ATOMIC ENERGY LICENSING ACT 1984

RADIATION PROTECTION (BASIC SAFETY STANDARDS) REGULATIONS 1988

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IN exercise of the powers conferred by section 68 and subsection (6) of section 25 of the Atomic Energy Licensing Act 1984, the Minister makes the following regulations: *Act 304.*

PART I

PRELIMINARY

1. These Regulations may be cited as the **Radiation Protection (Basic Safety Standards) Regulations 1988**. Citation.

2. These Regulations shall apply to all activities involving ionizing radiation. Application.

3. In these Regulations, unless the context otherwise requires— Interpretation.

"abnormal exposure" means an accidental exposure, an emergency exposure or a planned special exposure;

"absorbed dose" *(D)* means the quotient of *de* by *dm*, where *de* is the mean energy imparted by ionizing radiation to matter in a volume element and *dm* is the mass of matter in that volume element, represented by the formula—

$$D = de/dm;$$

"accidental exposure" means an unpredictable exposure that results in one or more persons receiving doses exceeding the annual dose limits;

"activity" *(A)* of an amount of radionuclide in a particular energy state at a given time is the quotient of *dN* by *dt*, where *dN* is the expectation value of the number of spontaneous nuclear transformation from that energy state in the time interval dt, represented by the formula—

$$A = dN/dt;$$

"annual dose" means the dose received over a period of one calender year;

"annual dose limit" means the value of the annual dose that must not be exceeded;

"annual limit on intake" or "ALI" means a secondary limit for occupational internal exposure whose value is specified in Table I of the Third Schedule;

"approved registered medical practitioner" means a registered medical practitioner who is approved by the appropriate authority to be responsible for the medical surveillance of workers;

"area monitoring" means radiation protection surveillance carried out in a supervised or controlled area;

"clean area" means an area where the annual dose received by a worker is not likely to exceed one-tenth of the annual dose limit;

"committed dose-equivalent" means the dose-equivalent that will be accumulated over 50 years following the intake of any radioactive material, nuclear material or prescribed substance into the body;

"committed effective dose-equivalent" means the effective dose-equivalent that will be accumulated over 50 years following the intake of any radioactive material, nuclear material or prescribed substance into the body;

"controlled area" means an area where the annual dose received by a worker is likely to exceed three-tenths of the annual dose limit;

"critical group" means that group of the members of the public whose exposure is reasonably homogeneous and is typical of individuals receiving the highest dose;

"critical pathway" means the route by which any radioactive material, nuclear material or prescribed substance travels to reach a critical group and causes radiation exposure;

"deep dose-equivalent index" at a point means the maximum dose-equivalent within the 28 centimetres diameter core of a 30 centimetres diameter sphere centred at that point and consisting of material equivalent to soft tissue with a density of one gramme per cubit centimetre;

"derived air concentration" or "DAC" for a given radionuclide means the activity concentration of that radionuclide in air (in Becquerel per cubic metre) as given in Table I of the Third Schedule;

"dose" means dose-equivalent, effective dose-equivalent, committed effective dose-equivalent or committed dose-equivalent;

"dose-equivalent" means the product of the absorbed dose and the effective quality factor;

"dose rate" means the dose per unit time;

"effective dose-equivalent" means the sum of the weighted dose-equivalents of all organs or tissues of interest;

"effective quality factor" of an ionizing radiation is a weighting factor for that particular ionizing radiation as given in the Second Schedule;

"effluent monitoring" means radiation protection surveillance carried out to ensure that the concentration of radioactive material, nuclear material or prescribed substance in effluent discharged into the environment does not exceed the release limit;

"emergency exposure" means a voluntary exposure justified in abnormal conditions for the purpose of bringing help to endangered individuals, preventing exposure of a large number of people or saving a valuable installation, whereby one or more of the annual dose limits laid down for a worker are likely to be exceeded;

"environmental monitoring" means radiation protection surveillance carried out to ensure that the radiation and radioactivity levels in the environment to not cause exposure exceeding the annual dose limit for an individual member of the public;

"external exposure" means exposure resulting from radiation sources outside the body;

"Helsinki Declaration" means the Declaration of Helsinki adopted by the World Medical Association as revised by the 29th World Medical Assembly in 1975;

"internal exposure" means exposure resulting from radiation sources inside the body;

"intervention level" means a level of dose-equivalent or effective dose-equivalent or intake of any radioactive material, nuclear material or prescribed substance which, if exceeded, requires intervention;

"investigation level" means a level of dose-equivalent or effective dose-equivalent or intake of any radioactive material, nuclear material or prescribed substance which, if exceeded, requires investigation;

"medical exposure" means exposure to ionizing radiation for the purpose of medical diagnosis, medical therapy or medical research;

"medical surveillance" means activities carried out by an approved registered medical practitioner to ensure that the general health of workers is not affected by radiation exposure;

"members of the public" means individuals in the population but does not include workers exposed to radiation in the course of their work;

"natural background radiation" means all ionizing radiation from natural terrestrial and cosmic sources, to the extent that the exposure which it causes is not increased by man;

"normal exposure" means exposure to ionizing radiation below the annual dose limit and which is under control through the system of dose limitation;

"operational limit" means a working limit which is lower than the annual dose limit;

"partial body exposure" means exposure predominantly affecting part of the body or of one or more organs or tissues, or exposure which is not regarded as uniform throughout the body;

"personnel monitoring" means radiation protection surveillance carried out on workers to ensure that the does received does not exceed the annual dose limits for workers;

"planned special exposure" means voluntary exposure during normal operation whereby one or more of the annual dose limits for a worker are likely to be exceeded, permitted only in situations when alternative techniques which do not involve such exposure cannot be used;

"radioactive contamination" means the contamination of any material, surface or environment or of any person, including both external skin contamination and internal contamination, irrespective of method of intake, by any radioactive material, nuclear material or prescribed substance;

"radiation protection officer" means a technically competent person appointed by the licensee and approved by the appropriate authority to supervise the application of appropriate radiation protection regulations, measures and procedures;

"radiation source" means an apparatus or material capable of emitting ionizing radiation;

"recording level" means a level of dose-equivalent or effective dose-equivalent or intake of radioactive material, nuclear material or prescribed substance above which the information is of sufficient interest from the radiation protection point of view to be worth recording and keeping;

"release limit" means the maximum amount of radionuclide content in a release that can be discharged into the environment;

"sealed source" means a radiation source consisting of any radioactive material, nuclear material or prescribed substance firmly incorporated in solid and effectively inactive material, or sealed in an inactive container of sufficient strength to prevent, under normal conditions of use, any dispersion of its contents;

"shallow dose-equivalent index" at a point means the maximum dose-equivalent within the spherical shell extending from a depth of 0.07 millimetre to a depth of 10 millimetres from the surface of a 300 millimetres diameter sphere centred at this point and consisting of material equivalent to soft tissue with a density of one gramme per cubic centimetre;

"supervised area" means an area where the annual dose received by a worker could exceed one-tenth but is not likely to exceed three-tenths of the annual dose limit;

"total exposure" means the sum of the internal and external exposures;

"whole body exposure" means exposure regarded as uniform throughout the body;

"worker" includes any person working under the instruction of the licensee, whether or not employed by the licensee, in the handling or use of, or who will come into contact with any radioactive material, nuclear material, prescribed substance or irradiating apparatus.

PART II

EXPOSURE

Chapter 1—System of Dose Limitation

Justification.

4. No person shall carry out or cause to be carried out any activity involving ionizing radiation unless such activity is justified in relation to its benefits and those of any available alternatives.

Optimisation.

5. Every licensee shall take steps to restrict the necessary exposure to any person and such exposure shall be as low as is reasonably achievable, economic and social factors being taken into account.

Annual dose limit.

6. (1) Every licensee shall ensure that no worker or member of the public receives exposure exceeding the annual dose limits.

(2) The annual dose limits shall not apply to medical exposure or exposure due to natural background radiation.

Chapter 2—Occupational Exposure

Special prohibitions.

7. (1) No person shall allow any person under the age of eighteen years to work in a controlled area but a person who has attained the age of sixteen years may be allowed to work in supervised area for training purposes only notwithstanding that he has not attained the age of eighteen years.

(2) No person shall allow any person under the age of sixteen years to work in a supervised or a controlled area.

(3) No person shall allow a female worker to work in a controlled area if she is or is suspected to be pregnant.

(4) No person shall employ a nursing mother in any work involving a high risk of radioactive contamination unless she is placed under special surveillance to detect any possible radioactive contamination.

Annual dose limit for whole body exposure of a worker.

8. (1) The annual dose limit for the whole body exposure of a worker shall be 50 millisieverts (mSv).

(2) For a female worker of reproductive capacity, the annual dose limit shall be the same as the limit specified in sub-regulation (1) except that any exposure shall be as uniformly distributed with time as is practicable.

(3) Where a female worker is pregnant, the dose to the foetus accumulated over the period of time between confirmation of pregnancy and the date of delivery shall not exceed 10 mSv.

Annual dose limit for the partial body exposure of a worker.

9. In the case of partial body exposure of a worker—

(a) the limit for the effective dose-equivalent evaluated by the method set out in Section II of the Second Schedule shall be 50 mSv in a year and the average dose in each organ or tissue shall not exceed 500 mSv in a year except for the lens of the eyes where the annual dose limit shall be 150 mSv; and

(b) where the exposure is through radioactive contamination of the skin, the limit specified in paragraph *(a)* shall apply to the dose averaged over any contaminated area of 100 square centimetres.

Chapter 3—Planned Special Exposure

Requirements governing planned special exposure.

10. (1) No person shall carry out a planned special exposure unless it is approved by the appropriate authority.

(2) No person shall cause or permit any person to participate in a planned special exposure unless the latter is a worker who volunteers to so participate.

(3) In choosing volunteers, the following shall be taken into account—

(a) previous experience;

(b) state of health;

(c) special skill; and

(d) social and economic responsibility.

(4) The licensee shall ensure that the dose received in the course of planned special exposures over a period of one calender year does not exceed twice the annual dose limits laid down in regulations 8 and 9 and, in a lifetime, five times those limits.

(5) No person shall cause or permit any worker to participate in a planned special exposure—

(a) if, during the previous 12 months, such worker has received an exposure giving rise to doses in excess of the annual dose limits laid down in regulations 8 and 9; or

(b) if such worker has previously received accidental or emergency exposures giving rise to doses the sum of which exceeds five times the annual dose limits laid down in regulations 8 and 9; or

(c) if such worker is a female of reproductive capacity.

(6) The licensee shall ensure that before receiving a planned special exposure the worker involved is thoroughly informed about the potential risks involved and is fully instructed in the measures to be taken to keep the exposures as low as is reasonably achievable.

(7) The licensee shall ensure that doses received from planned special exposures are recorded in the medical record provided for in regulation 45 together with doses received from normal exposures but they shall be clearly distinguishable from one another.

(8) The licensee shall ensure that doses received from planned special exposures are reported to the worker concerned, to the approved registered medical practitioner and to the appropriate authority.

Chapter 4—Exposure of Members of the Public

Annual dose limit for whole body exposure of members of the public.

11. (1) For whole body exposure—

(a) the annual dose limit for a member of the public shall be 1 mSv; and

(b) notwithstanding paragraph *(a)*, the annual dose limit for a member of the public who is likely to be exposed to ionizing radiation at or near the annual dose limit for prolonged periods (many years) shall be 5 mSv in a year, provided that the average annual dose over a lifetime does not exceed 1 mSv.

(2) The annual dose limits specified in sub-regulation (1) shall apply to the critical group of the population.

Annual dose limit for partial body exposure of members of the public.

12. (1) In the case of partial body exposure of a member of the public—

(a) the limit for the effective dose-equivalent evaluated by the method set out in Section II of the Second Schedule shall be 1 mSv in a year and the average dose for the skin and lens of the eyes shall not exceed 50 mSv in a year; and

(b) where the exposure is through radioactive contamination of the skin, the limits specified in paragraph *(a)* shall apply to the dose averaged over any contaminated area of 100 square centimetres.

(2) The annual dose limits specified in sub-regulation (1) shall apply to the critical group of the population.

PART III

COMPLIANCE WITH ANNUAL DOSE LIMITS

Compliance with limits for external exposure.

13. In the case of external exposure, the annual dose limits laid down in regulations 8, 9, 11 and 12 shall be deemed to have been complied with if the requirements laid down in Section I of the Third Schedule are met.

Compliance with limits for internal exposure.

14. In the case of internal exposure, the annual dose limits laid down in regulations 8, 9, 11 and 12 shall be deemed to have been complied with if the requirements laid down in Section II of the Third Schedule are met.

Compliance with limits for combination of external and internal exposures.

15. In the case of combinations of external and internal exposures the annual dose limits laid down in regulations 8, 9, 11 and 12 shall be deemed to have been complied with if the requirements laid down in Section III of the Third Schedule are met.

Evaluation of dose-equivalent and effective dose-equivalent.

16. For the purpose of compliance with regulations 8, 9, 11 and 12 the values for dose-equivalent and effective dose-equivalent shall be evaluated by methods specified in the Second Schedule.

Other methods of compliance.

17. Notwithstanding regulations 13, 14, 15 and 16, other methods of complying with the requirements of regulations 8, 9, 11 and 12 which are acceptable to the appropriate authority may be used.

PART IV

MEDICAL EXPOSURE

Medical diagnosis and treatment.

18. (1) Before any exposure is administered to the patient, the medical practitioner shall ascertain whether the desired information is already available or is not available from previous examinations or whether the same information can be obtained using any other procedure which does not involve the use of any radioactive material, nuclear material, prescribed substance or irradiating apparatus.

(2) When the medical practitioner reviews existing or plans new examination or treament procedures involving exposure to ionizing radiation, he shall take into account the detriments from such exposures.

(3) The medical practitioner shall always pay attention to details of radiological techniques that would ensure minimization of exposure to any embryo or foetus that might be present, whether or not the women is known to be pregnant.

Medical research.

19. (1) Dose limits for the exposure of a person as a result of medical research using any radioactive material, nuclear material, prescribed substance or irradiating apparatus shall be determined by the appropriate authority when such exposures give no clear benefit to the exposed individual.

(2) Any medical research using any radioactive material, nuclear material, prescribed substance or irradiating apparatus on human beings shall conform completely to such provisions of the Helsinki Declaration as are reproduced, with modifications, in the Fourth Schedule and no person shall undertake such research without the consent of the medical authority in charge of the institution where the exposures are to take place and such research shall be subject to any other laws relating to the subject matter.

Systematic radiological examination.

20. (1) No person shall carry out any systematic radiological examination on any person unless there are clear clinical needs and unless such examination is justified, taking into consideration the useful information expected to be obtained and the importance of this information to the person's health.

(2) No person shall carry out any systematic radiological examinations in mass screening, unless such examination is justified, taking into consideration the balance between the advantages implied for the individuals examined and for the population against the costs, including radiation detriment of the screening.

Radiological examination for occupational purposes.

21. (1) No person shall carry out any radiological examination for occupational purposes unless such examination is necessary for the purpose of evaluating the health of the person examined and his fitness for the work.

(2) Radiological examinations for occupational purposes shall be performed in a manner consistent with optimization of radiation protection.

Radiological examination for medico-legal or insurance purposes.

22. No person shall perform any radiological examination for the purpose of obtaining information for medico-legal purposes, or assessing the health of a person for insurance purposes, unless such examination is advantageous to the individual to be examined.

PART V

OPERATIONAL RADIATION PROTECTION

Radiation protection officer.

23. (1) The licensee shall employ a radiation protection officer.

(2) Sub-regulation (1) shall not apply if the appropriate authority is satisfied that suitable arrangements are made by the licensee to compensate for the duties of a radiation protection officer.

Classification of working areas.

24. (1) The licensee shall classify the working areas into clean, supervised and controlled areas.

(2) The licensee shall ensure that supervised or controlled areas are clearly demarcated and appropriate and legible notices and warning signs bearing the radiation symbol as prescribed in the First Schedule are posted conspicuously in strategic places.

(3) The notices mentioned in sub-regulation (2) shall be in the national language, and in any other language if necessary.

(4) The licensee shall ensure that operating instructions relevant to the supervised and controlled areas are posted conspicuously in such areas.

(5) No person shall enter a controlled area unless he has been assigned to the area or has been authorized to enter the area.

(6) Every person who has been given access to the supervised and controlled areas shall comply with prevailing instructions applicable to such areas issued by or under the authority of the licensee.

Monitoring of supervised and controlled areas.

25. (1) The licensee shall establish programmes for area monitoring in supervised and controlled areas.

(2) The programmes for area monitoring shall include—

(a) the assessment of external radiation levels at all appropriate locations;

(b) the assessment of levels of radioactive contamination at all appropriate locations;

(c) the assessment of radiation risks associated with accident or emergency situations.

(3) The licensee shall carry out area monitoring periodically and whenever there are changes in processes or equipment which are likely to result in changes of exposure situations.

(4) The area monitoring programme shall be reviewed periodically in the light of experience and also in the event of any major modification made to the installation or practices.

Personnel monitoring in controlled areas.

26. (1) The licensee shall carry out personnel monitoring for all workers in controlled areas.

