the dose rates likely to be received by the operators and is to ensure that these dose rates are not greater than those laid down in current regulations. Where walls or structures form the boundary of the radiation area, any doors or apertures in the wall or structures are to be locked, or other appropriate action taken to preclude inadvertent entry to the radiation area during exposure.

h. The exit port of the X-ray tube is to be covered with a lead cap during the "warming up" procedure. During exposures limiting shutters are to be fitted to the exit port where practical.

j. Any exposure to ionizing radiation is potentially harmful and the effects may not be immediately apparent. The senior NCO IC is to ensure that the Radiation Safety Officer is immediately notified when any individual receives, or is thought to have received, any exposure greater than that laid down under current regulations.

NDT INDUSTRIAL X-RAY EQUIPMENT

Sect	*Ref*	*Description*
63A	154	Andrex 260 KV
63A	156	Fedrex 160 KV
63A	171	Andrex 160 KV/360° Emitter
63A	172	Andrex 150 KV
63A	190	Raymac 50 KV
63A	191	Andrex 200 KV
63A	199	Andrex 80 KV
63A	200	Andrex 250 KV
63A	220	Andrex 150 KV BW
63A	228	Andrex 130 KV CP
63A	231	Phillips Didactix
63A	244	Andrex 160 KV
	NIV	Picker Hotshot 110 KV
63A	289	Gilardoni 80 KV
	NIV	Gilardoni 160 KV

RADIATION SAFETY INSTRUCTIONS FOR THE USE OF THE EXOREL X-RAY FLUOROSCOPE MODEL FL2

(AF/CX 384/74 MA4a(RAF)—March 1975)

Introduction

1. The Exorel X-Ray Fluoroscope Model FL2 which is designed for fluoroscopic inspection of parcels, packages, letters, and similar objects is in use in the RAF under the control of the Provost Marshal (RAF). It has been introduced into service for the purpose of searching suspicious items of mail without disturbing their contents or opening them and it will enable a trained operator to discover the presence of weapons, ammunition, or Improvised Explosive Devices (IEDs). The equipment is to be operated only by personnel who have been trained in its correct and safe operation to an approved standard.

Specification

2. The FL2 consists of a lead lined cabinet which houses an X-ray head mounted at the top with the X-rays beaming downward; the X-ray tube, which is oil cooled, operates in a continuous mode at 50–80 KV and 8mA. A multicore cable connects the X-ray head to the control unit which is housed at the bottom of the cabinet. A flap door gives access to the exposure section of which a fluoroscopic screen forms the base. The back of this screen which is white and covered with a sheet of clear perspex is visible. Below the fluoroscopic screen and facing a lead glass window is a front aluminized mirror. The metal plate covering the lead glass window should be taken off by unscrewing the knurled nuts and replaced with the eyepiece from inside the exposure section. The metal cover plate is then stowed inside the exposure section.

3. Delivered as a separate item is a remote control unit with red and green press-button switches and signal lights. mounted on a 12 metre cable with a plug which fits into a socket on the control panel. Also separate are 2–6′ x 1½″ dia lifting bars each with a collar 2′ from one end; and below the cabinet, running from side to side are two steel channels. For moving or lifting the cabinet one bar is inserted from the left and one from the right-hand side so that the collars act as stops and prevent it from sliding on the lifting bars. To have a convenient working height, the FL2 should be placed on a stout desk or bench. It requires no services other than a single phase 220/240 Volt AC 50/60 Hz only electricity supply with a perfect earth; this protects the operator and the equipment.

Operating Instructions

4. **Position of the Unit.** The X-ray head inside the cabinet is cooled by air which passes in through a grille at the left-hand side of the cabinet and out through a grille at the top. It is important therefore that there should be an unimpeded air supply to these two grilles.

5. **Mains Connection.** The mains cable has the British Standard colour coding. Brown should be connected to live, blue to neutral, and yellow/green to earth. The power consumption is 3.4 amp at top kV (Penetration No 4) and 8 mA. A 13 amp plug fitted with a 13 amp fuse should be used.

6. **Testing the FL2**

a. Plug into the mains socket and switch on; the "Mains" light will come on.

b. Switch the key switch to "ON". This will start up the oil circulation pump inside the X-ray head and the air-blower. As both are quiet in operation a check that the air-blower is operating should be made by placing a hand near the air outlet grille on the top of the cabinet. The green light "X-rays off" should also come on.

c. Turn the 4 position penetration switch (kV) to position one.

d. Turn the intensity potentiometer (mA control knob) fully anti-clockwise.

e. Close and fasten the cabinet door. The door handle must be turned to 180° to fasten securely and operate the micro-switches. If the door is not properly fastened X-rays will not come on.

f. Press the red button "X-rays on"—the green panel light should go off and the red light come on.

g. Turn the intensity potentiometer until the needle reads 6. The screen should now glow.

h. Switch off X-rays by pressing the green "OFF" button. Opening the cabinet door also switches X-rays off.

7. **Operation**

a. Open the cabinet door and insert a specimen to view.

b. Close and fasten the door and press the red button "X-rays on". When viewed through the visor an image should now be visible.

c. If the image is too dim the penetration switch should be turned to position 2, 3 or 4.

d. More brilliance can be obtained by turning the intensity potentiometer clockwise until the needle is at 8 mA which is the proper maximum setting.

e. If this potentiometer is turned too far the X-rays will cut out and the green light will come on. If this happens the intensity potentiometer should be turned anti-clockwise and the red "ON" button pressed. The red light should come on again and the screen should glow.

f. When the specimen has been inspected the green "OFF" button should be pressed when the green light should light up showing that the X-rays are off.

g. The cabinet door may be opened and the specimen changed.

h. If the door is opened without the X-rays being switched off, micro-switches operated by the unfastening of the door will cut the X-rays off.

j. If the door is then shut the red "ON" button must be pressed then in order to re-start the X-rays.

8. **Remote Operation.** The remote operation facility is provided so that specimens can be irradiated before viewing takes place.

a. The remote switch jack-plug should be inserted; the green light on the remote switch should light up.

b. The penetration switch should be set at 4 and the intensity potentiometer left at the setting for viewing.

c. The remote switch should be moved to its full length of 12 metres from the cabinet or to a prepared protected position.

d. The red button should be pressed. The green light will go off and the red light will light up indicating that X-rays are on. The X-rays should be left on for 30 seconds. The green "OFF" button should be pressed when the red light will go off and the green light come on.

e. If a number of specimens are being pre-irradiated they must all be on top of the white fluoroscopic screen so that they are in the direct X-ray beam.

Radiation Safety Precautions

9. The equipment generates ionizing radiation and can therefore be a potential source of danger to persons if incorrectly used. It is to be operated only in accordance with the following special-to-type radiation safety instructions and AP 4687A, Vol 2; this AP contains comprehensive instructions for the use of ionizing radiation in the RAF and in the instance of this FL2 equipment attention is particularly drawn to sections A, B, C, G and M.

a. *Notification.* Before FL2 equipment is operated on a RAF station or otherwise by RAF personnel, the intention is to be brought to notice of the appointed RSO and the SMO of the unit or station concerned.

b. *Competent Persons.* A NCO qualified as a Competent Person is to be specifically detailed to ensure compliance with all appropriate radiation safety instructions and this CP or a deputy, similarly qualified, is to be present and is to supervise all operations whenever the equipment is used or energized.

c. *Setting-Up.* All setting-up or uncoupling operations or movement of the installation operations are to be similarly supervised.

d. *Initial Use.* Before initial use, after a move or any other action that could change the radiation hazard, the equipment is to be checked for radiation leakage and the radiation area is to be confirmed; a Radiation Monitor Type NIS295B(6Z/1116865) or other approved instrument is to be used for this purpose and the monitor is to be examined immediately before use to ensure full serviceability.
Details of the radiation levels noted are to be recorded.

e. *Radiation Area.* Before any use the CP concerned is to supervise the setting-up of a continuous barrier around the radiation area (*ie* the area in which the dose rate exceeds 0.75 mr/hr). Warning signs are to be displayed on the X-ray cabinet and on the barrier; these signs are to be easily readable by personnel in the vicinity and are to include the ionizing radiation warning symbol to BS3510–1968 (*see* Leaflet K3, Annex L).

f. All persons other than those necessarily employed in operating the equipment are to be excluded from the radiation safety area or the proximity of the cabinet whilst the equipment is being operated.

g. The remote control panel and, if a closed circuit television is incorporated, the monitor screen are to be so placed that the operator has a clear view of the whole working area and in a location where the dose rate is not significantly above background.

h. *Radiation Workers.* All persons employed in operating the FL2 equipment are to be categorized Class A Radiation Workers under the terms of Leaflet C2. Routine medical examinations and the wearing of film badges will be required (*see* Leaflet Nos C3 and C4).

j. *Instructions.* All persons employed in operating this equipment are to receive adequate instruction on their duties and the relevant safety precautions necessary and documentary evidence of compliance is to be available for inspection.

k. *Security.* The equipment is to be adequately locked and secured when not in use and the key is to be kept in safe custody; the names of persons authorized to draw the key and issue details are to be recorded.

Incidents

10. It is inevitable that incidents posing radiation safety problems will occur, *eg* instances of doors jamming *etc.* Any remedial action must be directly supervised by the Competent Person concerned; a record should be kept of all incidents and subsequent action: attention is drawn to Leaflet B3.

RADIATION SAFETY INSTRUCTIONS FOR THE USE OF THE RAPIDEX X-50 HAND BAGGAGE SECURITY X-RAY EQUIPMENT

(D/DDC Med(RAF)/13/12/3, MA4a(RAF)—June 1978)

Introduction

1. The Rapidex X-50 hand baggage X-ray equipment is in use at certain aircraft passenger handling terminals within the RAF. It is an aid to Air Transport Security and under the control of the Director of Security (Provost Marshal)(RAF). The equipment provides a rapid and routine method of baggage inspection using X-rays to detect the presence of certain prohibited items. Training in the use and application of the X-50 in a security process is given to RAF Police at the RAF Police School, RAF Newton. Air Transport Security sections are to develop their local security procedures so as to gain maximum benefit from this aid. For reasons of radiation safety, (*see* para 8) Unit Radiation Safety Officers are to maintain nominal rolls of those who are required to operate the equipment.

2. The system will operate continuously and is fitted with castors to facilitate movement within the passenger control area. The inspection compartment has two doors back and front which open and close simultaneously when either door is activated. This provides for a through action baggage process if required.

Technical Specifications

3. The X-ray unit is a Pantak G200D with a power output rating of up to 6.5 mA at 150 kV. It can be operated from an input power supply of either 230 volts AC 50 Hz or 110 Volts AC 60 Hz which is controlled via an ignition type key switch. A series of interlocks prevent the generation of X-rays unless all doors are fully closed, thus reducing radiation leakage to a safe maximum of 0.5 mr/hr at the surface, which is within the international safety standards.

4. Comprehensive technical detail will be given in AP 119U–0402–13A5F, which will also contain information and fault analysis for operators and servicing personnel.

Installation

5. The complete system is fully transportable and can be set up for operation from a standard 230 V mains supply within a few minutes, using the following sequences:

a. Remove visor and control panels from inspection chamber.

b. Connect plug on left hand panel, through mounting hole ensuring correct orientation. Screw panel into position.

c. Repeat for right hand panel.

d. Connect 5 pin plug on mains lead to the socket fitted on the side of the unit and to a convenient 230 V mains supply.

e. Ensure door is open. Switch on both circuit breakers (up position).

f. Switch on (rotate key clockwise).

g. Press MAINS push button thus illuminating the MAINS, COOL and RAISE lamps.

Operating Procedure

6. The correct operating sequence of action is:

a. Place package for inspection centrally in chamber. The black lined square denotes maximum size for complete coverage of the fluorescent screen.

b. Press face to visor and close door. The rear door is connected to the front door and will automatically close.

c. Press the RAISE push button; the X-rays will switch on and the X-RAYS ON lamp will illuminate. The X-rays will rise automatically and increase screen brightness. The RAISE push button should be released when the examination is over, and the picture will disappear. The RAISE push button will produce a picture for about 15 seconds. If further scrutiny is required, slowly open and close the door and press the RAISE push button again; this will give a further 15-second exposure.

d. When satisfied with the examination, fully open the door, remove the package and repeat with the next item to be examined.

Closing Down Procedure

7. When the machine is to be temporarily closed down:

a. Leave the unit with doors open for ten to fifteen minutes to allow the X-ray tube head to cool down.

b. Turn key switch to 'off' and remove key.

c. Switch off the circuit breakers.

d. Switch off at mains supply.

Radiation Safety Precautions

8. The equipment generates ionizing radiations and can therefore be a potential source of danger to persons if incorrectly used. It is to be operated only in accordance with the following special-to-type radiation safety instructions and AP 4687A, Vol 2; this AP contains comprehensive instructions for the use of ionizing radiation in the RAF and, in the instance of this equipment, attention is particularly drawn to Sections A, B, C, G and M:

a. *Notification.* Before the Rapidex X-50 equipment is operated on a RAF station or otherwise by RAF personnel the intention is to be brought to the notice of the appointed RSO and the SMO of the unit or station concerned.

b. *Setting Up.* All setting-up or movement/installation operations are to be personally supervised by a competent person.

c. *Initial Use.* Before initial use, after a move, or any other action which could change the radiation hazard, the equipment is to be checked for radiation leakage; a Radiation Monitor Type NIS 295B (6Z/1116865) or other approved instrument is to be used for this purpose and is to be examined immediately before use to ensure full serviceability. Details of the radiation levels found are to be recorded.

d. *Operators.* All persons employed in operating the Rapidex X-50 equipment are to be categorized Class B radiation workers under the terms of Leaflet C2 of AP 4687A Vol 2. The wearing of film badges will be required (*see* Leaflet Nos C3 and C4).

e. *Instruction.* Adequate training in the safe operation of this equipment is to be given to all operators, and documentary evidence of compliance is to be available for inspection.

f. *Security.* The equipment is to be adequately locked and secured when not in use and the key is to be kept in safe custody; the names of persons authorized to draw the key and issue details are to be recorded.

g. *Periodic Monitoring.* Monitoring for radiation leakage is to be carried out monthly by a competent person using a monitor Type NIS 295B or other appropriate instrument. Details of the radiation levels found are to be recorded.

Incidents

9. Incidents posing radiation safety problems may occur. Any remedial action must be directly supervised by a competent person; a record is to be kept of all incidents and subsequent action. Attention is drawn to Leaflet B3.

(AL17, Sep 78)

SECTION H

STORAGE AND USE OF EQUIPMENT INCORPORATING RADIOACTIVE SOURCES

SECTION H

STORAGE AND USE OF EQUIPMENT INCORPORATING RADIOACTIVE SOURCES

CONTENTS LIST

STORAGE OF EQUIPMENT INCORPORATING INTEGRAL SOURCES

(AF/662/66 Pt II, Mech Eng 10(RAF)—28th March 1968)

1. Items of equipment incorporating integral sources need not necessarily be stored in radioactive storage areas, but the following precautions are necessary when storage other than in a radioactive storage is intended:—

a. No corrosive, flammable or explosive substance is to be taken into any building used to store equipment incorporating integral sources.

b. The area used is to be included in the areas covered by Leaflet Q2 (Fire Orders).

c. Where quantities of equipment incorporating integral sources are stored, an external radiation hazard may exist, and, if this is the case, the equipment is not to be stored in areas frequented by personnel. If radiation above the normal background radiation can be detected warning signs as prescribed in Leaflet E1 are to be posted. Warning signs are to be placed not closer than the line adjoining all points where the dose-rate reaches 0.75 mr/hr and are to be readable from all points of access to the area. Where necessary physical barriers are to be provided. If the area is a building the radiation level at any point on the outside of the building must not exceed 0.75 mr/hr and the building must be situated at least 20 yards from any point frequented by personnel.

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STORAGE OF EQUIPMENT INCORPORATING INTEGRAL SOURCES

(C.133061/60/Mech Eng 10 (RAF)—1st December, 1965)

1. Items of equipment incorporating integral sources need not necessarily be stored in radioactive storage areas but some of the requirements for radioactive storage areas, *ie* those mentioned in Leaflet No E 1, paragraph 6 and 11, must be applied to the storage of these items.

2. Where quantities of equipment incorporating integral sources are stored, an external radiation hazard may exist, and, if this is the case, equipment is not to be stored in areas frequented by personnel. If radiation (above the normal background radiation in the vicinity) can be detached in accordance with instructions issued AP 4883, then warning signs as prescribed in Leaflet No E 1, paragraph 8 are to be posted. The warning signs are to be placed not closer than the line adjoining all points where the dose rate reaches 0.75 mR/h (75 counts per second using 1320X beta/gamma probe) and are to be readable from all points of access to the area. Where necessary physical barriers are to be provided.

3. The provisons of Leaflet No E 1 paragraph 3 apply equally to equipment containing integral sources as to other classes of source; if radiation is detectable (by the means described in paragraph 2 above) outside the building, then the provisions of Leaflet No E 1, paragraph 4 must also apply.

SECTION J

INSPECTION, LOSS AND DISPOSAL OF RADIOACTIVE SOURCES

SECTION J

INSPECTION, LOSS AND DISPOSAL OF RADIOACTIVE SOURCES

CONTENTS LIST

INSPECTION, LOSS AND DISPOSAL OF RADIOACTIVE SOURCES

(AF/662/Pt III/MA4 (RAF) — 17th July 1969)

Inspection of Sources

1. Every radioactive source is to be examined periodically for signs of deterioration or damage, particularly corrosion. Inspections are to be carried out by the Officer in Charge of Radioactive Sources at least quarterly and immediately before the source is moved from one establishment to another. The date of each inspection is to be entered in the register of sources as it is carried out and the entry is to be supported by a certificate of inspection and condition in the form shown in the Annex to this leaflet, signed by the Officer in Charge of Radioactive Sources. A certified true copy of the certificate of inspection is to accompany each source when it is dispatched from one establishment to another. Equipment incorporating radioactive sources is to be inspected in accordance with the air publication for that equipment.

Leakage Testing of Sealed Radioactive Sources

2. All sealed radioactive sources, with the exception of those low activity alpha and beta sources used for training purposes or instrument testing and calibration, are to be tested for leakage of radioactive substance at least once every 26 months. These leakage tests, which are to be performed by a competent person, are to be made of:

a. every immediate container or bonding which forms part of a sealed source, or

b. every container in which a sealed source is permanently installed but which does not form part of the sealed source.

3. The results of all tests for leakage are to be kept in a register of sealed sources. The register is to be retained for 3 years from the date of the last entry.

4. **Method of Leakage Testing**

a. Wipe all the external surfaces of the sealed source thoroughly with a piece of filter paper, or other suitable material of high wet strength and absorptive capacity, moistened with a liquid. The liquid must not attack the material of the bonding or container of the source.

b. Monitor the filter paper using whatever monitoring equipment is held for training with, or calibration by, the source being tested.

c. If the monitoring indicates an activity or dose rate reading above background, the source is to be disposed of in accordance with Leaflet No N4.

Lost or Mislaid Sources

5. A search for any lost or mislaid source is to be instituted immediately and is to continue until such time as the source is found or it can be established that the likelihood of any person being at risk, either at the time or in the future, is negligible.

6. The Ministry of Defence (MA4a(RAF)) is to be notified immediately if a source is lost or mislaid.

The following information is required:

a. Type of source (section and reference number if allocated)

b. Nominal activity

c. Serial number

d. Brief outline of c

7. A copy of the findings of any formal investigation or Board of Inquiry convened to inquire into the circumstances attendant upon a lost or mislaid source is to be forwarded to the Ministry of Defence (MA4a(RAF)) for comment.

Disposal of Radioactive Sources

8. When a source is no longer needed, is damaged, or its activity is reduced below a useful level by decay, disposal instructions are to be obtained from the appropriate Supply Management branch of the Ministry of Defence. If instructions are given that the source is to be disposed of as scrap, then it is to be treated as radioactive waste and disposed of in accordance with Leaflet No N4.

Annex to
AP 4687A, Vol 2
Leaflet No J 1

CERTIFICATE OF INSPECTION OF RADIOACTIVE SOURCES

Issued in accordance with AP 4687A, Volume 2

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1. Command..... Station/Establishment..... Date.....

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2. Section/Reference No Quantity Serial Nos

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3. Certified that the sources listed above were inspected on (*date*).....
They were free from corrosion and other damage except as noted overleaf. They were fit for use with the exception of those listed as unserviceable overleaf.

Date..... Signature .....

Rank .....

Appointment .....

(*Note*: Unserviceable sources must be listed overleaf and the reason for unserviceability given.)

SECTION K

TRANSPORT OF RADIOACTIVE SUBSTANCES

SECTION K
TRANSPORT OF RADIOACTIVE SUBSTANCES

CONTENTS LIST

TRANSPORT OF RADIOACTIVE SUBSTANCES— GENERAL REQUIREMENTS

(AF/662/66PtII/MA4a(RAF)—17th June 1969)

Introduction

1. The purpose of the instructions contained in this section is to ensure that by complying with national and international regulations, radioactive substances, suitably packaged and labelled, are made safe to carry by normal transport—Service or civilian—by road, rail, sea or air.

2. **Responsibility.** Consignments of radioactive material, including radioactive waste for disposal or other transportation, are to be packed, labelled, marked and transported in accordance with the detailed instructions contained in this Section.

3. The responsibility for ensuring that the packaging and labelling is correct normally rests upon the person upon whose charge the radioactive substance is held.

4. The officer in charge of the particular mode of Service transport used—sea, air, road, *etc*—is responsible that the particular and relevant precautions as detailed are observed. The responsible person as defined above should seek advice and guidance as necessary from the unit Radiation Safety Officer.

5. **Instructions and Regulations.** These instructions are based upon the following national and international regulations:

a. International Atomic Energy Agency, Safety Series No 6—Regulations for the Safe Transport of Radioactive Materials.

b. Statutory Instrument 1970, No 1826, The Radioactive Substances (Carriage by Road (Great Britain) Regulations 1970.

c. Statutory Instrument 1965, No 1067, Merchant Shipping (Dangerous Goods) Rules 1965, and the Report and Recommendations of the Standing Advisory Committee on the carriage of Dangerous Goods in Ships, 1966 (The Blue Book).

d. The International Air Transport Association Regulations relating to the Carriage of Restricted Articles by Air, (13th Edition).

e. Post Office Act 1953 and Post Office Guide.

f. British Rail Publication BR22426 (Revised)—Dangerous Goods by Freight Train and by Passenger Train or similar service—List of Dangerous Goods and Conditions of Acceptance.

6. **Special Circumstances.** It is not possible, nor desirable, to include in these instructions all details of the national and international regulations concerning the subject and therefore, in the event that it becomes necessary to transport radioactive substances in circumstances not covered by this Section, the RSO should make direct reference to the regulations listed above and comply with them in every detail: any difficulty in interpretation should be referred to MOD, MA4a(RAF) through normal Service Channels. Any package that cannot meet the normal requirements of the references given should be dispatched under special arrangements authorized by MOD, MA4a(RAF); these special arrangements will normally require that the package is accompanied by a Competent Person who is familiar with the hazard and capable of dealing with the consequences of any accidents or mishaps.

CLASSIFICATION OF RADIONUCLIDES INTO GROUPS FOR TRANSPORT PURPOSES

(AF/662/66/Pt II/MA 4a(RAF)—17th June 1969)

1. Radionuclides are now classified into groups on a basis of the hazard which would arise in the event of an accident; this classification is to be used in the safe transport of radioactive material as detailed in this Air Publication.

2. Groups I-IVcorrespond roughly to the usual classification for radio toxicity although additional data are taken into account in assigning radionuclides to particular groups.

3. Groups V, VI and VII are mainly used for illumination tubes activated by a radioactive gas at atmospheric or sub-atmospheric pressure. Gases in bottle under pressure will normally fall in the appropriate Groups I to IV.

4. The table of radionuclides classified into groups is shown at Annex A

CLASSIFICATION OF RADIONUCLIDES INTO GROUPS FOR TRANSPORT PURPOSES

Radionuclide	*Group*
Argon 37 (Compressed or Uncompressed)	VI
Argon 41	II
Argon 41 (Uncompressed)	V
Actinium 227	I
Actinium 228	1
Americium 241	I
Americium 243	I
Arsenic 73	IV
Arsenic 74	IV
Arsenic 76	IV
Arsenic 77	IV
Astatine 211	III
Antimony 122	IV
Antimony 124	III
Antimony 125	III
Barium 131	IV
Barium 140	III
Beryllium 7	IV
Bismuth 206	IV
Bismuth 207	III
Bismuth 210	II
Bismuth 212	III
Berkelium 249	I
Bromine 82	IV
Carbon 14	IV
Calcium 45	IV
Calcium 47	IV
Cadmium 109	III
Cadmium 115m	III
Cadmium 115	IV
Cerium 141	IV
Cerium 143	IV
Cerium 144	III
Californium 249	I
Californium 250	I
Californium 252	I
Chlorine 36	III
Chlorine 38	IV
Curium 242	I
Curium 243	I
Curium 244	I
Curium 245	I
Curium 246	I
Cobalt 56	III
Cobalt 57	IV
Cobalt 58m	IV
Cobalt 58	IV
Cobalt 60	III
Chromium 51	IV
Caesium 131	III
Caesium 134m	IV
Caesium 134	III
Caesium 135	IV
Caesium 136	IV
Caesium 137	IV
Copper 64	IV
Dysprosium 154	III
Dysprosium 165	IV
Dysprosium 166	IV
Erbium 169	IV
Erbium 171	IV
Europium 150	III
Europium 152A (9.2 hrs)	IV
Europium 152B (12.7 hrs)	III
Europium 154	II
Europium 155	IV
Flourine 18	IV
Gallium 67	III
Gallium 72	IV
Gadolinium 153	IV
Gadolinium 159	IV
Germanium 71	IV
Gold 193	III
Gold 194	III
Gold 195	III
Gold 196	IV
Gold 198	IV
Gold 199	IV
Hafnium 181	IV
Holmium 166	IV
Iron 55	IV
Iron 59	IV
Iodine 124	III
Iodine 125	III
Iodine 126	III
Iodine 129	III
Iodine 131	III
Iodine 132	IV
Iodine 133	III
Iodine 134	IV
Iodine 135	IV
Indium 113m	IV
Indium 114m	III
Indium 115m	IV
Iridium 190	IV
Iridium 192	III
Iridium 194	IV

Radionuclide	*Group*
Krypton 85m	III
Krypton 85m (Uncompressed)	V
Krypton 85	III
Krypton 85 (Uncompressed)	IV
Krypton 87	II
Krypton 87 (Uncompressed)	V
Lanthanum 140	IV
Lutetium 172	III
Lutetium 177	IV
Lead 203	IV
Lead 210	II
Lead 212	II
Mixed Fission Products	II
Magnesium 28	III
Manganese 52	IV
Manganese 54	IV
Manganese 56	IV
Molybdenum 99	IV
Mercury 197m	IV
Mercury 197	IV
Mercury 203	IV
Nebium 95m	IV
Niobium 95	IV
Niobium 97	IV
Neodymium 147	IV
Neodymium 149	IV
Nickel 56	III
Nickel 59	IV
Nickel 63	IV
Nickel 65	IV
Neptunium 237	I
Neptunium 239	I
Osmium 185	IV
Osmium 191m	IV
Osmium 191	IV
Osmium 193	IV
Phosphorous 32	IV
Protactinium 230	I
Protactinium 231	I
Protactinium 233	II
Silver 105	IV
Silver 110m	III
Silver 111	IV
Palladium 103	IV
Palladium 109	IV
Promethium 147	IV
Promethium 149	IV
Polonium 210	I
Praseodymium 142	IV
Praseodymium 143	IV
Platinum 191	IV
Platinum 193m	IV
Platinum 197m	IV
Platinum 197	IV
Plutonium 238	I
Plutonium 239	I
Plutonium 240	I
Plutonium 241	I
Plutonium 242	I
Radium 223	II
Radium 224	II
Radium 226	I
Radium 228	I
Rubidium 86	IV
Rubidium 87	IV
Rubidium natural	IV
Rhenium 183	IV
Rhenium 186	IV
Rhenium 187	IV
Rhenium 188	IV
Rhenium natural	IV
Rhodium 103m	IV
Rhodium 105	IV
Radon 220	IV
Radon 222	II
Ruthenium 97	IV
Ruthenium 103	IV
Ruthenium 105	IV
Ruthenium 106	III
Sulpher 35	IV
Scandium 46	III
Scandium 47	IV
Scandium 48	IV
Selenium 75	IV
Silicon 31	IV
Samarium 145	III
Samarium 147	III
Samarium 151	IV
Samarium 153	IV
Strontium 85m	IV
Strontium 85	IV
Strontium 89	III
Strontium 90	II
Strontium 91	III
Strontium 92	IV
Silver 111	IV
Tin 113	IV
Tin 117m	III
Tin 121	III
Tin 125	IV
Tritium (other than specified in Gr VII below)	IV
Tritium (as T2 or HT) in form of compressed or uncompressed gas and tritium activated luminous paint or tritium gas absorbed on a solid carrier	VII
Tantalum 182	III
Terbium 160	III

Radionuclide	*Group*
Technetium 96m	IV
Technetium 96	IV
Technetium 97m	IV
Technetium 97	IV
Technetium 99m	IV
Technetium 99	IV
Tellurium 125m	IV
Tellerium 127m	IV
Tellurium 127	IV
Tellurium 129m	III
Tellurium 129	IV
Thorium 227	II
Thorium 228	1
Thorium 230	1
Thorium 231	I
Thorium 232	III
Thorium 234	II
Thallium 200	IV
Thallium 201	IV
Thallium 202	IV
Thallium 204	III
Thulium 168	III
Thulium 170	III
Thulium 171	IV
Uranium 230	II
Uranium 232	I
Uranium 233	II
Uranium 234	II
Uranium 235	III
Uranium 236	II
Uranium 238	III
Uranium natural	III
Uranium enriched	III
Uranium depleted	III
Uranium irradiated	III
Vanadium 48	IV
Vanadium 49	III
Xenon 125 (Compressed or Uncompressed)	III
Xenon 131m	III
Xenon 131m (Uncompressed)	V
Xenon 133	III
Xenon 133 (Uncompressed)	VI
Xenon 135	II
Xenon 135 (Uncompressed)	V
Yttrium 88	III
Yttrium 90	IV
Yttrium 91m	III
Yttrium 91	III
Yttrium 92	IV
Yttrium 93	IV
Ytterbium 175	IV
Zinc 65	IV
Zinc 69m	IV
Zinc 69	IV
Zirconium 93	IV
Zirconium 95	III
Zirconium 97	IV

Note: Uncompressed shall mean at a pressure not exceeding one atmosphere absolute at 0°C and mean at sea level.