(2) The doses received from external exposures shall be measured by the use of one or more approved personnel monitoring devices carried continuously on every person working in controlled area.

(3) The doses received from internal exposures shall be evaluated using techniques and procedures approved by the appropriate authority.

(4) The frequency of assessment under sub-regulations (2) and (3) shall be determined by the potential external exposure or potential internal exposure involved; and where the worker has or is suspected of having an accidental exposure or accidental intake of any radioactive material, nuclear material or prescribed substance, the assessment shall be carried out immediately.

Exposure records.

27. (1) The licensee shall, when appointing a new worker who has been a radiation worker, obtain the exposure record in respect of that worker, and the former employer shall supply the exposure record of the worker upon request by the licensee.

(2) In the case of a new worker who has worked with a licensee who has ceased operation, the new employer shall obtain the worker's exposure record from the appropriate authority.

(3) Doses received by a worker during normal operation, planned special exposure and accidental and emergency exposures shall be recorded together but they shall be distinguishable.

(4) The appropriate authority shall provide record-keeping procedures for keeping records of exposure of workers who work in controlled areas under different licensees.

Personnel monitoring results.

28. The licensee shall inform each worker in writing of the worker's personnel monitoring results and radiation exposure status not later than two weeks from the date the results are available.

Retention of personnel monitoring results.

29. (1) The results of personnel monitoring of a worker shall be retained by the licensee subject to the provision of regulation 45.

(2) In the case of exposure exceeding the annual dose limits, the licensee shall ensure that the results of personnel monitoring are submitted to an approved registered medical practitioner who shall interpret their implications to the health of the worker concerned.

(3) When a worker occupationally receives an abnormal exposure exceeding twice the annual dose limit the licensee shall ensure that such worker undergoes a medical review by the approved registered medical practitioner.

(4) Whenever an accident or emergency occurs, the licensee shall ensure that the results of personnel monitoring are submitted to the approved registered medical practitioner immediately.

Investigation of over-exposure.

30. If exposure in excess of the dose limits laid down in regulations 8, 9, 10, 11 and 12 occurs or is suspected to have occurred, the licensee shall carry out an investigation to determine the circumstances in which the exposure took place and to determine its consequences, and he shall submit a report to the appropriate authority.

Notification and report of all abnormal exposures.

31. (1) The licensee shall notify the appropriate authority of all accidental and emergency exposures within 24 hours after such accidental and emergency exposures.

(2) The licensee shall submit to the appropriate authority a written report of all accidental and emergency exposures within 30 days after such exposures and such report shall contain—

(a) the particulars of the licensee and the time, date and place of occurrence;

(b) a description of the material involved, including its kind and quantity, and its chemical and physical forms, where appropriate;

(c) the results of the dose assessment of the individuals exposed or likely to have been exposed, a description of the circumstances under which the exposures could have been received;

(d) the results of the preliminary environmental assessment, whenever appropriate;

(e) the actions which have been taken, or will be taken, to ensure that any potential hazard arising from the occurrence is under control;

(f) the procedures or measures which have been or will be adopted to prevent recurrence of such exposures; and

(g) any other information which the licensee deems necessary.

Medical surveillance of workers.

32. (1) The licensee shall cause medical surveillance to be carried out on his workers.

(2) Medical surveillance of workers shall be carried out by an approved registered medical practitioner.

General principles of medical surveillance.

33. (1) Medical surveillance of workers shall be based on the principles that govern occupational medicine in general.

(2) The medical surveillance of workers shall include, as appropriate—

(a) pre-employment medical examinations;

(b) general health surveillance;

(c) periodic reviews of health; and

(d) medical examination at termination of employment or retirement.

Prohibition on employment of workers.

34. No person shall employ any person as a worker for any period if the latter is found to be medically unfit to be a worker.

Pre-employment medical examination.

35. (1) Every person who is to be employed in a supervised or controlled area shall undergo pre-employment medical examination.

(2) A pre-employment medical examination shall include an inquiry into the person's medical history including all known previous exposures to ionizing radiation resulting either from his previous employment or from previous medical examination or treatment or both, and shall also include any clinical or other investigation which may be necessary to determine his general state of health.

General health surveillance.

36. The licensee shall ensure that an approved registered medical practitioner is given access to the working premises and to any information which such approved registered medical practitioner may require in order to ascertain the state of health of a worker under surveillance.

Periodic reviews of health.

37. (1) The licensee shall ensure that health of a worker is reviewed regularly to determine whether such worker remains fit to perform his duties.

(2) The nature of the periodic reviews of health shall depend on the type and extent of exposure to ionizing radiation and on the individual worker's state of health.

(3) Without prejudice to sub-regulations (1) and (2), the state of health of a worker shall be reviewed at least once in five years for a worker in a supervised area, once in two years for a worker in a controlled area and more frequently if the worker's exposure conditions and state of health so requires.

Medical examination at termination of employment or retirement.

38. (1) Every worker shall undergo a medical examination at termination of employment or retirement, as the case may be, and such medical examination shall be carried out by an approved registered medical practitioner who shall indicate, based on his examination of the worker, if there is any need for medical surveillance of the worker to continue after termination of employment or retirement.

(2) The period of surveillance after termination of employment or retirement shall be as long as the approved registered medical practitioner carrying out the examination referred to in sub-regulation (1) deems necessary in order to safeguard the health of the person concerned.

Medical supervision.

39. Where occupationally related radiation induced diseases are suspected, the licensee shall provide medical supervision as appropriate.

Authority of an approved registered medical practitioner.

40. An approved registered medical practitioner shall have the authority, on medical grounds—

(a) to declare a worker temporarily unfit for his normal duties;

(b) to advise the licensee on the reinstating of such a worker in his normal duties; and

(c) to advise the licensee on the transfer of a worker to other duties.

Payment for medical expenses.

41. Medical examination and treatment shall be provided by the licensee at no cost to the worker.

Special medical examination.

42. The licensee shall provide special medical examination for worker who have received doses exceeding the limits laid down in regulations 8 and 9.

Contingency provisions for health care of workers.

43. In addition to the periodic reviews of health provided for in regulation 37 and the special medical examination provided for in regulation 42, the licensee shall make contingency provisions to enable futher examination or decontamination measures or urgent remedial treatment to be undertaken when considered necessary by an approved registered medical practitioner.

Worker to be informed of conclusions of medical examination.

44. Where an approved registered medical practitioner carries out any medical examination on a worker, he shall inform the worker of the conclusions derived from such medical examination.

Maintenance of medical records of workers.

45. (1) The licensee shall maintain a medical record for each worker and it shall be kept up to date as long as he remains a worker.

(2) The medical record of a worker is confidential and every person who has access to it shall maintain the confidentiality of the record.

(3) the licensee shall retain the medical record of a worker in the form and manner acceptable to the appropriate authority.

(4) The medical record of a worker shall include the following—

(a) information regarding the general nature of the work involving exposure to radiation, and the type of radiation involved;

(b) results of pre-employment medical examination;

(c) results of general health surveillance, periodic reviews of health and special medical examination;

(d) results of dose assessment during normal operation, planned special exposure and accidental and emergency exposures;

(e) radiation exposure history, for a worker who has worked in controlled areas under different licensees; and

(f) results of medical examinations at termination of employment or retirement.

(5) The medical record of a worker shall be kept by the licensee for a period of 30 years after the termination of his employment as a radiation worker or his retirement, as the case may be, after which the licensee shall transfer the record to the appropriate authority.

(6) The licensee shall transfer the medical records of his workers to the appropriate authority once the licensee ceases operations.

(7) Notwithstanding sub-regulations (5) and (6), where a licensee ceases operations and another licensee takes over the operation, the former licensee shall transfer all medical records of workers to the new licensee.

Establishment of recording, investigation and intervention levels.

46. (1) The licensee shall establish recording levels, investigation levels and intervention levels where appropriate and such levels shall be subject to the approval of the appropriate authority.

(2) The licensee shall record all values at or above the recording level.

Establishment of operational limits.

47. The licensee shall establish operational limits which shall be subject to the approval of the appropriate authority.

Emergency plans and procedures.

48. (1) The licensee shall establish an emergency plan to deal with every foreseeable emergency situations.

(2) Every emergency plan established under sub-regulation (1) shall be subject to the approval of and conditions imposed by the appropriate authority.

(3) An emergency plan shall include—

(a) the emergency organisation;

(b) an outline of the lines of communication with the appropriate authority and relevant public authorities;

(c) a classification of emergencies;

(d) measures to be taken during an emergency;

(e) actions to be taken subsequent to the emergency;

(f) the intervention levels for different emergency situations; and

(g) a list and description of the equipment necessary for use during an emergency.

Training.

49. (1) The licensee shall ensure that every worker—

(a) is informed of the potential health risks involved in his job;

(b) is instructed in the precautions to be taken; and

(c) is given appropriate training on radiation protection relevant to his duties.

(2) The licensee shall provide appropriate retraining and facilities for updating the skills and knowledge of the workers.

Protective measures, devices, and instruments.

50. (1) The licensee shall ensure that all protective measures and devices meet the requirements of these Regulations and that all instruments are in good working condition.

(2) The licensee shall ensure that inspection and testing of protective measures and devices and measuring instruments are carried out periodically by a person acceptable to the appropriate authority.

Control of release.

51. (1) The appropriate authority shall specify a release limit.

(2) In specifying the release limit, the appropriate authority shall take into consideration, among other things, the following information—

(a) the results of pre-operational environmental monitoring conducted for a period of not less than twelve months;

(b) the determination of the critical pathways;

(c) the selection of critical groups of the population; and

(d) an assessment of the radiation exposure to members of the public resulting from the release.

(3) The licensee shall carry out adequate effluent monitoring and proper accounting of any radioactive material, nuclear material or prescribed substance discharged.

(4) Whenever the appropriate authority so requires, the licensee shall complement effluent monitoring by environmental monitoring the manner of which shall be approved by the appropriate authority.

Protection of licensed materials.

52. The licensee shall take measures to protect all radioactive materials, nuclear materials, prescribed substances, irradiating apparatus and facilities to prevent theft or sabotage.

Notification of theft and loss.

53. (1) The licensee shall, upon discovering any theft or loss of any radioactive material, nuclear material, prescribed substance or irradiating apparatus in his possession or control—

(a) notify the appropriate authority of such theft or loss within 24 hours;

(b) submit a complete report of the theft or loss to the appropriate authority within 30 days.

(2) The report to be submitted by the licensee under paragraph *(b)* of sub-regulation (1) shall contain—

(a) a description of the licensed apparatus, substance or material involved, including its kind, quantity and its chemical and physical forms, wherever appropriate;

(b) a description of the circumstances under which the loss or theft occurred;

(c) a statement of the whereabouts or probable whereabouts of the licensed apparatus, substance or material involved;

(d) the possible radiation exposure to individuals, circumstances under which the exposures could have occurred, and the extent of potential hazard to members of the public;

(e) the actions which have been taken, or will be taken, to recover the licensed apparatus, substance, or material;

(f) the procedures or measures which have been or will be adopted to prevent a recurrence of the loss or theft of the licensed apparatus, substance or material; and

(g) any other information which the licensee deems necessary.

Responsibilities of a worker.

54. (1) Every worker shall follow all instructions, rules and procedures issued by the licensee for the control of exposure to ionizing radiation and refrain from careless and reckless practices or actions that could result in unnecessary exposure to himself or to his fellow workers.

(2) Every worker shall use, as instructed, all facilities, devices and protective equipment provided by the licensee to limit any possible exposure.

(3) Every worker shall use approved personnel monitoring devices when provided by the licensee for assessing exposure.

(4) No worker, unless duly authorized, shall interfere with, remove, alter or displace any safety device or other equipment furnished for his protection or the protection of others, or interfere with any method or process adopted for the control of exposure to ionizing radiation; and every worker shall take all reasonable precautions to prevent damage to such equipment and to keep it in a good operating condition.

(5) Every worker shall immediately report all accidental exposures or intakes or any suspected exposure or intake of radioactive material, nuclear material or prescribed substance to his supervisor or the radiation protection officer.

(6) Every worker shall immediately report any damage to or malfunction of any safety equipment to his supervisor or the radiation protection officer.

(7) Every female worker shall, as soon as she suspects that she is pregnant, report such suspected pregnancy to the approved registered medical practitioner.

Appropriate authority may require reports and document to be submitted.

55. (1) The appropriate authority may require the licensee to submit any or all of the following—

(a) a report on area monitoring;

(b) a report on environmental monitoring;

(c) a report on effluent monitoring;

(d) a report on accidental and emergency exposures;

(e) operational procedures, instructions and manuals;

(f) a report on personnel monitoring;

(g) training programmes;

(h) physical protection measures;

(i) a report by approved registered medical practitioners;

(j) emergency plans and procedures; and

(k) other reports and records which the appropriate authority deems necessary.

(2) Whenever the appropriate authority requires the licensee to submit any report, record or other document under sub-regulation (1), the licensee shall comply with such requirement.

PART VI

CESSATION OF OPERATIONS, DECOMMISSIONING OR ABANDONMENT OF LICENSED FACILITIES

Cessation of operations, decommissioning or abandonment of licensed facilities.

56. (1) The licensee shall not—

(a) cease to operate;

(b) decommission; or

(c) abandon,

any licensed facility or waste management system except with the written approval of and in accordance with the instructions of the appropriate authority.

(2) The licensee shall notify the appropriate authority in writing when he intends to cease to operate, decommission or abandon his licensed facility—

(a) of the most probable date of the cessation, decommissioning or abandonment; and

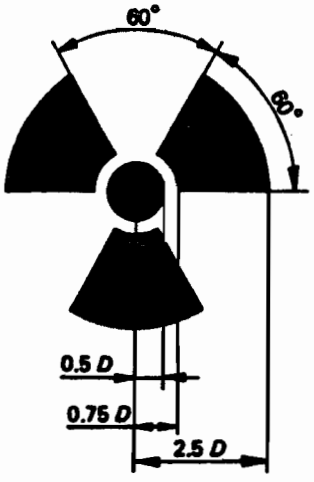
(b) of the plans for cessation of operations, decommissioning or abandonment to be undertaken, in the interest of the security of any radioactive material, nuclear material or prescribed substance and of the health and safety of the workers and members of the public.

FIRST SCHEDULE

RADIATION SYMBOL

(Regulation 24)

The radiation symbol shall consist of a three-blade design shown below using the radiation caution colours, that is black for the design and yellow for the background. *D* is the diameter of the central circle. For warning signs, the minimum value of *D* shall be 8 millimetres.



SECOND SCHEDULE

DOSE-EQUIVALENT AND EFFECTIVE DOSE-EQUIVALENT
(Regulation 16)

SECTION I

Method of Evaluating Dose-Equivalent

(1) Dose-equivalent *(H)* shall be equal to the product of absorbed dose *(D)* multiplied by effective quality factor *($\bar{Q}$)* represented by the formula—

$$H = D\bar{Q}$$

The $\bar{Q}$ values for the various types of ionizing radiation shall be as given in Table I.

Table I. $\bar{Q}$ Values.

Types of radiation (A)	$\bar{Q}$ (B)
X-rays, gamma-rays, beta-rays, electrons and positrons	1
Neutrons with energy equal to or less than 0.01 MeV	2.3
Protons and singly charged particles of rest mass greater than one atomic mass unit	10
Neutrons of unknown energy, neutron energy greater than 0.01 MeV	20
Alpha-particles and multicharged particles	20

SECTION II

Method of Evaluating Effective Dose-Equivalent

(2) The effective dose-equivalent *(H_E)* shall be equal to the sum of the average dose-equivalent *(H_T)* in an organ or tissue multiplied by the weighting factor *(w_T)* for that organ or tissue, represented by the formula—

$$H_E = \sum_T w_T H_T$$

The values of w_T for various tissues shall be as specified in Table II.

Table II. Weighting factor *(w_T)* for various tissues.

Tissue (A)	w_T (B)
gonads	0.25
breast	0.15
red bone marrow	0.12
lung	0.12
thyroid	0.03
bone (surfaces)	0.03
remainder of the tissue	0.30

THIRD SCHEDULE

COMPLIANCE CONDITIONS FOR EXPOSURE
(Regulations 13, 14 and 15)

SECTION I

External Exposure

(1) The annual dose limits laid down in regulations 8 and 9 for workers shall be deemed to have been complied with if the following conditions are met:

(i) $\frac{H_{I,\,s}}{500\ (\text{mSv})} \leqslant 1$; and

(ii) $\frac{H_{I,\,d}}{50\ (\text{mSv})} \leqslant 1$

where

$H_{I,\,s}$ is the annual shallow dose-equivalent index; and

$H_{I,\,d}$ is the annual deep dose-equivalent index.

(2) The annual dose limits laid down in regulations 11 and 12 for members of the public shall be deemed to have been complied with if the following conditions as applied to the critical group are met:

(i) $\frac{H_{I,\,s}}{50\ (\text{mSv})} \leqslant 1$; and

(ii) $\frac{H_{I,\,d}}{1\ (\text{mSv})} \leqslant 1$

where

$H_{I,\,s}$ is the annual shallow dose-equivalent index; and

$H_{I,\,d}$ is the annual deep dose-equivalent index.

SECTION II

Internal Exposure

(3) The annual dose limits laid down in regulations 8 and 9 for workers shall be deemed to have been complied with if the annual intake of radionuclide does not exceed the annual limit on intake or the derived air concentration as specified in Table I for the various radionuclides.

(4) In the case of internal exposure due to a mixture of intake of radionuclides with known composition, the annual dose limits laid down in regulations 8 and 9 for workers shall be deemed to have been complied with if the following conditions are met:

(i) $\sum_j \frac{I_j}{I_{j,\,L}} \leqslant 1$; or

(ii) $\sum_j \frac{C_j}{C_{j,\,L}} \leqslant 1$, whichever is applicable

where

I_j is the annual intake of radionuclide j;

$I_{j,\,L}$ is the annual limit on intake of radionuclide j as specified in Table I;

C_j is the annual average concentration of radionuclide j in air inhaled; and

$C_{j,\,L}$ is the derived air concentration of radionuclide j in air as specified in Table I.

(5) If the composition of the mixture of intake of radionuclides is not known but the presence of certain radionuclides can be positively excluded, the annual dose limits laid down in regulations 8 and 9 for workers shall be deemed to have been complied with if the annual intake of radionuclides does not exceed the annual limit on intake or the derived air concentration corresponding to the lowest limit among the limits laid down in Table I for the radionuclides that may be present.

(6) If the exact composition of the mixture of intake of radionuclides is not known but the radionuclides in it have been identified, the annual dose limits laid down in regulations 8 and 9 for workers shall be deemed to have been complied with if the annual intake of radionuclides does not exceed the annual limit on intake or the derived air concentration corresponding to the lowest limit among the limits laid down in Table I for the radionuclides present.

(7) If the concentration and toxicity of one radionuclide in the mixture of intake of radionuclides predominates, the annual dose limits laid down in regulations 8 and 9 for workers shall be deemed to have been complied with if the annual intake of radionuclides does not exceed the annual limit on intake or the derived air concentration specified in Table I for the given radionuclide.

(8) The annual dose limits laid down in regulations 11 and 12 for members of the public shall be deemed to have been complied with if the annual intake of radionuclides by the critical group does not exceed one-fiftieth of the annual limit on intake or the derived air concentration as specified in Table I for the various radionuclides.

(9) In the case of internal exposure due to a mixture of intake of radionuclides with a known composition, the annual dose limits laid down in regulations 11 and 12 for members of the public shall be deemed to have been complied with if the following conditions as applied to the critical group is met:

(i) $\sum_j 50\left(\frac{I_j}{I_{j,\,L}}\right) \leq 1$; or

(ii) $\sum_j 50\left(\frac{C_j}{C_{j,\,L}}\right) \leq 1$; whichever is applicable

where

I_j is the annual intake of radionuclide j;

$I_{j,\,L}$ is the annual limit on intake of radionuclide j as specified in Table I;

C_j is the annual average concentration of radionuclide j in air inhaled; and

$C_{j,\,L}$ is the derived air concentration of radionuclide j in air as specified in Table I.

(10) If the composition of the mixture of intake of radionuclides is not known but the presence of certain radionuclides can be positively excluded, the annual dose limits laid down in regulations 11 and 12 for the members of the public shall be deemed to have been complied with if the annual intake of radionuclides by the critical group does not exceed one-fiftieth of the annual limit on intake or the derived air concentration corresponding to the lowest limit among the limits laid down in Table I for the radionuclides that may be present.

(11) If the exact composition of the mixture of intake of radionuclides is not known but the radionuclides in it have been identified, the annual dose limits laid down in regulations 11 and 12 for members of the public shall be deemed to have been complied with if the annual intake of radionuclides by the critical group does not exceed one-fiftieth of the annual limit on intake or the derived air concentration corresponding to the lowest limit laid down in Table I for the radionuclides present.

(12) If the concentration and toxicity of one radionuclide in the mixture of intake of radionuclides predominates, the annual dose limits laid down in regulations 11 and 12 for members of the public shall be deemed to have been complied with if the annual intake of radionuclides by the critical group does not exceed one-fiftieth of the annual limit on intake or the derived air concentration specified in Table I for the given radionuclide.

SECTION III

Combination of External and Internal Exposures

(13) The annual dose limits laid down in regulations 8 and 9 for workers shall be deemed to have been complied with if the following conditions are met:

(i) $\frac{H_{I,\,s}}{500\ (\text{mSv})} \leq 1$; and

(ii) $\frac{H_{I,\,d}}{50\ (\text{mSv})} + \sum_{j} \frac{K_j}{K_{j,\,L}} \leq 1$

where

$H_{I,\,s}$ is the annual shallow dose-equivalent index;

$H_{I,\,d}$ is the annual deep dose-equivalent index;

$\frac{K_j}{K_{j,\,L}}$ is the ratio $\frac{I_j}{I_{j,\,L}}$ or $\frac{C_j}{C_{j,\,L}}$, whichever is applicable

I_j is the annual intake of radionuclide j;

$I_{j\,L}$ is the annual limit on intake for radionuclide j as specified in Table I;

C_j is the annual average concentration of radionuclide j in air inhaled; and

$C_{j,\,L}$ is the derived air concentration of radionuclide j in air as specified in Table I.

(14) The annual dose limits laid down in regulations 11 and 12 for the members of the public shall be deemed to have been complied with if the following conditions as applied to the critical group are met:

(i) $\frac{H_{I,\,s}}{50\ (\text{mSv})} \leq 1$; and

(ii) $\frac{H_{I,\,d}}{1\ (\text{mSv})} + \sum_{j} 50\left(\frac{K_j}{K_{j,\,L}}\right) \leq 1$

where

$H_{I,\,s}$ is the annual shallow dose-equivalent index;

$H_{I,\,d}$ is the annual deep dose-equivalent index;

$\frac{K_j}{K_{j,\,L}}$ is the ratio $\frac{I_j}{I_{j,\,L}}$ or $\frac{C_j}{C_{j,\,L}}$, whichever is applicable

I_j is the annual intake of radionuclide j;

$I_{j,\,L}$ is the annual limit on intake for radionuclide j as specified in Table I;

C_j is the annual average concentration of radionuclide j in air inhaled; and

$C_{j,\,L}$ is the derived air concentration of radionuclide j in air as specified in Table I.

(15) The method of evaluating summation for the different situations of intake of radionuclides shall be in accordance with the methods specified in Section II.

Table I

ANNUAL LIMIT ON INTAKE AND DERIVED AIR CONCENTRATION FOR VARIOUS RADIONUCLIDES

[This table gives the annual limits on intake (in Becquerel) and derived air concentration (in Becquerel per cubic metre) for varios nuclides. The values are based on a forty-hour week. To convert ALI expressed in Curie to DAC, the relevant value should be divided by 3.7×10^{10} and to obtain DAC expressed in Curie per cubic metre the relevant value should be divided by 3.7×10^{10}. In the table, abbreviations "LLI wall" and "St. wall" mean *lower large intestine wall* and *stomach wall*, respectively.

ACTINIUM

Radionuclide		*Oral*	*Inhalation*		
		a	b	c	d
^{224}Ac	ALI	7×10^{7} (7×10^{7}) LLI wall	1×10^{6} (1×10^{6}) Bone surface	2×10^{6}	2×10^{6}
	DAC	—	4×10^{2}	8×10^{2}	7×10^{2}
^{225}Ac	ALI	2×10^{6} (2×10^{6}) LLI wall	1×10^{4} (2×10^{4}) Bone surface	2×10^{4}	2×10^{4}
	DAC	—	4×10^{0}	1×10^{1}	1×10^{1}
^{226}Ac	ALI	5×10^{6} (5×10^{6}) LLI wall	1×10^{5} (1×10^{5}) Bone surface	2×10^{5}	2×10^{5}
	DAC	—	5×10^{1}	8×10^{1}	7×10^{1}
^{227}Ac	ALI	7×10^{3} (1×10^{4}) Bone surface	2×10^{1} (3×10^{1}) Bone surface	6×10^{1} (1×10^{2}) Bone surface	1×10^{2}
	DAC	—	6×10^{-3}	3×10^{-2}	6×10^{-2}
^{228}Ac	ALI	9×10^{7}	4×10^{5} (6×10^{5}) Bone surface	1×10^{6} (2×10^{6}) Bone surface	2×10^{6}
	DAC	—	1×10^{2}	6×10^{2}	7×10^{2}

a All compounds of actinium.

b All commonly occurring compounds of actinium other than those in c and d.

c Halides and nitrates.

d Oxides and hydroxides.

ALUMINIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{26}Al	ALI	1×10^{7}	2×10^{6}	3×10^{6}
	DAC	—	1×10^{3}	1×10^{3}

a All compounds of aluminium.

b All commonly occurring compounds of aluminium other than those in c.

c Metallic aluminium, oxides, hydroxides, carbides, halides and nitrates.

AMERICIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{237}Am	ALI	3×10^{9}	1×10^{10}
	DAC	—	4×10^{6}
^{238}Am	ALI	1×10^{9}	1×10^{8} (2×10^{8}) Bone surface
	DAC	—	4×10^{4}
^{239}Am	ALI	2×10^{8}	5×10^{8}
	DAC	—	2×10^{5}
^{240}Am	ALI	8×10^{7}	1×10^{8}
	DAC	—	4×10^{4}
^{241}Am	ALI	5×10^{4} (9×10^{4}) Bone surface	2×10^{2} (4×10^{2}) Bone surface
	DAC	—	8×10^{-2}
$^{242}Am^{m}$	ALI	5×10^{4} (9×10^{4}) Bone surface	2×10^{2} (4×10^{2}) Bone surface
	DAC	—	8×10^{-2}
^{242}Am	ALI	2×10^{8}	3×10^{6} (3×10^{6}) Bone surface
	DAC	—	1×10^{3}
^{243}Am	ALI	5×10^{4} (9×10^{4}) Bone surface	2×10^{2} (4×10^{2}) Bone surface
	DAC	—	8×10^{-2}
$^{244}Am^{m}$	ALI	2×10^{9} (3×10^{9}) Bone surface	1×10^{8} (2×10^{8}) Bone surface
	DAC	—	6×10^{4}
^{244}Am	ALI	1×10^{8}	6×10^{6} (1×10^{7}) Bone surface
	DAC	—	3×10^{3}
^{245}Am	ALI	1×10^{9}	3×10^{9}
	DAC	—	1×10^{6}
$^{246}Am^{m}$	ALI	2×10^{9} (2×10^{9}) St. wall	6×10^{9}
	DAC	—	3×10^{6}
^{246}Am	ALI	1×10^{9}	4×10^{9}
	DAC	—	2×10^{9}

a, b All compounds of americium.

It should be noted that greater gastro-intestinal absorption might be expected for complexed forms of the element and that enhanced absorption has been reported in very young rats.

ANTIMONY

Radionuclide		*Oral*		*Inhalation*	
		a	b	c	d
^{115}Sb	ALI	3×10^{9}	3×10^{9}	9×10^{9}	1×10^{10}
	DAC	—	—	4×10^{6}	5×10^{6}
^{116}Sb^{m}	ALI	8×10^{8}	8×10^{8}	3×10^{9}	5×10^{9}
	DAC	—	—	1×10^{6}	2×10^{6}
^{116}Sb	ALI	3×10^{9} (3×10^{9}) St. wall	3×10^{9} (3×10^{9}) St. wall	1×10^{10}	1×10^{10}
	DAC	—	—	4×10^{6}	5×10^{6}
^{117}Sb	ALI	3×10^{9}	3×10^{9}	8×10^{9}	1×10^{10}
	DAC	—	—	3×10^{6}	4×10^{6}
^{118}Sb^{m}	ALI	2×10^{8}	2×10^{8}	7×10^{8}	8×10^{8}
	DAC	—	—	3×10^{5}	3×10^{5}
^{119}Sb	ALI	6×10^{8}	5×10^{8}	2×10^{9}	1×10^{9}
	DAC	—	—	7×10^{5}	4×10^{5}
^{120}Sb ($T_{1/2}$=15.89 minutes)	ALI	4×10^{9} (6×10^{9}) St. wall	4×10^{9} (6×10^{9}) St. wall	2×10^{10}	2×10^{10}
	DAC	—	—	7×10^{6}	8×10^{6}
^{120}Sb	ALI	4×10^{7}	3×10^{7}	8×10^{7}	5×10^{7}
($T_{1/2}$=5.76 days)	DAC	—	—	3×10^{4}	2×10^{4}
^{122}Sb	ALI	3×10^{7} (3×10^{7}) LLI wall	3×10^{7} (3×10^{7}) LLI wall	9×10^{7}	4×10^{7}
	DAC	—	—	4×10^{4}	2×10^{4}
^{124}Sb^{m}	ALI	9×10^{9} (1×10^{10}) St. wall	9×10^{9}	3×10^{10}	2×10^{10}
	DAC	—	—	1×10^{7}	9×10^{6}
^{124}Sb	ALI	2×10^{7}	2×10^{7}	3×10^{7}	9×10^{6}
	DAC	—	—	1×10^{4}	4×10^{3}
^{125}Sb	ALI	8×10^{7}	7×10^{7}	9×10^{7}	2×10^{7}
	DAC	—	—	4×10^{4}	8×10^{3}
^{126}Sb^{m}	ALI	2×10^{9} (2×10^{9}) St. wall	2×10^{9} (2×10^{9}) St. wall	7×10^{9}	7×10^{9}
	DAC	—	—	3×10^{6}	3×10^{6}
^{126}Sb	ALI	2×10^{7}	2×10^{7}	4×10^{7}	2×10^{7}
	DAC	—	—	2×10^{4}	8×10^{3}
^{127}Sb	ALI	3×10^{7} (3×10^{7}) LLI wall	3×10^{7} (3×10^{7}) LLI wall	8×10^{7}	3×10^{7}
	DAC	—	—	3×10^{4}	1×10^{4}
^{128}Sb	ALI	5×10^{7}	4×10^{7}	2×10^{8}	1×10^{8}
($T_{1/2}$=9.01 hours)	DAC	—	—	7×10^{4}	5×10^{4}
^{128}Sb	ALI	3×10^{9}	3×10^{9}	1×10^{10}	2×10^{10}
($T_{1/2}$=10.4 minutes)		(4×10^{9}) St. wall	(4×10^{9}) St. wall	1×10^{10}	
	DAC	—	—	6×10^{6}	7×10^{6}
^{129}Sb	ALI	1×10^{8}	1×10^{8}	3×10^{8}	3×10^{8}
	DAC	—	—	1×10^{5}	1×10^{5}

ANTIMONY—*(cont.)*

Radionuclide		*Oral*			
		a	b	c	d
^{130}Sb	ALI	7×10^{8}	7×10^{8}	2×10^{9}	3×10^{9}
	DAC	—	—	1×10^{6}	1×10^{6}
^{131}Sb	ALI	6×10^{8} (6×10^{8}) Thyroid	6×10^{8} (6×10^{8}) Thyroid	9×10^{8} (1×10^{9}) Thyroid	9×10^{8} (2×10^{9}) Thyroid
	DAC	—	—	4×10^{5}	4×10^{5}

a Tartar emetic.

b Compounds of antimony other than that in a.

c Commonly occurring compounds of antimony other than those in d.

d Oxides, hydroxides, halides, sulphides, sulphates and nitrates.

ARGON

Radionuclide	*Inhalation*
^{37}Ar	5×10^{10}

Radio-nuclide	*Semi-infinite cloud*	*1000 m³ room*	*500 m³ room*	*100 m³ room*
^{39}Ar	7×10^{6} (5×10^{8}) Skin	7×10^{6} (7×10^{9}) Skin	7×10^{6} (9×10^{9}) Skin	7×10^{6} (2×10^{10}) Skin
^{41}Ar	1×10^{5}	2×10^{6} (3×10^{6}) Skin	2×10^{6} (3×10^{6}) Skin	2×10^{6} (6×10^{6}) Skin

For those radionuclides that emit either photons or β-particles of considerable energy, exposure in a cloud of a radioactive noble gas is usually limited by external irradiation, since dose-equivalent rates from gas absorbed in tissue or contained in the lungs will be negligible in comparison with the dose-equivalent rates to tissues from external irradiation. An exception is ^{37}Ar, which emits very-low-energy Auger electrons and X-rays. The DACs for ^{39}Ar and ^{41}Ar are therefore based on considerations of external irradiation for ^{37}Ar on dose-equivalent in lung.

ARSENIC

Radionuclide		*Oral*	*Inhalation*
		a	b
^{69}As	ALI	1×10^{9} (2×10^{9}) St. wall	4×10^{9}
	DAC	—	2×10^{6}
^{70}As	ALI	5×10^{8}	2×10^{9}
	DAC	—	8×10^{5}
^{71}As	ALI	1×10^{8}	2×10^{8}
	DAC	—	7×10^{4}
^{72}As	ALI	3×10^{7}	5×10^{7}
	DAC	—	2×10^{4}

ARSENIC—*(cont.)*

Radionuclide		*Oral*	*Inhalation*
		a	b
^{73}As	ALI	3×10^{8}	6×10^{7}
	DAC	—	3×10^{4}
^{74}As	ALI	6×10^{7}	3×10^{7}
	DAC	—	1×10^{4}
^{76}As	ALI	4×10^{7}	5×10^{7}
	DAC	—	2×10^{4}
^{77}As	ALI	2×10^{8} (2×10^{8}) LLI wall	2×10^{8}
	DAC	—	8×10^{4}
^{78}As	ALI	3×10^{8}	8×10^{8}
	DAC	—	3×10^{5}

a All compounds of arsenic.

b All commonly occurring compounds of arsenic.