THE PACKAGING AND LABELLING OF RADIOACTIVE MATERIALS FOR TRANSPORT

(AF/662/66/Pt III/MA4a(RAF)—17th June 1969)

Introduction

1. The purpose of special packaging and labelling for radioactive materials is to ensure that, when correctly packaged and labelled, they can be carried in ordinary vehicles as normal items of equipment. There are four basic types of package depending upon the type and activity of the radioactive contents and also upon the degree of protection that the package can provide. Special labels are fixed to the package and these are related to the radioactive contents and the external dose rate from the package; labels also vary according to the method of transport, *ie* rail, air, road or sea and according to the regulations which are complied with. The labels are marked with the principle radioactive contents of the package, the activity and the transport index. A summary of the requirements for packaging, labelling and marking as it affects non-fissile radionuclides is given at Annex A and details of the various labels are given at Annexes C to L.

Types of Packages

2. a. **Exempt Packages.** Packages in which the quantity or specific activity of the radioactive material is so small that the dispersal of the contents in an accident would result in negligible damage are classed as Exempt packages. This type of package does not have to conform to detailed specifications or tests and information concerning suitable construction procedures and requirements is given in Leaflet K 7. The conditions for exemption and other requirements for this type of packaging are given at Annex A. Exempt packages are not to be marked RADIOACTIVE on the exterior neither are they to bear any exterior radiation signs or markings. The component of the package that is intended to retain the radioactive material must be marked RADIOACTIVE in such a manner that the marking will be visible before the containing vessel or package can be opened. The recipient of an Exempt or other package of radioactive material should be notified in advance that the package is being sent.

b. **Type A Packages.** Consignments of radioactive material within the activity limits given in Annex A and where in the event of an accident, the dispersal of the radioactive contents will provide only a minor hazard, are appropriate to a Type A package; the Type A package may, according to its contents, be White Label CAT I, Yellow Label CAT II, or Yellow Label CAT III. For construction specifications and test procedures for Type A packages, *see* Annex B. It is intended that ultimately some Type A packages will be available as stores items, but in the meantime units requiring to consign material within this range are authorized to produce and use Type A packages complying with the above mentioned specification and test requirements; (such packages require Ministry of Transport approval and where such approval is sought initial application should be made to MOD, MA 4a (RAF) through normal channels).

c. **Type B Packages.** Consignments of radioactive material within the limits indicated in Annex A for Type B packages would, if dispersed due to accident, constitute a major hazard: such packagings must comply with stringent requirements; they are not covered by the Service regulations in this Air Publication.

Labelling of Packages

3. Packages containing radioactive material within the limits given in Annex A are to be appropriately labelled prior to transport by road, rail, sea or air. Two labels must be fixed to the outside of every White Label or Yellow Label package, one on each of opposite sides and the information required on the labels is to be clearly marked with waterproof ink. The use of these White or Yellow Labels does not exempt the package from additional labelling which may be necessary in respect of other hazards, for example hazards arising from corrosive or flamable materials, *etc.*

Special Consignments

4. Consignments beyond the limits shown in Annex A and quantities of fissile material above the exempt amounts indicated are subject to further regulations and unless the movement of such materials is in accordance with predetermined MOD policy and instructions, the approval of MOD, MA4a (RAF) must be obtained before any movement is authorized.

Transport Index

5. It is necessary to mark on the White or Yellow Lable the Transport Index. The main purpose of the Transport Index is to enable the carrier, in stowing the packages, to ensure that the dose rate that the driver receives is properly limited, *see* Leaflet K 4. The Transport Index for a package is a number expressing the maximum radiation dose in millirem per hour at one metre (3 ft 3 inches) from the centre of the package or, where any overall external dimension of the package exceeds two metres, the number expressing the larger of the following:

a. The maximum radiation dose rate at the end of a long axis of the package, and:

b. The maximum radiation dose rate at a distance of one metre perpendicular to the long axis of the package.

The number expressing the Transport Index should be rounded up to the first decimal place.

PACKAGING AND LABELLING FOR THE TRANSPORT OF RADIOACTIVE MATERIALS BY ROAD, RAIL, SEA AND AIR — SUMMARY OF REQUIREMENTS

Item	General Category	Package Type	Radioactive Material		Dose Rate	Requirement for Special Radioactive Labelling	Packaging Requirements
			Group	Max Activity			
1	Radioactive Material in small quantities	Exempt	I II III IV Special* Form V VI VII Tritium Oxide in Aqueous Solution	0.01 mCi 0.1 mCi 1 mCi 1 mCi 1 mCi 1 mCi 1 mCi 25 Ci 0.5 mCi per ml	Not to exceed a. 0.5 m rem/hr at external surface. b. Unfixed contamination on external surface not to exceed: beta/gamma emitters 10^{-4} μ Ci/cm^2 alpha emitters 15^{-5} μ Ci/cm^2	a. None externally. b. The component of the package which is intended to prevent leakage of the radioactive material must bear the marking "RADIOACTIVE" in such a manner that it will be visible before the containment vessel can be opened.	a. The package must not contain more than a total of 15 grammes of U233, U235, PU239, PU241 or any mixture of them. b. The package must not contain any pyrophoric or explosive material or unnecessary materials or documents. c. The package must be such that throughout the journey there can be no leakage of radioactive material under normal conditions of transport. d. For air transport of liquid radioactive materials the inside container must be surrounded by sufficient absorbent material to retain the contents.

ITEM	GENERAL CATEGORY	PACKAGE TYPE	RADIOACTIVE MATERIAL		DOSE RATE	REQUIREMENT FOR SPECIAL RADIOACTIVE LABELLING	PACKAGING REQUIREMENTS
			GROUP	MAX ACTIVITY			
							e. Radioactive luminized articles or parts, contaminated components and/or radioactive waste within these limits which are to be transported, are to be initially retained in a sealed ~~polythene~~ P.V.C. bag.
	Note: **SPECIAL FORM.* This category covers materials which are in such a form that there is virtually no chance of the material becoming dispersed in any credible type of accident. Two types of SPECIAL FORM material are recognized, "Massive Solid Form" and when the radioactive material is contained in a capsule. For further details see IAEA Regulations.						f. The smallest external dimension is to exceed 6 inches.
2	Instruments and articles such as clocks, valves and manufactured goods where the radioactive material is in non-readily dispersible form. PER ARTICLE	Exempt	I II III IV Special Form V VI VII	0.1 m Ci 1 m Ci 10 m Ci 50 m Ci 50 m Ci 1 Ci 1 Ci 25 Ci	As above. The dose rate at 10 cm from any unpacked article, instrument or item is not to exceed 10 mrem/hr.	None	a. As item 1a. b. As item 1b. c. As item 1d. d. Securely packed in strong packaging. e. As item 1f.

Item	General Category	Package Type	Radioactive Material		Dose Rate	Requirement for Special Radioactive Labelling	Packaging Requirements
			Group	Max Activity			
3	As Item 2—per package	Exempt	I II III IV Special Form V VI VII	1 mCi 50 mCi 3 Ci 3 Ci 20 Ci 1 Ci 1 Ci 200 Ci	As Item 1	None	As Item 2
4	Radioactive material in moderate quantities	Type A	I II III IV Special Form V VI VII	1 mCi 50 mCi 3 Ci 20 Ci 20 Ci 20 Ci 1000 Ci 1000 Ci	As Item 1	*WHITE LABEL CAT I.* For Road, Air, Sea and Passenger Train use RAF Form F–PKG–212A. For Freight Train use BR Label 7F1	a. As Item 1. b. Two labels required one on each side of opposite sides. c. Every label must show principal radioactive contents and activity. d. If over 1 cwt, weight to be marked on exterior. e. MOT identification and serial number to be on exterior. f. Package to be plainly and durably marked TYPE A. g. The outside of the package is to incorporate a seal which is not readily breakable and which will be evidence that the package has not been illicitly opened. *Note:* See Annex B for full TYPE A Packaging Requirements and for Test Requirements.
					In excess of Item 1 a. but does not exceed 10 mrem/hr. at external surface or 0.5 mrem/hr at 1 metre from centre of package; Item 1 b. applies	*YELLOW LABEL CAT II.* For Road, Air and Sea use RAF Form F–PKG–212B. For Passenger Train use BR Label 7P2. For Freight Train use BR Label 7F2.	
					In excess of above but does not exceed 200 mrem/hr at external surface or 10 mrem/hr at 1 metre from centre of package. Item 1 b. applies.	*YELLOW LABEL CAT III.* For Road, Air and Sea use RAF Form F–PKG–211. For Passenger Train use BR Label 7P3A or 7P3B. For Freight Train use BR Label 7F3A or 7F3B.	

Item	General Category	Package Type	Radioactive Material		Dose Rate	Requirement for Special Radioactive Labelling	Packaging requirements
			Group	Max Activity			
						Note: For Rail Transport CAT III is subdivided as follows: Surface dose rate not to exceed 200 mrem/hr but, a. *CAT IIIA.* Dose rate at 1 metre from centre of package not to exceed 1.5 mrem/hr and Transport Index not to exceed 1.5. b. *CAT IIIB.* Dose rate at 1 metre from centre of package not to exceed 10 mrem/hr and Transport Index not to exceed 10.	
5	Packages containing radioactive materials above the limits for TYPE A as above where dispersal due to accident would be very hazardous.	TYPE B	I II III IV Special Form V VI VII	20 Ci 20 Ci 200 Ci 200 Ci 5000 Ci 5000 Ci 50,000 Ci 50,000 Ci	As Item 4.	As Item 4.	a. As Item 4. b. Requirements for packaging for transport of radioactive materials requiring TYPE B packaging should be referred to MOD, MA4a (RAF).
6	Empty packages of any type which have contained radioactive materials.	—	—	—	As Item 1b.	a. To be marked Empty Package Having Contained Radioactive Material. b. All previous radioactive markings or labelling to be removed.	Packages must be in good condition and securely closed.

THE REQUIREMENTS FOR TYPE A PACKAGING

Definition

1. **Packaging.** One or more receptacles which may include absorbent material, spacing structures, radiation shielding or cooling devices, shock absorbent and/or thermal insulating devices. The receptacles may have external devices for absorbing shock or insulations etc. For large sources the vehicle with its tie-down system may be part of the packaging.
The Containment Vessel. This is the receptacle which retains the radioactive material.
The Package. This is the packaging and the radioactive material as presented for transport.

2. **Design Principles and Construction Features.**

a. The package must be capable of being easily handled and properly secured to the vehicle.

b. A package of over 10kg and up to 50kg must be provided with a means of manual handling.

c. A package of over 50kg must be designed for mechanical handling.

d. Lifting attachments must conform to normal RAF lifting equipment standards including "snatch" lifting requirements: lid lifting, attachments must be capable of supporting the entire weight of the package in "snatch" conditions.

e. The outer layer of the package must be designed so as to avoid the collection of rain water.

f. External surfaces of packaging must as far as possible avoid protruding features and must be capable of easy decontamination.

g. Packaging must stand up to temperature changes, vibration and resonance such as will arise during transport and all closing devices nuts, *etc* must be designed to prevent inadvertent loosening.

h. The containment vessel must be leakproof and securely closed with a positive locking device which cannot be opened unintentionally or by possible internal pressure; it must be resistant to corrosion by the contents. The containment vessel must take into account the radiolytic decomposition of material and must be able to withstand a reduction of ambient pressure to 0.5 atmosphere (absolute).

j. If the containment vessel is to travel abroad it must be made of metal, otherwise of MOT approved material.

k. The packaging must be such that no build-up of internal pressure can disrupt the containment vessel.

l. To reduce the radiation dose rate the containment vessel must, if necessary, be provided with a shield either inside or outside the vessel; the vessel may be the shield.

m. A shield which encloses a containment vessel must be so designed as to prevent the unintentional release of that vessel and, where the shield and the containment vessel within it form a separate unit, the shield must be capable of being securely closed by a positive fastening device which is independent of any other packaging structure.

n. Where the reduction in dose rate depends upon the distance between the containment vessel and the exterior of the package the design and construction must ensure that this distance is maintained.

o. For gamma emitters in quantities in excess of 3Ci and with a radiation shield of melting point below 815 °C the package shall include a closed metal vessel no external dimension of which shall be less than 5cm. The metal shall be such that the vessel will maintain its integrity when subjected to flame in an oxidising atmosphere at 800 °C for 4 hours. Tin coated mild steel not less than 0.2mm thick satisfies this requirement.

p. Any feature added to the package at the time of transport must not detract from the safety of it.

Performance Specifications

3. a. The Type A packaging must be designed as above and must be adequate to prevent loss or dispersal of the radioactive content and to retain its shielding if the package is subject to the tests as specified in BS 3895: Pt I, 1965. The tests applicable to Type A packaging comprise a water spray test, a free drop test, a compression test, and a penetration test; an additional free drop test applies in the circumstances described in sub-paras b and c.

b. Type A packaging designed for liquids must in addition be adequate to prevent loss or dispersal of the radioactive contents if the package was subject to the test applicable to such packaging and specified

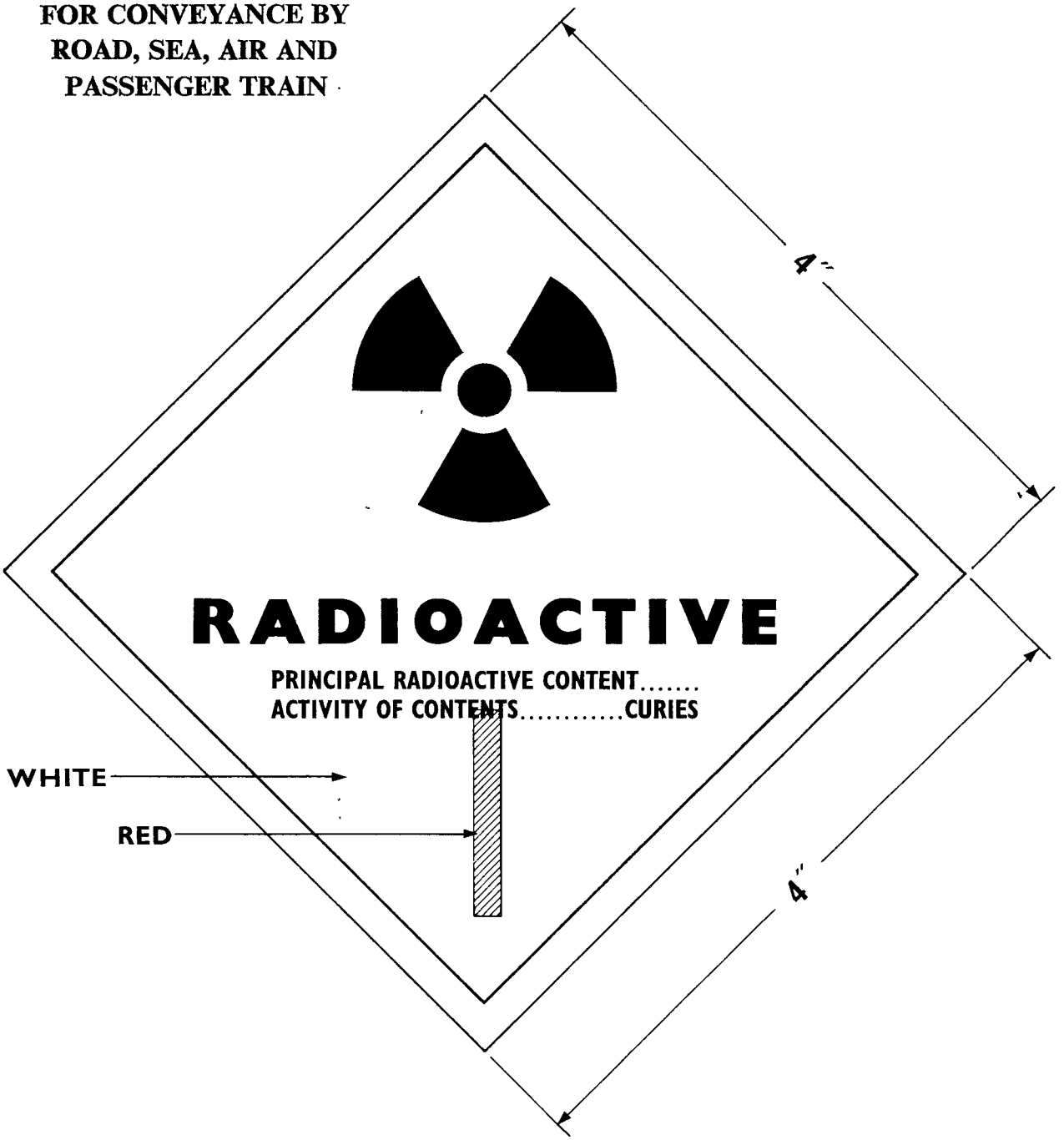
in BS 3895: Pt I, 1965, unless sufficient absorbent material is provided within the containment vessel to absorb twice the volume of the liquid content and:

(1) The absorbent material is within the shielding; or

(2) The absorbent material is outside the shielding, provided that it can be shown that if the liquid content were taken up by the absorbent material the resultant dose rate at the surface of the package would not exceed 1000 millirems per hour.

c. Type A packaging designed for tritium gas under Group VII in excess of 200 Ci and further gases in excess of 20 Ci must in addition be adequate to prevent loss or dispersal of the radioactive content if the containment vessel of that package was separately subjected to the tests applicable to such packaging and specified in BS 3895: Pt 1, 1965.

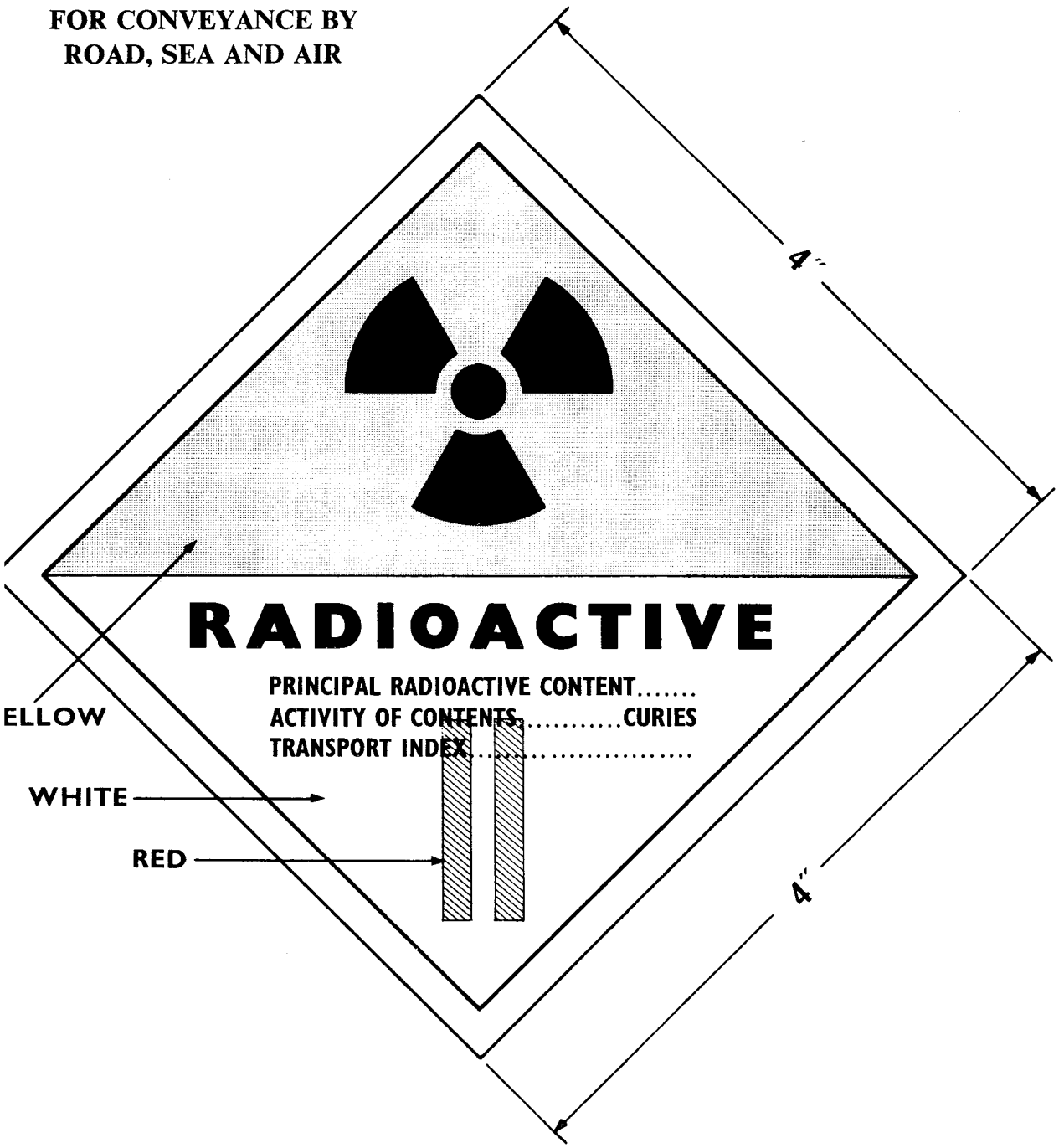
CATEGORY I WHITE LABEL FOR CONVEYANCE BY ROAD, SEA, AIR AND PASSENGER TRAIN



AVAILABLE AS RAF FORM F/PKG/212A

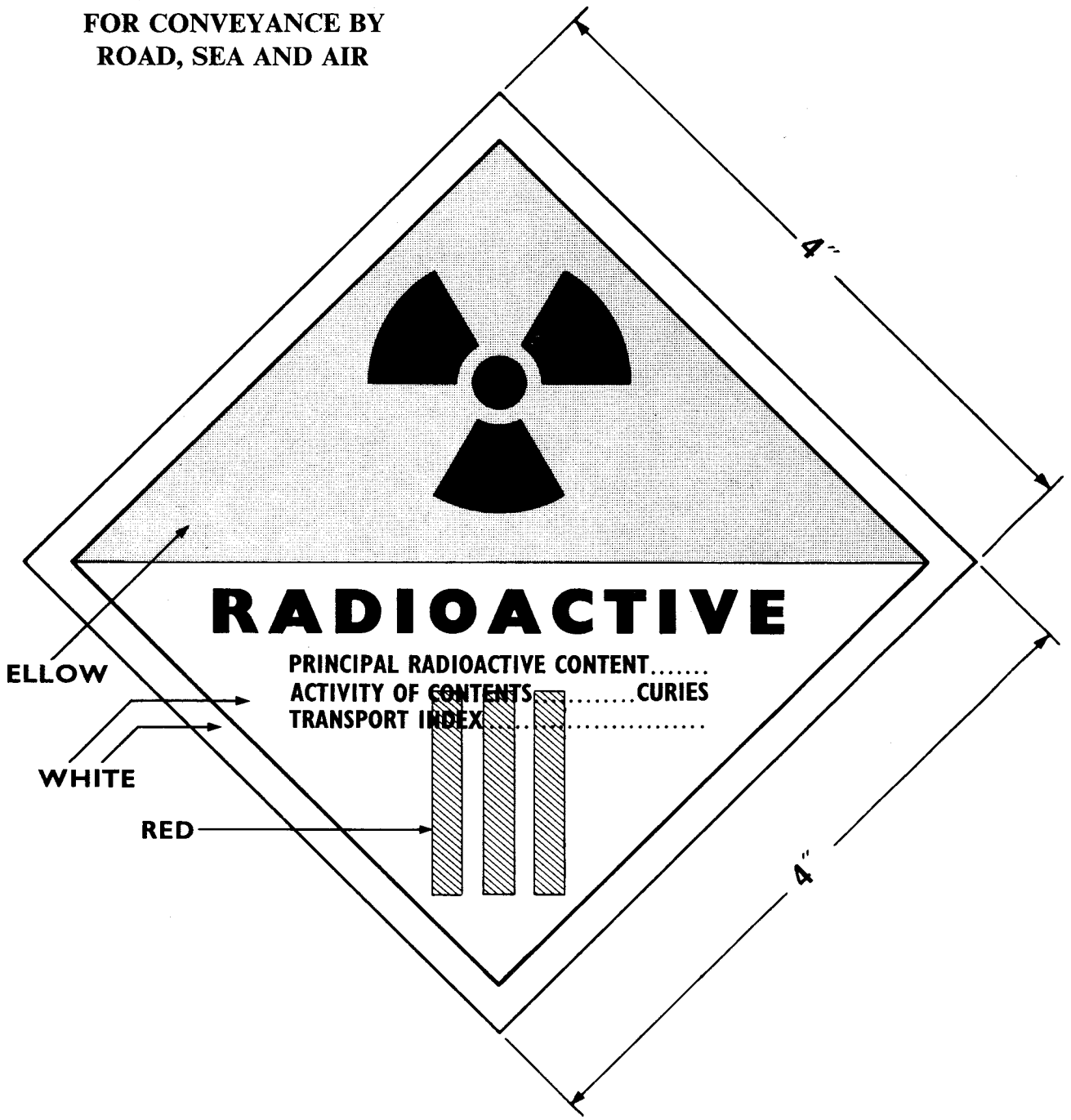
(AL17, Sep 78)