ASTATINE

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{207}At	ALI	2×10^{8}	1×10^{8}	8×10^{7}
	DAC	—	4×10^{4}	3×10^{4}
^{211}At	ALI	5×10^{6}	3×10^{6}	2×10^{6}
	DAC	—	1×10^{3}	8×10^{2}

a All compounds of astatine.

b Astatides of H, Li, Na, K, Rb Cs, Fr.

c Astatides of lanthanides, and astatides of Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu and astatides of Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Mn, Tc, Re.

BARIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{126}Ba	ALI	2×10^{8}	6×10^{8}
	DAC	—	2×10^{5}
^{128}Ba	ALI	2×10^{7}	7×10^{7}
	DAC	—	3×10^{4}
$^{131}Ba^{m}$	ALI	1×10^{10} (2×10^{10}) St. wall	5×10^{10}
	DAC	—	2×10^{7}
^{131}Ba	ALI	1×10^{8}	3×10^{8}
	DAC	—	1×10^{5}

BARIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*
		a	b
$^{133}Ba^{m}$	ALI	9×10^{7} (1×10^{8}) LLI wall	3×10^{8}
	DAC	—	1×10^{5}
^{133}Ba	ALI	6×10^{7}	3×10^{7}
	DAC	—	1×10^{4}
$^{135}Ba^{m}$	ALI	1×10^{8}	4×10^{8}
	DAC	—	2×10^{5}
^{139}Ba	ALI	5×10^{8}	1×10^{9}
	DAC	—	5×10^{5}
^{140}Ba	ALI	2×10^{7} (2×10^{7}) LLI wall	5×10^{7}
	DAC	—	2×10^{4}
^{141}Ba	ALI	9×10^{8}	3×10^{9}
	DAC	—	1×10^{6}
^{142}Ba	ALI	2×10^{9}	5×10^{9}
	DAC	—	2×10^{6}

a, b All compounds of barium.

BERKELIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{245}Bk	ALI	8×10^{7}	5×10^{7}
	DAC	—	2×10^{4}
^{246}Bk	ALI	1×10^{8}	1×10^{8}
	DAC	—	5×10^{4}
^{247}Bk	ALI	4×10^{4} (8×10^{4}) Bone surface	2×10^{2} (3×10^{2}) Bone surfase
	DAC	—	8×10^{-2}
^{249}Bk	ALI	2×10^{7} (3×10^{7}) Bone surface	8×10^{4} (1×10^{5}) Bone surface
	DAC	—	3×10^{1}
^{250}Bk	ALI	4×10^{8}	2×10^{7} (3×10^{7}) Bone surface
	DAC	—	7×10^{3}

a, b All compounds of berkelium.

BERYLLIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{7}Be	ALI	2×10^{9}	8×10^{8}	7×10^{8}
	DAC	—	3×10^{5}	3×10^{5}
^{10}Be	ALI	4×10^{7} (4×10^{7}) LLI wall	6×10^{6}	5×10^{5}
	DAC	—	2×10^{3}	2×10^{2}

a All compounds of beryllium.
b All commonly occurring compounds of beryllium except those in c.
c Oxides, halides and nitrates.

BISMUTH

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{200}Bi	ALI	1×10^{9}	3×10^{9}	4×10^{9}
	DAC	—	1×10^{6}	2×10^{6}
^{201}Bi	ALI	4×10^{8}	1×10^{9}	1×10^{9}
	DAC	—	4×10^{5}	6×10^{5}
^{202}Bi	ALI	5×10^{8}	1×10^{9}	3×10^{9}
	DAC	—	6×10^{5}	1×10^{6}
^{203}Bi	ALI	9×10^{7}	2×10^{8}	2×10^{8}
	DAC	—	1×10^{5}	9×10^{4}
^{205}Bi	ALI	5×10^{7}	9×10^{7}	5×10^{7}
	DAC	—	4×10^{4}	2×10^{4}
^{206}Bi	ALI	2×10^{7}	5×10^{7}	3×10^{7}
	DAC	—	2×10^{4}	1×10^{4}
^{207}Bi	ALI	4×10^{7}	6×10^{7}	1×10^{7}
	DAC	—	3×10^{4}	5×10^{3}
$^{210}Bi^{m}$	ALI	2×10^{6} (2×10^{6}) Kidneys	2×10^{5} (2×10^{5}) Kidneys	3×10^{4}
	DAC	—	7×10^{1}	1×10^{1}
^{210}Bi	ALI	3×10^{7}	9×10^{6} (1×10^{7}) Kidneys	1×10^{6}
	DAC	—	4×10^{3}	4×10^{2}
^{212}Bi	ALI	2×10^{8}	9×10^{6}	1×10^{7}
	DAC	—	4×10^{3}	4×10^{3}
^{213}Bi	ALI	3×10^{8}	1×10^{7}	1×10^{7}
	DAC	—	5×10^{3}	5×10^{3}
^{214}Bi	ALI	6×10^{8} (8×10^{8}) St. wall	3×10^{7}	3×10^{7}
	DAC	—	1×10^{4}	1×10^{4}

a All commonly occuring compounds of bismuth.
b Nitrates.
c All compounds of bismuth other than that in b.

BROMINE

Radionuclide		Oral	Inhalation	
		a	b	c
$^{74}Br^{m}$	ALI	5×10^{8} (8×10^{8}) St. wall	1×10^{9}	2×10^{9}
	DAC	—	6×10^{5}	6×10^{5}
^{74}Br	ALI	8×10^{8} (1×10^{9}) St. wall	3×10^{9}	3×10^{9}
	DAC	—	1×10^{6}	1×10^{6}
^{75}Br	ALI	1×10^{9} (1×10^{9}) St. wall	2×10^{9}	2×10^{9}
	DAC	—	7×10^{5}	8×10^{5}
^{76}Br	ALI	1×10^{8}	2×10^{8}	2×10^{8}
	DAC	—	7×10^{4}	7×10^{4}
^{77}Br	ALI	6×10^{8}	9×10^{8}	7×10^{8}
	DAC	—	4×10^{5}	3×10^{5}
$^{80}Br^{m}$	ALI	8×10^{8}	6×10^{8}	5×10^{8}
	DAC	—	3×10^{5}	2×10^{5}
^{80}Br	ALI	2×10^{9} (3×10^{9}) St. wall	7×10^{9}	8×10^{9}
	DAC	—	3×10^{6}	3×10^{6}
^{82}Br	ALI	1×10^{8}	2×10^{8}	1×10^{8}
	DAC	—	6×10^{4}	6×10^{4}
^{83}Br	ALI	2×10^{9} (3×10^{9}) St. wall	2×10^{9}	2×10^{9}
	DAC	—	1×10^{6}	1×10^{6}
^{84}Br	ALI	7×10^{8} (1×10^{9}) St. wall	2×10^{9}	2×10^{9}
	DAC	—	9×10^{5}	1×10^{6}

a All compounds of bromine.
b All bromides of H, Li, Na, K, Rb, Cs, Fr.
c All bromides of lanthanides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Mn, Tc, Re.

CADMIUM

Radionuclide		Oral	Inhalation		
		a	b	c	d
^{104}Cd	ALI	8×10^{8}	2×10^{9}	4×10^{9}	4×10^{9}
	DAC	—	1×10^{6}	2×10^{6}	2×10^{6}
^{107}Cd	ALI	8×10^{8}	2×10^{9}	2×10^{9}	2×10^{9}
	DAC	—	8×10^{5}	9×10^{5}	8×10^{5}
^{109}Cd	ALI	1×10^{7} (2×10^{7}) Kidneys	1×10^{6} (2×10^{6}) Kidneys	4×10^{6} (5×10^{6}) Kidneys	4×10^{6}
	DAC	—	5×10^{2}	2×10^{3}	2×10^{3}

CADMIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*		
		a	b	c	d
$^{113}Cd^{m}$	ALI	9×10^{5} (1×10^{6}) Kidneys	9×10^{4} (1×10^{5}) Kidneys	3×10^{5} (4×10^{5}) Kidneys	5×10^{5}
	DAC	—	4×10^{1}	1×10^{2}	2×10^{2}
^{113}Cd	ALI	8×10^{5} (1×10^{6}) Kidneys	8×10^{4} (1×10^{5}) Kidneys	3×10^{5} (4×10^{5}) Kidneys	5×10^{5}
	DAC	—	3×10^{1}	1×10^{2}	2×10^{2}
$^{115}Cd^{m}$	ALI	1×10^{7}	2×10^{6} (3×10^{6}) Kidneys	5×10^{6}	5×10^{6}
	DAC	—	8×10^{2}	2×10^{3}	2×10^{3}
^{115}Cd	ALI	3×10^{7} (4×10^{7}) LLI wall	5×10^{7}	5×10^{7}	5×10^{7}
	DAC	—	2×10^{4}	2×10^{4}	2×10^{4}
$^{117}Cd^{m}$	ALI	2×10^{8}	5×10^{8}	6×10^{8}	5×10^{8}
	DAC	—	2×10^{5}	3×10^{5}	2×10^{5}
^{117}Cd	ALI	2×10^{8}	4×10^{8}	6×10^{8}	5×10^{8}
	DAC	—	2×10^{5}	3×10^{5}	2×10^{5}

a All inorganic compounds of cadmium.
b All compounds of cadmium except those in c and d.
c Sulphides, halides and nitrates.
d For all oxides and hydroxides.

CAESIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{125}Cs	ALI	2×10^{9} (3×10^{9}) St. wall	5×10^{9}
	DAC	—	2×10^{6}
^{127}Cs	ALI	2×10^{9}	4×10^{9}
	DAC	—	1×10^{6}
^{129}Cs	ALI	9×10^{8}	1×10^{9}
	DAC	—	5×10^{5}
^{130}Cs	ALI	2×10^{9} (4×10^{9}) St. wall	7×10^{9}
	DAC	—	3×10^{6}
^{131}Cs	ALI	8×10^{8}	1×10^{9}
	DAC	—	5×10^{5}
^{132}Cs	ALI	1×10^{8}	1×10^{8}
	DAC	—	6×10^{4}
^{134}Cs	ALI	3×10^{6}	4×10^{6}
	DAC	—	2×10^{3}
$^{134}Cs^{m}$	ALI	4×10^{9} (4×10^{9}) St. wall	5×10^{9}
	DAC	—	2×10^{6}

CAESIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*
		a	b
^{135}Cs	ALI	3×10^{7}	4×10^{7}
	DAC	—	2×10^{4}
$^{135}Cs^{m}$	ALI	4×10^{9}	7×10^{9}
	DAC	—	3×10^{6}
^{136}Cs	ALI	2×10^{7}	2×10^{7}
	DAC	—	1×10^{4}
^{137}Cs	ALI	4×10^{6}	6×10^{6}
	DAC	—	2×10^{3}
^{138}Cs	ALI	7×10^{8} (1×10^{9}) St. wall	2×10^{9}
	DAC	—	9×10^{5}

a, b All compounds of caesium.

CALCIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{41}Ca	ALI	1×10^{8} (1×10^{8}) Bone surface	1×10^{8} (1×10^{8}) Bone surface
	DAC	—	6×10^{4}
^{45}Ca	ALI	6×10^{7}	3×10^{7}
	DAC	—	1×10^{4}
^{47}Ca	ALI	3×10^{7}	3×10^{7}
	DAC	—	1×10^{4}

a, b All compounds of calcium.

CALIFORNIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{244}Cf	ALI	9×10^{8} (1×10^{9}) St. wall	2×10^{7}	2×10^{7}
	DAC	—	9×10^{3}	9×10^{3}
^{246}Cf	ALI	1×10^{7} (2×10^{7}) LLI wall	4×10^{5}	3×10^{5}
	DAC	—	2×10^{2}	1×10^{2}
^{248}Cf	ALI	8×10^{5} (1×10^{6}) Bone surface	3×10^{3} (5×10^{3}) Bone surface	4×10^{3}
	DAC	—	1×10^{0}	2×10^{0}
^{249}Cf	ALI	4×10^{4} (8×10^{4}) Bone surface	2×10^{2} (3×10^{2}) Bone surface	5×10^{2} (5×10^{2}) Bone surface
	DAC	—	8×10^{-2}	2×10^{-1}

CALIFORNIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{250}Cf	ALI	1×10^{5} (2×10^{5}) Bone surface	5×10^{2} (8×10^{2}) Bone surface	1×10^{3}
	DAC	—	2×10^{-1}	4×10^{-1}
^{251}Cf	ALI	4×10^{4} (8×10^{4}) Bone surface	2×10^{2} (3×10^{2}) Bone surface	5×10^{2} (5×10^{2}) Bone surface
	DAC	—	8×10^{-2}	2×10^{-1}
^{252}Cf	ALI	2×10^{5} (4×10^{5}) Bone surface	1×10^{3} (2×10^{3}) Bone surface	1×10^{3}
	DAC	—	4×10^{-1}	6×10^{-1}
^{253}Cf	ALI	2×10^{7} (3×10^{7}) Bone surface	7×10^{4}	6×10^{4}
	DAC	—	3×10^{1}	3×10^{1}
^{254}Cf	ALI	1×10^{5}	8×10^{2}	6×10^{2}
	DAC	—	4×10^{-1}	3×10^{-1}

a All compounds of californium.
b All compounds of californium except those in c.
c Oxides and hydroxides.

CARBON

Radionuclide		*Oral*	*Inhalation*
		a	b
^{11}C	ALI	2×10^{10}	2×10^{10}
	DAC	—	6×10^{6}
^{14}C	ALI	9×10^{7}	9×10^{7}
	DAC	—	4×10^{4}

a, b All labelled organic compounds of carbon except carbon monoxide and carbon dioxide.

CARBON DIOXIDE

Radionuclide		*Inhalation*
^{11}C	ALI	2×10^{10}
	DAC	1×10^{7}
^{14}C	ALI	8×10^{9}
	DAC	3×10^{6}

CARBON MONOXIDE

Radionuclide		*Inhalation*
^{11}C	ALI	4×10^{10}
	DAC	2×10^{7}
^{14}C	ALI	6×10^{10}
	DAC	3×10^{7}

CERIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{134}Ce	ALI	2×10^{7} (2×10^{7}) LLI wall	3×10^{7}	2×10^{7}
	DAC	—	1×10^{4}	1×10^{4}
^{135}Ce	ALI	6×10^{7}	1×10^{8}	1×10^{8}
	DAC	—	6×10^{4}	5×10^{4}
^{137}Ce	ALI	2×10^{9}	5×10^{9}	5×10^{9}
	DAC	—	2×10^{6}	2×10^{6}
$^{137}Ce^{m}$	ALI	9×10^{7} (9×10^{7}) LLI wall	2×10^{8}	1×10^{8}
	DAC	—	7×10^{4}	6×10^{4}
^{139}Ce	ALI	2×10^{8}	3×10^{7}	2×10^{7}
	DAC	—	1×10^{4}	1×10^{4}
^{141}Ce	ALI	6×10^{7} (7×10^{7}) LLI wall	3×10^{7}	2×10^{7}
	DAC	—	1×10^{4}	9×10^{3}
^{143}Ce	ALI	4×10^{7} (4×10^{7}) LLI wall	7×10^{7}	6×10^{7}
	DAC	—	3×10^{4}	2×10^{4}
^{144}Ce	ALI	8×10^{6} (9×10^{6}) LLI wall	9×10^{5}	5×10^{5}
	DAC	—	4×10^{2}	2×10^{2}

a All compounds of cerium.
b All compounds of cerium except those in c.
c Oxides, hydroxides and fluorides.

CHLORINE

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{36}Cl	ALI	6×10^{7}	9×10^{7}	9×10^{6}
	DAC	—	4×10^{4}	4×10^{3}
^{38}Cl	ALI	6×10^{8} (9×10^{8}) St. wall	2×10^{9}	2×10^{9}
	DAC	—	6×10^{5}	7×10^{5}
^{39}Cl	ALI	8×10^{8} (1×10^{9}) St. wall	2×10^{9}	2×10^{9}
	DAC	—	8×10^{5}	9×10^{5}

a All compounds of chlorine.

b Chlorides of H, Li, Na, K, Rb, Cs, Fr.

c Chlorides of lanthanides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Mn, Tc, Re.