:ATEGORY II YELLOW LABEL
FOR CONVEYANCE BY
ROAD, SEA AND AIR



VAILABLE AS RAF FORM F/PKG/212B

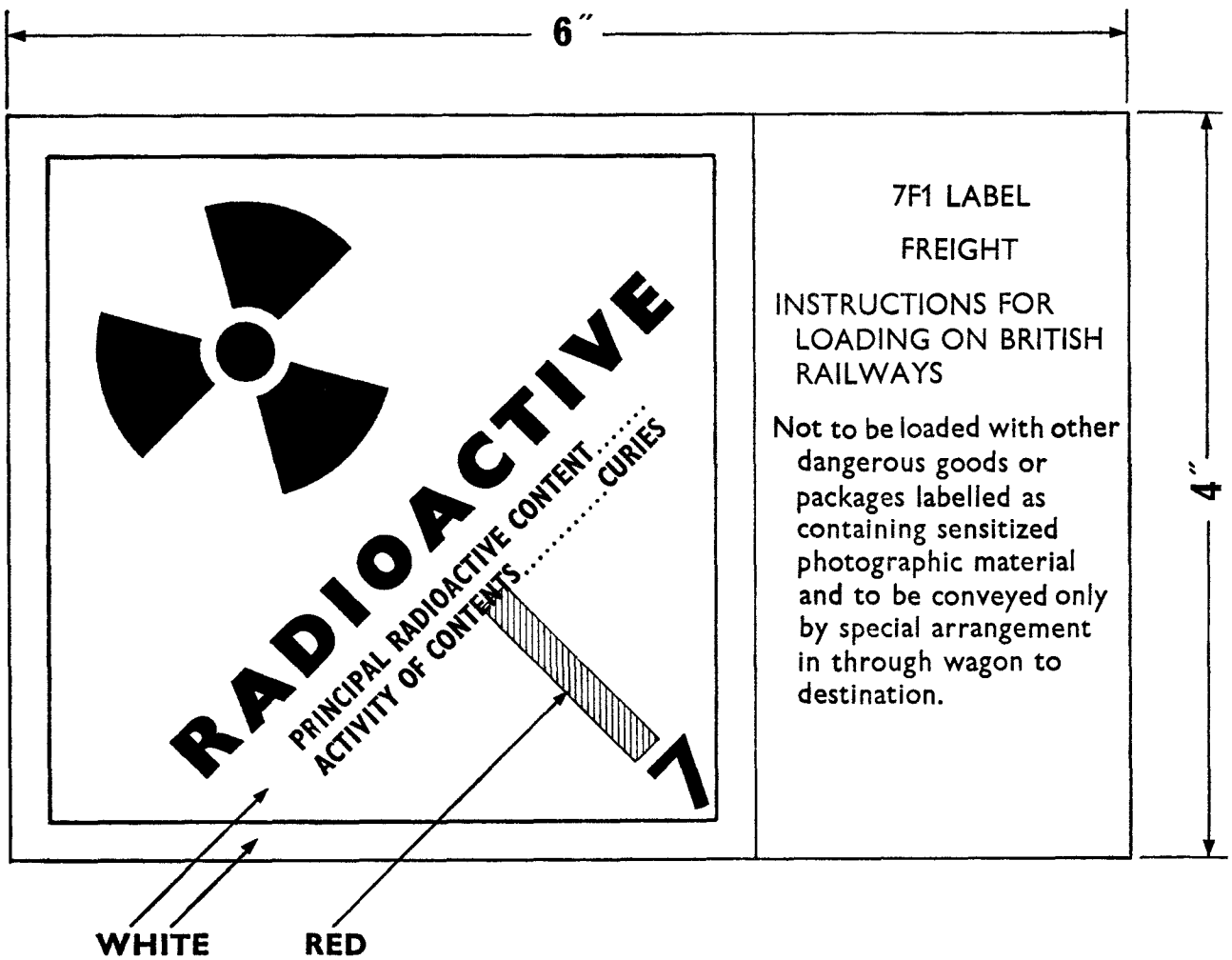
CATEGORY III YELLOW LABEL FOR CONVEYANCE BY ROAD, SEA AND AIR



AVAILABLE AS RAF FORM F/PKG/211

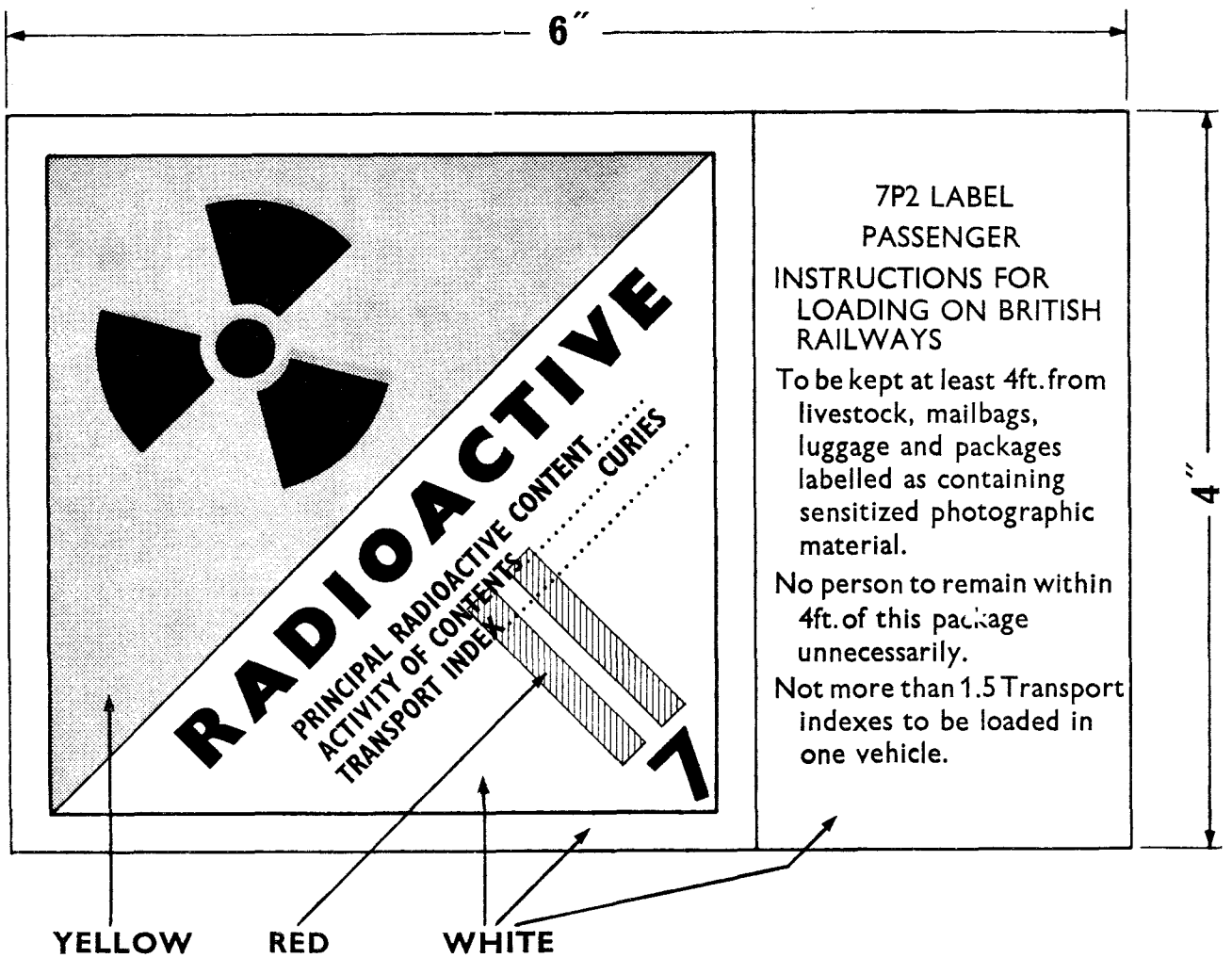
(AL17, Sep 78)

LABEL FOR CATEGORY I PACKAGES FOR CONVEYANCE BY FREIGHT TRAIN



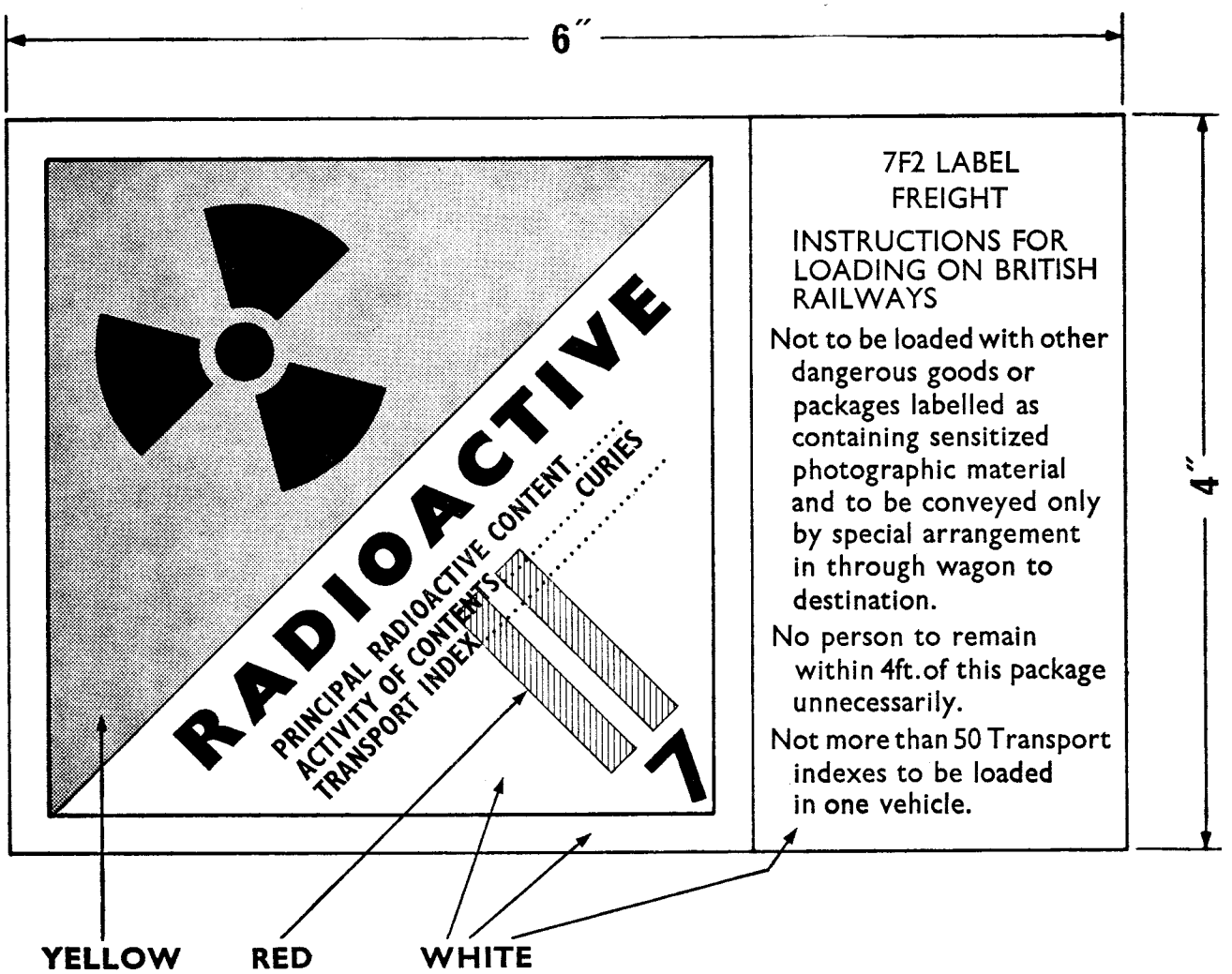
BR LABEL 7FI

LABEL FOR CATEGORY II PACKAGES FOR CONVEYANCE BY PASSENGER TRAIN



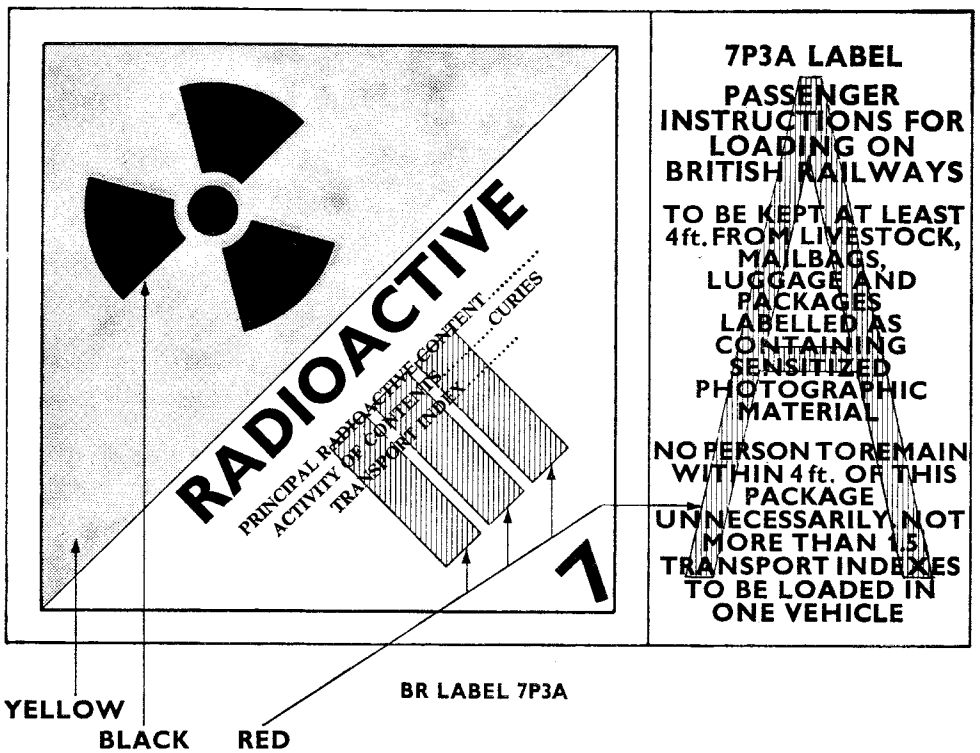
BR LABEL 7P2

LABEL FOR CATEGORY II PACKAGES FOR CONVEYANCE BY FREIGHT TRAIN

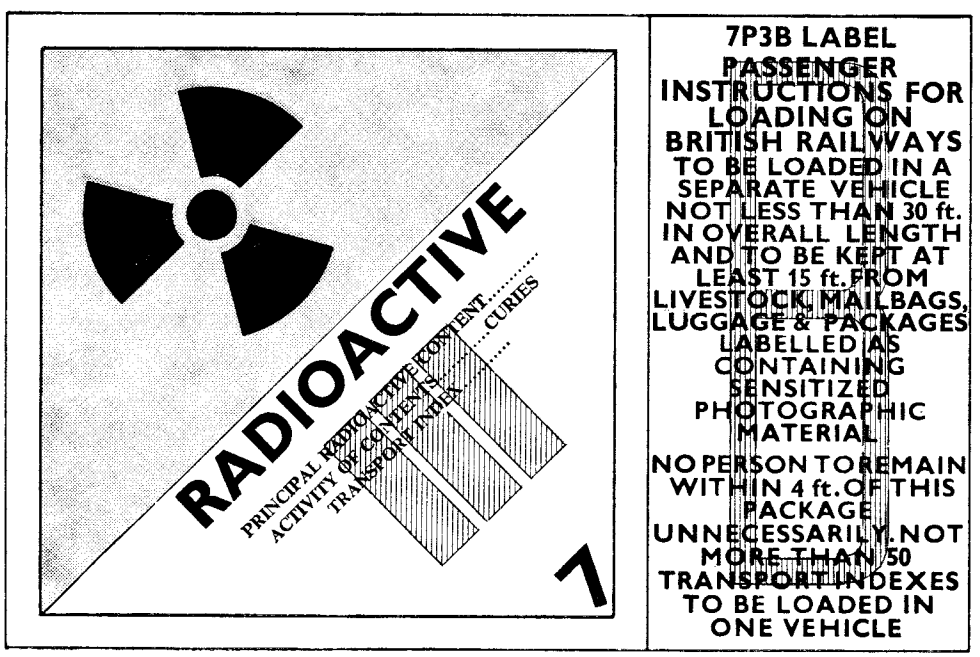


BR LABEL 7F2

LABELS FOR CATEGORY III PACKAGES FOR CONVEYANCE BY PASSENGER TRAIN

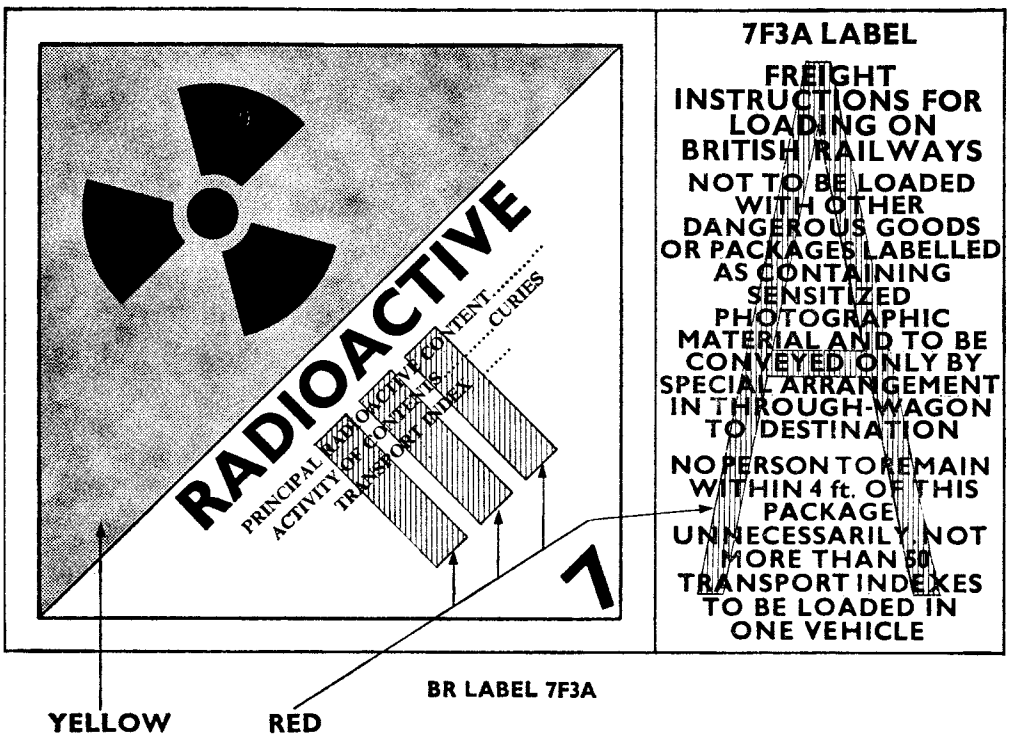


BR LABEL 7P3A

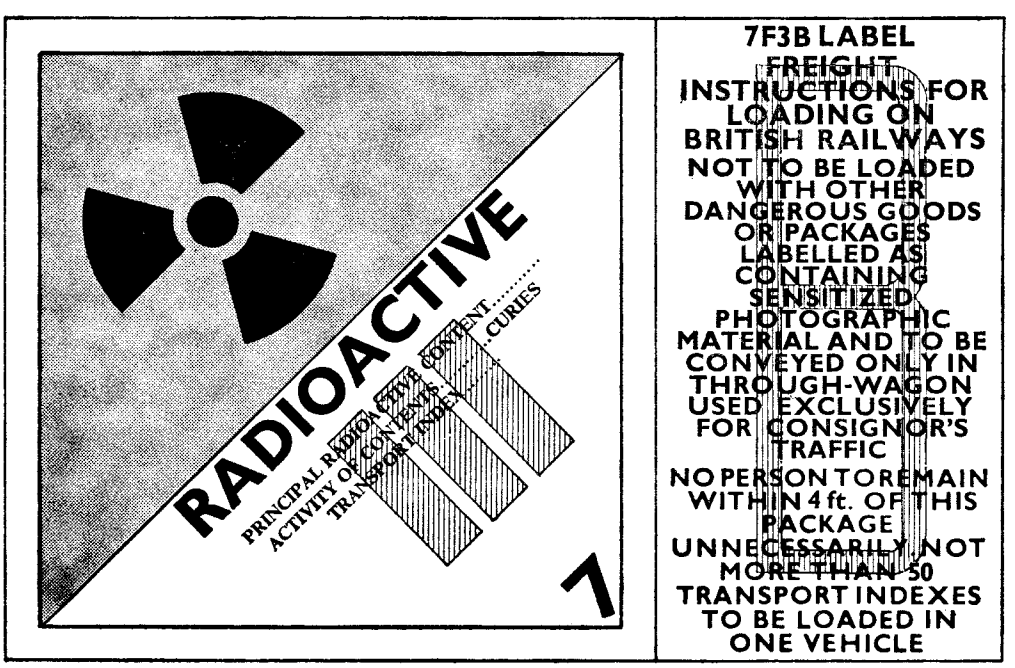


BR LABEL 7P3B

LABELS FOR CATEGORY III PACKAGES FOR CONVEYANCE BY FREIGHT TRAIN

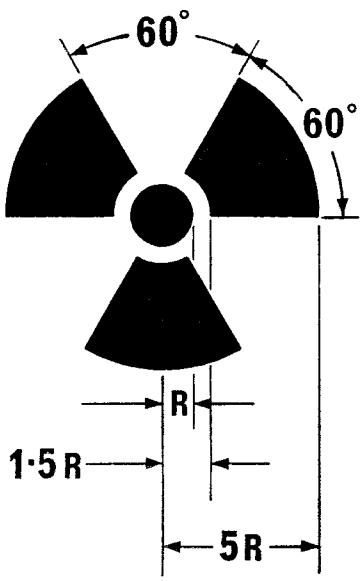


BR LABEL 7F3A



BR LABEL 7F3B

BASIC IONIZING RADIATION SYMBOL
(To BS 3510-1968)



Colours of Symbol and Background

The area shown shaded in the figure shall be coloured black, and shall be placed upon a background of sufficient area for the symbol to be distinctive. The background should be yellow, except where for transport purposes it is white.

Use of Symbol

The basic ionizing radiation symbol shall be used or displayed only to signify the actual or potential presence of ionizing radiation.

Availability

This symbol is available for use as a self adhesive label as follows:

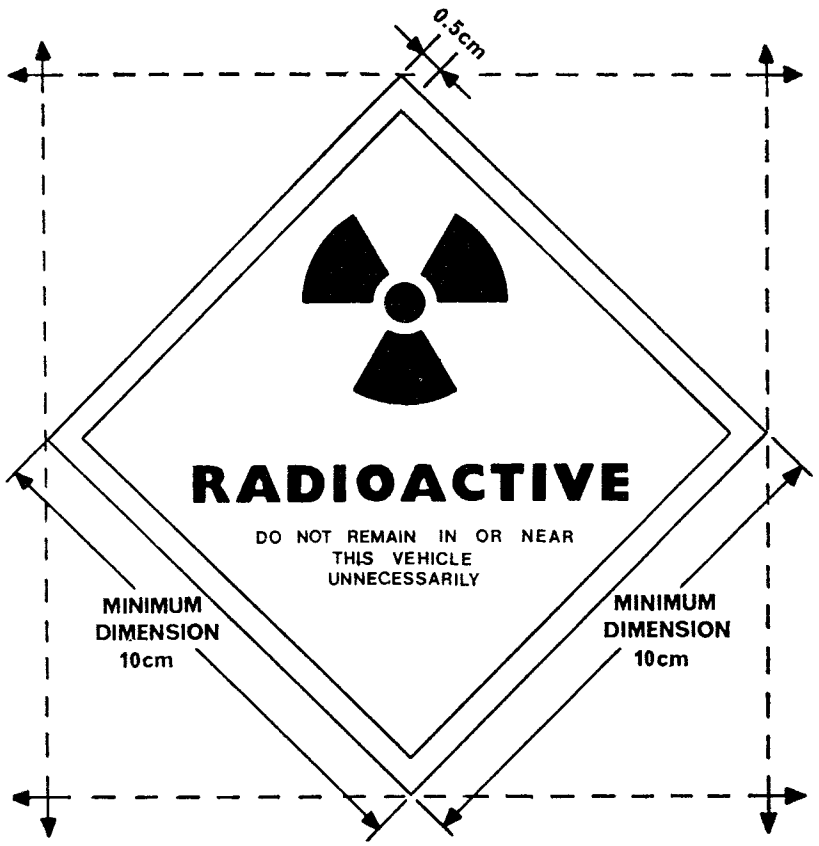
Warning Label Radioactive 6″ DIA — 12Z/79

Warning Label Radioactive 3″ DIA — 12Z/80

Warning Label Trefoil 6" DIA - 12Z/84 (As 12Z/79 less word 'RADIOACTIVE' for use with electronic apparatus)

AL8

LABEL FOR VEHICLES



NOTE—When dimensions larger than the minimum dimensions shown are used, the relative proportions must be maintained.

THE TRANSPORT OF RADIOACTIVE MATERIALS BY ROAD

(AF/662/66 Pt IV/MA4a(RAF)—31 March 1971)

Introduction

1. The Officer i/c Mechanical Transport or his authorized deputy is responsible for the implementation of these instructions except as otherwise stated in this Leaflet; he should seek the guidance and advice of the Unit Radiation Safety Officer where necessary.

2. Where White or Yellow Label packages are intended for road transport in civilian vehicles, the fact that they are subject to special radiation safety precautions must be brought to the attention of the carrier by the consignor.

3. Where radioactive substances are consigned, it must be verified that the consignee has been made aware of the facts and is prepared to accept the package.

Classification and Dose Rate—Drivers and Passengers

4. Drivers whose whole body annual dose rate for the year is not expected to exceed 1.5 rems (*eg* 2 mrem per hour for 750 hours per year, based on an average of 15 driving hours per week for 50 weeks) are exempt from the general provisions of the regulations normally applicable to Classified Workers and therefore no routine film badges or records of accumulated dose are necessary.

5. If the driver or any passenger is not exempt as in paragraph 4 he is to wear a film badge.

6. The dose rate inside the driver's cab must normally be kept below 2 mrem/hr, this is to limit as far as possible, the radiation to which drivers are exposed and to avoid the possible necessity to grade the driver as a Classified Worker.

7. No person under the age of 18 is to drive or be carried anywhere on a vehicle if the consignment being transported is a Yellow Label package or if the dose rate in the driver's cab exceeds 2 mrem/hr.