CHROMIUM

Radionuclide		*Oral*		*Inhalation*		
		a	b	c	d	e
^{48}Cr	ALI	2×10^{8}	2×10^{8}	4×10^{8}	3×10^{8}	3×10^{8}
	DAC	—	—	2×10^{5}	1×10^{5}	1×10^{5}
^{49}Cr	ALI	1×10^{9}	1×10^{9}	3×10^{9}	4×10^{9}	3×10^{9}
	DAC	—	—	1×10^{6}	2×10^{6}	1×10^{6}
^{51}Cr	ALI	1×10^{9}	1×10^{9}	2×10^{9}	9×10^{8}	7×10^{8}
	DAC	—	—	7×10^{5}	4×10^{5}	3×10^{5}

a Compounds with chromium in the hexavalent state.

b Compounds with chromium in the trivalent state.

c All compounds of chromium except those in d and e.

d Halides and nitrates.

e Oxides and hydroxides.

COBALT

Radionuclide		*Oral*		*Inhalation*	
		a	b	c	d
^{55}Co	ALI	4×10^{7}	6×10^{7}	1×10^{8}	1×10^{8}
	DAC	—	—	4×10^{4}	4×10^{4}
^{56}Co	ALI	2×10^{7}	2×10^{7}	1×10^{7}	7×10^{6}
	DAC	—	—	5×10^{3}	3×10^{3}
^{57}Co	ALI	3×10^{8}	2×10^{8}	1×10^{8}	2×10^{7}
	DAC	—	—	4×10^{4}	1×10^{4}
^{58}Co	ALI	6×10^{7}	5×10^{7}	4×10^{7}	3×10^{7}
	DAC	—	—	2×10^{4}	1×10^{4}
$^{58}Co^{m}$	ALI	2×10^{9}	2×10^{9}	3×10^{9}	2×10^{9}
	DAC	—	–	1×10^{6}	1×10^{6}
^{60}Co	ALI	2×10^{7}	7×10^{6}	6×10^{6}	1×10^{6}
	DAC	—	—	3×10^{3}	5×10^{2}
$^{60}Co^{m}$	ALI	4×10^{10} (5×10^{10}) St. wall	4×10^{10} (5×10^{10}) St. wall	1×10^{11}	1×10^{11}
	DAC	—	—	6×10^{7}	4×10^{7}
^{61}Co	ALI	7×10^{8}	8×10^{8}	2×10^{9}	2×10^{9}
	DAC	—	—	1×10^{6}	9×10^{5}
$^{62}Co^{m}$	ALI	1×10^{9} (2×10^{9}) St. wall	1×10^{9} (2×10^{9}) St. wall	6×10^{9}	6×10^{9}
	DAC	—	—	3×10^{6}	2×10^{6}

a Oxides and hydroxides and all other inorganic compounds of cobalt ingested in tracer quantities.

b Organically complexed compounds and all inorganic compounds of cobalt except oxides and hydroxides in the presence of carrier material.

c All compounds of cobalt except those in d.

d Oxides, hydroxides, halides and nitrates.

COPPER

Radionuclide		*Oral*	*Inhalation*		
		a	b	c	d
^{60}Cu	ALI	1×10^{9} (1×10^{9}) St. wall	3×10^{9}	4×10^{9}	4×10^{9}
	DAC	—	1×10^{6}	2×10^{6}	2×10^{6}
^{61}Cu	ALI	5×10^{8}	1×10^{9}	2×10^{9}	1×10^{9}
	DAC	—	5×10^{5}	6×10^{5}	5×10^{5}
^{64}Cu	ALI	4×10^{8}	1×10^{9}	9×10^{8}	8×10^{8}
	DAC	—	5×10^{5}	4×10^{5}	3×10^{5}
^{67}Cu	ALI	2×10^{8}	3×10^{8}	2×10^{8}	2×10^{8}
	DAC	—	1×10^{5}	8×10^{4}	7×10^{4}

a All compounds of copper.

b All inorganic compounds of copper other than those in c and d.

c Sulphides, halides and nitrates.

d Oxides and hydroxides.

CURIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{238}Cm	ALI	6×10^{8}	4×10^{7}
	DAC	—	2×10^{4}
^{240}Cm	ALI	4×10^{6} (5×10^{6}) Bone surface	2×10^{4} (2×10^{4}) Bone surface
	DAC	—	8×10^{0}
^{241}Cm	ALI	5×10^{7}	9×10^{5} (1×10^{6}) Bone surface
	DAC	—	4×10^{2}
^{242}Cm	ALI	2×10^{6} (3×10^{6}) Bone surface	1×10^{4} (1×10^{4}) Bone surface
	DAC	—	4×10^{0}
^{243}Cm	ALI	7×10^{4} (1×10^{5}) Bone surface	3×10^{2} (5×10^{2}) Bone surface
	DAC	—	1×10^{-1}
^{244}Cm	ALI	9×10^{4} (2×10^{5}) Bone surface	4×10^{2} (7×10^{2}) Bone surface
	DAC	—	2×10^{-1}
^{245}Cm	ALI	5×10^{4} (8×10^{4}) Bone surface	2×10^{2} (3×10^{2}) Bone surface
	DAC	—	8×10^{-2}
^{246}Cm	ALI	5×10^{4} (8×10^{4}) Bone surface	2×10^{2} (3×10^{2}) Bone surface
	DAC	—	8×10^{-2}

CURIUM—*(cont.)*

Radionuclide		*Oral* a	*Inhalation* b
^{247}Cm	ALI	5×10^{4} (9×10^{4}) Bone surface	2×10^{2} (4×10^{2}) Bone surface
	DAC	—	9×10^{-2}
^{248}Cm	ALI	1×10^{4} (2×10^{4}) Bone surface	5×10^{1} (9×10^{1}) Bone surface
	DAC	—	2×10^{-2}
^{249}Cm	ALI	2×10^{9}	5×10^{8} (8×10^{8}) Bone surface
	DAC	—	2×10^{5}

a, b All compounds of curium.

It should be noted that greater gastro-intestinal absorption might be expected for complexed forms of curium and that enhanced absorption has been reported in very young rats.

DYSPROSIUM

Radionuclide		*Oral* a	*Inhalation* b
^{155}Dy	ALI	3×10^{8}	9×10^{8}
	DAC	—	4×10^{5}
^{157}Dy	ALI	7×10^{8}	2×10^{9}
	DAC	—	1×10^{6}
^{159}Dy	ALI	5×10^{8}	9×10^{7}
	DAC	—	4×10^{4}
^{165}Dy	ALI	5×10^{8}	2×10^{9}
	DAC	—	7×10^{5}
^{166}Dy	ALI	2×10^{7} (3×10^{7}) LLI wall	3×10^{7}
	DAC	—	1×10^{4}

a All compounds of dysprosium.

b All commonly occuring compounds of dysprosium.

EINSTEINIUM

Radionuclide		*Oral* a	*Inhalation* b
^{250}Es	ALI	2×10^{9}	2×10^{7} (4×10^{7}) Bone surface
	DAC	—	1×10^{4}
^{251}Es	ALI	3×10^{8}	4×10^{7} (4×10^{7}) Bone surface
	DAC	—	2×10^{4}

EINSTEINIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*
		a	b
^{253}Es	ALI	8×10^{6} (8×10^{6}) LLI wall	6×10^{4}
	DAC	—	2×10^{1}
$^{254}Es^{m}$	ALI	1×10^{7} (1×10^{7}) LLI wall	4×10^{5}
	DAC	—	2×10^{2}
^{254}Es	ALI	8×10^{5} (1×10^{6}) Bone surface	4×10^{3} (5×10^{3}) Bone surface
	DAC	—	2×10^{0}

a, b All compounds of einsteinium.

ERBIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{161}Er	ALI	6×10^{8}	2×10^{9}
	DAC	—	1×10^{6}
^{165}Er	ALI	2×10^{9}	7×10^{9}
	DAC	—	3×10^{6}
^{169}Er	ALI	1×10^{8} (1×10^{8}) LLI wall	9×10^{7}
	DAC	—	4×10^{4}
^{171}Er	ALI	1×10^{8}	4×10^{8}
	DAC	—	2×10^{5}
^{172}Er	ALI	4×10^{7} (5×10^{7}) LLI wall	5×10^{7}
	DAC	—	2×10^{4}

a, b All compounds of erbium.

EUROPIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{145}Eu	ALI	6×10^{7}	7×10^{7}
	DAC	—	3×10^{4}
^{146}Eu	ALI	4×10^{7}	5×10^{7}
	DAC	—	2×10^{4}
^{147}Eu	ALI	1×10^{8}	6×10^{7}
	DAC	—	3×10^{4}
^{148}Eu	ALI	4×10^{7}	1×10^{7}
	DAC	—	5×10^{3}

EUROPIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*
		a	b
^{149}Eu	ALI	4×10^{8}	1×10^{8}
	DAC	—	5×10^{4}
^{150}Eu	ALI	1×10^{8}	3×10^{8}
($T_{1/2}$=12.62 hours)	DAC	—	1×10^{5}
^{150}Eu	ALI	3×10^{7}	7×10^{5}
($T_{1/2}$=32.2 years)	DAC	—	3×10^{2}
$^{152}Eu^{m}$	ALI	1×10^{8}	2×10^{8}
	DAC	—	1×10^{5}
^{152}Eu	ALI	3×10^{7}	9×10^{5}
	DAC	—	4×10^{2}
^{154}Eu	ALI	2×10^{7}	7×10^{5}
	DAC	—	3×10^{2}
^{155}Eu	ALI	1×10^{8}	3×10^{6} (5×10^{6}) Bone surface
	DAC	—	1×10^{3}
^{156}Eu	ALI	2×10^{7}	2×10^{7}
	DAC	—	7×10^{3}
^{157}Eu	ALI	8×10^{7}	2×10^{8}
	DAC	—	8×10^{4}
^{158}Eu	ALI	7×10^{8}	2×10^{9}
	DAC	—	9×10^{5}

a All compounds or europium.

b All commonly occurring compounds of europium.

FERMIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{252}Fm	ALI	2×10^{7}	5×10^{5}
	DAC	—	2×10^{2}
^{253}Fm	ALI	5×10^{7} (5×10^{7}) LLI wall	4×10^{5}
	DAC	—	2×10^{2}
^{254}Fm	ALI	1×10^{8}	4×10^{6}
	DAC	—	2×10^{3}
^{255}Fm	ALI	2×10^{7}	8×10^{5}
	DAC	—	3×10^{2}
^{257}Fm	ALI	2×10^{6} (3×10^{6}) Bone surface	9×10^{3}
	DAC	—	4×10^{0}

a, b All compounds of fermium.

FLUORINE

Radionuclide		*Oral*	*Inhalation*		
		a	b	c	d
^{18}F	ALI	2×10^{9} (2×10^{9}) St. wall	3×10^{9}	3×10^{9}	3×10^{9}
	DAC	—	1×10^{6}	1×10^{6}	1×10^{6}

a All compounds of fluorine.

b Fluorides of H, Li, Na, K, Rb, Cs, Fr.

c Fluorides of Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, As, Sb, Bi, Fe, Ru, Os, Co, Ph, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Mn, Tc, Re.

d Lanthanide fluoride.

FRANCIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{222}Fr	ALI	8×10^{7}	2×10^{7}
	DAC	—	7×10^{3}
^{223}Fr	ALI	2×10^{7}	3×10^{7}
	DAC	—	1×10^{4}

a, b All compounds of francium.

GADOLINIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{145}Gd	ALI	2×10^{9} (2×10^{9}) St. wall	6×10^{9}	6×10^{9}
	DAC	—	2×10^{6}	3×10^{6}
^{146}Gd	ALI	5×10^{7}	5×10^{6}	1×10^{7}
	DAC	—	2×10^{3}	4×10^{3}
^{147}Gd	ALI	7×10^{7}	2×10^{8}	1×10^{8}
	DAC	—	6×10^{4}	5×10^{4}
^{148}Gd	ALI	4×10^{5} (9×10^{5}) Bone surface	3×10^{2} (6×10^{2}) Bone surface	1×10^{3} (2×10^{3}) Bone surface
	DAC	—	1×10^{-1}	5×10^{-1}
^{149}Gd	ALI	1×10^{8}	8×10^{7}	9×10^{7}
	DAC	—	3×10^{4}	4×10^{4}
^{151}Gd	ALI	2×10^{8}	1×10^{7} (2×10^{7}) Bone surface	4×10^{7}
	DAC	—	6×10^{3}	2×10^{4}
^{152}Gd	ALI	6×10^{5} (1×10^{6}) Bone surface	4×10^{2} (8×10^{2}) Bone surface	2×10^{3} (3×10^{3}) Bone surface
	DAC	—	2×10^{-1}	6×10^{-1}

GADOLINIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{153}Gd	ALI	2×10^{8}	5×10^{6} (9×10^{6}) Bone surface	2×10^{7}
	DAC	—	2×10^{3}	9×10^{3}
^{159}Gd	ALI	1×10^{8}	3×10^{8}	2×10^{8}
	DAC	—	1×10^{5}	9×10^{4}

a All compounds of gadolinium.
b All commonly occurring compounds of gadolinium other than those in c.
c Oxides, hydroxides and fluorides.

GALLIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{65}Ga	ALI	2×10^{9} (2×10^{9}) St. wall	6×10^{9}	7×10^{9}
	DAC	—	3×10^{6}	3×10^{6}
^{66}Ga	ALI	4×10^{7}	1×10^{8}	1×10^{8}
	DAC	—	5×10^{4}	4×10^{4}
^{67}Ga	ALI	3×10^{8}	5×10^{8}	4×10^{8}
	DAC	—	2×10^{5}	2×10^{5}
^{68}Ga	ALI	6×10^{8}	2×10^{9}	2×10^{9}
	DAC	—	6×10^{5}	8×10^{5}
^{70}Ga	ALI	2×10^{9} (3×10^{9}) St. wall	6×10^{9}	7×10^{9}
	DAC	—	3×10^{6}	3×10^{6}
^{72}Ga	ALI	4×10^{7}	1×10^{8}	1×10^{8}
	DAC	—	5×10^{4}	5×10^{4}
^{73}Ga	ALI	2×10^{8}	6×10^{8}	6×10^{8}
	DAC	—	2×10^{5}	2×10^{5}

a All compounds of gallium.
b All compounds of gallium other than those in c.
c Oxides, hydroxides, carbides, halides and nitrates.

GERMANIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{66}Ge	ALI	9×10^{8}	1×10^{9}	7×10^{8}
	DAC	—	4×10^{5}	3×10^{5}
^{67}Ge	ALI	1×10^{9} (2×10^{9}) St. wall	3×10^{9}	4×10^{9}
	DAC	—	1×10^{6}	2×10^{6}
^{68}Ge	ALI	2×10^{8}	1×10^{8}	4×10^{6}
	DAC	—	6×10^{4}	2×10^{3}

GERMANIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{69}Ge	ALI	5×10^{8}	6×10^{8}	3×10^{8}
	DAC	—	2×10^{5}	1×10^{5}
^{71}Ge	ALI	2×10^{10}	2×10^{10}	2×10^{9}
	DAC	—	7×10^{6}	7×10^{5}
^{75}Ge	ALI	2×10^{9} (3×10^{9}) St. wall	3×10^{9}	3×10^{9}
	DAC	—	1×10^{6}	1×10^{6}
^{77}Ge	ALI	3×10^{8}	4×10^{8}	2×10^{8}
	DAC	—	2×10^{5}	9×10^{4}
^{78}Ge	ALI	8×10^{8} (9×10^{8}) St. wall	8×10^{8}	8×10^{8}
	DAC	—	3×10^{5}	3×10^{5}

a All compounds of germanium.
b Commonly occuring compounds of germanium other than those in c.
c Oxides, sulphides and halides.

GOLD

Radionuclide		*Oral*	*Inhalation*		
		a	b	c	d
^{193}Au	ALI	3×10^{8}	1×10^{9}	8×10^{8}	7×10^{8}
	DAC	—	4×10^{5}	3×10^{5}	3×10^{5}
^{194}Au	ALI	1×10^{8}	3×10^{8}	2×10^{8}	2×10^{8}
	DAC	—	1×10^{5}	8×10^{4}	8×10^{4}
^{195}Au	ALI	2×10^{8}	4×10^{8}	5×10^{7}	2×10^{7}
	DAC	—	2×10^{5}	2×10^{4}	7×10^{3}
^{198}Au^{m}	ALI	4×10^{7}	1×10^{8}	4×10^{7}	4×10^{7}
	DAC	—	4×10^{4}	2×10^{4}	2×10^{4}
^{198}Au	ALI	5×10^{7}	1×10^{8}	7×10^{7}	6×10^{7}
	DAC	—	6×10^{4}	3×10^{4}	3×10^{4}
^{199}Au	ALI	1×10^{8} (1×10^{8}) LLI wall	3×10^{8}	1×10^{8}	1×10^{8}
	DAC	—	1×10^{5}	6×10^{4}	6×10^{4}
^{200}Au^{m}	ALI	4×10^{7}	1×10^{8}	1×10^{8}	9×10^{7}
	DAC	—	5×10^{4}	4×10^{4}	4×10^{4}
^{200}Au	ALI	1×10^{9}	2×10^{9}	3×10^{9}	3×10^{9}
	DAC	—	1×10^{6}	1×10^{6}	1×10^{6}
^{201}Au	ALI	3×10^{9} (3×10^{9}) St. wall	8×10^{9}	9×10^{9}	8×10^{9}
	DAC	—	3×10^{6}	4×10^{6}	3×10^{6}

a All compounds of gold.
b All compounds of gold except those in c and d.
c Halides and nitrates.
d Oxides and hydroxides.