8. No unathorized passengers may be carried with radioactive packages other than Exempt packages; any authorized passenger must be carried in the driver's cab.

Vehicle Loading

9. All packages or radioactive material must be packed, labelled, handled and carried in accordance with current instructions; and the consignor is to certify on RAF Form 658 that the package contains radioactive materials and is correctly packed and labelled in accordance with the requirements of AP 4687A Vol 2. Exempt packages, (*see* Annex A to Leaflet K3) are not hazardous and may be treated as non-radioactive.

10. White and Yellow packages and Exempt packages may be safely carried in the same compartment as other goods, with the following exceptions:

a. Unexposed photographic films and plates.

b. Highly inflammable and spontaneoulsy combustible substances.

c. Explosive substances within the meaning of the Explosive Act 1875(b).

d. Organic peroxide or oxidising substances.

e. Nitric acid of more than 70% purity or a mixture of nitric acid and sulphuric acids containing more than 30% nitric acid.

NB The above does not apply to materials normally carried in the unladen vehicle.

11. The radioactive packages should be securely stowed in the vehicle and all White and Yellow Label packages must be carried in the goods compartment. The driver's cab should be separated from the goods compartment by a solid partition but if this is not possible it will suffice that the dose rate anywhere in the driver's compartment does not exceed 2 mrem/hr at any time.

12. All Yellow Label packages are marked with a Transport Index (*see* Leaflet K3), and such packages must not be stored nearer to the driver's compartment than the appropriate distance given in the following table:

Sum of Transport Indices	*Distance (Metres)*
Up to 2	1.0
2—4	1.4
4—5	1.5
5—10	2.3
10—20	3.0
20—30	4.0
30—40	4.4
40—50	5.0

The Transport Index must not exceed 50 for any one vehicle, for this purpose trailers count as vehicles.

13. The conditions detailed in paragraph 12 may be disregarded if it can be certified that the level of radiation in the driver's cab is less than 2 mrem/hr. In this case a certificate to this effect must be given to the driver and a record of any survey carried out for this purpose must be kept by the unit RSO.

Warning Notice

14. All vehicles carrying White or Yellow Label packages must be provided with a warning notice conforming to the following:

a. The notice must be not less than 12 cm square.

b. The letters (in CAPITALS) must be black on a white background.

c. All lettering must be embossed or stamped.

d. Capital letters in the word "RADIOACTIVE" are to be not less than 12 mm high; all other capital letters are to be not less than 5 mm high.

e. The notice must be fire and water resistant.

f. The notice must be securely posted in the vehicle in a position where it is plainly visible to the driver but does not obstruct his view of the road.

g. The notice is to include the name, address and telephone number of the unit to which the vehicle belongs or is attached.

h. The notice is to be in the form set out below.

This vehicle is carrying

RADIOACTIVE MATERIALS

If undamaged the packages are **SAFE TO HANDLE**

In case of accident

get in touch with

The Police

and

Particulars, address and Tel. No. of Unit

Warning Labels on Vehicles

15. Vehicles carrying White or Yellow Label packages are to be labelled by the secure attachment to each side of the vehicle of a label which is plainly visible to a person standing on that side. The labels are to be of the type shown at Annex M to Leaflet No K3, (*see* para 20 concerning passenger carrying vehicles).

Driver's Certificate

16. Whenever a mechanical transport driver is required to transport radioactive packages, other than Exempt Packages, he is to be provided with a certificate signed by the consignor. The certificate is to be headed as follows:

Certificate issued in accordance with the Radioactive Substances (Carriage by Road) (Great Britain) Regulations, 1970. The certificate is to contain the following detail:

a. Name, address and telephone number of the unit concerned.

b. Telephone number of the Radiation Safety Officer of the unit of despatch.

c. Number and inventory of packages and all relevant details of the consignment. The details are to include:

(1) Description of contents including radionuclide. This item to begin with the words "RADIOACTIVE MATERIAL".

(2) Quantity of radionuclide.

(3) Transport Group.

(4) Type of Package.

(5) Transport Index.

17. The certificate is to conclude with the following words of certification:

"This is to certify that the above-named goods are properly described and are packed and marked in accordance with the applicable provisions of the Radioactive Substances (Carriage by Road) (Great Britain) Regulations 1970 or of the International Regulations as laid down in AP 4687A, Vol 2 and are in a proper condition for transport."

Instructions to Drivers

18. When transporting radioactive packages other than Exempt packages the driver should be fully briefed for the journey. The following instructions are to be included in the local MT orders as applicable to RAF drivers transporting radioactive materials:

a. The driver must not leave a vehicle carrying White or Yellow Label packages unless the load compartments are locked or the packages are otherwise secured against unlawful removal.

b. The driver must not without reasonable cause leave a vehicle carrying any Yellow Label package completely unattended in a public place where it is out of his sight. Where necessary the driver should if possible, night-stop at a Service unit where the vehicle is to be securely parked and where steps are to be taken to ensure that a clear space of six feet is maintained all round the vehicle during its stay.

c. Vehicles containing Yellow Label packages must not be parked for more than one hour unless steps are taken to ensure a clear space of at least six feet is maintained around the vehicle throughout the period of its stay.

d. The positioning of the consignment in the load bearing compartment is not to be altered during the journey.

e. The driver is to ensure that packages are not wilfully damaged or opened during the journey.

f. No unathorized person is to travel with the consignment.

g. The police and parent unit are to be informed as soon as possible in the event of any of the following occurrences:

(1) Loss or theft of package.

(2) Damage of package in road accident or other cause.

(3) Vehicle or package in danger of fire or any other hazard.

The Carriage of Radioactive Materials by RAF or Private Passenger Carrying Vehicles

19. In addition to the other relevant instructions in this Air Publication the following limitations apply when radioactive materials are carried in Royal Air Force passenger carrying vehicles or in private cars.

(For the purposes of this instruction passenger carrying vehicles refers to vehicles adapted to carry not more than eight passengers including the driver.)

a. The packages must be constructed and labelled in accordance with current instructions.

b. Not more than ten White or Yellow packages taken together are to be carried.

c. The total Transport Index of the packages must not exceed 10.

d. No White or Yellow Label packages must be carried in the occupied compartment of the vehicle.

e. No passenger is to be under 18 years of age.

f. Either the driver or one of the passengers must be conversant with the radiation hazard associated with the consignment.

20. The requirements of paragraphs 15, 16 and 17 above do not apply when radioactive materials are carried in the vehicle referred to in paragraph 19 above.

Vehicle Contamination

21. Vehicles which are regularly or frequently used for the transportation of radioactive materials are to be periodically surveyed for radiation from fixed or unfixed contamination in the load carrying compartments. This survey is to be carried out under the direction of the unit Radiation Safety Officer. Any vehicle in which there is harmful contamination is to be taken out of service as soon as possible; it is not to carry goods or passengers until it has been decontaminated.

22. The procedure given in paragraph 21 is to be applied to any vehicle when it is known or suspected that a radiation package has leaked either as a result of an accident or for any other reason. Incidents involving damage to White or Yellow packages are to be reported in accordance with Leaflet No B5.

Further Exemption

23. The requirements of paragraph 15, 16 and 17 above, do not apply in relation to the carriage of radioactive waste if:

a. the waste is being carried in the course of its removal to a tip dump or pit intended for the deposit of refuse: and

b. its removal to such tip dump or pit has been specifically approved in accordance with Section N.

THE TRANSPORT OF RADIOACTIVE MATERIALS BY AIR

(AF/662/66 Pt III/MA4 (RAF)—19th July 1969)

Introduction

1. The transport of radioactive materials by air in all civil aircraft is in accordance with the Regulations of the International Air Transport Association, (IATA); the IATA regulations are based upon the International Atomic Energy Authority Regulations for the Safe Transport of Radioactive Materials from which the instructions contained in Leaflets KI, K2 and K3 are also derived.

2. Leaflets K1, K2 and K3 detail the general requirements and conditions for the safe transport of radioactive materials by all surface means and can be applied to transport by air provided that liquid radioactive material is retained in an inner container which is surrounded by sufficient absorbent material to retain the liquid contents.

3. In general the Royal Air Force conforms with the IAEA regulations in transporting radioactive material in transport aircraft and the appropriate day to day instructions are contained in the Criteria for the Carriage of Dangerous Goods in Transport Aircraft and in AP 101A—1101—1. The instructions given in the above references are derived from AP 4687**A**, Vol 2 which should be consulted if any doubt arises.

Bids for Air Movements

4. a. Bids to transport radioactive materials by air are to be submitted to the Controlling Air Movement Authority in the area.

b. For consignments originating in the UK this means that the bid should be forwarded to the Air Cargo Allocation Centre at Headquarters Air Support Command.

c. For consignments originating overseas bids should be routed as directed by the area headquarters (usually the air booking centre at RAF command headquarters).

d. Bids are to be made out on RAF Forms 1380 (Air Waybill). The Air Waybill is to be boldly marked "RADIOACTIVE" in red and with the appropriate vocabulary section and reference of the source if applicable.

e. The Air Waybills (F 1380) should also state:

(1) The category of the package, *eg* Type A package CAT II-Yellow Label.
(2) External dose rate measurement expressed in millirems per hour.

f. Each set of Forms 1380 is to be accompanied by a safety certificate provided by the Consignor (3 copies) and signed by the radiation Safety Officer. The applicable National Regulation to be quoted on the safety certificate is contained in the following references:

(1) Criteria for the Carriage of Dangerous Cargo in RAF Transport Aircraft, issued by DD Mov 1 (RAF).
(2) AP 101A-1101-1, Chapter 6-6, Air Transport Operations Manual, General and Technical Information.

Responsibilities of Unit Movement Officer

5. The Unit Movement Officer is responsible for ensuring that packages for air transport have been correctly labelled in accordance with the accompanying F1380 and Safety Certificate but note that the responsibility for ensuring correct packaging and labelling of radioactive materials rests upon the person upon whose charge the material is held (*see* Leaflet K1, para 3). The Unit Movement Officer is to provide the captain of the aircraft with a certificate containing the following information:

a. Name and address of consignee.
b. Inventory of packages dispatched including identification markings.
c. Description of contents including radionuclide and quantity.
d. Category of Package.
e. Transport Index where necessary.

Normally the appropriate copy of the RAF F 1380 will satisfy the requirements of the above mentioned certificate.

Carriage in RAF Transport Aircraft (Cargo Role)

6. a. Radiation packages must be constructed and labelled in accordance with current instructions; this instruction does not apply to packages exempt from labelling.

b. White Label packages (CAT I) can be carried in the aircraft belly hold.

c. Yellow Label packages must be carried in the main cabin of the aircraft.

d. There is no limitation on the number of White Label packages (CAT I) which may be carried at one time.

e. The total Transport Indices of all Yellow Label packages (CAT II and III) must not exceed 50.

f. Except as provided for in sub-para g Yellow Label packages (CATs II and III) must not be stored nearer the crew cabin than the appropriate distances in the following table:

Sum of Indices	*Distances (Metres)*
Up to 2	1.0
2— 4	1.4
4— 5	1.5
5—10	2.3
10—20	3.0
20—30	4.0
30—40	4.4
40—50	5.0

g. The conditions stated in sub-para f may be disregarded if it can be certified that the level of radiation in the main crew cabin is less than 2 mrem/hr. A certificate to this effect must be given to the captain of the aircraft and a record of any survey carried out for this purpose must be kept by the Unit RSO.

Carriage in RAF Transport Aircraft (Passenger Role)

7. a. The packages must be constructed and labelled in accordance with current instructions.

b. White Label packages (CAT I) may be carried in the belly hold.

c. Yellow Label packages (CATs II and III) are not to be carried.

d. No more than ten (10) White Label packages (CAT I) can be carried.

e. Either the captain, an aircrew member, or one of the passengers must be conversant with the associated radiation hazards of the consignment.

Control of Radiation Dose to the Aircrew and Passengers (RAF Transport Aircraft)

8. a. If any member of the aircrew or any passenger is a classified worker he or she must wear a film badge.

b. If the dose rate at the position occupied by the aircrew or passengers exceeds 2 mrem/hr they will normally be required to wear film badges.

c. If the dose rate exceeds the limits of sub-para b no person under 18 years of age may be carried.

Safety Precautions and Instructions (RAF Transport Aircraft)

9. a. If any leakage of a radioactive package is known or suspected, the aircraft loading and unloading areas of the Departure and Arrival Air Movements Section and any transportation or other equipment used must be surveyed for contamination. A radioactive contaminated aircraft must not be used until it has been cleared for unrestricted use.

b. Any accident occurring during which packages may have become damaged or if any package is lost or stolen during transit must be reported to MOD, MA 4a(RAF) as soon as possible.

c. Radioactive material must not be carried:

(1) In an aircraft carrying explosives, petroleum products, corrosive or oxidizing substances, compressed or liquified gases.

(2) In an aircraft carrying undeveloped photographic film.

d. The consignment must not be removed from the aircraft during transit unless special instructions to the contrary have been given.

e. If storage during transit is necessary for periods longer than 24 hours the package must be placed in a recognized radiation storage area or building.

Instructions to Air Quartermaster

10. a. If he is not a classified radiation worker, the Air Quartermaster is to wear a film badge if required to do so by the Radiation Safety Officer.

b. If carrying White or Yellow Label packages (CAT I-III) the aircraft may be left unattended subject to the following instructions:

(1) The load compartment is locked and secure.

(2) The aircraft must not be parked for longer than one hour unless a two metre clear space can be maintained around it.

c. The consignment is not to be removed from the aircraft unless specific instructions to the contrary are issued.

d. The positioning of the consignment in the load bearing compartment is not to be altered during the journey.

e. Labels and warning signs are not to be wilfully defaced or removed.

Disposal at Destination Airfield

11. Consignments are to be cleared from arrival airfields with the least possible delay and to assist the consignee in effecting rapid collection the consignor is to signal intended flight details to the consignee with copies to the Controlling Air Movement Authority, the despatching airfield and the destination airfield. When the consignment is despatched the despatching airfield is to signal actual despatch details to *en route* airfields, the destination airfield and the consignee, with copies to the Controlling Air Movement Authority and the consignor.

Jettisoning

12. Because of the danger of scattering radioactive contamination, radioactive consignments should not be jettisoned in flight unless it is imperative for the safety of the aircraft to do so. If such consignments are jettisoned, the map reference and/or other identification, should, where possible, be noted to assist in recovering the consignment.

THE TRANSPORTATION OF RADIOACTIVE MATERIALS BY SEA, RAIL AND VIA THE POSTAL SERVICES

(AF/662/66/Pt III/MA 4a(RAF)—dated 17th March 1968)

Sea Transport

1. The transport of radioactive materials by sea is in general conformity with the IAEA Regulations as given in this Section; the specific regulations are contained in the Carriage of Dangerous Goods in Ships (The Blue Book). Appendix B of the Blue Book contains the recommendations of the Standing Advisory Committee for the Carriage of Radioactive Substances. The International Marine Consultative Organization deals with standards for the transport of dangerous goods and has issued a Dangerous Goods Code; Part 7 of this code deals with radioactive materials.

Transport by Rail

2. The rail transport of radioactive materials is in accordance with the IAEA Regulations although some variation in labelling occurs, *see* Annex to Leaflet K3. The specific regulations are contained in Section 7 of BR22426 (Revised), "Dangerous Goods by Freight Train and by Passenger Train or similar service—List of Dangerous Goods and Conditions of Acceptance".

Transmission by Inland Parcel Post

3. Small quantities of radioactive materials are accepted for dispatch through the inland parcel post if the requirements of White Label packages are met and the package is suitable. Containers and receptacles must be submitted to the Postal Service, Department HMB, Headquarters Building, GPO St Martins-le-Grand, London, EC1 for approval. Normally the parcel post should not be used to transport radioactive materials unless circumstances make it necessary; the postal services are not to be used to transport radioactive materials outside the UK. Regulations for the transport of radioactive materials by post are contained in the Post Office Act, 1953 and the Post Office Guide.

THE PACKAGING OF RADIOACTIVE MATERIALS— EXEMPT PACKAGES

(AF/662/66 Part II/MA 4a (RAF)—14th March 1969)

Introduction

1. Annex A to Leaflet K3 defines the types and quantities of radioactive materials that may be transported as Exempt packages. The following instructions are intended for use as broad guidance to those units having a requirement to transport small consignments of radioactive materials that do not require Type A or higher grade packaging.

Defining the Contents

2. In some instances it may be difficult to establish the radionuclides and the activity that requires transportation and, where there is any doubt in this respect, the matter should be referred to MOD, MA 4a(RAF) through the normal channels. Where the radionuclides and the activity is known to be within the prescribed limits suitable action as indicated in the following paragraphs should be taken.

Possible Disposal as Waste

3. If the radioactive material is such that it can be disposed of through the normal refuse collection service then such disposal action should be taken (*see* Section N).

General Packaging Requirements

4. When radioactive materials are consigned as Exempt packages the internal package that is designed to contain the radioactive material is to bear the standard trefoil sign and the word "RADIOACTIVE" in such a manner that the label will be seen before the internal containing package is opened. If there are two internal containers, *ie* one inside the other, each must be so labelled. Attention is drawn to Item 1 of Annex A to Leaflet K3 and to the label shown at Annex L to that Leaflet.

Shielding Exempt Packages

5. It is necessary to reduce the radiation dose rate from those radionuclides that can be transported as Exempt packages (a) so that the dose rate for Exempt packages can be achieved and (b) as normal practice in reducing where possible the radiation dose rate. In order to do this the inner container may be placed and retained by packaging, in the centre of a larger container so that the exterior dose rate is reduced by distance; alternatively or additionally the inner container may be screened with lead or other materials. The inner container may be retained in its position in the outer container by packing with various materials such as strong cardboard, fibre board, polystyrene or wood, *etc.*

Liquid or Powdered Forms—Packaging

6. Radioactive materials in liquid or powdered form should be retained in a glass or plastic bottle and the stopper of the bottle should be sealed and secured to prevent accidental spillage. The bottle should be surrounded by sufficient absorbant material such as cotton wool, saw dust, vermiculites, *etc*, as will absorb and retain twice the liquid contents of the bottle. The bottle should be contained in an inner container and this should be sealed with adhesive tape or if necessary by mechanical means.

The Outside Container

7. The dose rate at the surface of the outside container constitutes a factor in determining the category of the package and therefore as stated earlier the outer package may be made large so that the dose rate from the centrally positioned and retained inner package is reduced; the outer packing should be robust and securely fastened. If the package is Class A or of higher category it must be labelled RADIOACTIVE on its exterior in accordance with Leaflet K3 Annex A. Exempt packages must not be externally labelled RADIOACTIVE.

SECTION M

QUALIFICATIONS AND TRAINING OF PERSONNEL WORKING WITH IONIZING RADIATION

SECTION M

QUALIFICATIONS AND TRAINING OF PERSONNEL WORKING WITH IONIZING RADIATION

CONTENTS LIST

QUALIFICATIONS OF PERSONNEL

(AF/CX 383/74 MA4a(RAF) MAY 1976)

Radiation Safety Officers

1. Radiation Safety Officers are to attend a Radiation Safety Officers Course at the Institute of Naval Medicine, Alverstoke, or other similar course approved by the Ministry of Defence DHR(RAF).

Competent Persons

2. Competent Persons responsible for the control of sources of ionizing radiation or the control of radiation safety aspects of sources of non-ionizing radiation are annotated accordingly as follows:

a. Competent Person (CP) – Ionizing Radiation responsibilities.

b. Competent Person (CP/RF) – Radio-Frequency Radiation responsibilities.

c. Competent Person (CP/L) – Laser Radiation responsibilities.

3. All Competent Persons with responsibilities for sources of radiation are required either:

a. To attend and qualify on a course of instruction recognized as appropriate by the Ministry of Defence DHR(RAF), or

b. To be judged competent by virtue of previous experience and qualification to the satisfaction of the Ministry of Defence DHR(RAF).

Competent Persons (CP)

4. A Competent Person (CP) will normally attend the Competent Person's Course at the Institute of Naval Medicine, Alverstoke but a selected course at such places as the RAF Armament Support Unit, the Central Servicing Development Establishment, RAF Regiment Depot, Defence NBC School or the appropriate School of Technical Training will be acceptable.

5. Before using industrial radiography equipment the operator must have satisfactorily completed either a suitable course at the Central Servicing Development Establishment or a QAS Course or other course approved by MOD(DHR(RAF)). Special arrangements for additional external instruction may also be necessary.

6. For the use of NBC defence training courses the following persons may be considered as qualified:

a. An officer, warrant officer, or NCO who has qualified at an appropriate course at the Defence NBC School or at the RAF Regiment Depot, and whose course report is annotated "Qualified in the Use, Care, and Storage of Radioactive Training Aids".

b. A civil defence instructor qualified in accordance with AP 3335, Section 3.

7. Users of medical and dental radiography equipment are to receive training and be qualified to the standard determined by Ministry of Defence (DHR(RAF)).

SECTION N

DISPOSAL OF RADIOACTIVE WASTE, CONTAMINATED SCRAP AND EQUIPMENT CONTAINING RADIOACTIVE SUBSTANCES

SECTION N

DISPOSAL OF RADIOACTIVE WASTE, CONTAMINATED SCRAP AND EQUIPMENT CONTAINING RADIOACTIVE SUBSTANCES

CONTENTS LIST

DISPOSAL OF RADIOACTIVE WASTE AND CONTAMINATED SCRAP GENERAL REQUIREMENTS

(D/DDC Med(RAF/13/12/3, MA4a(RAF)—June 1978)

1. The disposal of radioactive waste in the United Kingdom is controlled under the Radioactive Substance Act 1960. Although the Act does not apply formally to RAF establishments, the disposal of radioactive waste must generally be approved by the authorizing Department which is, according to the location of the premises, the Department of the Environment, the Welsh Office, the Scottish Development Department or the Ministry of Health and Social Services, Northern Ireland. However the approval of the authorizing Department is not required for the disposal of radioactive waste which can be made in a manner prescribed in Exemption Orders made under the 1960 Act. (*See* Leaflets Nos N2, N3 and N4). The supply policy for the disposal of radioactive waste in the RAF is controlled by MOD, SS36(RAF) but all bids from UK units for such disposal are co-ordinated and submitted to D of E by HQ RAF Support Command (Gp Capt Unit Supply).

2. The method of disposal of radioactive waste depends upon the type of waste or scrap and the nature and amount of radioactive content; where it can be done safely, disposal by local methods is preferred but note that the burning of radioactive waste is not permitted. The following methods of disposal are normally available:

a. With refuse disposed of under local contract arrangements *ie* ordinary refuse (no approval required).

b. By burial on the local authority refuse area HQRAFSC (Unit Supply 2) initiate consultation between the authorizing Department and the local authority.

c. Through the drainage system.

d. By disposal to the Atomic Energy Authority.

NB Station refuse tips are not to be used for the disposal of radioactive waste.

3. Applications for approval for the disposal of radioactive waste are to be submitted to HQRAFSC (Unit Supply 2) through normal channels. The detail required is specified for certain categories of waste in the N Leaflets but in all instances the application must include:

a. A description of the waste (liquid, solid, scrap metal *etc*).

b. The radionuclide in the waste and the total activity (microcuries or millicuries) of each radionuclide in the waste to be disposed of in a week or month.

c. A description of the container.

d. The proposed method of disposal.

4. Radioactive waste and scrap is to be disposed of as it arises if it is possible to do so within the terms of the approval or exemption. It may be necessary to store wastes which are to be buried, or disposed of to the Atomic Energy Authority, but the disposal must be made as soon as practicable. If immediate disposal is not possible the waste is to be stored in specially marked containers and shielded as necessary within the terms of Leaflet No E1.

5. It is the responsibility of the OC Eng Wing/CIO and the appointed Radiation Safety Officer to determine the radioactive level of contaminated waste and scrap; Monitor Type 617 (6Z6204137) and Doserate Meter NIS295B (6Z111865) are available from CRSOs.

6. When radioactive waste and scrap fulfils the following conditions it is to be disposed of from where it is lying, and is not to be returned to the Supply Squadron:

a. The activity is to be within the limits for local disposal as approved or as stated in the appropriate leaflet.

b. The method of disposal is to be with refuse or by burial at the local authority refuse area or through the drainage system.

c. The items disposed of are not to be subject to further equipment accounting.

7. Material with a level of activity returned to the Supply Squadron must be packaged, labelled and transported in accordance with Section K. For exempt packages the external wrapping must not be marked "Radioactive" but the unwrapped equipment or *internal* packing must have a label attached giving the following information:

a. Details of the equipment/material, section/reference and description.

b. Radionuclide.

c. Level of activity.

8. Persons directly concerned in the disposal of radioactive waste or contaminated scrap are to act only under the direction of the Station Radiation Safety Officer, his authorized deputy or in accordance with his written instructions; these instructions will normally include the wearing of protective gloves—22G/1214 or 22G/986–989 and the observance of normal good hygiene *ie* no smoking during the work and washing before eating and before and after the use of toilets.

9. Where instructions are given for equipment to be disposed of to the Atomic Energy Authority, attentions is drawn to the following:

a. *Leaflet N7, Annex A:* Specimen Form RSA4, this form may be produced locally A4 size, provided that it is an exact facsimile of the specimen.

b. *Leaflet N7, Annex B:* National Disposal Service Schedule of Charges. Payment is to be made locally, supported by a receipted copy of relevant convoy notes (RAF Form 158), which is to include brief details of the type and quantity of the contaminated equipments and a cross-reference to the relevant Form RSA4.

c. *Leaflet N8:* Transportation Procedure and Section K.

10. Normal internal accounting procedures will apply to all radioactive equipment which requires further accounting action forwarded to the Supply Squadron. When the categorization of this equipment as scrap or waste is due to the level of radioactivity, the relevant voucher authorizing strike-off action is to be certified accordingly. The certificate is to include details of the level of radioactivity and reference to this AP. Disposal of such equipment will be the responsibility of the Supply Squadron.

DISPOSAL OF SCRAP RADIOACTIVE ELECTRONIC VALVES

(D/DDC Med(RAF)/13/12/3, MA4a(RAF)—June 1978)

1. The Radioactive Substances (Electronic Valves) Exemption Order 1967 applies only to valves which contain not more than:

   a. 1 microcurie in total of type 1 radionuclides.

   b. 10 microcuries in total of type 2 radionuclides.

   c. 150 microcuries in total of type 3 radionuclides.

2. The types of radionuclides referred to in the Exemption Order are:

TYPE 1	TYPE 2	TYPE 3
Cobalt 60	Carbon 14	Tritium
Nickel 63	Chlorine 36	Krypton 85
Caesium 137	Promethium 147	
Thorium (any isotope)		
Thallium 204		
Radium 226		
Uranium (any isotope)		

3. For disposal purposes valves are to be classified as follows:

   a. *Class1:* Those which contain not more than:

      (1) 0.1 microcurie in total of type 1 radionuclides.

      (2) 1 microcurie in total of type 2 radionuclides.

      (3) (a) Not more than 10 microcuries Krypton 85 type 3 nuclide.

          (b) Not more than 150 microcuries Tritium (H_3) type 3 nuclide.

   b. *Class 2:* Valves which contain:

      (1) A sum total of type 1 radionuclides in excess of 0.1 microcurie but less than 1.0 microcurie.

      (2) A sum total of type 2 radionuclides in excess of 1.0 microcurie but less than 10 microcuries.

      (3) Not more than 100 microcuries Krypton 85 type nuclide.

   c. *Hazard Grade:* Valves which exceed the overall limits stated in sub-paras a and b above.

4. Class 1 and 2 valves are to be disposed of with ordinary refuse under the following conditions but there must be no deliberate breakage of such valves:

   a. The valves may be broken or intact.

   b. Not more than quantity 100 Class 1 valves may be disposed of at any one time (*see* also para 5).

   c. Not more than quantity 10 Class 2 valves may be disposed of in any seven day period (*see* also para 5). Broken Class 2 valves are to be disposed of on the day they are broken but if it is not possible to do so by reason of the inadequacy of non-radioactive waste in which to disperse them, up to 5 broken Class 2 valves may be placed in a press-in-lid metal container marked "Broken Class 2 Valves", and action taken in accordance with para 5.

   d. The valves are to be well dispersed in the ordinary refuse.

5. All Hazard Grade Valves and quantities of Class 1 and 2 valves which it is impractical to dispose of under para 4c above are to be reported to the HQRAFSC (Unit Supply 2) for disposal instructions. Such reports are to include the following information:

a. Section and reference numbers, description, quantity and class.

b. Radionuclides if known.

c. Estimated total activity in microcuries (μCi) of each radionuclide in each article and total in each container.

d. The nature of each container, inner and outer.

e. The number of articles of each type in each container.

f. The approximate size and weight of each container.

g. The maximum dose rate at the surface of each container in millirads in air per hour.

h. The location of the radioactive material for disposal.

6. When disposal through the Atomic Energy Authority is agreed with the authorizing Department, HQRAFSC instructions will call for the submission of completed forms RSA4, one copy each to the AEA, to HQRAFSC (Unit Supply 2) and to the authorizing Department. Units submitting forms RSA4 will be advised in due course by the AEA of the address to which the contaminated equipment is to be delivered.

7. With regard to disposal to the AEA, attention is drawn to Leaflet N7.

8. Leaflet E2 lists the valves currently in use within the RAF which are or may be radioactive. Users are warned that the standard of marking of these valves and their packages varies and that valves of older manufacture may be less adequately marked.

DISPOSAL OF SCRAP LUMINIZED ARTICLES AND COMPONENTS

(D/DDC Med(RAF)/13/12/3, MA4a(RAF)—June 1978)

1. Scrap luminized articles and components are to be disposed of with the ordinary refuse under the following conditions:

   a. No article or component is to contain more than 1 μCi of radium, 3 μCi of americium 241, 2 millicuries of promethium 147, or 100 millicuries of tritium.

   b. Not more than Qty 10 items are to be disposed of in any seven day period.

   c. The items are well dispersed in the ordinary refuse.

   d. Station refuse tips are not to be used.

2. Any items in excess of the limits quoted in para 1a above, or large quantities which it is impracticable to dispose of under the conditions quoted in para 1b, are to be reported through normal channels to HQRAFSC (Unit Supply 2) for disposal instructions. Such reports are to include the following information:

   a. Section and reference numbers, description and quantity.

   b. Radionuclides, if known.

   c. Estimated total activity in microcuries (μCi) of each radionuclide in each article and total in each container.

   d. The nature of each container, inner and outer.

   e. The number of articles of each type in each container.

   f. The approximate size and weight of each container.

   g. The maximum dose rate at the surface of each container in millirads in air per hour.

   h. Location of the radioactive equipment for disposal.

3. When disposal through the Atomic Energy Authority is agreed with the authorizing Department, HQRAFSC instructions will call for the submission of completed Forms RSA4, one copy each to the AEA, to HQRAFSC (Unit Supply 2) and to the authorizing Department. Units submitting Forms RSA4 will be advised in due course by the AEA of the address to which the contaminated equipment is to be delivered.

4. In connection with disposal to the AEA, the attention of Units is drawn to Leaflet N7.

5. Annex A lists luminized items currently in use within the RAF, which are known to exceed the limits in para 1 above. This list is not necessarily comprehensive and any other luminized items believed to be in excess of the limits are to be monitored.

RADIOACTIVE LUMINOUS ARTICLES

A. INSTRUMENTS

Ref No	*Description*	*Ref No*	*Description*
6A/155	Thermometer Oil Temp	6B/2692	Spring Counter Reset
284	Thermometer Oil Temp	2695	Handle Storage
304	Gauge Fuel Pressure	2696	Contact Storage
389	Level Fore and Aft	14B/9425616	Timer, Clockwork, Darkroom
632	Gauge Fuel Contents		
675	Indicator Turn & Slip	14B/9425617	Timer, Clockwork, Darkroom c/w alarm
778	Tachometer Engine Speed		
1150	Clock	6B/9101000	Watch, Wrist, GS
1175	Gauge Oil Pressure	551	Watch, Chronograph
1209	Directional Gyro	6D/232	Indicator Flow
		246	Gauge, Quantity Oxygen
1215	Gauge Fuel Contents	480	Valve Cut-off
1476	Thermometer	514	Regulator
1481	Thermometer Radiator	584	Plates, Luminous
1498	Horizon Artificial	915	Regulator
1543	Indicator Air Speed	916	Oxygen Set
1664	Gauge Fuel Contents	1286	Regulators Oxygen Mk 11C
1787	Gauge Fuel Contents	1597	Indicator Flow Oxy Mk 3A
1788	Gauge Fuel Contents	1608	Oxygen Set
		1610	Regulator
1804	Indicator Turret Position	1713	Oxygen Set
6D/1981	Thermometer Air	6D/1945	Plate Selector
		3014	Oxygen Set
2670	Gauge Fuel Contents		
2682	Gauge Boost	6DF/978	Switch

Ref No	*Description*	*Ref No*	*Description*
2688	Gauge Pressure	6E/374	Compass, Marching
2690	Gauge Pressure	395	Compass, Prismatic
2692	Gauge Pressure		
2695	Gauge Suction	6FX/202	Indicator
2772	Label "Air"	106A/690	Indicator, Directional Gyro
2776	Label "Hydrogen"		
		6J/660	Filter Oil Type
2906	Gauge Boost		
3125	Gauge Fuel Contents	1032	Control Units Directional
3126	Gauge Fuel Contents	1033	Control Units Bank & Climb
3452	Bezel and Disc Assembly	1002	Control Units Directional
3482	Altimeter	1003	Control Units Bank & Climb
3826	Gauge Fuel Contents		
4098	Gauge Fuel Contents	6TB/1649	Coupling Unit Bombing
4654	Gauge		
5037	Gauge Oil Contents	10G/1039212	Switchboard
5118	Gauge Fuel Contents		
6305	Tachometer	10G/YA.6733	Switchboard
6491	Gauge Pressure		
		106A/1315	Gauge
313	Sextant Mk 9		
399	Compass Astro Mk 2A	715	Indicator, Rate of Climb
106A/561	Gyro Unit Type B	6B/921	Indicator, Airspeed
6B/742	Repeater, Luminous	1039	Gauges Fuel Contents
1671	Compass, Wrist	1044	Gauges Manifold Pressure
1672	Compass Type P11	1068	Gauges De-Icer Pressure
1673	Compass Type P12	1335	Gauges Fuel Pressure
6B/2593	Compass Wrist	1336	Gauges Oil Pressure

Ref No	*Description*	*Ref No*	*Description*
		1562	Indicator (for Pioneer Magnesyn Compass)
	B. OTHER LUMINOUS ARTICLES		
4G/3140	Disc Radioactive		
7E/2682	Thimbles Luminous		
26DE	Door Marker, Luminous		
27C/2184	Patch, Disc, Radioactive (Fitted to 16H/1323 Dinghy Type D)		
32B/1063	Strip Luminous		
26SR/3863*	Starboard escape hatch internal release handle		
26SR/3995*	Parachute Exit Door Jettison Handle		
26SR/12388*	Sextant Station Dome Release Level		
15A, NIV CQ20347*	Crew's Parachute Static Line		
26SR/15818*	Port and Starboard Jettison Levers		
26SR/3193*	Manual Depressurization Valve Level		
NIV*	Fire Extinguisher and Axe Luminous Labels		
26SR/12977*	Luminous Tags around Parachute Exit Door		
26WA/6932	Broardhurst 100/1 Marker		

All other luminous painted items on Valiant and other aircraft

*Valiant aircraft

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DISPOSAL OF SCRAP SEALED RADIOACTIVE SOURCES

(D/DDC Med(RAF)/13/12/3, MA4a(RAF)—June 1978)

1. Primary sources, either forming part of an instrument or separate, which come within the limits stated below, are to be disposed of with ordinary refuse. These limits are:

   a. The total number of microcuries of all the radionuclides present in each source must not exceed five.

   b. The number of such sources disposed of by this means in any week must not exceed ten.

2. Scrap sealed radioactive sources may otherwise be disposed of, without restriction, by returning them to the manufacturer of the sources or sending them to anyone who is authorized under Section 6 of the Radioactive Substances Act 1960 to dispose of such sources (usually the manufacturer of the instrument which contains the source).

3. Any scrap sources which cannot be disposed of by the means mentioned above are to be reported through normal channels to HQRAFSC (Unit Supply 2) for disposal instructions. Such reports are to include the following information:

   a. Section and reference numbers, description and quantity.

   b. Radionuclides, if known.

   c. Estimated total activity in microcuries (μCi) of each radionuclide in each article and total in each container.

   d. The nature of each container, inner and outer.

   e. The number of articles of each type in each container.

   f. The approximate size and weight of each container.

   g. The maximum dose rate at the surface of each container in millirads in air per hour.

   h. Location of the radioactive equipment for disposal.

4. When disposal through the Atomic Energy Authority is agreed with the authorizing Department, HQRAFSC instructions will call for the submission of completed Forms RSA4, one copy each to the AEA, to HQRAFSC (Unit Supply 2) and to the authorizing Department. Units submitting Forms RSA4 will be advised in due course by the AEA as to where the sources are to be delivered. In connection with the disposal to the AEA, attention is drawn to Leaflet N7.

DISPOSAL OF CONTAMINATED CLOTHING, CLEANING MATERIALS AND MISCELLANEOUS WASTE

(D/DDC Med(RAF)/13/12/3, MA4a(RAF)—June 1978)

1. Contaminated clothing, cleaning materials and miscellaneous waste are to be disposed of as follows according to the level of radioactivity:

a. *Up to* 10^{-4} μ/Ci/cm^2. Clothes may be laundered and no special precautions are necessary; clothing which has been contaminated with radioactive material is not to be sent to the dry cleaners.

b. *From* 10^{-4} to 10^{-3} μ/Ci/cm^2. Clothes may be laundered under special arrangements but each article will count against the approved quota for the laundry. Contaminated clothing is to be segregated from non-contaminated clothing and stored in suitable containers while awaiting transit to the laundry.

c. 10^{-3} to 10^{-2} μ/Ci/cm^2. Clothes are not to be laundered, cleaning cloths, clothes and rags are to be disposed of before they become contaminated to a level of 10^{-2} μ/Ci/cm^2 by mixing small quantities of them in with other solid non-radioactive refuse. They must not be allowed to accumulate. A suitable dilution factor for cleaning cloths and rags is 1 lb radioactive waste to 10 lbs of non-radioactive waste.

d. *Above* 10^{-2} μ/Ci/cm^2. Cleaning cloths, clothing and rags contaminated above this level are to be put into suitable sealed containers, such as oil drums and are to be transported to the refuse tip under arrangements agreed with the Local Authority. These arrangements are made through the authorizing Authority, *see* Leaflet N1. Station refuse tips are not to be used.

NOTE: Contamination levels may be assessed by using Monitor Type 617 with the detector window held about 5 cms from the surface being monitored and the shutter fully open. The instrument reading is directly proportional to the contamination level and cps above background can be converted into μCi/cm^2 as follows:

$$15 \text{ cps} = 10^{-4} \mu\text{Ci/cm}^2.$$
$$150 \text{ cps} = 10^{-3} \mu\text{Ci/cm}^2.$$

2. Working protective clothing disposed of under these arrangements is to be made unwearable.

3. Any clothing, cleaning rag or miscellaneous waste with a level of radioactivity greater than 10^{-2} μ/Ci/cm^2 or any excess quantity of clothing or rag which it is impracticable to dispose of under the conditions quoted in paras 1 and 2, is to be reported through the normal channels to HQRAFSC (Unit Supply 2) for disposal instructions. Clothing is to be converted to rag by weight. Such reports are to include the following information:

a. Section and reference number, description and weight.

b. Average level of activity.

c. Radionuclide.

d. Location of rags.

4. When disposal through the Atomic Energy Authority is agreed with the authorizing Department, HQRAFSC instructions will call for the submission of completed Forms RSA4, one copy of each to the AEA, to HQRAFSC (Unit Supply 2) and to the authorizing Department. Units submitting Forms RSA4 will be advised in due course by the AEA, as to where the articles are to be delivered.

5. In connection with disposal to the AEA, attention is drawn to Leaflets N7 and N8.

DISPOSAL OF RADIOACTIVE AIRFRAME SCRAP

(D/DDC Med(RAF)/13/12/3, MA4a (RAF)—June 1978)

Introduction

1. Aircraft which habitually fly at altitudes of 30,000 feet and above in northern latitudes (approximately 40°—90° north) tend to collect radioactive debris from nuclear test explosions. Some of this debris is removed by washing, but some adheres to the paint or bare metal of the aircraft surface.

2. When an airframe is disposed of as scrap it is normally melted down and the contamination either burns off with the paint or mixes in with the melted metal.

3. The contaminated burnt paint can be disposed of under the regulations for the disposal of radioactive waste. If the contamination mixes with the melted metal it may increase the natural radioactivity of the metal to a significant level, currently assessed at $5 \times 10^{-5}\mu Ci/gram$. If this occurs the contaminated metal must be diluted with uncontaminated metal before it can be re-used; for this reason it is necessary to ensure that as much contamination as possible is removed from the aircraft before they are sold as scrap metal.

Applicability

4. The airframes affected by this Instruction are those types currently monitored for radioactivity levels (*see* leaflet P 1).

Definition

5. In this context the term "airframe scrap" includes airframes virtually complete and large detachable parts, such as fins, rudders, ailerons, *etc*. Attention is drawn to the different procedure for painted and unpainted airframes.

Monitoring

6. Any luminous components are to be removed and disposed of separately. The remaining scrap is then to be monitored in accordance with Leaflet P 1 and the appropriate certificate issued by the Radiation Safety Officer.

Airframes Free of Contamination

7. If no contamination is found a certificate of freedom from radioactive contamination, in accordance with Annex A is to be issued. Normal sales procedure may then be followed with the proviso that documents offering the airframe for sale are to be endorsed as follows:

> "This airframe has been monitored and no radioactivity has been found. It may be disposed of without special precautions".

Painted Airframes with Average Contamination of 10^{-4} $\mu Ci/cm^2$ or Less

8. Painted airframes with average contamination of 10^{-4} $\mu Ci/cm^2$ or less may be disposed of by sale under normal procedures after the completion of a certificate in accordance with Annex B; the certificate is to be sent to Ministry of Defence Sales 4al(A). Documents offering the airframe for sale will be endorsed by MOD as follows:

> "The metal offered for sale in this airframe bears slight residual radioactive contamination, but this is below the level at which special precautions are necessary during handling, or for which authorization is required before disposal".

9. The Ministry of Defence will be responsible for informing the Department of Employment and the authorizing department of the sale of the airframe, the buyer and the level of radioactivity.

(AL17, Sep 78)

Painted Airframes with Average Contamination Exceeding 10^{-4} μCi/cm²

10. When the average contamination of a painted airframe exceeds 10^{-4} μCi/cm², it may be possible to reduce the contamination below this figure by removing the more highly contaminated parts. If so, this is to be done and the more highly contaminated parts are to be disposed of as radioactive material. The remainder of the airframe may then be sold as in para 8 above.

11. If reduction of the average contamination to 10^{-4}μCi/cm² or below is not possible a certificate, in accordance with Annex C, is to be sent to Ministry of Defence Sales 4a1(A).

12. Documents offering the airframe for sale will be endorsed by MOD:

"As a result of flying at high altitudes, parts of the metal offered for sale bear slight residual radioactive contamination. These parts have been checked and have been found to be below the level at which special handling precautions are required, other than the following:

a. Avoid unnecessary handling of the scrap by wearing ordinary industrial gloves.

b. Avoid dry dust raising operations.

c. Observe normal standards of hygiene such as washing before eating *etc.*"

13. Before invitations to tender are issued the Ministry of Defence Sales 4al(A) will inform the Department of the Environment of the total weight of scrap and the level of radioactivity and obtain their agreement to the sale.

14. In due course, Ministry of Defence Sales 4a1(A) will inform the Department of the Environment of the purchaser of the scrap.

Unpainted Airframes with An Average Contamination of 3×10^{-5} μCi/cm² or Less

15. When an unpainted airframe with an average contamination of 3×10^{-5} μCi/cm² or less is offered for disposal the procedure in para 8 is to be followed, with the exception that the certificate shown in Annex B is to be suitably amended in para 1, line 2.

Unpainted Airframes with an Average Contamination Exceeding 3×10^{-5} μCi/cm²

16. When an unpainted airframe with an average contamination exceeding 3×10^{-5} μCi/cm² is offered for disposal the procedures in para 10 to 14 inclusive are to be followed "applying the value 3×10^{-5} μCi/cm² in para 11".

Crashed Aircraft

17. Identifiable engine parts and luminous components are to be removed from the crashed aircraft and disposed of according to any level of radioactivity present.

18. The remainder of the crashed aircraft is to be disposed of according to the certificate of radioactivity issued *vide* para 7 to 16 above.

CERTIFICATE OF FREEDOM FROM RADIOACTIVE CONTAMINATION

Aircraft Type and Number

The external surface of this airframe has been monitored for radioactivity and no significant radioactive contamination has been found. All radioactive components have been removed.

.....

.....(Rank)
Radiation Safety Officer

.....
for Officer Commanding

RAF .....

.....Date

CERTIFICATE OF FREEDOM FROM RADIOACTIVE CONTAMINATION

Aircraft Type and Number

1. The external surface of this airframe has been monitored for radioactivity and the average level is below 10^{-4} uCi/cm^2. No special precautions against radioactive contamination are therefore necessary when handling the airframe or disposing of it as scrap.

2. All radioactive components have been removed.

3. The airframe is painted/unpainted (delete as necessary).

.....

.....(Rank)
Radiation Safety Officer

.....
for Officer Commanding

RAF .....

.....Date

CERTIFICATE OF RADIOACTIVE CONTAMINATION

Aircraft Type and Number

1. As a result of flying at high altitudes this airframe bears slight residual radioactive contamination. The airframe has been washed and the contamination has been reduced to an average of uCi/cm².

2. All radioactive components have been removed.

3. The airframe is painted/unpainted (delete as necessary).

.....

.....(Rank)
Radiation Safety Officer

.....
for Officer Commanding

RAF .....

.....Date

DISPOSAL OF OTHER RADIOACTIVE SCRAP

(D/DDC Med(RAF)/13/12/3, MA4a(RAF)—June 1978)

1. Any other arisings of radioactive scrap or material not covered by the provision of Leaflets 1 to 6 are to be reported through normal channels to HQRAFSC (Unit Supply 2) for disposal instructions. Such reports are to include the following information:

   a. Section and reference numbers, description and quantity.

   b. (1) Radionuclide, if known.
      (2) Nature of contamination (state whether from high flying or other causes).

   c. Level of activity.

   d. A description of the container.

   e. Location of the radioactive items for disposal.

2. When disposal through the Atomic Energy Authority is agreed with the authorizing Department, HQRAFSC instructions will call for the submission of completed Forms RSA4, one copy of each to the AEA, to HQRAFSC (Unit Supply 2) and to the authorizing Department. Units submitting Forms RSA4 will be advised in due course by the AEA of the address to which the radioactive items/materials are to be delivered.

3. In connection with disposal to the AEA, attention is drawn to Annexes A and B to this Leaflet and to Leaflet N8.

In lieu of RSA4

Annex A to AP 4687A, Vol 2
Leaflet No N 7

Senders reference.....

For completion by AEA

Disposal Certificate No.....

RADIOACTIVE SUBSTANCES ACT 1960
NATIONAL DISPOSAL SERVICE

NOTICE to the United Kingdom Atomic Energy Authority of intention to send to them radioactive waste authorised under section 6 of the Radioactive Substances Act, 1960 for disposal to premises occupied by them.

NOTES

(a) This Notice must be completed in duplicate by or on behalf of the sender. One duplicate must then be sent to the Authority at the address of the premises occupied by them to which the sender is authorised to dispose of the waste according to his Certificate of Authorisation and the other duplicate to the ~~Ministry of Housing and Local Government~~ Department of the Environment, Whitehall, S.W.1.

(b) The Authority's directions for the delivery of the waste will be sent to the sender at the address specified in paragraph 2 of this notice.

(c) Where more than one class of waste is specified in the sender's Certificate of Authorization, a separate Notice must be completed for each class of waste and in paragraph 6 it should be stated whether the class of waste to which the Notice relates is "combustible solid", "incombustible solid", "mixed trash" or "non-standard waste".

(d) In paragraphs 7 and 9 the containers referred to are the outer or outermost containers in those cases where inner containers or linings are used.

(e) Where an inner container other than the normal 10 gallon carboy or winchester type is used for liquid wastes a drawing of the container should accompany the copy of this Notice sent to the Authority.

(f) If it is not practicable to give precise answers to the question in paragraph 9 about the amount of radioactivity in the waste and the maximum dose rate on the outside surface of a container, the best practicable estimates should be made. Where the answers given are estimates this should be indicated.

SENDER'S NOTICE
(See Note (a))

1. I/We ..... of/whose registered office is situated at.....

hereby give notice to the United Kingdom Atomic Energy Authority of my/our intention to send them at the premises occupied by them at.....

the radioactive wastes described in this notice

.....

To:—The United Kingdom Atomic Energy Authority

.....

.....

.....

Signature of sender or of person authorised to sign on behalf of the sender(s)

date.....

(AL3, Aug 67)

2. Address of premises occupied by the sender to which the Authority's delivery directions are to be sent (see note (b))

.....

3. Name, telephone number and extension (if any) of the person authorised to give further information in respect of this Notice.....

4. Name and address of the person to whom accounts are to be rendered.....

.....

5. Reference number and date of the Certificate of Authorisation furnished by the Minister which certifies that the sender is authorised to dispose of the waste to the Authority.....

.....

6. Class of waste to which this Notice relates (see Note (c)).....

7. Number of containers (see Note (d)).....

8. Mode of Transport ie British Road Services, own transport, etc.....

9. The following particulars should be given for each container and its contents (see Note (d))

If the consignment consists of more than 3 containers give the particulars in respect of the additional containers on separate sheets.

Identification letter if more than one container			
Description and size of container (see Note (e))			
Weight of waste (if solid) Volume of waste (if liquid)			
Maximum dose-rate on outside surface of container in milliroentgens per hour (see Note (f))			
Number and description of each *inner* lining or container (if any)			
Radioactive substances present in container (or in each *inner* lining or container, if any)			
State nature of waste in container (or in each *inner*) lining of container, if any), i.e. if liquid, nature of solvent; if solid, whether in powder form			
Is plastic present in the container either in the form of an inner lining or container or in the waste itself (Answer 'yes' or 'not sure'.)			
Details of any toxic explosive or inflamable hazard associated with the waste			
Any other relevant information			
Is container to be returned?			

DEPARTMENT OF THE ENVIRONMENT
NATIONAL DISPOSAL SERVICE
SCHEDULE OF CHARGES
SECOND EDITION

PART I—STANDARD WASTE

For standard waste, that is to say, radioactive waste of such a nature and so packed as to fall within one or other of the two Classes described in Column 1 of this Part of the Schedule, the charges payable are those specified in respect of that Class in Column 3.

CLASS 1—COMBUSTIBLE SOLIDS		CHARGES
1. *Nature of Waste* Solid waste (excluding large animal carcasses or parts thereof) which— a. is combustible by nature; and b. is sufficiently dry to burn readily; and c. is not explosive or highly inflammable; and d. is packed in accordance with the Packing Requirements set out in the adjacent column; and e. is of such a nature that, if packed in accordance with these requirements— (1) the dose rate at any point at the surface of the metal drum does not at any time exceed 200 milliroentgens per hour in air; and (2) not more than 1 millicurie of alpha emitters and not more than 10 millicurie of beta emitters are present in the drum; and (3) the weight of plastic material, rubber and small animal carcases (if any) present in the drum does not exceed 5% of the total weight of the contents of the drum.	2. *Packing Requirements* a. Faeces and other putrid or offensive matter (if any) must be separated from the other waste and packed in plastic bags (see Practice Note 1) or waxed cardboard containers or sealed metal containers. b. Other waste together with any bags or containers containing offensive matter must be packed in plastic bags (see Practice Note 1), or if that other waste is dry, in waxed paper containers. c. The last mentioned bags or containers must be so tied up or sealed as to prevent the escape of their contents and be easily removable from the metal drums in which they are contained. d. All such bags or containers must be contained in metal drums (see Practice Note 2). e. Any such drum— (1) Must not exceed 18 ins (460mm) in diameter or 24 ins (610mm) in height; and (2) must have the whole of its top removable in the form of a lid, the lid being securely closed with a gasket made of rubber or similar material between it and the body of the drum, and (3) must not contain more than 50 kilograms of waste.	3. £5·00 per consignment Plus 30p per kilogramme

	Practice Note 1. For waste which is being packed for disposal to the Authority's Research Establishment at Harwell plastic bags must be of the type which will be provided free of charge by the Authority on request. Other plastic bags must NOT be used. (Department of the Environment: The Radioactive Substances (Carriage by Road) (Great Britain) Regulations 1970; and the Codes of Practice, (1) for the Carriage of Radioactive Materials by Road and, (2) for the Storage of Radioactive Material in Transit). 2. The Authority requests that, if practicable, each drum should contain only one of the bags, or containers referred to in paragraph d. above.	

CLASS 2—INCOMBUSTIBLE SOLIDS AND MIXED TRASH		CHARGES
1. *Nature of Waste* Solid waste (excluding large animal carcasses or parts thereof and fluid sludge) which: a. is incombustible by nature; and b. is not floatable in water; and c. is packed in accordance with the Packing Requirements set out in the adjacent column; and d. is of such a nature that, if packed in accordance with those requirements— (1) the dose rate at any point at the surface of the metal drum does not at any time exceed 200 milliroentgens per hour in air; and (2) not more than 1 millicurie of alpha emitters and not more than 50 millicuries of beta emitters are present in the drum.	2. *Packing Requirements* The waste must either be packed in: a. Metal drums which do not exceed 24 ins (610mm) in diameter or 36 ins (915mm) in height with the whole of the top removable in the form of a lid. The lid must be securely closed with a gasket made of rubber or similar material; or b. strong industrial packages in accordance with directions from the United Kingdom Atomic Energy Authority.	3. £5·00 per consignment Plus £15·00 per cubic metre where the customer supplies suitable containers.

PART II—NON-STANDARD WASTE

For non-standard waste, that is to say radioactive waste of such a nature or so packed as not to fall within one or other of the two Classes described in column 1 of Part I of the Schedule, such charges are payable as the Secretary of State may fix.

PART III—EXTRA CHARGES

In addition to the charges specified or referred to in Parts I and II of the Schedule, such charges as the Secretary of State may fix are payable if—

a. the waste is collected by the Authority instead of being sent; or
b. the Authority provides containers; or
c. the Authority agrees, or deems it desirable, to decontaminate containers.

Administrative costs. A charge of 5% will be levied on each account.

In this Schedule, "the Authority" means the United Kingdom Atomic Energy Authority.