HAFNIUM

Radionuclide		Oral	Inhalation	
		a	b	c
^{170}Hf	ALI	1×10^{8}	2×10^{8}	2×10^{8}
	DAC	—	9×10^{4}	7×10^{4}
^{172}Hf	ALI	5×10^{7}	3×10^{5} (7×10^{5}) Bone surface	1×10^{6} (2×10^{6}) Bone surface
	DAC	—	1×10^{2}	6×10^{2}
^{173}Hf	ALI	2×10^{8}	5×10^{8}	4×10^{8}
	DAC	—	2×10^{5}	2×10^{5}
^{175}Hf	ALI	1×10^{8}	4×10^{7} (4×10^{7}) Bone surface	4×10^{7}
	DAC	—	1×10^{4}	2×10^{4}
$^{177}Hf^{m}$	ALI	7×10^{8}	2×10^{9}	3×10^{9}
	DAC	—	9×10^{5}	1×10^{6}
$^{178}Hf^{m}$	ALI	9×10^{6}	5×10^{4} (9×10^{4}) Bone surface	2×10^{5} (3×10^{5}) Bone surface
	DAC	—	2×10^{1}	8×10^{1}
$^{179}Hf^{m}$	ALI	4×10^{7}	1×10^{7} (2×10^{7}) Bone surface	2×10^{7}
	DAC	—	5×10^{3}	9×10^{3}
$^{180}Hf^{m}$	ALI	3×10^{8}	8×10^{8}	9×10^{8}
	DAC	—	3×10^{5}	4×10^{5}
^{181}Hf	ALI	4×10^{7}	6×10^{6} (1×10^{7}) Bone surface	2×10^{7}
	DAC	—	3×10^{3}	7×10^{3}
$^{182}Hf^{m}$	ALI	1×10^{9}	3×10^{9}	5×10^{9}
	DAC	—	1×10^{6}	2×10^{6}
^{182}Hf	ALI	7×10^{6} (1×10^{7}) Bone surface	3×10^{4} (7×10^{4}) Bone surface	1×10^{5} (3×10^{5}) Bone surface
	DAC	—	1×10^{1}	5×10^{1}
^{183}Hf	ALI	8×10^{8}	2×10^{9}	2×10^{9}
	DAC	—	7×10^{5}	9×10^{5}
^{184}Hf	ALI	9×10^{7}	3×10^{8}	2×10^{8}
	DAC	—	1×10^{5}	1×10^{5}

a All compounds of hafnium.
b All commonly occurring compounds of hafnium other than those in c.
c Oxides, hydroxides, halides, carbides and nitrates.

HOLMIUM

Radionuclide		Oral	Inhalation
		a	b
^{155}Ho	ALI	2×10^{9}	6×10^{9}
	DAC	—	2×10^{6}
^{157}Ho	ALI	1×10^{10}	5×10^{10}
	DAC	—	2×10^{7}
^{159}Ho	ALI	8×10^{9}	4×10^{10}
	DAC	—	2×10^{7}

HOLMIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*
		a	b
^{161}Ho	ALI	4×10^{9}	2×10^{10}
	DAC	—	6×10^{6}
$^{162}Ho^{m}$	ALI	2×10^{9}	1×10^{10}
	DAC	—	4×10^{6}
^{162}Ho	ALI	2×10^{10} (3×10^{10}) St. wall	9×10^{10}
	DAC	—	4×10^{7}
$^{164}Ho^{m}$	ALI	4×10^{9}	1×10^{10}
	DAC	—	5×10^{6}
^{164}Ho	ALI	7×10^{9} (8×10^{9}) St. wall	2×10^{10}
	DAC	—	1×10^{7}
$^{166}Ho^{m}$	ALI	2×10^{7}	3×10^{5}
	DAC	—	1×10^{2}
^{166}Ho	ALI	3×10^{7} (3×10^{7}) LLI wall	7×10^{7}
	DAC	—	3×10^{4}
^{167}Ho	ALI	6×10^{8}	2×10^{9}
	DAC	—	9×10^{5}

a, b All compounds of holmium.

HYDROGEN

Radionuclide		*Oral*	*Inhalation*
^{3}H (Tritiated water)	ALI	3×10^{9}	3×10^{9}
	DAC	—	8×10^{5}
^{3}H (Elemental tritium)	ALI	—	—
	DAC	—	2×10^{10}

Absorption of tritium through the skin is included in the calculations for DAC.

INDIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{109}In	ALI	7×10^{8}	2×10^{9}	2×10^{9}
	DAC	—	7×10^{5}	1×10^{6}
^{110}In ($T_{1/2}$=69.1 minutes)	ALI	6×10^{8}	2×10^{9}	2×10^{9}
	DAC	—	7×10^{5}	9×10^{5}
^{110}In ($T_{1/2}$=4.9 hours)	ALI	2×10^{8}	6×10^{8}	7×10^{8}
	DAC	—	3×10^{5}	3×10^{5}
^{111}In	ALI	2×10^{8}	2×10^{8}	2×10^{8}
	DAC	—	1×10^{5}	1×10^{5}
^{112}In	ALI	6×10^{9} (9×10^{9}) St. wall	2×10^{10}	3×10^{10}
	DAC	—	1×10^{7}	1×10^{7}

INDIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
$^{113}In^{m}$	ALI	2×10^{9}	5×10^{9}	7×10^{9}
	DAC	—	2×10^{6}	3×10^{6}
$^{114}In^{m}$	ALI	1×10^{7} (1×10^{7}) LLI wall	2×10^{6}	4×10^{6}
	DAC	—	1×10^{3}	2×10^{3}
$^{115}In^{m}$	ALI	5×10^{8}	2×10^{9}	2×10^{9}
	DAC	—	7×10^{5}	7×10^{5}
^{115}In	ALI	1×10^{6}	5×10^{4}	2×10^{5}
	DAC	—	2×10^{1}	8×10^{1}
$^{116}In^{m}$	ALI	9×10^{8}	3×10^{9}	4×10^{9}
	DAC	—	1×10^{6}	2×10^{6}
$^{117}In^{m}$	ALI	4×10^{8}	1×10^{9}	2×10^{9}
	DAC	—	5×10^{5}	7×10^{5}
^{117}In	ALI	2×10^{9}	6×10^{9}	8×10^{9}
	DAC	—	3×10^{6}	3×10^{6}
$^{119}In^{m}$	ALI	1×10^{9} (2×10^{9}) St. wall	5×10^{9}	5×10^{9}
	DAC	—	2×10^{6}	2×10^{6}

a All compounds of indium.
b All compounds of indium except those in c.
c Oxides, hydroxides, halides and nitrates.

IODINE

Radionuclide		*Oral*	*Inhalation*
		a	b
^{120}I	ALI	1×10^{8} (3×10^{8}) Thyroid	3×10^{5} (5×10^{8}) Thyroid
	DAC	—	1×10^{5}
$^{120}I^{m}$	ALI	4×10^{8} (5×10^{8}) Thyroid	8×10^{8}
	DAC	—	3×10^{5}
^{121}I	ALI	4×10^{8} (1×10^{9}) Thyroid	7×10^{8} (2×10^{9}) Thyroid
	DAC	—	3×10^{5}
^{123}I	ALI	1×10^{8} (4×10^{8}) Thyroid	2×10^{8} (7×10^{8}) Thyroid
	DAC	—	9×10^{4}
^{124}I	ALI	2×10^{6} (6×10^{6}) Thyroid	3×10^{6} (1×10^{7}) Thyroid
	DAC	—	1×10^{3}
^{125}I	ALI	1×10^{6} (5×10^{6}) Thyroid	2×10^{6} (8×10^{6}) Thyroid
	DAC	—	1×10^{3}

IODINE—*(cont.)*

Radionuclide		*Oral*	*Inhalation*
		a	b
^{126}I	ALI	8×10^5 (3×10^6) Thyroid	1×10^6 (4×10^6) Thyroid
	DAC	—	5×10^2
^{128}I	ALI	2×10^9 (2×10^9) St. wall	4×10^9
	DAC	—	2×10^6
^{129}I	ALI	2×10^5 (7×10^5) Thyroid	3×10^5 (1×10^6) Thyroid
	DAC	—	1×10^2
^{130}I	ALI	1×10^7 (4×10^7) Thyroid	3×10^7 (7×10^7) Thyroid
	DAC	—	1×10^4
^{131}I	ALI	1×10^6 (4×10^6) Thyroid	2×10^6 (6×10^6) Thyroid
	DAC	—	7×10^2
^{132}I	ALI	1×10^8 (3×10^8) Thyroid	3×10^8 (6×10^8) Thyroid
	DAC	—	1×10^5
$^{132}I^m$	ALI	1×10^8 (4×10^8) Thyroid	3×10^8 (7×10^8) Thyroid
	DAC	—	1×10^5
^{133}I	ALI	5×10^6 (2×10^7) Thyroid	1×10^7 (3×10^7) Thyroid
	DAC	—	4×10^3
^{134}I	ALI	8×10^8 (1×10^9) Thyroid	2×10^9
	DAC	—	7×10^5
^{135}I	ALI	3×10^7 (9×10^7) Thyroid	6×10^7 (2×10^8) Thyroid
	DAC	—	2×10^4

a All commonly occurring compounds of iodine.
b All compounds of iodine.

IRIDIUM

Radionuclide		*Oral*	*Inhalation*		
		a	b	c	d
^{182}Ir	ALI	2×10^9 (2×10^9) St. wall	5×10^9	6×10^9	5×10^9
	DAC	—	2×10^6	2×10^6	2×10^6
^{184}Ir	ALI	3×10^8	9×10^8	1×10^9	1×10^9
	DAC	—	4×10^5	5×10^5	4×10^5

IRIDIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*		
		a	b	c	d
^{185}Ir	ALI	2×10^{8}	5×10^{8}	4×10^{8}	4×10^{8}
	DAC	—	2×10^{5}	2×10^{5}	2×10^{5}
^{186}Ir	ALI	9×10^{7}	3×10^{8}	2×10^{8}	2×10^{8}
	DAC	—	1×10^{5}	1×10^{5}	9×10^{4}
^{187}Ir	ALI	4×10^{8}	1×10^{9}	1×10^{9}	1×10^{9}
	DAC	—	5×10^{5}	5×10^{5}	4×10^{5}
^{188}Ir	ALI	7×10^{7}	2×10^{8}	1×10^{8}	1×10^{8}
	DAC	—	7×10^{4}	5×10^{4}	5×10^{4}
^{189}Ir	ALI	2×10^{8} (2×10^{8}) LLI wall	2×10^{8}	1×10^{8}	1×10^{8}
	DAC	—	7×10^{4}	6×10^{4}	6×10^{4}
$^{190}Ir^{m}$	ALI	6×10^{9}	7×10^{9}	8×10^{9}	7×10^{9}
	DAC	—	3×10^{6}	3×10^{6}	3×10^{6}
^{190}Ir	ALI	4×10^{7}	3×10^{7}	4×10^{7}	3×10^{7}
	DAC	—	1×10^{4}	2×10^{4}	1×10^{4}
$^{192}Ir^{m}$	ALI	1×10^{8}	3×10^{6}	8×10^{6}	6×10^{5}
	DAC	—	1×10^{3}	3×10^{3}	2×10^{2}
^{192}Ir	ALI	4×10^{7}	1×10^{7}	1×10^{7}	8×10^{6}
	DAC	—	4×10^{3}	6×10^{3}	3×10^{3}
$^{194}Ir^{m}$	ALI	2×10^{7}	3×10^{6}	6×10^{6}	4×10^{6}
	DAC	—	1×10^{3}	3×10^{3}	2×10^{3}
^{194}Ir	ALI	4×10^{7}	1×10^{8}	8×10^{7}	7×10^{7}
	DAC	—	5×10^{4}	3×10^{4}	3×10^{4}
$^{195}Ir^{m}$	ALI	3×10^{8}	9×10^{8}	1×10^{9}	8×10^{8}
	DAC	—	4×10^{5}	4×10^{5}	3×10^{5}
^{195}Ir	ALI	6×10^{8}	2×10^{9}	2×10^{9}	2×10^{9}
	DAC	—	6×10^{5}	8×10^{5}	7×10^{5}

a All compounds of iridium.

b All compounds of iridium except those in c and d.

c Halides, nitrates and metallic iridium.

d Oxides and hydroxides.

IRON

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{52}Fe	ALI	3×10^{7}	1×10^{8}	9×10^{7}
	DAC	—	5×10^{4}	4×10^{4}
^{55}Fe	ALI	3×10^{8}	7×10^{7}	2×10^{8}
	DAC	—	3×10^{4}	6×10^{4}
^{59}Fe	ALI	3×10^{7}	1×10^{7}	2×10^{7}
	DAC	—	5×10^{3}	8×10^{3}
^{60}Fe	ALI	1×10^{6}	2×10^{5}	7×10^{5}
	DAC	—	1×10^{2}	3×10^{2}

a All compounds of iron.

b All commonly occurring compounds of iron except those in c.

c Oxides, hydroxides and halides.

KRYPTON

Radio-nuclide	*Semi-infinite cloud*	*1000 m^3 room*	*500 m^3 room*	*100 m^3 room*
^{74}Kr	1×10^5	1×10^6 (3×10^6) Skin	1×10^6 (3×10^6) Skin	1×10^6 (6×10^6) Skin
^{76}Kr	3×10^5	7×10^6	9×10^6	2×10^7
^{77}Kr	1×10^5	2×10^6 (3×10^6) Skin	2×10^6 (4×10^6) Skin	2×10^6 (7×10^6) Skin
^{79}Kr	6×10^5	1×10^7	2×10^7	3×10^7
^{81}Kr	2×10^7	1×10^8 (5×10^8) Lens	1×10^8 (6×10^8) Lens	1×10^8 (9×10^8) Lens
$^{83}Kr^m$	4×10^8 (7×10^9) Lens	4×10^8 (7×10^9) Lens	4×10^8 (7×10^9) Lens	4×10^8 (8×10^9) Lens
$^{85}Kr^m$	8×10^5	5×10^6 (2×10^7) Skin	5×10^6 (3×10^7) Skin	5×10^6 (4×10^7) Skin
^{85}Kr	5×10^6 (5×10^7) Skin	5×10^6 (1×10^9) Skin	5×10^6 (1×10^9) Skin	5×10^6 (2×10^9) Skin
^{87}Kr	2×10^5	8×10^5 (5×10^6) Skin	8×10^5 (6×10^6) Skin	8×10^5 (1×10^7) Skin
^{88}Kr	7×10^4	2×10^6	2×10^6	3×10^6 (4×10^6) Skin

Exposure in a cloud of radioactive noble gas is mainly determined by external irradiation, since dose-equivalent rate from gas absorption in tissue or contained in the lungs will be negligible in comparison with dose-equivalent rate to organs and tissues from external irradiation.

LANTHANUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{131}La	ALI	2×10^9	4×10^9	6×10^9
	DAC	—	2×10^6	3×10^6
^{132}La	ALI	1×10^8	4×10^8	4×10^8
	DAC	—	2×10^5	2×10^5
^{135}La	ALI	1×10^9	4×10^9	4×10^9
	DAC	—	2×10^6	1×10^6
^{137}La	ALI	4×10^8	2×10^6 (3×10^6) Liver	1×10^7 (1×10^7) Liver
	DAC	—	1×10^3	4×10^3
^{138}La	ALI	3×10^7	1×10^5	5×10^5
	DAC	—	5×10^1	2×10^2
^{140}La	ALI	2×10^7	5×10^7	4×10^7
	DAC	—	2×10^4	2×10^4

LANTHANUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{141}La	ALI	1×10^{8}	3×10^{8}	4×10^{8}
	DAC	—	1×10^{5}	2×10^{5}
^{142}La	ALI	3×10^{8}	8×10^{8}	1×10^{9}
	DAC	—	3×10^{5}	5×10^{5}
^{143}La	ALI	1×10^{9} (1×10^{9}) St. wall	4×10^{9}	3×10^{9}
	DAC	—	2×10^{6}	1×10^{6}

a All compounds of lanthanum.

b Commonly occurring compounds of lanthanum other than those in c.

c Oxides and hydroxides.