This is to certify that this is the document referred to in the Certificate of Authorisation for the Disposal of Radioactive Waste dated ..... and issued to .... under the Radioactive..... Substances Act 1960.

.....

Signed by the authority of the Secretary of State for the Environment.

..... in the Department of the Environment.

TRANSPORTATION OF RADIOACTIVE WASTE TO ATOMIC ENERGY AUTHORITY PROCEDURE

(AF/662/66, Part IV, MA4a(RAF)—March 1971)

1. Radioactive waste for disposal is to be transported to AEA in accordance with Section K.

2. The following containers are to be used:

40D 1608 Drums Radioactive Waste Large

40D 1609 Drums Radioactive Waste Small

40D 1529 Bags Waxed Paper ($28\frac{1}{4}$ in x 30 in) for use with large drums

40D 1530 Bags Waxed Paper ($21\frac{7}{8}$ in x 24 in) for use with small drums.

These drums and the appropriate size of waxed paper bag for use as internal container are to be demanded from No 25 MU quoting this leaflet as authority. Demands are to be for "30 days loan" and are to be endorsed "Required for disposal of radioactive waste to AEA".

3. The supply of these drums is very limited; they are not to be used for any purpose other than the return of waste to AEA; they are to be recovered from AEA after use and returned to No 25 MU.

NB The above containers are Class A containers for surface transport only.

DISPOSAL OF RADIOACTIVE WASTE FROM AIRCRAFT WASHING PLATFORMS

(D/DDC Med(RAF)/13/12/3, MA4a(RAF)—June 1978)

1. Aircraft which are regularly flown at altitudes of 30,000 ft and above in northern latitudes (approximately 40° to 90°N) tend to collect radioactive debris from nuclear test explosions.

2. **Waste from Washing Platforms.** When it is necessary to wash aircraft which may be contaminated, as in para 1 above, the authorized washing platforms, which are provided, are to be used. The drainage from these platforms is arranged so that most of the fission products are trapped in oil traps or settlement tanks before the waste water is discharged to the local sewage plant or drains.

3. It is the responsiblity of the Radiation Safety Officer to liaise with the local office of the Department of the Environment who will arrange for these tanks to be cleaned out every six months. Samples of the sludge are to be monitored with a Monitor Type 617 with the detector window held about 5 cms from the surface of the sludge and the shutter fully open. The instrument reading is directly proportional to the radioactivity level and cps above background can be converted into $\mu Ci/cm^2$ as follows:

$$15 \text{ cps} = 10^{-4} \ \mu Ci/cm^2$$
$$150 \text{ cps} = 10^{-3} \ \mu Ci/cm^2$$

If any level above 10^{-4} $\mu Ci/cm^2$ is found, the following precautions are to be taken:

a. The workmen employed in cleaning out the settlement tanks are to wear rubber boots and overalls, and afterwards are to wash their hands before eating, drinking or smoking.

b. The sludge is to be placed in suitable containers such as empty oil drums after which disposal instructions are to be sought by application through HQRAFSC (Unit Supply 2) to the Department of the Environment. (*See* Leaflet N1.) Instruction received will probably result in disposal on a local authority tip.

c. A record of the operation is to be kept by the Radiation Safety Officer showing date, number and type of containers, counts per second at the surface of the sludge, count per second at the surface of the containers and where the containers are buried.

d. If the activity recorded is less than 10^{-4} $\mu Ci/cm^2$ the waste may be disposed of without special precautions.

DISPOSAL OF RADIOACTIVE WASTE — COMMANDS ABROAD

(D/DDC Med(RAF)/13/12/3, MA4a (RAF)—June1978)

1. Disposal of radioactive waste at stations in Commands abroad is to be in accordance with local national regulations where such regulations exist.

2. Where local national regulations do not exist the following action is to be taken subject to the agreement of any recognized local authority:

a. All radioactive waste equivalent to that which in the United Kingdom would be disposed of through the normal refuse disposal service is to be similarly disposed of overseas.

b. All radioactive waste which in the United Kingdom would be disposed of by arrangement with the local authority is to be disposed of overseas by burial under five feet of soil or uncontaminated waste. If this method of disposal is impracticable, the circumstances are to be reported to the parent Command Headquarters.

c. All radioactive waste equivalent to that which in the United Kingdom would be reported to HQRAFSC (Unit Supply 2) in accordance with Leaflet No N7 is to be reported to the parent Command Headquarters, giving the relevant details. The overseas Command Headquarters will consider whether to dispose of the radioactive waste at the overseas location or not and, if the former course is decided upon, appropriate instructions will be given to the Unit after agreement has been reached with MOD MA4a(RAF) on the specific method to be adopted.

3. In certain circumstances and when authorized by MOD MA4a(RAF) radioactive waste may be disposed of overseas by sinking in deep sea water. In such circumstances the waste is to be in containers which are perforated and ballasted and will retain the waste. Ballasting is to be such that the specific gravity of the container and its contents is approximately 1·2. The precise deep sea area in which disposal takes place is to be decided by the Command Engineering Armament Staff in consultation with the local British Naval Authorities. The criteria in selecting the area of sinking are to be such as will ensure that the radioactive waste will not be washed ashore.

4. Arrangements for the disposal of radioactive waste in Commands abroad are to be approved by the Competent Medical Authority.

DISPOSAL OF RAF AIRCRAFT OR OTHER EQUIPMENT CONTAINING RADIOACTIVE SUBSTANCES

(D/DDC Med(RAF)/13/12/3, MA4a(RAF—June 1978)

1. It is important to ensure that when items of RAF equipment are disposed of, as far as is practicable all radioactive substances including specific radioactive sources are removed prior to disposal unless the equipment is to be used for its designed purpose or is being disposed of by return to the manufacturer. When equipment is returned or otherwise disposed of in the latter circumstances, full details of the included radioactive substances must be passed to the recipient whose written agreement to accept the consignment must be obtained before the equipment is released to him. Care must be taken to ensure that all current radiation safety instructions applicable to the item have been fully implemented.

2. When, as in para 1, it is necessary to remove radioactive substances, including specific sources, from RAF equipment, the work is to be supervised by a qualified Competent Person who is to ensure that the work is carried out in accordance with current authorization procedure and the following conditions:

a. *Equipment Containing Specific Radioactive Sources.* Autolycus equipment, certain fire extinguishing systems, and some targets and drogues, *etc* contain radioactive sources and, if the equipment concerned is not disposed of by return to the makers or for designed use, the sources should be removed and disposed of as radioactive waste. Detailed removal instructions should be provided by the sponsor branch concerned.

b. *Luminous Markers.* All luminous markers should be detached preferably by removal of the luminized part or surface complete; acceptable levels of residual radiation are as follows:

(1) *Beta Lights.* Every reasonable effort should be made to remove all beta lights, however when it can be shown that removal would necessitate the expenditure of excessive effort in terms of manpower, individual small beta lights may be allowed to remain.

(2) *Other Luminized Markers.* All other luminized markers should be removed to the following acceptable level:

(*a*) No visible luminous paint is to remain.

(*b*) Alpha smear test is to show no smearable contamination remaining.

(*c*) Residual contamination from any beta/gamma source is not to exceed 10^{-4} $\mu Ci/Cm^2$ averaged over an area of a 20 centimetre square (*see* Leaflet P 1).

c. *Mass Balance Weights (Containing Depleted Uranium).* All depleted uranium balance weights must be identified and accounted for; when disposed of it must be ensured that the buyer is informed in writing that the weights are depleted uranium and not lead; disposal by return to the initial supplier is preferred.

3. In cases where doubt exists as to the appropriate act to be taken, the advice of MOD (MA4a(RAF)) should be sought through normal Service channels.

SECTION P

AIRCRAFT CONTAMINATION

SECTION P

AIRCRAFT CONTAMINATION

CONTENTS LIST

RADIOACTIVE CONTAMINATION OF AIRCRAFT AND AIRCRAFT COMPONENTS — MONITORING

(D/DDC Med(RAF)/13/12/3, MA4a(RAF) dated June 1978)

Introduction

1. Radioactive debris from nuclear test explosions remains in the stratosphere for many years and tends to concentrate in the Northern Hemisphere north of latitude 40°. Since the nuclear air test moratorium of 1963, there has been a steady decrease in the stratospheric inventory of this debris to an insignificant amount and hence radioactive contamination of aircraft no longer poses a problem. It is, however, considered prudent to maintain aircraft and aircraft component monitoring effort on a sample basis to provide data on the current situation. It is considered unnecessary to monitor the clothing worn by aircraft servicing personnel.

Aircraft Affected

2. The aircraft types to be monitored are those which habitually fly at above 30,000 ft in the Northern Hemisphere, north of latitude 40°. RAF aircraft types which fall into this category are:

a. Canberra PR7 and PR9.

b. Vulcan B2.

c. Nimrod R.

d. VC10.

e. Victor K2.

Each station operating any of the above aircraft at the heights and latitudes quoted is to monitor one of each such aircraft type at six-monthly intervals.

Note: Sample monitoring is not to be performed on aircraft operating in the air sampling role.

Monitoring Procedures

3. The radiation monitor to be used in these aircraft surveys is:
Radiation Monitor, Type 617 (6Z–6204137) — used and prepared in accordance with AP 112G–1315–5F Chap 2 and AP 112G–1315–1 Chap 2.

4. The sample monitoring should, ideally, be carried out immediately preceding routine washing of the aircraft.

5. **Method.** It has been found practical to obtain the average level of activity of an aircraft by monitoring a part only of its surface thereby achieving an economy of effort. The procedure to be followed is to consider the under (or most convenient) surface of one side of an aircraft, divide it into 8 to 12 suitable areas and obtain the average level of contamination for each area and hence of the combined areas; the final figure is acceptable as giving the average surface level of activity for the whole aircraft.

6. The average level of activity for any of the 8 to 12 areas is to be obtained by the operator surveying the area and making a mental average from the instrument readings.

7. **Hot spots.** It is possible during these surveys that "hot spots" will be noted; such readings should be recorded on Form Stats 951 (formerly Form Stats 151) in column (e) but should not be taken into account when assessing average levels. "Hot Spots" will be noted at MOD MA4a(RAF) and, where necessary, advice will be given.

Reporting

8. On the completion of each survey, Form Stats 951 is to be completed in duplicate by the transfer of details from the proforma, Annex A. A Copy of Form Stats 951 is to be sent to MOD MA4a(RAF) and also to the Command Headquarters of the station concerned.

Interpretation of Instrument Readings

9. Instrument readings are to be interpreted as follows:
Radiation Monitor, Type 617. With the detector window held about 5 cms from a surface contaminated with fission products to a level of 10^{-4} $\mu Ci/cm^2$ and with the shutter fully open, an instrument indication of 15 counts per second (cps) above background can be expected. The instrument indication is in direct proportion to the contamination level, for example:

$$15 \text{ counts per second} = 10^{-4} \ \mu Ci/cm^2$$
$$150 \text{ counts per second} = 10^{-3} \ \mu Ci/cm^2$$

Monitoring of Aircraft Components

10. Sample monitoring of air-driven, air-fed or air-cooled components will be carried out by nominated depth C servicing units only. These units will report the activity levels found to MOD MA4a(RAF) and Command Headquarters.

RADIOACTIVE CONTAMINATION OF AIRCRAFT-MONITORING RESULTS PROFORMA

RAF Station — Surveyed by
Aircraft Type .....
Aircraft No .....
Instrument Type and Serial Number.....

	Date	Total Flying Hours	Contamination Level $\mu Ci/cm^2$	Remarks
Last Survey				
This Survey				

	Zone	Beta/Gamma Average CPS	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
	Average for Aircraft	$\mu Ci/cm^2$	

HOT SPOTS

	Location	CPS	Remarks
1			
2			
3			
4			

RADIOACTIVE CONTAMINATION OF PROTECTIVE CLOTHING

(AF/CT 1696/69 MA4a(RAF) dated February 1973)

Introduction

1. Protective clothing worn by aircraft servicing personnel who come into contact with aircraft contaminated with fission products will in turn become contaminated. The parts of clothing which become most contaminated are the areas of the wrist and feet, pockets, front at waist level and the knees. This contamination could be a danger to health if it is allowed to build up. It can be removed by laundering but there is a limit to the amount of contamination and hence the amount of contaminated clothing which can be sent to the laundry.

2. It is, therefore, necessary to ensure that contamination does not build up and to this end 10% of protective clothing used on the aircraft types indicated in paragraph 2 of leaflet P 1 is to be monitored.

Frequency of Monitoring

3. Clothing of aircraft servicing personnel is to be monitored weekly before being sent for laundering. If it is found that the contamination levels of 10^{-3} μCi/cmE are reached at the weekly check, clothing should be monitored and changed more frequently to prevent this level being exceeded.

Method of Monitoring

4. **Overalls.** The contamination level of overalls is to be assessed by selecting an area of about 1 square foot on the front of the overall at waist level. The overalls are to be laid flat on a bench and the area is to be monitored slowly with a Radiation Monitor Type 617 (shutter open) and held with the detector window about 5 cms from the contaminated surface or, with a Radiation Monitor Type 1320X fitted with a Beta/Gamma probe (shutter open) and held about 2·5 cms from the contaminated surface. A mental average of the contamination is to be assessed and this average is to be regarded as the contamination level of the overalls.

5. **Dust Coats and Cold Weather Jackets.** Dust coats and cold weather jackets are to be monitored as shown in paragraph 4.

6. **Cold Weather Trousers.** Cold weather trousers are to be monitored as shown in Paragraph 4. The area selected for monitoring should be in the region of the knees.

7. **Cold Weather Gloves.** Cold weather gloves should be held as flat as possible and the average contamination assessed from the palm area.

8. **Cold Weather Hats.** Cold weather hats should be placed on a flat surface and the average contamination assessed from the peak area.

Assessment of Contamination

9. Contamination levels may be assessed by converting cps into microcuries per square centimetre, as follows:

a. *Radiation Monitor Type 617*
15 Cps beta/gamma = 10^{-4} μCi/cm^2
150 Cps beta/gamma = 10^{-3} μCi/cm^2

b. *Radiation Monitor Type 1320X*
8 Cps beta/gamma = 10^{-4} μCi/cm^2
80 Cps beta/gamma = 10^{-3} μCi/cm^2

Action to be Taken

10. Clothing which has been contaminated with radioactive material is not to be sent to dry cleaners. It is to be laundered in accordance with the instructions contained in the following paragraphs.

11. **Up to 10^{-4} μCi/cm^2.** Clothing which is contaminated to less than 10^{-4} μCi/cm^2 may be laundered without restriction. It is, therefore, desirable to change overalls frequently to prevent the contamination exceeding 10^{-4} uCi/cm^2.

12. **Up to 10^{-3} μCi/cm^2.** If clothing becomes contaminated to between 10^{-4} and 10^{-3} μCi/cm^2 it may be laundered under special arrangements, but each article will count against the approved quota for

the laundry. For quota purposes cold weather trousers and cold weather jackets count as one item. Cold weather caps do not count against the quota. Contaminated clothing is to be segregated from non-contaminated clothing and stored in suitable containers whilst waiting transit to the laundry.

13. **$10^{-3}\mu$ Ci/cm² and Above.** Clothing should not be allowed to become contaminated above 10^{-3} uCi/cm², if it does it is to be disposed of as rags in accordance with Leaflet N 5, and is to be struck off charge by CIV as a non-formal loss. A report that this has been done is to be sent to Ministry of Defence, MA4a(RAF).

14. **Cold Weather Gloves.** Cold weather gloves can neither be cleaned nor laundered. If the con tamination level exceeds $10^{-3}\mu$ Ci/cm² they are to be disposed of in accordance with paragraph 13.

Special Precautions

15. Laundering will impair the waterproof qualities of cold weather clothing. Care is to be taken to avoid unnecessary contact with contaminated surfaces and by using overalls rather than cold weather clothing when working on aircraft. When washing aircraft the appropriate waterproof clothing should be worn. Cold weather clothing should be laundered as infrequently as is compatible with cleanliness and health.

Returns

16. To enable the Ministry of Defence to follow any trends in contamination levels a return on RAF Form Stats 152 is to be compiled in respect of the last working week in January, April, July and October. Two copies of the Form are to be sent to Command Headquarters by the 15th of the following month. Command Headquarters are to forward one copy of each return in one batch to Ministry of Defence MA4a(RAF) by 21st of that month.

RADIOACTIVE CONTAMINATION OF AIRCRAFT COMPONENTS

(Reference: AF/662/66, Part IV, MA4a(RAF)—1 January 1971)

1. When, due to flight in the stratosphere or for other reasons, aircraft become contaminated with the debris from nuclear explosions, problems arise in the servicing and handling of components.

2. The components most likely to be contaminated are those that are subjected to ram air, *eg* air cooled electrical equipment, ducting, and parts positioned in high flow rate or air impact areas.

3. The concentration of radioactive debris in the stratosphere has declined over the past few years and at present significant levels are unlikely to be met but nevertheless the following precautions are to be observed when handling such components whether fitted to or removed from an aircraft which has habitually been flown at over 30,000 ft or is otherwise believed to be contaminated in this manner.

a. Personnel handling these equipments are to observe normal hygiene by washing their hands before eating, drinking or smoking. Any cuts on the hands should be covered with a non-absorbent dressing.

b. Contaminated components for dispatch to industry or to other service units are to be treated as Exempt Packages in accordance with Leaflet K7, paragraph 3.

c. In all cases, before radioactive components are consigned, it must be verified that the consignee has been made aware of the facts and is prepared to accept the package. Leaflet K4 paragraph 3 refers.

d. Where possible within the bounds of existing servicing requirements, parts should be cleaned of loose contamination before dispatch using appropriate fluids. Written instructions should be given to those engaged on this decontamination work and the instructions are to be approved by the unit RSO who is to call for additional precautions *eg* gloves, masks *etc* if after assessing the hazard he considers that such action is necessary.

4. It is not possible to state precisely how to determine whether or not components, in general, are to be classified as contaminated. Many factors as shape, dimensions, screening, washed or dirty, *etc* must be considered and the RSO should give guidance based on the following:

a. Simple items with no internal parts should have the external loose contamination removed, after which, if there are no internal surfaces that can possibly be contaminated, they are to be considered as uncontaminated.

b. Where internal contamination, fixed or unfixed, is present, classification will depend upon the exterial dose rate related to the screening effects of shape, material and dimensions; in the case of a low external dose rate, *ie* 0.1 mr/hr or 1-5 CPS (1320X), from a small item, it can be concluded that the internal unfixed contamination is insignificant. Such a low dose rate at the exterior of a large item would not have the same interpretation.

c. Certain items may exhibit dose rates when new or re-conditioned; such dose rates may be due to fixed contamination or to manufacturing processes; knowledge of any such dose rates is useful in assessing.

d. The RSO should consider the foregoing and if as a result he is of the opinion that when the item is handled and/or dismantled, unfixed contamination of significant quantity can be exposed, he should assess the item as contaminated.

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SECTION Q

ACCIDENTAL RELEASE OF RADIOACTIVE SUBSTANCES

SECTION Q

ACCIDENTAL RELEASE OF RADIOACTIVE SUBSTANCES

CONTENTS LIST

ACTION IN THE EVENT OF THE RELEASE OF A RADIOACTIVE SUBSTANCE

(AF/662/Pt III, Mech Eng 10(RAF)—28th March 1968)

1. In the event of the release of a radioactive substance inside a building all doors and windows are to be closed and fans and fume cupboard extracts shut-off. The Station Medical Officer and Station Radiation Safety Officer are to be informed immediately.

2. Casualties are to be treated in the normal way except that the Medical Officer is to be informed that they may be contaminated.

Action following a Minor Release

3. If the release involves only a small amount of contamination, the following actions are to be taken. Gloves are to be worn. Radioactive substances are to be carefully wiped up with absorbent tissue. Wet radioactive substances are to be absorbed using blotting paper or similar material. If very active substances presenting an ingestion hazard are involved a face mask is to be worn; the affected area is then to be monitored using the appropriate probe. Decontamination is to be carried out until the contamination has been reduced to the maximum permissible level. All tissues and papers used in decontamination are to be placed in a polythene bag, sealed and disposed of as radioactive waste. If the radioactive substance has a short half-life the area need not be decontaminated but it is to be roped off and the radioactive substances are to be allowed to decay to the maximum permissible level before the building or area is again used.

4. Gloves and contaminated clothing are to be removed and left in the contaminated area, they are then to be monitored and disposed of as stated in Leaflet No P2. Personnel are to wash their hands thoroughly when work is completed and also before eating, drinking or smoking. Skin which has become contaminated is to be washed under a running tap. Cuts or abrasions are to be reported to the Medical Officer immediately, the Medical Officer is to be informed that the injury may be contaminated. If he is not immediately available, the wound is to be washed with running water and covered with a dry water-proof dressing.

5. The release is to be reported to the Ministry of Defence in accordance with Leaflet No F1, paragraph 13.

6. The action to be taken when a valve containing a radioactive substance is broken is stated in Leaflet No. E2.

Action following a Major Release

7. If the release involves a considerable amount of contamination, the building or area is to be evacuated. Personnel are to remain nearby until they have been monitored, except for casualties who may be evacuated to the Station Medical Centre if their injuries allow. The treatment of casualties is to take priority over decontamination and containment of contamination.

8. Contaminated personnel are to be dealt with as for a minor release, except that personal cleansing is to commence as soon as possible under the guidance of a Medical Officer. Care is to be taken to ensure that contamination does not enter the bloodsteam through a roughening or breaking of the skin.

9. The release is to be reported to the Ministry of Defence in accordance with Leaflet No F1, paragraph 13 and the Ministry of Defence will issue detailed instructions for decontamination. Decontamination is not to be carried out until these instructions have been received.

Unit Orders

10. The contents of this Leaflet are to be included in Station or Unit Orders.

FIRE PRECAUTIONS

(AF/662/66 Mech Eng 10(RAF)—28th March 1968)

1. The location of all radioactive substances including radioactive sources held on a Unit is to be included in Fire Orders and, subject to security limitations, is to be made known to civilian fire fighters who may be called upon to fight fires in the area.

2. The following actions are to be taken by appropriate personnel in the event of a fire occurring in a building or area containing radioactive substances.

a. The person discovering the fire will take action in accordance with normal fire procedure, *i.e.* call for help and try to put it out.

b. The Officer who takes charge of the fire fighting is to ensure that the following action is taken:

(1) All doors and windows of the affected rooms are to be closed and fans and fume cupboard extracts are to be shut off.

(2) Personnel in the building or area who may become contaminated are to evacuate the building or immediate area, but are to remain nearby until they have been monitored.

(3) Casualties are to be treated in the normal way except that the Medical Officer is to be informed that they may be contaminated.

(4) The Station Radiation Safety Officer is to be informed immediately that a fire which may involve radioactive substances has occurred.

(5) If a release has occurred action is to be taken to avoid the spread of contamination. Although fire fighting is to take priority, the unnecessary spread of contamination is to be prevented. Firemen entering the area are to take precautions, such as respiratory protection, as shown in AP 957, The RAF Fire Manual. Smoke and effluent from fires involving radioactive substances are to be avoided.

(6) The area is to be cordoned and instructions shown in Leaflet No Q1 are to be complied with.

(7) When the fire has been extinguished the whole area, including vehicles and equipment which has been in the area is to be monitored. Vehicles and equipment are not to be allowed to leave the area until they are freed from contamination.

3. The Unit Radiation Safety Officer is to ensure that any release of radioactivity is reported to the Ministry of Defence in accordance with Leaflet No F1, paragraph 13.

4. The contents of this Leaflet are to be included in Station or Unit Fire Orders.

LUMINIZED MARKINGS—PRECAUTIONS TO REDUCE RADIATION HAZARDS

(AF/7413/66 MA4A(RAF) dated August 1972)

Introduction

1. A great variety of items including aircraft equipment and ground equipment has, in the past, been luminized with a radium or promethium based compound applied in the form of paint or "stick-on" markers. If there is no protective coating, or if it has been damaged, it is possible for the radioactive substance to flake off or to be rubbed off during handling: this gives rise to a radiation hazard because the radioactive material may enter the body by inhalation, ingestion or through skin damage *etc*. The following detail indicates an approved method of maintaining a protective coating over the radium or promethium based marker until such time as the offending item can be replaced by an innocuous item. All action taken in accordance with this instruction is to be carried out under the direct supervision of the Unit Radiation Safety Officer.

Action to be Taken

2. a. *Identification.* Radium and promethium based luminous compound or paint is cream coloured when viewed in daylight and glows a greenish yellow in the dark. It has been applied, often indiscriminately, to such items as aircraft emergency handles, switches, switch guards, parachute or dingy stowage, compass bezels *etc* and to ground equipment, compressed gas connectors, vehicle or trolley extremities, radar consoles, dark room and barrack clocks *etc*. It is not feasible to prepare a comprehensive list of equipment affected since investigations have shown that the type and location of markers varies even between aircraft and equipments of the same type. However, it is possible to locate visually any luminous marker in the dark and then positively identify those containing radium or promethium by monitoring for Beta/Gamma radiation with a Radiation Monitor type 1320X (6Z/9491562) fitted with the appropriate probe. A defective protective coating can be quickly detected by wiping the luminous surface (and the immediate surrounds) with a tissue and subsequently monitoring the tissue.

b. Tritium based compounds and paints are also used for luminizing the later types of equipment; this is similar in appearance to a radium based compound but does not normally give off any appreciable radiation. This instruction does not therefore apply to tritium activated markers *eg*, Betalites, (in cases of doubt, treat luminized surfaces other than Betalites as radium based).

c. *Immediate Action.* Once any luminized surface emitting Beta or Gamma radiation has been located, and is seen to be not sealed or otherwise covered by an integral glass or plastic protective cover, apply a coat of Polyurethane Varnish (Stores Reference 33B/1618. Varnish, Polyurethane Water White, provisioned as a varnish and accelerator kit) with a disposable brush or swab used exclusively for this purpose. When this coat is dry apply two more coats with another brush, allowing the second coat to dry before the third is applied. This operation is to be carried out at the first available opportunity.

d. *Repetitive Action.* If there is any possibility of the protective coat of varnish being worn off by constant use or of it being damaged, further coats are to be applied at intervals depending upon the amount of use or liability to damage. As a guide, markers handled frequently every day should be re-varnished every three months; those handled infrequently every day should be re-varnished every twelve months. Other markers need only be re-varnished if the protective coat is damaged.

Recording

3. A record that this instruction has been complied with is to be made on the appropriate servicing record of the equipment concerned.

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PART 3

NON-IONIZING RADIATION

ORDERS AND INSTRUCTIONS

SECTION R

LASER RADIATION SAFETY

SECTION R

LASER RADIATION SAFETY

CONTENTS LIST

LASER RADIATION SAFETY – GENERAL REQUIREMENTS

(D/DDC Med(RAF)/13/1/3B/MA4a(RAF) – April 1980)

Introduction

1. A laser produces a beam of electromagnetic energy, usually of high intensity, which in some systems is concentrated into a narrow beam of very small angular divergence. The beam may be visible if the laser wavelength lies in the visible part of the spectrum (0.4 to 0.7 micrometres), or invisible if it transmits in the infra-red spectrum with a wavelength greater than 0.7 micrometres. The word laser is an acronym for Light Amplification by Stimulated Emission of Radiation.

2. The primary effect of the laser beam on matter is one of surface burning. Military lasers currently in service will not cause any significant skin burns. Lasers transmitting in the wave band 0.4 to 1.4 micrometres can cause serious burn damage to the retina, the light sensitive area at the back of the eye. Lasers transmitting at wavelengths greater than 1.4 micrometres can damage the cornea which is at the front of the eye.