LEAD

Radionuclide		*Oral*	*Inhalation*
		a	b
$^{195}Pb^{m}$	ALI	2×10^{9}	7×10^{9}
	DAC	—	3×10^{6}
^{198}Pb	ALI	1×10^{9}	2×10^{9}
	DAC	—	1×10^{6}
^{199}Pb	ALI	8×10^{8}	3×10^{9}
	DAC	—	1×10^{6}
^{200}Pb	ALI	1×10^{8}	2×10^{8}
	DAC	—	1×10^{5}
^{201}Pb	ALI	3×10^{8}	7×10^{8}
	DAC	—	3×10^{5}
$^{202}Pb^{m}$	ALI	3×10^{8}	1×10^{9}
	DAC	—	4×10^{5}
^{202}Pb	ALI	5×10^{6}	2×10^{6}
	DAC	—	8×10^{2}
^{203}Pb	ALI	2×10^{8}	4×10^{8}
	DAC	—	1×10^{5}
^{205}Pb	ALI	1×10^{8}	5×10^{7}
	DAC	—	2×10^{4}
^{209}Pb	ALI	9×10^{8}	2×10^{9}
	DAC	—	9×10^{5}
^{210}Pb	ALI	2×10^{4} (4×10^{4}) Bone surface	9×10^{3} (1×10^{4}) Bone surface
	DAC	—	4×10^{0}
^{211}Pb	ALI	4×10^{8}	2×10^{7}
	DAC	—	1×10^{4}
^{212}Pb	ALI	3×10^{6} (5×10^{6}) Bone surface	1×10^{6}
	DAC	—	5×10^{2}
^{214}Pb	ALI	3×10^{8}	3×10^{7}
	DAC	—	1×10^{4}

a All compounds of lead.

b All commonly occurring compounds of lead.

LUTETIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{169}Lu	ALI	9×10^{7}	2×10^{8}	2×10^{8}
	DAC	—	7×10^{4}	6×10^{4}
^{170}Lu	ALI	4×10^{7}	8×10^{7}	7×10^{7}
	DAC	—	3×10^{4}	3×10^{4}
^{171}Lu	ALI	7×10^{7}	7×10^{7}	7×10^{7}
	DAC	—	3×10^{4}	3×10^{4}
^{172}Lu	ALI	4×10^{7}	4×10^{7}	4×10^{7}
	DAC	—	2×10^{4}	2×10^{4}
^{173}Lu	ALI	2×10^{8}	1×10^{7} (2×10^{7}) Bone surface	1×10^{7}
	DAC	—	4×10^{3}	4×10^{3}
^{174}Lu^{m}	ALI	8×10^{7} (1×10^{8}) LLI wall	9×10^{6} (1×10^{7}) Bone surface	8×10^{6}
	DAC	—	4×10^{3}	3×10^{3}
^{174}Lu	ALI	2×10^{8}	4×10^{6} (8×10^{6}) Bone surface	6×10^{6}
	DAC	—	2×10^{3}	2×10^{3}
^{176}Lu^{m}	ALI	3×10^{8}	9×10^{8}	8×10^{8}
	DAC	—	4×10^{5}	4×10^{5}
^{176}Lu	ALI	3×10^{7}	2×10^{5} (4×10^{5}) Bone surface	3×10^{5}
	DAC	—	7×10^{1}	1×10^{2}
^{177}Lu^{m}	ALI	3×10^{7}	4×10^{6} (5×10^{6}) Bone surface	3×10^{6}
	DAC	—	2×10^{3}	1×10^{3}
^{177}Lu	ALI	8×10^{7} (9×10^{7}) LLI wall	8×10^{7}	8×10^{7}
	DAC	—	3×10^{4}	3×10^{4}
^{178}Lu^{m}	ALI	2×10^{9} (2×10^{9}) St. wall	7×10^{9}	6×10^{9}
	DAC	—	3×10^{6}	3×10^{6}
^{178}Lu	ALI	1×10^{9} (2×10^{9}) St. wall	5×10^{9}	4×10^{9}
	DAC	—	2×10^{6}	2×10^{6}
^{179}Lu	ALI	2×10^{8}	7×10^{8}	6×10^{8}
	DAC	—	3×10^{5}	2×10^{5}

a All compounds of lutetium.

b Commonly occurring compounds of lutetium other than those in c.

c Oxides, hydroxides and fluorides.

MAGNESIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{28}Mg	ALI	2×10^{7}	6×10^{7}	5×10^{7}
	DAC	—	3×10^{4}	2×10^{4}

a All compounds of magnesium.

b All compounds of magnesium except those in c.

c Oxides, hydroxides, carbides, halides and nitrates.

MANGANESE

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{51}Mn	ALI	7×10^{8}	2×10^{9}	2×10^{9}
	DAC	—	8×10^{5}	9×10^{5}
^{52}Mn	ALI	3×10^{7}	4×10^{7}	3×10^{7}
	DAC	—	2×10^{4}	1×10^{4}
$^{52}Mn^{m}$	ALI	1×10^{9} (1×10^{9}) St. wall	3×10^{9}	4×10^{9}
	DAC	—	1×10^{6}	2×10^{6}
^{53}Mn	ALI	2×10^{9}	5×10^{8} (9×10^{8}) Bone surface	4×10^{8}
	DAC	—	2×10^{5}	2×10^{5}
^{54}Mn	ALI	7×10^{7}	3×10^{7}	3×10^{7}
	DAC	—	1×10^{4}	1×10^{4}
^{56}Mn	ALI	2×10^{8}	6×10^{8}	8×10^{8}
	DAC	—	2×10^{5}	3×10^{5}

a All compounds of manganese.

b All compounds of manganese except those in c.

c Oxides, hydroxides, halides and nitrates.

MENDELEVIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{257}Md	ALI	3×10^{8}	4×10^{6}
	DAC	—	1×10^{3}
^{258}Md	ALI	3×10^{6} (3×10^{6}) Bone surface	1×10^{4} (1×10^{4}) Bone surface
	DAC	—	5×10^{0}

a, b All compounds of mendelevium.

MERCURY (inorganic)

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
$^{193}Hg^{m}$	ALI	1×10^{8}	3×10^{8}	3×10^{8}
	DAC	—	1×10^{5}	1×10^{5}
^{193}Hg	ALI	6×10^{8}	2×10^{9}	2×10^{9}
	DAC	—	7×10^{5}	6×10^{5}
^{194}Hg	ALI	3×10^{7}	2×10^{6}	4×10^{6}
	DAC	—	7×10^{2}	2×10^{3}
$^{195}Hg^{m}$	ALI	9×10^{7}	2×10^{8}	1×10^{8}
	DAC	—	8×10^{4}	6×10^{4}
^{195}Hg	ALI	5×10^{8}	1×10^{9}	1×10^{9}
	DAC	—	5×10^{5}	5×10^{5}
$^{197}Hg^{m}$	ALI	1×10^{8}	3×10^{8}	2×10^{8}
	DAC	—	1×10^{5}	8×10^{4}
^{197}Hg	ALI	2×10^{8}	4×10^{8}	3×10^{8}
	DAC	—	2×10^{5}	1×10^{5}
$^{199}Hg^{m}$	ALI	2×10^{9}	5×10^{9}	7×10^{9}
	DAC	—	2×10^{6}	3×10^{6}
^{203}Hg	ALI	9×10^{7}	5×10^{7}	4×10^{7}
	DAC	—	2×10^{4}	2×10^{4}

a All inorganic compounds of mercury.
b Sulphates.
c Oxides, hydroxides, halides, nitrates and sulphides.

MERCURY (organic)

Radionuclide		*Oral*		*Inhalation*
		a	b	c
$^{193}Hg^{m}$	ALI	3×10^{8}	2×10^{8}	5×10^{8}
	DAC	—	—	2×10^{5}
^{193}Hg	ALI	2×10^{9}	7×10^{8}	2×10^{9}
	DAC	—	—	1×10^{6}
^{194}Hg	ALI	6×10^{5}	2×10^{6}	1×10^{6}
	DAC	—	—	4×10^{2}
$^{195}Hg^{m}$	ALI	2×10^{8}	1×10^{8}	2×10^{8}
	DAC	—	—	9×10^{4}
^{195}Hg	ALI	1×10^{9}	6×10^{8}	2×10^{9}
	DAC	—	—	7×10^{5}
$^{197}Hg^{m}$	ALI	3×10^{8}	1×10^{8}	3×10^{8}
	DAC	—	—	1×10^{5}
^{197}Hg	ALI	4×10^{8}	3×10^{8}	5×10^{8}
	DAC	—	—	2×10^{5}
$^{199}Hg^{m}$	ALI	2×10^{9} (4×10^{9}) St. wall	2×10^{9} (2×10^{9}) St. wall	6×10^{9}
	DAC	—	—	2×10^{6}
^{203}Hg	ALI	2×10^{7}	3×10^{7}	3×10^{7}
	DAC	—	—	1×10^{4}

a Methyl mercury.
b All organic compounds of mercury other than that in a.
c All organic compounds of mercury.

MERCURY (vapours)

Radionuclide		*Inhalation*
$^{193}Hg^{m}$	ALI	3×10^{8}
	DAC	1×10^{5}
^{193}Hg	ALI	1×10^{9}
	DAC	5×10^{5}
^{194}Hg	ALI	1×10^{6}
	DAC	5×10^{2}
$^{195}Hg^{m}$	ALI	1×10^{8}
	DAC	6×10^{4}
^{195}Hg	ALI	1×10^{9}
	DAC	5×10^{5}
$^{197}Hg^{m}$	ALI	2×10^{8}
	DAC	8×10^{4}
^{197}Hg	ALI	3×10^{8}
	DAC	1×10^{5}
$^{199}Hg^{m}$	ALI	3×10^{9}
	DAC	1×10^{6}
^{203}Hg	ALI	3×10^{7}
	DAC	1×10^{4}

MOLYBDENUM

Radionuclide		*Oral*		*Inhalation*	
		a	b	c	d
^{90}Mo	ALI	2×10^{8}	7×10^{7}	3×10^{8}	2×10^{8}
	DAC	—	—	1×10^{5}	7×10^{4}
^{93}Mo	ALI	1×10^{8}	9×10^{8}	2×10^{8}	7×10^{6}
	DAC	—	—	8×10^{4}	3×10^{3}
$^{93}Mo^{m}$	ALI	4×10^{8}	2×10^{8}	7×10^{8}	5×10^{8}
	DAC	—	—	3×10^{5}	2×10^{5}
^{99}Mo	ALI	6×10^{7}	4×10^{7} (4×10^{7}) LLI wall	1×10^{8}	5×10^{7}
	DAC		—	4×10^{4}	2×10^{4}
^{101}Mo	ALI	2×10^{9} (2×10^{9}) St. wall	2×10^{9} (2×10^{9}) St. wall	5×10^{9}	6×10^{9}
	DAC	—	—	2×10^{6}	2×10^{6}

a MoS_2.
b All other compounds of molybdenum.
c All compounds of molybdenum except those in d.
d Oxides, hydroxides and MoS_2.

NEODYMIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{136}Nd	ALI	6×10^{8}	2×10^{9}	2×10^{9}
	DAC	—	9×10^{5}	8×10^{5}
^{138}Nd	ALI	7×10^{7}	2×10^{8}	2×10^{8}
	DAC	—	1×10^{5}	8×10^{4}
^{139}Nd^{m}	ALI	2×10^{8}	6×10^{8}	5×10^{8}
	DAC	—	3×10^{5}	2×10^{5}
^{139}Nd	ALI	3×10^{9}	1×10^{10}	1×10^{10}
	DAC	—	5×10^{6}	5×10^{6}
^{141}Nd	ALI	6×10^{9}	3×10^{10}	2×10^{10}
	DAC	—	1×10^{7}	9×10^{6}
^{147}Nd	ALI	4×10^{7} (5×10^{7}) LLI wall	3×10^{7}	3×10^{7}
	DAC	—	1×10^{4}	1×10^{4}
^{149}Nd	ALI	4×10^{8}	1×10^{9}	9×10^{8}
	DAC	—	4×10^{5}	4×10^{5}
^{151}Nd	ALI	3×10^{9}	7×10^{9}	7×10^{9}
	DAC	—	3×10^{6}	3×10^{6}

a All compounds of neodymium.

b All commonly occurring compounds of neodymium other than those in c.

c Oxides, hydroxides, carbides and fluorides.

NEPTUNIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{232}Np	ALI	1×10^{9} (2×10^{5}) Bone surface	9×10^{7} (2×10^{8}) Bone surface
	DAC	—	4×10^{4}
^{233}Np	ALI	3×10^{10}	1×10^{11}
	DAC	—	5×10^{7}
^{234}Np	ALI	8×10^{7}	1×10^{8}
	DAC	—	4×10^{4}
^{235}Np	ALI	4×10^{8}	5×10^{7} (5×10^{7}) Bone surface
	DAC	—	2×10^{4}
^{236}Np ($T_{1/2}=1.15\times10^{5}$ years)	ALI	1×10^{4} (2×10^{4})	1×10^{3} (2×10^{3}) Bone surface
	DAC	—	4×10^{-1}
^{236}Np ($T_{1/2}=22.5$ hours)	ALI	2×10^{7} (3×10^{7}) Bone surface	1×10^{6} (3×10^{6}) Bone surface
	DAC	—	6×10^{2}

NEPTUNIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*
		a	b
^{237}Np	ALI	3×10^{3} (5×10^{3}) Bone surface	2×10^{2} (4×10^{2}) Bone surface
	DAC	—	9×10^{-2}
^{238}Np	ALI	3×10^{7}	3×10^{6} (6×10^{6}) Bone surface
	DAC	—	1×10^{3}
^{239}Np	ALI	6×10^{7} (6×10^{7}) LLI wall	9×10^{7}
	DAC	—	4×10^{4}
^{240}Np	ALI	8×10^{8}	3×10^{9}
	DAC	—	1×10^{6}

a, b All compounds of neptunium.

NICKEL (Inorganic)

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{56}Ni	ALI	5×10^{7}	7×10^{7}	5×10^{7}
	DAC	—	3×10^{4}	2×10^{4}
^{57}Ni	ALI	6×10^{7}	2×10^{8}	1×10^{8}
	DAC	—	7×10^{4}	5×10^{4}
^{59}Ni	ALI	9×10^{8}	1×10^{8}	3×10^{8}
	DAC	—	6×10^{4}	1×10^{5}
^{63}Ni	ALI	3×10^{8}	6×10^{7}	1×10^{8}
	DAC	—	2×10^{4}	4×10^{4}
^{65}Ni	ALI	3×10^{8}	9×10^{8}	1×10^{9}
	DAC	—	4×10^{5}	5×10^{5}
^{66}Ni	ALI	1×10^{7} (2×10^{7}) LLI wall	6×10^{7}	2×10^{7}
	DAC	—	2×10^{4}	2×10^{4}

a All compounds of nickel.

b All commonly occurring compounds of nickel other than those in c and d.

c Oxides, hydroxides and carbides.

d Nickel entering the respiratory system as nickel carbonyl is deposited there and then translocated to the transfer compartment with a biological half-life of 0.1 days. After entry into the transfer compartment the metabolic model for inorganic compounds of nickel applies.

NICKEL (Vapours)

Radionuclide		*Inhalation*
^{56}Ni	ALI	4×10^{7}
	DAC	2×10^{4}
^{57}Ni	ALI	2×10^{8}
	DAC	1×10^{5}
^{59}Ni	ALI	7×10^{7}
	DAC	3×10^{4}

NICKEL (Vapours)—*(cont.)*

Radionuclide		*Inhalation*
^{63}Ni	ALI	3×10^{7}
	DAC	1×10^{4}
^{65}Ni	ALI	6×10^{8}
	DAC	3×10^{5}
^{66}Ni	ALI	1×10^{8}
	DAC	5×10^{4}

NIOBIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{88}Nb	ALI	2×10^{9} (3×10^{9}) St. wall	8×10^{9}	8×10^{9}
	DAC	—	4×10^{6}	3×10^{6}
^{89}Nb ($T_{1/2}$=66 minutes)	ALI	4×10^{8}	2×10^{9}	1×10^{9}
	DAC	—	6×10^{5}	6×10^{5}
^{89}Nb ($T_{1/2}$=122 minutes)	ALI	2×10^{8}	7×10^{8}	6×10^{8}
	DAC	—	3×10^{5}	2×10^{5}
^{90}Nb	ALI	4×10^{7}	1×10^{8}	9×10^{7}
	DAC	—	4×10^{4}	4×10^{4}
^{93}Nb^{m}	ALI	3×10^{8} (4×10^{8}) LLI wall.	7×10^{7}	6×10^{6}
	DAC	—	3×10^{4}	3×10^{3}
^{94}Nb	ALI	4×10^{7}	7×10^{6}	6×10^{5}
	DAC	—	3×10^{3}	2×10^{2}
^{95}Nb	ALI	8×10^{7}	5×10^{7}	4×10^{7}
	DAC	—	2×10^{4}	2×10^{4}
^{95}Nb^{m}	ALI	8×10^{7} (9×10^{7}) LLI wall	1×10^{8}	8×10^{7}
	DAC	—	4×10^{4}	3×10^{4}
^{96}Nb	ALI	4×10^{7}	1×10^{8}	9×10^{7}
	DAC	—	4×10^{4}	4×10^{4}
^{97}Nb	ALI	8×10^{8}	3×10^{9}	3×10^{9}
	DAC	—	1×10^{6}	1×10^{6}
^{98}Nb	ALI	5×10^{8}	2×10^{9}	2×10^{9}
	DAC	—	8×10^{5}	8×10^{5}

a All compounds of niobium.

b All compounds of niobium except those in c.

c Oxides and hydroxides.