Defence Standard, British Standard and STANAG

3. The information and instructions contained in this Section comply with the requirements for laser safety published in Defence Standard 05-40; 'Evaluation and Control of Laser Hazards' (which promulgates STANAG 3606) and British Standards Institution Publication BSI 4803: 'Radiation Safety of Laser Products and Equipment Classification, Requirements and User Guide'. Also, employment and general safety precautions for maintenance tasks on laser equipments are detailed in Order No 1752 of RAF Orders and Procedures AP 100B–01. This leaflet also implements STANAG 2900(Med): 'Laser Radiation – Medical Surveillance and Evaluation of Over-Exposure'.

Responsibilities

4. The appointments and responsibilities of departments and individuals at all levels are given in Leaflet B1; attention is also drawn to Leaflet B3 which concerns the reporting of accidents.

THE PROTECTION AND MEDICAL SURVEILLANCE OF PERSONNEL WORKING WITH LASERS

(D/DDC Med(RAF)/13/1/3B/MA4a(RAF) – April 1980)

THE HAZARD

Laser Classifications

1. Laser equipments are allocated into one of five laser classifications according to their hazard potential. The laser classification must be marked on each laser equipment. Laser classifications are summarized below, the full definitions are contained in Def Stan 05-40.

a. Class 1 lasers are intrinsically eye safe.

b. Class 2 lasers are not eye safe but protection is normally afforded by the human eye blink reflex. Continuous observations of a Class 2 laser is hazardous.

c. Class 3a lasers are eye safe to the unaided eye but hazardous when viewed through a magnifying optical instrument.

d. Class 3 lasers are hazardous. (Referred to as Class 3b in Draft BSI 4803).

e. Class 4 lasers are not only hazardous but the laser energy reflected from a matt surface (diffuse reflection) can be hazardous.

Note:
There is no hazard from any laser equipment if its power supply is not switched on.

Hazard Situations

2. The following hazard situations should be understood:

a. *Intra-beam viewing hazard.* It is hazardous to view, or even to glance at, the source of a potentially hazardous class of laser from within the beam (intra-beam viewing) when within the prescribed hazard distance.

b. *Secondary beam hazard.* For those equipments where a secondary beam exists around the main beam, it is also hazardous to view the laser source from within the secondary hazard area unless outside the quoted safe distance.

c. *Viewing through optical instruments.* The effect of using an optical magnifying instrument is to increase the hazard distance by approximately the magnifying power of the instrument. Hence a laser may be apparently safe to use within a certain training area boundary but would be hazardous to a member of the general public who viewed the laser intra-beam using binoculars from outside the training area boundary.

d. *Reflected laser energy.* Most laser systems operate by receiving a small proportion of the energy reflected from the target. Generally, the concentrated energy in the beam is scattered when it strikes the target so that it is reflected in a multitude of different directions (diffuse reflection), and the reflected energy is not hazardous except when the target is very close to the laser. However, shiny perfectly flat surfaces, albeit of very small area, can produce a specular reflection when the laser beam, or part of it, is reflected without an increase in divergence or loss of intensity. This specularly reflected beam is just as hazardous as the main beam. A wet film on painted surfaces can produce reflected energy containing a specular

component, which could be hazardous. (Laser beams obey the reflection laws for light).

e. *Potential hazard to laser maintenance staff.* The firing of a laser in a confined space for test purposes presents a potential hazard from the secondary beam, the main beam and reflected laser energy. Further instructions are at para 11.

f. *High voltage laser systems.* Most pulsed laser systems employ a high excitation voltage of several tens of thousands of volts which constitutes serious potential hazard.

Evaluation of Hazard Areas

3. **Military Laser Safety Committee (MLSC).** The MLSC is a Tri-Service committee working under the auspices of the Ordnance Board. The primary task is to advise the Ministry of Defence on the safe use of laser equipments used by the Services. Before a laser is introduced into service, representatives of the MLSC carry out an evaluation of the laser equipment and this forms the basis of the safety assessment. The MLSC also advise a safety trace for use on authorized ranges and training areas. Final clearance of laser equipments and associated safety procedures in the RAF is given by the MOD(RAF) Radiation Health and Safety Committee (Leaflet A2).

4. **Maximum Permissible Exposure (MPE).** The Institute of Aviation Medicine (IAM) RAF advise the MLSC on the appropriate maximum permissible exposure levels to be applied for all laser systems. MPE levels are used in the preparation of safety traces.

5. **Nominal Ocular Hazard Distance (NOHD).** This is the distance at which the main laser beam irradiance or radiant energy falls below the appropriate MPE level for unaided intra-beam viewing, or after reflection of the beam from a specular surface.

6. **Hazard Area.** The laser hazard area is the zone in which a person could be at risk from laser radiation. The dimensions of the laser hazard area are dependent on the NOHD, the angular divergence of the beam and the pointing accuracy of the laser. The pointing accuracy depends on the mounting and control system and whether the laser is engaging a moving or stationary target and operator proficiency.

PROTECTION PROCEDURES

General Use of Lasers

7. In times of peace, lasers of Class 3 or 4 are not to be fired outside approved areas where they will be subject to the control measures at para 10 of this Leaflet. Class 1 lasers are by definition completely safe and may be operated outside such areas. Class 2 and 3a lasers may, with the discretion of local commanders, be similarly operated outside such areas on ground authorized for military training purposes. Due account is to be taken of the presence of children or other individuals whose curiosity might be such as to put them at risk by close and intensive scrutiny of the laser beam and its source.

Personnel in a Hazard Area

8. Whenever possible the laser hazard area should be clear of all personnel during laser operations. If it is essential to fire a potentially hazardous class of laser when persons are known to be in the hazard area, one of the following protection measures must be adopted:

a. *Use of Laser Protective Goggles.* Personnel must wear authorized pattern laser protective goggles which give protection at the laser wavelength being used. All authorized goggles are marked with the appropriate waveband. The term goggles includes authorized laser protective filters fitted to optical instruments.

b. *Warned but Unprotected Personnel.* Personnel who do not wear laser protective goggles must not look into the direction of the laser when it is being fired and should turn

their backs on the laser. This entails the use of an effective communication system between the laser firing point and all unprotected persons in the hazard area.

Personnel in a Low Hazard Area (LHA)

9. In certain systems, mostly confined to air-to-surface systems, a LHA may be included in the safety trace. The LHA is an additional area, extending outside the hazard area, which could possibly be irradiated in the event of a control system malfunction which causes the laser to point in a spurious direction. Where the risk level to persons in a low hazard area is sufficiently small, the MLSC may advise laser operations under specified conditions.

Range Safety Procedures

10. The following procedures, as appropriate, are to be promulgated in Standing Orders concerning safety when firing Class 3 or Class 3a lasers.

a. *Weapon Firing.* All potentially hazardous lasers should be treated as a weapon and, whenever such lasers are to be fired, the warning procedures adopted for conventional weapon firings must be applied to warn the general public of the danger area.

b. *Accidental Laser Firing.* In circumstances when a laser equipment must be left unattended on a range, it is to be made safe to avoid the risk of its accidental use, or use by unauthorized persons.

c. *Preparation of Laser Targets.* All targets used for laser operations are to be of a matt non-glossy surface and must be free from glass surfaces such as windscreens, periscopes, mirrors, etc. (Special instructions are to be issued should a Class 4 laser be used.)

d. *Preparation of the Ground.* Ground over which a laser is to be fired, (if it is within the hazard area), is to be clear of flat shiny surfaces which might produce specular reflections. Specular reflections from small still water puddles could hazard aircraft crew down range from the puddle.

e. *Livestock.* Lasers are not to be fired when livestock could be at risk from laser radiation.

f. *Laser Warning Sign.* The laser warning sign is to be displayed at the laser firing point for all types of lasers excepting those in the Class 1 category and airborne mounted lasers.

g. *Wet Target Caution.* The viewing of certain wet targets through magnifying optical instruments when the target is close to a powerful Class 3 laser could be hazardous. Advice on the engagement and observation of targets close to the laser area is to be included in the safety trace.

h. *Airborne Laser Systems.* Airborne lasers must only be operated in the area and within the altitude band prescribed for the laser operation. The start of the lasers firing area is determined by the First Laser Firing Point (FLFP).

Note. **Spectators and Other Persons Near the Laser.** There is no hazard to spectators, operators and other persons in the vicinity of the laser provided they remain outside the safety trace hazard area. For systems having a secondary beam hazard area, it is advisable to keep all persons adequately clear of this zone.

Repair and Maintenance

11. Repair, maintenance and test of laser equipments should be undertaken normally only in an area designated as a Laser Protective Enclosure. Safety instructions for the repair of lasers are contained in appropriate technical publications. The main features which are to be provided in a Laser Protective Enclosure are summarized as follows:

a. Where the laser beam is not totally enclosed, the Enclosure is not to allow the escape of hazardous laser emissions. Any windows must be blacked out.

b. Where the laser beam is not totally enclosed, a specially prepared area of suitably approved absorbent material is to contain the radiant exposure, including side lobes, without emitting hazardous reflections or causing a fire risk.

c. Entry to the Enclosure is to be controlled. All entrances are to be fitted with interlocks which stop laser firing whenever an entrance is opened and which prevent further firing until reset on closing the entrance.

d. Hazardous areas within the enclosure should be marked and when feasible should not be at eye-level.

e. Bright illumination should be provided.

f. All electrical installations are to be safe.

g. A Laser Warning Sign is to be displayed at the entrance(s).

h. The desirable features to be included in a Laser Protective Enclosure are as follows:

(1) The total enclosure of the laser radiant exposure.

(2) Fixed overall geometry maintained between the laser, the target holder and beam stop, and the enclosure tube.

(3) Prevention of unauthorized operation of the laser device by use of a key switch in the power supply circuit. (Keys are to be made available to authorized persons only).

12. When an approved Laser Protective Enclosure is not available, alternative precautions are necessary to safeguard the maintenance staff and other persons. Where there is no lockable door, entry into the hazard area is to be controlled by a sentry. Where doubt exists on the hazard level in such an area, advice should be sought from the RSO/Technically Qualified Officer.

MEDICAL SURVEILLANCE

Notification

13. Commanding Officers and Heads of Establishments are responsible for ensuring that the information contained in para 14 below is passed to the officer in medical charge on the following personnel required to work in a laser hazard area:

a. Repair and maintenance staff who work in a Laser Protective Enclosure where the wearing of laser protective goggles is mandatory.

b. Exceptionally a person who by nature of the task is considered by his Commanding Officer likely to be put at risk of receiving laser over-exposure.

c. Personnel who are suspected of receiving laser over-exposure.

Exclusions. Laser equipment operators and spectators of laser operations who stay outside the laser hazard area are not at risk.

14. The following information is to be passed to the officer in medical charge on each individual liable to be subjected to over-exposure.

a. The name of the individual.

b. His task in the laser hazard area.

c. The wavelength, classification, mode of operation and energy/power output of the equipment(s).

d. Details of any personal safety equipment employed.

e. Background information.

15. Personnel working in laser hazard areas who are in the risk categories of para 13 above are to have their personal medical records annotated accordingly (on the F Med 4 envelope for Service personnel), and are to be medically examined by a specialist ophthalmologist as follows:

a. Initially during the four weeks prior to starting work in a laser hazard area for the first time, or when restarting after a lapse of more than 12 months.

b. Finally at the termination of employment in a laser hazard area.

c. If an over-exposure to laser radiation is suspected.

d. At other times at the discretion of the officer in medical charge.

16. Following a suspected over-exposure, the individual is to be referred to the Unit Medical Officer where a preliminary medical examination will be made consisting of those parts of the examination listed in Annex A that are appropriate, but without the use of a mydriatic. The record of this examination will be the basis of the specialist referral required by sub-para 15c.

SPECIAL MEDICAL EXAMINATION FOR PERSONNEL EXPOSED TO LASER RADIATION

1. The initial and final examinations and those conducted in cases of suspected or actual over-exposure to laser radiation are to be carried out by an RAF ophthalmologist and are to contain at least the following:

a. Ocular and relevant general medical history.

b. Assessment of visual acuity for far and near with and without correction.

c. Test of colour vision if not already recorded in the individual's medical documents.

d. Tests of the central vision using the Amsler grid.

e. Examination of fundus oculi, with use of a mydriatic when appropriate.

f. Examination of the cornea and lens with a slit lamp microscope.

g. Fundus photography, mandatory if there is significant abnormality of the posterior pole.

h. Colour photographs or accurate drawings of any abnormality of the eye whether or not it is thought to be due to the effects of laser radiation.

j. Other tests at the discretion of the ophthalmologist.

QUALIFICATIONS OF PERSONNEL

(D/DDC Med(RAF)/13/1/3B/MA4a(RAF) – April 1980)

Radiation Safety Officers (RSO)

1. Radiation Safety Officers are to attend a Radiation Safety Officers' Course at the Institute of Naval Medicine (INM) Alverstoke, or other similar course approved by the Ministry of Defence DHR(RAF). In addition, if the RSO is also the Technically Qualified Officer appointed by the OC Engineering Wing or QAO to be responsible for the radiation safety practices applied to specific laser sources of radiation (*see* Leaflet No B1) he is to attend a Laser Safety Course at the INM (para 7).

Technically Qualified Officers (TQO)

2. Technically Qualified Officers appointed in accordance with Leaflet No B1 by the OC Engineering Wing or QAO to be responsible for radiation safety practices applied to specific laser sources of radiation are to attend a Radiation Safety Officers' Course at the Institute of Naval Medicine (INM) Alverstoke or other similar course approved by the Ministry of Defence DHR(RAF). In addition they are to attend a Laser Safety Course at the INM (para 7).

Competent Persons

3. Competent Persons responsible for the control of sources of ionizing radiation or the control of radiation safety aspects of sources of non-ionizing radiation are annotated accordingly as follows:

a.	Competent Person (CP)	–	Ionizing radiation responsibilities
b.	Competent Person RF (CP/RF)	–	Radio Frequency radiation responsibilities
c.	Competent Person Laser (CP/L)	–	Laser radiation responsibilities

4. All Competent Persons are required either:

a. to attend and qualify on a course of instruction recognized as appropriate by MOD DHR(RAF), or

b. to be judged, competent by virtue of previous experience and qualification to the satisfaction of MOD DHR(RAF).

Competent Persons Laser (CP/L)

5. A CP/L will normally be appointed on the basis of the individual's branch or trade training as advised by the specialist officer concerned. However, a CP/L is additionally required to attend a Laser Safety Course at the INM (para 7).

Range Safety Officers

6. Range Safety Officers at ranges where laser firing is authorized are to attend a Laser Safety Course at the RAF Institute of Aviation Medicine or the Royal Military College of Science, Shrivenham (para 8).

Laser Safety Courses

7. Laser Safety Courses for RSOs, TQOs, and CP/Ls are held three times per year at the INM. They

are each of one day's duration and applications for vacancies on a course are to be submitted to the INM (copy to MOD MA4a(RAF)) through normal channels.

8. Laser Safety Courses suitable for Range Safety Officers are held at the RAF Institute of Aviation Medicine and the Royal Military College of Science, Shrivenham (one course per year at each location). Applications for vacancies should be submitted to MOD MA4a(RAF) through normal channels.

SECTION S

RADIO-FREQUENCY RADIATION — RADIATION SAFETY

RADIO FREQUENCY RADIATION—RADIATION SAFETY

CONTENTS LIST

RADIO–FREQUENCY RADIATION – GENERAL REQUIREMENTS

(D/DDC Med(RAF)/13/1/3B/MA4a(RAF) - October 1979)

1. **Introduction.** Radio-frequency radiation (RF), is non-ionizing electromagnetic radiation and is part of a wide spectrum which embraces radiant heat, infra-red and radio, radar and countermeasures radiation. Exposure to RF radiation is potentially dangerous to personnel through general heating of the body. Some tissues are more sensitive than others and the critical organ of the body in this respect is the crystalline lens of the eye. Significant heating effects are possible on exposure to power densities in the region of 100 mW/cm^2 or more, and heating of internal organs can occur without any sensation of heat being felt. RF radiation may also produce non-thermal biological effects but these are not considered significant in man in the light of present medical knowledge.

2. **Regulations, Codes of Practice and Stanag.** Safety regulations for the protection of personnel against the effects of RF radiation are contained in HMSO Publication 1960 (Safety Precautions Relating to Intense Radio-Frequency Radiation) and the Mintech Intense Radio-Frequency Radiation Code of Practice (1968 Edition). These codes of practice were adopted for mandatory use throughout the Royal Air Force in 1960 and 1968 respectively, for frequencies above 30 MHz.

3. Stanag 2345, which was promulgated in February 1979, introduced new criteria for the evaluation and control of personnel exposure to radio-frequency radiation within the frequency range 10 kHz to 300 GHz. The United Kingdom has ratified the Stanag but has reserved the right to apply the personnel exposure limitations quoted in Leaflet No S2, para 4.

4. All unnecessary radiation exposure should be avoided and all personnel at risk are to be briefed about the hazards.

5. **Responsibilities.** The appointments and responsibilities of departments and individuals at all levels are given in Leaflet No B1; attention is also drawn to Leaflet No B3 which concerns the reporting of incidents.

THE PROTECTION AND MEDICAL SURVEILLANCE OF PERSONNEL EXPOSED TO RADIO–FREQUENCY (RF) RADIATION

(D/DDC Med(RAF)/13/32B/MA4a(RAF) – April 1980)

PROTECTION

Permissible Power Densities

1. Permissible Power Density is that intensity of RF radiation which, in the light of present medical knowledge, is not expected to cause any detectable bodily injury to a person at any time during his lifetime.

2. Only thermal factors have been incorporated in the development of permissible exposure standards. These are based on the following concepts:

a. An approximate limit of power density can be estimated when only gross volume heating of the body is considered.

b. The steady state temperature elevation depends on the ratio of the part of the body surface irradiated to the total body surface, increasing proportionately to the area of irradiation.

3. The determination of current standards is limited by inadequate information about modulation effects, peak power effects, field intensity effects, or frequency dependencies.

4. Application of the Safety Regulations contained in the Codes of Practice is to be governed by the following RF radiation exposure limits which are to apply to all personnel:

a. *For Frequencies 30 MHz and above*

(1) The permissible RF power density for continuous whole body exposure is 100 W/m^2 (10 mW/cm^2).

(2) The permissible RF power density for whole body exposure to RF radiation from pulsed modulation systems without a rotating aerial is 100 W/m^2 (10 mW/cm^2) averaged over any one second.

(3) The permissible RF power density for whole body exposure to RF radiation from rotating aerial systems (including pulsed modulation systems) is 100 W/m^2 (10 mW/cm^2) averaged over any one second.

b. *For Frequencies below 30 MHz*

(1) The permissible RF radiation electric field strength for continuous daily whole body exposure is 1000 volts/metre.

5. Where operational requirements may dictate, servicing personnel may be permitted to enter an RF radiation restricted area where the power density exceeds 100 W/m^2 (10 mW/cm^2), but the duration of exposure must be limited to the time derived from the following equation:

$$T = \frac{6 \times 10^5}{S^2}$$

where T = permissible time of exposure in minutes during any one hour period
S = power density in the area to be occupied in W/m^2

This equation can be used for power densities up to 1000 W/m^2 (100 mW/cm^2), but because exposures of less than 2 minutes duration are operationally impractical, its use is normally limited to power densities in the range 100 to 500 W/m^2 (10 to 50 mW/cm^2).

RF Radiation Control Areas

6. The area immediately surrounding an RF installation, to which the entry of personnel must be strictly controlled in accordance with a precise set of safety rules, is classed as an RF Radiation Restricted Area or an RF Radiation Danger Area, depending on the intensity of the RF radiation that exists within the area. The Mintech Code of Practice (1968 Edition) clearly defines the boundaries of these two radiation control areas in terms of RF radiation power density and details the safety rules that govern the entry of personnel into these areas. In addition to the safety rules given in the Code of Practice, the following rules are to be applied:

a. For frequencies below 30 MHz, an RF Radiation Restricted Area is to be established around any RF installation where the electric field strength exceeds 1000 volts/metre.

b. When servicing personnel are authorized to enter an RF Radiation Restricted Area in accordance with the provisions of para 5 above, the authorizing officer is to state the time limitations appropriate to the power density to be experienced and is to maintain a valid record.

7. The boundaries of RF Radiation Control Areas are to be determined by reference to Leaflet S3, or by calculation as described in Leaflet S4, and where practicable, by measurement of the power density at prescribed distances from an antenna, using approved power density meters. In cases of difficulty or doubt, the assistance of Support Command Signals Headquarters (SCSHQ) is to be sought under the terms of EEI 8350, through the appropriate command headquarters.

Occupationally Exposed Personnel

8. Personnel who are exposed to RF radiation in the course of their work and who have to be exposed from time to time to RF radiation power densities in excess of 100 W/m^2 (10 mW/cm^2) are to be classed as Occupationally Exposed Personnel, and are to be subject to medical surveillance.

MEDICAL SURVEILLANCE

Notification

9. Commanders are to bring to the attention of the officer in medical charge the names of servicemen and/or civilian RAF employees on the unit who are occupationally exposed to RF radiation. Normally, this notification will be made by the officer responsible for the equipment.

10. The notification is to include the following information in addition to the names of personnel:.

a. The nature of the task or operation performed by each individual.

b. The maximum power density and frequency band of the radiation to which each individual is exposed in the performance of his duties.

Medical Examination

11. All personnel classed as occupationally exposed to RF radiation are to be subjected to pre- and post-employment medical examination, by an RAF Ophthalmologist, to a standard defined by the RAF Consultant Adviser in Ophthalmology. Whilst classed as occupationally exposed to RF radiation,

personnel are to be subjected to a periodic examination, conducted by the medical officer of the unit, to exclude any unexpected gross change. This examination will not normally require the use of a mydriatic to examine the lens. The frequency of the periodic examination will be determined by the competent medical authority.

Note. Medical surveillance should take account of special groups which would include those with medical prosthesis and metal implants (excluding dental fillings and dental prosthesis) who should be referred for occupational medical assessment.

12. Any individual who is over-exposed or is suspected of being over-exposed to RF radiation is to be referred to an RAF Ophthalmologist as soon as possible. Other actions concerning any such incident are detailed in Leaflet No B3.

Medical Records

13. The results of these medical examinations are to be recorded on F/Med/143; for civilian RAF employees the F/Med/143 is to be retained in the Unit Medical Centre.

PERSONNEL HAZARD DISTANCES FROM RADIO FREQUENCY RADIATION TRANSMITTERS

(AF/CX 287/74/MA4a (RAF)—May 1977)

1. Tables A and B which follow give the maximum RF hazard distances from airborne and ground radio and radar equipment in RAF use, which radiate RF fields having an intensity greater than 100 W/m^2 (10 mW/cm^2). The distances tabled correspond to an average power flux intensity of 100 W/m^2 (10 mW/cm^2), this being the maximum permissible intensity for continuous whole body exposure to radiated RF fields at frequencies of 30 MHz and above.

2. Tables C and D list airborne and ground transmitters in RAF use which radiate RF fields of intensity less than 100 W/m^2 (10 mW/cm^2). These tables refer to power density within the collimated beam. Power densities within the aerial structure may be considerably greater and therefore hazardous.

3. For RF fields radiated at frequencies of below 30 MHz, the maximum field strength in which continuous body exposure is permitted is 1000 Volts/m. There are currently no RF radiation sources used by the RAF, operating at frequencies of below 30 MHz which either individually or in the configurations currently used, radiate RF fields exceeding 1000 Volts/m.

4. Tables A and B define the hazard distance for the direction in which antenna gain is a maximum. For those situations in which it is necessary for personnel to enter regions which are at distances less than those tabled, a more refined analysis of the radiated field must be carried out, taking account, where applicable, of antenna gain in specific directions other than that for which it is a maximum.

TABLE A—HAZARDOUS AIRBORNE TRANSMITTERS

EQUIPMENT	PERSONNEL HAZARD DISTANCE FOR CONTINUOUS EXPOSURE—METRES (RADIATED BEAM STATIONARY—*SEE NOTE*)
~~ARI 5810~~	~~12~~
~~ARI 5851~~	~~5~~
~~ARI 5878~~	~~12~~
ARI 5897	12
ARI 5919	10
ARI 5928	12
ARI 5930	13
~~ARI 5951~~	~~5~~
ARI 5952	13
ARI 5964	14
ARI 5966/7	54
ARI 18075	1
ARI 18076	2
ARI 18146	1
ARI 18205	1
~~ARI 23041~~	~~6~~
~~ARI 23083~~	~~6~~
ARI 23165	5
ARI 23166	4
ARI 23167	2
ARI 23220/3/5	31
ARI 23234	2

Note: The hazard distances for stationary antennae of airborne installations given in Table A are relatively small; for simplicity these should be used to delineate hazardous areas associated with such installations under all conditions.

TABLE B—HAZARDOUS GROUND TRANSMITTERS

EQUIPMENT	PERSONNEL HAZARD DISTANCE FOR CONTINUOUS EXPOSURE—METRES	
	RADIATED BEAM STATIONARY	RADIATED BEAM SCANNING
UPS-1	21	7
TPS-34A	123	11
AN/FPS-49	1170	*See Note* 1
S259	34	10
Rapier-search	6	2
Rapier-guidance	10	*See Note* 1
RTS-2	32	*See Note* 1
Type 82	186	7
Type 84	100	13
Type 85—lower power mode	448	31
Type 85—medium power mode	633	105
Type 85—high power mode	895	133
Type 86	178	*See Note* 1
Type 87	355	*See Note* 1
Type 88—D band	46	19
Type 88—E/F band	137	
Type 89	168	109 *See Note* 2
AN/FPS-6	146	69 *See Note* 2
HF200	158	124 *See Note* 2
FGRI 18188	8	*See Note* 1
ECI96B	5	*See Note* 1
FGRI 26054	2520	*See Note* 1
FGRI 26055	2250	*See Note* 1
FGRI 26056	794	*See Note* 1
AR-1	30	3
AR-15/2	33	3
~~CR-787A~~	~~18~~	~~3~~

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Notes: (1) The radiated beam from this equipment either does not scan or scans in a non-cyclic manner, therefore the stationary hazard distance should be applied.

(2) This distance is calculated for the minimum angle of nutation.

TABLE C—AIRBORNE TRANSMITTERS RADIATING LESS THAN 100 W/m² (10 mW/cm²)

(to be issued later)

TABLE D—GROUND TRANSMITTERS RADIATING LESS THAN 100 W/m² (10 mW/cm²)

Type 80 Mk I, II and III

SLA 3B

SLA 3C

SLA 3D

ACR 7D Mk 2

ACR 430

AC 3 ~~S 264~~

S 264A

Type 424

Type 13

Type 14

FGRI 5976

AC 3 ~~FGRI 26062a~~

AC 3 ~~FGRI 26062b~~

RADIO FREQUENCY RADIATION (≥30 MHz) SAFETY DISTANCES—METHOD OF CALCULATION

(AF/CX 287/74/MA4a (RAF)—May 1977)

Introduction

1. Current medical advice is that continuous exposure of the whole human body to power densities up to 100 $Wm/^2$ (10 mW/cm²) averaged over any one second period, or time limited exposure up to 1000 W/m² (100 mW/cm²) does not cause permanent thermal damage. The procedures described in this leaflet are intended to enable the safe distances or time limits for the simpler configurations of radar/communications transmitting systems to be determined. Where accidental exposure is suspected, the incident power density may be calculated. If more detailed information is required on the methods of calculation, reference should be made to SCSHQ Technical Report No 76003 dated September 1976.

Calculation of safe distance and flux density on the centre axis of a stationary RF energy beam

2. The electromagnetic field in front of an aerial falls into three regions, the near field, the intermediate field and the far field. The near and intermediate fields are alternatively known as the Fresnel Region, and the far field as the Fraunhoffer Region.

3. The near field region is characterized by a parallel (collimated) beam within which the power density can reach but not exceed a value calculated as:

$$S=\frac{4P}{A} \text{ watts/metre}^2 \quad \ldots\ldots (1)$$

where P is the mean transmitted power in watts and A is the area of the aerial in square metres.

4. For a pulsed radar where the Peak Power ($\hat{P}$) of the transmitter is quoted it is necessary to calculate mean power from:

$$P=\hat{P}\times\tau\times \text{prf watts} \quad \ldots\ldots (2)$$

where τ is the pulse width in seconds and prf is the pulse repetition frequency in pulses per second.

5. **Inter-relation between area and gain.** In some cases, it may not be possible to determine A from some physical element, so A is calculated from:

$$A=1{\cdot}67\times\text{Effective Aperture}=1{\cdot}67\ \frac{G_0\lambda^2}{4\pi}=0{\cdot}133G_0\lambda^2 \text{ metre}^2 \quad \ldots\ldots (3)$$

where λ is the wavelength of the electromagnetic radiation, and is related to frequency by

$$\lambda=\frac{C}{F} \text{ metres} \quad \ldots\ldots (4)$$

where C is the velocity of EM radiation (300,000,000 metres/sec) and F is the frequency in hertz.

6. Note that the value of G_0 required is the power gain ratio over an isotropic (*ie* perfectly omni-directional) radiator. However, aerial gain is usually quoted as a dB value above isotropic in which case,

$$G_0=\text{Anti log}_{10}\left[\frac{(\text{dB value})}{10}\right] \quad \ldots\ldots (5)$$

7. Some types of aerial, typically Yagi arrays, may sometimes be quoted as dB above a dipole, in which case since a dipole has 2·15dB gain above isotropic,

$$G_0=\text{Anti log}_{10}\left[\frac{(\text{dB value})+2{\cdot}15}{10}\right] \quad \ldots\ldots (6)$$

8. Where A can be determined from aerial dimensions, but G_0 (required in subsequent calculations) is not quoted, it may be calculated from:

$$G_0=\frac{4\pi A}{\lambda^2} \quad \ldots\ldots(7)$$

9. In the above formula, it is assumed that physical area and effective aperture are equal, which gives the highest value of G_0 and worst case RF hazard distance.

10. **RADHAZ Assessment.** If the value of S calculated from equation (1) does not exceed 100 W/m², then no further calculation is necessary, the power density being safe at all distances.

11. If, however, S exceeds 100 W/m² the situation may or may not be safe and it is next necessary to calculate the limit of the near field range from:

$$R=\frac{A}{2\lambda} \text{ metres} \quad \ldots\ldots(8)$$

12. At any distance less than R the unsafe power density will exist. Beyond R, the intermediate and far fields are characterized by a diverging beam and the power density falls off at a rate inversely proportional to distance squared because the available power spreads itself across an ever increasing area. The power density at any specified distance r metres, (r>R) can be calculated from:

$$S=\frac{P\times G_0}{4\pi r^2} \text{ watts/metre}^2 \quad \ldots\ldots(9)$$

13. Substituting the permitted maximum power density of 100 W/m² for S and re-arranging for r, the minimum safe distance (r_{min}) for continuous exposure can be calculated from:

$$r_{min}=\sqrt{\frac{P\times G_0}{400\pi}}=0{\cdot}0282\sqrt{P\,G_0} \text{ metres} \quad \ldots\ldots(10)$$

14. If S is in excess of 100 W/m² but is less than 1000 W/m², exposure can be permitted, providing it is limited to T_p minutes in any hour where:

$$T_p=\frac{6\times 10^5}{S^2} \text{ minutes/hr} \quad \ldots\ldots(11)$$

15. Where S exceeds 1000 W/m², exposure is totally prohibited. The corresponding range ($r_{prohibited}$) can be calculated from:

$$r_{prohibited}=\sqrt{\frac{P\times G_0}{4000\pi}}=0{\cdot}00891\sqrt{P\times G_0} \text{ metres} \quad \ldots\ldots(12)$$

16. Fig 1, at the end of this leaflet, shows in flow chart format how the above calculations may be applied most effectively.

Calculations to take account of Aerial Polar Diagram and Scanning

17. The calculations so far relate to the situation directly on the axis of a stationary beam. If this condition is safe then no further calculation is necessary. If an unsafe result is indicated, but in practice the aerial is either scanning or is not illuminating the subject position along its main axis, then accounting for these factors will indicate a reduced power density.

18. If the aerial is stationary and the subject position is less than the near field range, the subject is safe providing his position is well clear of the volume formed by the projection of the actual reflector area along the aerial axis, to the limit of the near field.

19. If the aerial is stationary and the subject position is greater than the near field range, reference should be made to the aerial polar diagram. Determine the azimuth and elevation co-ordinates of the subject position relative to the aerial axis and find the corresponding reduction of gain from the

polar diagram. If a dB value is obtained, use equation (5) to obtain the power ratio, $G\theta\varphi$ (If adequate polar diagram information is not available, the procedure cannot be applied and the on-axis figure must be taken, or measurements made, *see* para 33). Note that $G\theta\varphi$ is the normalized gain relative to G_0, *eg* at the −3dB points, $G\theta\varphi = 0{\cdot}5$, irrespective or the actual value of G_0, which has already been accounted for in equation (9).

20. The power density at the subject position (S′) can then be calculated from:

$$S' = S \times G\theta\varphi \text{Watts/metre}^2 \quad \ldots\ldots (13)$$

21. If the aerial is scanning, the subject may not be illuminated all of the time and the long term average power density may be reduced accordingly. However, should a slow scan rate or a wide beam result in the time of each illumination exceeding 1 second, this should be treated as repeated periods of continuous exposure and equation (11) applied. The time of each illumination for a subject position in the far or intermediate field is calculated from:

$$T = \frac{\text{Beamwidth (degrees)}}{\text{Rate of Scan (degrees per sec)}} \text{ seconds} \quad \ldots\ldots (14)$$

The time of each illumination for a subject position in the near field is calculated from:

$$T = \frac{2 \times \sin^{-1}\left[\dfrac{\text{Linear aerial aperture dimension in plane of scan}}{2 \times \text{distance from aerial to subject}}\right]}{\text{Rate of Scan}} \text{seconds} \quad \ldots\ldots (15)$$

22. The long term average power density for a scanning beam is calculated from:

$$S' = S \times D \text{ watts/metre}^2 \quad \ldots\ldots (16)$$

where D is the scan duty cycle. Similarly the minimum safe range for continuous exposure for a scanning beam, $r_{\text{min scan}}$, (where $r_{\text{min scan}} > R$) becomes:

$$r_{\text{min scan}} = 0.0282\sqrt{PG_0D} \text{ metres} \quad \ldots\ldots (17)$$

and the range for the total prohibition corresponding to 1000 W/m^2, $r_{\text{prohibited scan}}$, (where $r_{\text{prohibited scan}} > R$) becomes:

$$r_{\text{prohibited scan}} = 0{\cdot}00891\sqrt{PG_0D} \text{ metres} \quad \ldots\ldots (18)$$

23. The scan duty cycle is defined as:

$$D = \frac{\text{Time taken for beam to traverse a fixed point}}{\text{Periodic time of scan}} \quad \ldots\ldots (19)$$

24. For a subject position in the intermediate or far fields and a uniformly rotating aerial, equation (19) simplifies to:

$$D = \frac{\text{Angular beamwidth in degrees}}{360} \quad \ldots\ldots (20)$$

25. For a subject position in the near field and a uniformly rotating aerial, equation (19) approximates to:

$$D = \frac{\text{Linear aerial aperture dimension in plane of rotation}}{2\pi \times \text{Distance from aerial to subject}} \quad \ldots\ldots (21)$$

26. For a subject position in the intermediate or far fields and an aerial scanning uniformly over an arc, equation (19) simplifies to

$$D = \frac{\text{Angular beamwidth in degrees}}{\text{Angle of scanning arc in degrees}} \quad \ldots\ldots (22)$$

27. For a subject position in the near field and an aerial scanning uniformly over an arc, equation (19) approximates to:

$$D = \frac{\text{Linear aerial aperature dimension in plane of rotation}}{2\pi \times \text{ distance from aerial to subject}} \times \frac{360}{\text{Angle of scanning arc in degrees}} \quad \ldots\ldots (23)$$

28. Note that equation (23) can have a numerical value exceeding unity. This corresponds to continuous illumination due to the proximity to the aerial, and the limiting value

$$D = 1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (24)$$

should be applied.

29. Where a quoted angular beamwidth or polar diagram is not available (although use of these is to be preferred), an approximate value can be calculated from

$$\text{3dB Angular Beamwidth} = \frac{64\lambda}{\text{Linear aerial aperture dimension in plane of required beamwidth (metres)}} \text{ degrees} \quad \ldots\ldots\ldots \quad (25)$$

30. It frequently occurs that the subject position of interest is off-axis in the plane normal to the plane of scan. In this case polar diagram and scan duty cycle have both to be accounted for, *ie*

$$S' = S \times G\theta \times D \text{ watts/metre}^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (26)$$

where $G\theta$ is the normalized gain relative to G_0 (*see* para 19).

31. An efficient method of working through the above procedures is shown in flow chart format in Fig. 2.

Special Advice

32. Where sufficient data is not available for accurate calculation to be made, specialist advice should be sought.

33. Where calculations are being conducted as a result of an incident to determine if a subject has been exposed to risk, details of estimated power density, duration of exposure, and frequency of radiation are to be communicated immediately to the Medical Officer and RSO in accordance with Leaflet B3. The calculations should be checked as soon as possible by measurement (*see* para 32).

Multiple Radar Illumination

34. In multiple radar situations, the power density, at the point of interest, due to each radar should be added and the total power density compared with the 100 W/m^2 criterion, etc. However, in those comparatively rare situations where 2 or more radars are driven from a common oscillator and are coherent, the voltage fields should be added. Note that equipments listed in Tables C and D of Leaflet S3 which are not hazardous individually may be hazardous in combination.

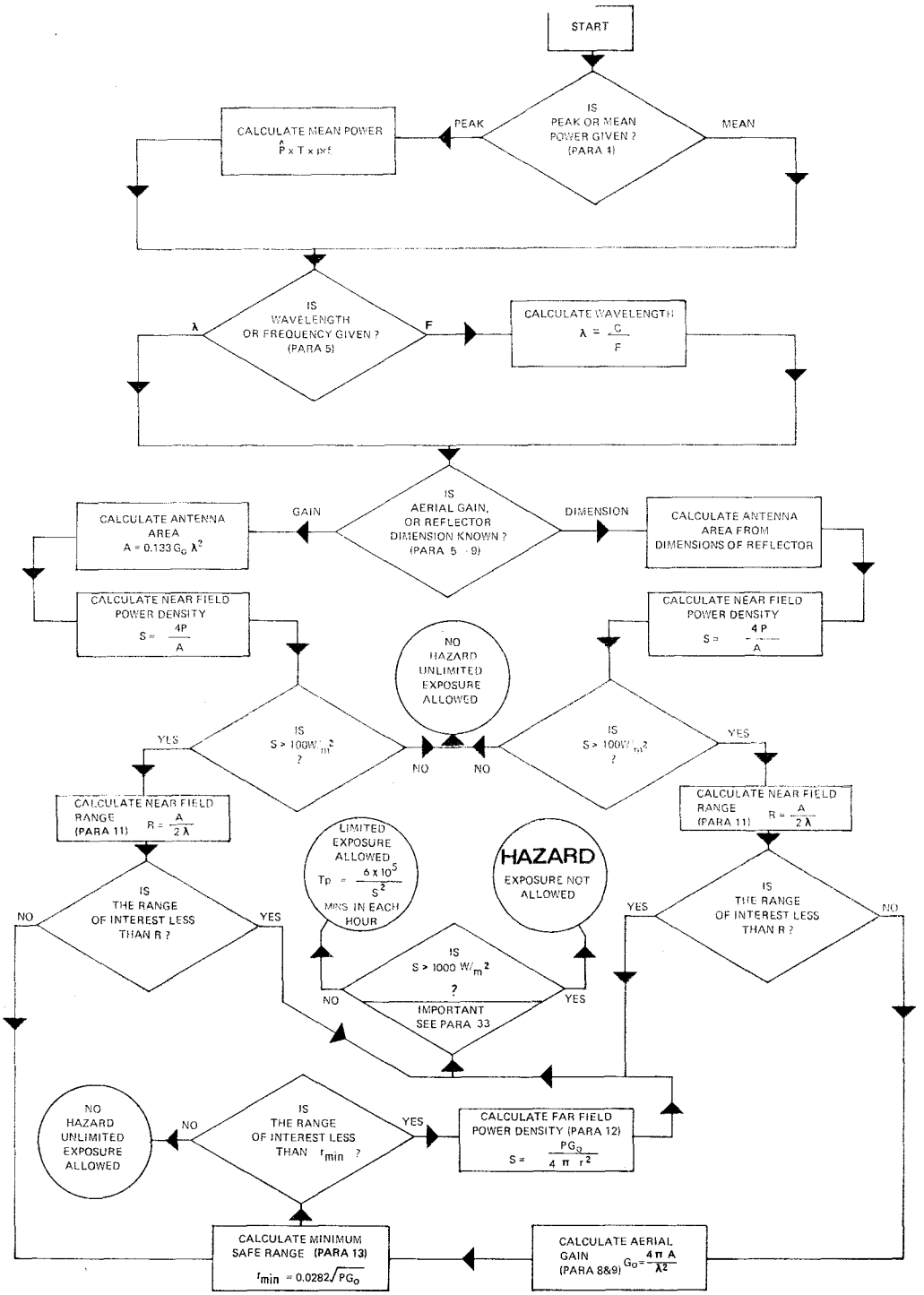

Fig. 1. Procedure to determine the extent of RADHAZ on the axis of a stationary RF energy beam ($\geqslant$ 30MHz)

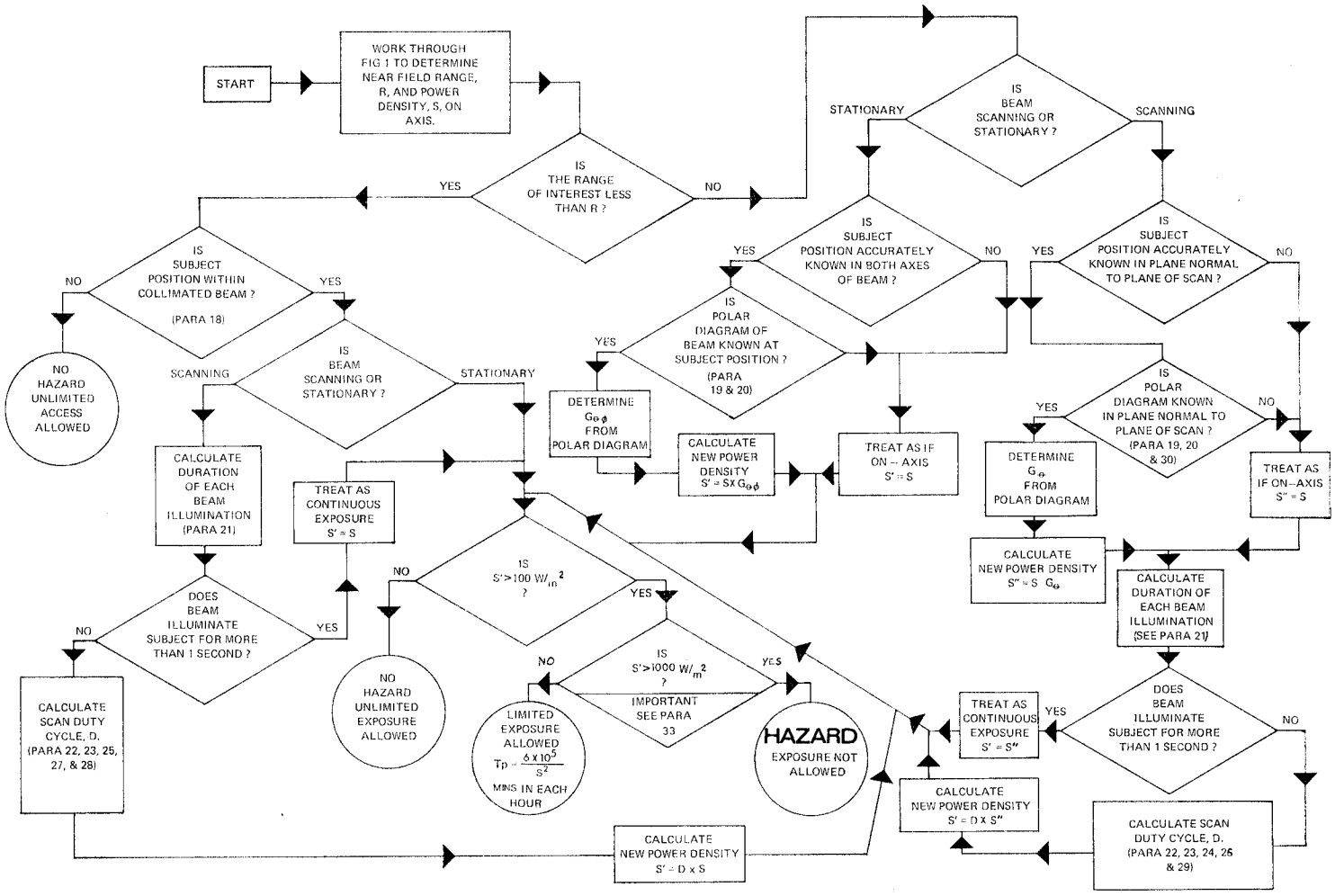

Fig. 2. Procedure to determine the extent of RADHAZ off axis or in a scanning RF energy beam ($\leqslant$ 30 MHz)

QUALIFICATIONS OF PERSONNEL

(AF/CX 383/74 MA4a(RAF) MAY 1976)

Radiation Safety Officers

1. Radiation Safety Officers are to attend a Radiation Safety Officers Course at the Institute of Naval Medicine, Alverstoke, or other similar course approved by the Ministry of Defence DHR(RAF).

Technically Qualified Officers

2. Technically qualified officers appointed, in accordance with Leaflet B1, by the OC Engineering Wing or QAO to be responsible for the radiation safety practices applied to specific radio frequency sources of radiation, are to attend a Radiation Safety Officers Course at the Institute of Naval Medicine, Alverstoke, or other similar course approved by the Ministry of Defence DHR(RAF).

Competent Persons

3. Competent Persons responsible for the control of sources of ionizing radiation or the control of radiation safety aspects of sources of non-ionizing radiation are annotated accordingly as follows:

a. Competent Person (CP) – Ionizing Radiation responsibilities.

b. Competent Person (CP/RF) – Radio-frequency Radiation responsibilities.

c. Competent Person (CP/L) – Laser Radiation responsibilities.

4. All Competent Persons with responsibilities for sources of radiation are required either:

a. To attend and qualify on a course of instruction recognized as appropriate by the Ministry of Defence DHR(RAF), or

b. To be judged competent by virtue of previous experience and qualification to the satisfaction of the Ministry of Defence DHR(RAF).

Competent Persons Radio-frequency – (CP/RF)

5. A Competent Person (CP/RF) will normally be appointed on the advice of the specialist officer concerned and on the basis of the individual's branch or trade training; such appointments are to be notified and/or cancelled through normal channels generally in the manner shown at Annex A.

Annex A to
AP 4687A, Vol 2
Leaflet No S6

To: DHR(RAF)
CRSO

FROM:

DATE:

REF:

NOTIFICATION OF APPOINTMENT OR TERMINATION OF APPOINTMENT OF COMPETENT PERSON LASER (CP/L) AND/OR COMPETENT PERSON RADIO-FREQUENCY (CP/RF)

The undermentioned personnel have been appointed as Competent Persons as indicated and the appointment has been recorded in SROs.

SERVICE NO	RANK	BRANCH/TRADE	NAME & INITIALS	*QUALIFYING COURSE & DATE

**EQUIPMENT CONCERNED

DATE OF APPOINTMENT ..... DATE OF TERMINATION OF APPOINTMENT.....

---

*THIS COURSE MUST CONTAIN TRAINING IN RF OR LASER RADIATION SAFETY TO A STANDARD PREVIOUSLY ACCEPTED BY DHR(RAF)
**REFERENCE TO RELEVANT CORRESPONDENCE WILL SUFFICE.

NAME & RANK
IN BLOCK LETTERS.....

(AL 15, May 76)

SECTION T

MICROWAVE OVENS — RADIATION SAFETY

MICROWAVE OVENS—RADIATION SAFETY

CONTENTS LIST

Leaflet No

MICROWAVE OVENS–GENERAL REQUIREMENTS

(D/DDC Med(RAF)/13/1/3B/MA4a(RAF) – October 1979)

Introduction

1. Microwave ovens are used for industrial and scientific purposes, and to reheat or cook food through the thermal effect of electromagnetic radiations. The frequency of the radiation normally employed is 2450 Megahertz.

2. The performance standard for microwave ovens required by the Royal Air Force is that these equipments comply with British Standard 5175 and additionally meet the power density limits of microwave radiation leakage set by the Department of Health, Education and Welfare of the United States Government.

Performance Standard

3. This performance standard shall apply to all microwave ovens that are provided or purchased for use on RAF stations or in RAF vehicles, marine craft and aircraft. All microwave ovens so introduced must be provided with an individual and serially numbered certificate stating that the item complies with this RAF standard.

4. The power density limit of the microwave radiation emitted by an oven when energized shall not exceed:

a. 1 mW/cm^2 at any point 5 cm or more from any external surface of the oven on receipt from the manufacturer, and

b. 5 mW/cm^2 at any point 5 cm or more from any external surface of the oven during its useful life.

5. The measurements necessary to test these limits shall be made with the microwave oven operating at its maximum output and containing a load of 275 $\pm$ 15 millilitres of tap water at an initial temperature of 20 $\pm$ 5 °C and containing 1% NaCl, placed within the cavity at the centre of the load-carrying surface. The water container shall be a low form 600 millilitre beaker having an inside diameter of approximately 8.5 centimetres and made of an electrically non-conductive material such as glass or plastic. The measurements shall be made with the door fully closed as well as with the door fixed in any position which allows the oven to operate. The period of operation during test shall not be less than 5 minutes.

Monitoring

6. Microwave ovens are to be monitored at least once every 12 months to ensure that the leakage power density quoted in sub-para 4b is not exceeded. Normally this monitoring will be performed by Environmental Health Technicians (EHTs) from Command Headquarters during the course of their routine station inspections; in addition, the RAF Consultants in Radiobiology will monitor ovens during their radiation inspection of units.

7. If, for whatever reason, neither the EHTs nor the Consultant Radiobiologists are able to carry out the required monitoring during the 12 month period, monitoring is to be done by the Radiation Safety Officer or Competent Person (RF) using monitoring equipment loaned from either the Command Environmental Health Officer or the RAF Institute of Community Medicine.

8. If, at any time it is suspected that the leakage power density of an oven may be in excess of the safety limit due to, for example, damage to the door seals or deformation of the door itself, a radiation leakage test is to be performed before the oven is again used.

9. Whenever monitoring reveals a leakage power density in excess of the stated limit, the fact is to be reported to MOD DHR(RAF) and the oven taken out of service until it has been satisfactorily repaired by the manufacturer or his accredited agent.

SAFETY PRECAUTIONS FOR THE USE OF MICROWAVE OVENS

(D/DDC Med(RAF)/13/13B/MA4a(RAF) – October 1979)

Operation

1. All microwave ovens are to be installed, operated, and serviced in accordance with the manufacturer's instructions. Clear and precise operating instructions for the oven are to be mounted on the front near the control panel.

2. An oven is not to be used if it appears in any way damaged or distorted.

3. No modifications or repairs are to be carried out except by the manufacturer or his accredited agent.

Safety Instructions

4. Clear and precise safety instructions are to be displayed on or near the oven. These are to include:

a. Switch the oven off before opening the door.

b. Never insert objects through the grill door or around the door seal.

c. Never tamper with or inactivate the oven safety interlocks.

d. Never operate any empty oven.

e. Clean regularly the oven cavity, the door and door seals with water and a mild detergent. Do not use scouring pads, steel wool or other abrasives.

f. Do not attempt to rectify faults; call for maintenance servicing.

Records

5. The following records are to be maintained:

a. The certificate issued in accordance with Leaflet T1, para 3, is to be identified by a serial number and retained by or on behalf of the individual holding the equipment on charge.

b. Records of servicing and details of the radiation leakage tests required by Leaflet T1, para 6, are to be retained similarly.

HEADQUARTERS ROYAL AIR FORCE SUPPORT COMMAND
Royal Air Force Brampton Huntingdon Cambs PE18 8QL

Telephone Huntingdon (STD 0480) 52151 ext 2831

See Distribution

Please reply to The Air Officer Commanding in Chief
Your reference
Our reference RAFSC/106716/5/AM7A
Date 1 July 1981

MICROWAVE OVEN - PERFORMANCE STANDARD

Reference:

A. AP 4687A, Vol 2, Leaflet T1.

1. Reference A currently requires that all microwave ovens introduced into the RAF shall be provided with an individual and numbered certificate stating that the leakage power density at 5cm from any external surface does not exceed 1mW/cm^2 on receipt from the manufacturer.

2. Such certification is often difficult, if not impossible to obtain from the manufacturer or his agent and, therefore, a relaxation is being introduced. In future, if the individual certificate is unobtainable, a microwave oven may be introduced provided that it is monitored within three months of receipt to ensure that microwave leakage does not exceed 5mW/cm^2.

3. Reference A will be amended as follows:

Para 2 - Line 2 will read "..... comply with British Standard 5175 and preferably will also meet the power density limits....."

Para 3 - will read:

"3. The preferred leakage power density limits of microwave ovens provided or purchased for use on RAF Stations or in RAF vehicles, marine craft and aircraft are as follows:

a. 10W/m^2 (1mW/cm^2) at any point 5cm or more from any external surface of the oven on receipt from the manufacturer, and

b. 50W/m^2 (5mW/cm^2) at any point 5cm or more from any external surface of the oven during its useful life.

Whenever possible an individual certificate is to be obtained from the supplier or manufacturer stating that the oven fully complies with the above standard".

Para 4 - will read:

"4. Where no certificate is available, the individual holding the equipment on charge is to ensure that the oven is monitored within three months of receipt to the standard defined in sub-para 3b above".

Para 5 - Line 1 will read "The measurement necessary to test the limit defined in sub-para 3b is to be made.....".

Para 6 - Lines 1 and 2 will read "Routine monitoring of microwave ovens is to be done at least once every 12 months to ensure that the leakage power density quoted in sub-para 3b is not exceeded. Normally .....".

Para 7 - Line 2 will read "the monitoring required by para 4 or 6, it is to be done by .....".

4. Leaflet T2, sub-para 5a, will also be amended to read:

"a. Any certificate issued in accordance with Leaflet T1, para 3.....".

5. Notification of this impending change to Reference A is to be brought to the attention of those concerned.

pp R S BOYMAN
Flt Lt
for AOC in C

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