OSMIUM

Radionuclide		Oral	Inhalation		
		a	b	c	d
^{180}Os	ALI	4×10^{9}	1×10^{10}	2×10^{10}	2×10^{10}
	DAC	—	6×10^{6}	7×10^{6}	7×10^{6}
^{181}Os	ALI	5×10^{8}	2×10^{9}	2×10^{9}	2×10^{9}
	DAC	—	7×10^{5}	7×10^{5}	7×10^{5}
^{182}Os	ALI	8×10^{7}	2×10^{8}	2×10^{8}	1×10^{8}
	DAC	—	9×10^{4}	7×10^{4}	6×10^{4}
^{185}Os	ALI	9×10^{7}	2×10^{7}	3×10^{7}	3×10^{7}
	DAC	—	8×10^{3}	1×10^{4}	1×10^{4}
$^{189}Os^{m}$	ALI	3×10^{9}	9×10^{9}	8×10^{9}	6×10^{9}
	DAC	—	4×10^{6}	3×10^{6}	3×10^{6}
$^{191}Os^{m}$	ALI	5×10^{8}	1×10^{9}	8×10^{8}	7×10^{8}
	DAC	—	4×10^{5}	3×10^{5}	3×10^{5}
^{191}Os	ALI	8×10^{7} (9×10^{7}) LLI wall	8×10^{7}	6×10^{7}	5×10^{7}
	DAC	—	3×10^{4}	2×10^{4}	2×10^{4}
^{193}Os	ALI	6×10^{7} (6×10^{7}) LLI wall	2×10^{8}	1×10^{8}	1×10^{8}
	DAC	—	7×10^{4}	5×10^{4}	4×10^{4}
^{194}Os	ALI	2×10^{7} (2×10^{7}) LLI wall	2×10^{6}	2×10^{6}	3×10^{5}
	DAC	—	6×10^{2}	9×10^{2}	1×10^{2}

a All compounds of osmium.
b All compounds of osmium except those in c and d.
c Halides and nitrates.
d Oxides and hydroxides.

PALLADIUM

Radionuclide		Oral	Inhalation		
		a	b	c	d
^{100}Pd	ALI	5×10^{7}	5×10^{7}	5×10^{7}	5×10^{7}
	DAC	—	2×10^{4}	2×10^{4}	2×10^{4}
^{101}Pd	ALI	5×10^{8}	1×10^{9}	1×10^{9}	1×10^{9}
	DAC	—	5×10^{5}	5×10^{5}	5×10^{5}
^{103}Pd	ALI	2×10^{8} (3×10^{8}) LLI wall	2×10^{8}	2×10^{8}	1×10^{8}
	DAC	—	1×10^{5}	7×10^{4}	5×10^{4}
^{107}Pd	ALI	1×10^{9} (1×10^{9}) LLI wall	8×10^{8} (8×10^{8}) Kidneys	3×10^{8}	1×10^{7}
	DAC	—	3×10^{5}	1×10^{5}	6×10^{3}
^{109}Pd	ALI	9×10^{7}	2×10^{8}	2×10^{8}	2×10^{8}
	DAC	—	1×10^{5}	9×10^{4}	7×10^{4}

a All compounds of palladium.
b All commonly occurring compounds of palladium other than those in c and d.
c Nitrates.
d Oxides and hydroxides.

PHOSPHOURS

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{32}P	ALI	2×10^{7}	3×10^{7}	1×10^{7}
	DAC	—	1×10^{4}	6×10^{3}
^{33}P	ALI	2×10^{8}	3×10^{8}	1×10^{8}
	DAC	—	1×10^{5}	4×10^{4}

a Dietary phosphorus is well absorbed from the GI tract.
b All compounds of phosphorus except phosphates given in c.
c Phosphates of Zn^{2+}, Su^{3+}, Mg^{2+}, Fe^{3+}, Bi^{3+1} and lanthanides.

PLATINUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{186}Pt	ALI	5×10^{8}	1×10^{9}
	DAC	—	6×10^{5}
^{188}Pt	ALI	6×10^{7}	6×10^{7}
	DAC	—	3×10^{4}
^{189}Pt	ALI	4×10^{8}	1×10^{9}
	DAC	—	4×10^{5}
^{191}Pt	ALI	1×10^{8}	3×10^{8}
	DAC	—	1×10^{5}
$^{193}Pt^{m}$	ALI	9×10^{7} (1×10^{8}) LLI wall	2×10^{8}
	DAC	—	9×10^{4}
^{193}Pt	ALI	1×10^{9} (2×10^{9}) LLI wall	9×10^{8}
	DAC	—	4×10^{5}
$^{195}Pt^{m}$	ALI	7×10^{7} (8×10^{7}) LLI wall	2×10^{8}
	DAC	—	7×10^{4}
$^{197}Pt^{m}$	ALI	6×10^{8}	2×10^{9}
	DAC	—	7×10^{5}
^{197}Pt	ALI	1×10^{8}	4×10^{8}
	DAC	—	1×10^{5}
^{199}Pt	ALI	2×10^{9}	5×10^{9}
	DAC	—	2×10^{6}
^{200}Pt	ALI	4×10^{7}	1×10^{8}
	DAC	—	5×10^{4}

a,b All compounds of platinum.

PLUTONIUM

Radionuclide		*Oral*		*Inhalation*	
		a	b	c	d
^{234}Pu	ALI	3×10^{8}	3×10^{8}	8×10^{6}	7×10^{6}
	DAC	—	—	3×10^{3}	3×10^{3}
^{235}Pu	ALI	3×10^{10}	3×10^{10}	1×10^{11}	9×10^{10}
	DAC	—	—	5×10^{7}	4×10^{7}
^{236}Pu	ALI	8×10^{5} (1×10^{6}) Bone surface	6×10^{6}	7×10^{2} (1×10^{3}) Bone surface	1×10^{3}
	DAC	—	—	3×10^{-1}	6×10^{-1}
^{237}Pu	ALI	5×10^{8}	5×10^{8}	1×10^{8}	1×10^{8}
	DAC	—	—	5×10^{4}	5×10^{4}
^{238}Pu	ALI	3×10^{5} (5×10^{5}) Bone surface	3×10^{6} (3×10^{6}) Bone surface	2×10^{2} (4×10^{2}) Bone surface	6×10^{2} (6×10^{2}) Bone surface
	DAC	—	—	9×10^{-2}	3×10^{-1}
^{239}Pu	ALI	2×10^{5} (4×10^{5}) Bone surface	2×10^{6} (3×10^{6}) Bone surface	2×10^{2} (4×10^{2}) Bone surface	5×10^{2} (6×10^{2}) Bone surface
	DAC	—	—	8×10^{-2}	2×10^{-1}
^{240}Pu	ALI	2×10^{5} (4×10^{5}) Bone surface	2×10^{6} (3×10^{6}) Bone surface	2×10^{2} (4×10^{2}) Bone surface	5×10^{2} (6×10^{2}) Bone surface
	DAC	—	—	8×10^{-2}	2×10^{-1}
^{241}Pu	ALI	1×10^{7} (2×10^{7}) Bone surface	1×10^{8} (2×10^{8}) Bone surface	1×10^{4} (2×10^{4}) Bone surface	2×10^{4} (3×10^{4}) Bone surface
	DAC	—	—	4×10^{0}	1×10^{1}
^{242}Pu	ALI	3×10^{5} (5×10^{5}) Bone surface	3×10^{6} (3×10^{6}) Bone surface	2×10^{2} (4×10^{2}) Bone surface	6×10^{2} (6×10^{2}) Bone surface
	DAC	—	—	9×10^{-2}	2×10^{-1}
^{243}Pu	ALI	6×10^{8}	6×10^{8}	1×10^{9}	1×10^{9}
	DAC	—	—	5×10^{5}	6×10^{5}
^{244}Pu	ALI	3×10^{5} (5×10^{5}) Bone surface	3×10^{6} (3×10^{6}) Bone surface	2×10^{2} (4×10^{2}) Bone surface	6×10^{2} (6×10^{2}) Bone surface
	DAC	—	—	9×10^{-2}	2×10^{-1}
^{245}Pu	ALI	8×10^{7}	8×10^{7}	2×10^{8}	2×10^{8}
	DAC	—	—	7×10^{4}	6×10^{4}

a For all commonly occurring compounds of plutonium.
b For oxides and hydroxides of plutonium.
c All commonly occurring compounds of plutonium except those in d.
d PuO_2.

It should be noted that data are reported which indicate a much higher gastro-intestinal absorption for certain compounds of plutonium that are unlikely to be encountered in occupational exposure, e.g. hexavalent plutonium compounds, citrates, and other organic complexes; absorption is also increased in the very young.

POLONIUM

Radionuclide		Oral	Inhalation	
		a	b	c
^{203}Po	ALI	9×10^{8}	2×10^{9}	3×10^{9}
	DAC	—	1×10^{6}	1×10^{6}
^{205}Po	ALI	8×10^{8}	1×10^{9}	3×10^{5}
	DAC	—	6×10^{5}	1×10^{6}
^{207}Po	ALI	3×10^{8}	9×10^{8}	1×10^{9}
	DAC	—	4×10^{5}	4×10^{5}
^{210}Po	ALI	1×10^{5}	2×10^{4}	2×10^{4}
	DAC	—	1×10^{1}	1×10^{1}

a All compounds of polonium.
b All compounds of polonium except those in c.
c Oxides, hydroxides and nitrates.

POTASSIUM

Radionuclide		Oral	Inhalation
		a	b
^{40}K	ALI	1×10^{7}	1×10^{7}
	DAC	—	6×10^{3}
^{42}K	ALI	2×10^{8}	2×10^{8}
	DAC	—	7×10^{4}
^{43}K	ALI	2×10^{8}	3×10^{8}
	DAC	—	1×10^{5}
^{44}K	ALI	8×10^{8} (1×10^{9}) St. wall	2×10^{9}
	DAC	—	1×10^{6}
^{45}K	ALI	1×10^{9} (2×10^{9}) St. wall	4×10^{9}
	DAC	—	2×10^{6}

a, b All compounds of potassium.

PRASEODYMIUM

Radionuclide		Oral	Inhalation	
		a	b	c
^{136}Pr	ALI	2×10^{9} (3×10^{9}) St. wall	9×10^{9}	8×10^{9}
	DAC	—	4×10^{6}	3×10^{6}
^{137}Pr	ALI	1×10^{9}	6×10^{9}	5×10^{9}
	DAC	—	2×10^{6}	2×10^{6}
$^{138}Pr^{m}$	ALI	4×10^{8}	2×10^{9}	2×10^{9}
	DAC	—	8×10^{5}	7×10^{5}

PRASEODYMIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{139}Pr	ALI	1×10^{9}	4×10^{9}	4×10^{9}
	DAC	—	2×10^{6}	2×10^{6}
$^{142}Pr^{m}$	ALI	3×10^{9}	6×10^{9}	5×10^{9}
	DAC	—	3×10^{6}	2×10^{6}
^{142}Pr	ALI	4×10^{7}	8×10^{7}	7×10^{7}
	DAC	—	3×10^{4}	3×10^{4}
^{143}Pr	ALI	3×10^{7} (4×10^{7}) LLI wall	3×10^{7}	2×10^{7}
	DAC	—	1×10^{4}	1×10^{4}
^{144}Pr	ALI	1×10^{9} (2×10^{9}) St. wall	5×10^{9}	4×10^{9}
	DAC	—	2×10^{6}	2×10^{6}
^{145}Pr	ALI	1×10^{8}	3×10^{8}	3×10^{8}
	DAC	—	1×10^{5}	1×10^{5}
^{147}Pr	ALI	2×10^{9} (3×10^{9}) St. wall	7×10^{9}	7×10^{9}
	DAC	—	3×10^{6}	3×10^{6}

a All compounds of praseodymium.
b All commonly occurring compounds of praseodymium other than those in c.
c Oxides, hydroxides, carbides and fluorides.

PROMETHIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{141}Pm	ALI	2×10^{9} (2×10^{9}) St. wall	7×10^{9}	6×10^{9}
	DAC	—	3×10^{6}	3×10^{6}
^{143}Pm	ALI	2×10^{8}	2×10^{7}	3×10^{7}
	DAC	—	9×10^{3}	1×10^{4}
^{144}Pm	ALI	5×10^{7}	4×10^{6}	4×10^{6}
	DAC	—	2×10^{3}	2×10^{3}
^{145}Pm	ALI	4×10^{8}	7×10^{6} (8×10^{6}) Bone surface	7×10^{6}
	DAC	—	3×10^{3}	3×10^{3}
^{146}Pm	ALI	6×10^{7}	2×10^{6}	2×10^{6}
	DAC	—	8×10^{2}	7×10^{2}
^{147}Pm	ALI	2×10^{8} (2×10^{8}) LLI wall	5×10^{6} (7×10^{6}) Bone surface	5×10^{6}
	DAC	—	2×10^{3}	2×10^{3}
$^{148}Pm^{m}$	ALI	3×10^{7}	1×10^{7}	1×10^{7}
	DAC	—	4×10^{3}	5×10^{3}

PROMETHIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{148}Pm	ALI	2×10^{7} (2×10^{7}) LLI wall	2×10^{7}	2×10^{7}
	DAC	—	8×10^{3}	8×10^{3}
^{149}Pm	ALI	4×10^{7} (5×10^{7}) LLI wall	7×10^{7}	7×10^{7}
	DAC	—	3×10^{4}	3×10^{4}
^{150}Pm	ALI	2×10^{8}	7×10^{8}	6×10^{8}
	DAC	—	3×10^{5}	3×10^{5}
^{151}Pm	ALI	7×10^{7}	1×10^{8}	1×10^{8}
	DAC	—	6×10^{4}	5×10^{4}

a All compounds of promethium.
b All compounds of promethium other than those in c.
c Oxides, hydroxides, carbides and fluorides.

PROTACTINIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{227}Pa	ALI	1×10^{8}	4×10^{6}	4×10^{6}
	DAC	—	2×10^{3}	2×10^{3}
^{228}Pa	ALI	5×10^{7}	5×10^{5} (8×10^{5}) Bone surface	4×10^{5}
	DAC	—	2×10^{2}	2×10^{2}
^{230}Pa	ALI	2×10^{7} (3×10^{7}) Bone surface	2×10^{5}	1×10^{5}
	DAC	—	7×10^{1}	5×10^{1}
^{231}Pa	ALI	7×10^{3} (2×10^{4}) Bone surface	6×10^{1} (1×10^{2}) Bone surface	1×10^{2} (2×10^{2}) Bone surface
	DAC	—	2×10^{-2}	6×10^{-2}
^{232}Pa	ALI	5×10^{7}	8×10^{5} (2×10^{6}) Bone surface	2×10^{6} (3×10^{6}) Bone surface
	DAC	—	3×10^{2}	9×10^{2}
^{233}Pa	ALI	5×10^{7} (6×10^{7}) LLI wall	3×10^{7}	2×10^{7}
	DAC	—	1×10^{4}	9×10^{3}
^{234}Pa	ALI	9×10^{7}	3×10^{8}	2×10^{8}
	DAC	—	1×10^{5}	1×10^{5}

a All compounds of protactinium.
b Commonly occurring compounds of protactinium other than those in c.
c Oxides and hydroxides.

RADIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{223}Ra	ALI	2×10^{5} (3×10^{5}) Bone surface	3×10^{4}
	DAC	—	1×10^{1}
^{224}Ra	ALI	3×10^{5} (6×10^{5}) Bone surface	6×10^{4}
	DAC	—	3×10^{1}
^{225}Ra	ALI	3×10^{5} (6×10^{5}) Bone surface	2×10^{4}
	DAC	—	1×10^{1}
^{226}Ra	ALI	7×10^{4} (2×10^{5}) Bone surface	2×10^{4}
	DAC	—	1×10^{1}
^{227}Ra	ALI	6×10^{8} (9×10^{8}) Bone surface	5×10^{8} (7×10^{8}) Bone surface
	DAC	—	2×10^{5}
^{228}Ra	ALI	9×10^{4} (1×10^{5}) Bone surface	4×10^{4}
	DAC	—	2×10^{1}

a All compounds of radium.
b All commonly occurring compounds of radium.

RADON

Radon daughters: short-lived decay products of ^{222}Rn: ^{218}Po (RaA), ^{218}At, ^{214}Pb (RaB), ^{214}Bi (RaC), ^{214}Po (RaC') and ^{210}Tl (RaC'').

The annual limit on intake (ALI) for radon (^{222}Rn) daughters is 0.02 Joules of inhaled potential alpha energy. This value corresponds to (i) a derived air concentration (DAC) of 8.3 microjoules per cubic meter (0.4 Working Level); or (ii) an annual limit of exposure (ALE) of 0.017J.h.m.$^{-3}$ (5 Working Level Months).

Thoron daughters: Short-lived decay products of ^{220}Rn: ^{216}Po (ThA), ^{212}Pb (ThB), ^{212}Bi (ThC'), ^{212}Po (ThC') and ^{208}Tl (ThC'').

The annual limit of intake (ALI) for thoron (^{220}Rn) daughters is 0.06 Joules of inhaled potential alpha energy. This value corresponds to (i) a derived air concentration (DAC) of 25 microjoules per cubic metre (1.2 Working Level); or (ii) an annual limit of exposure (ALE) of 0.05 J.h.m.$^{-3}$ (15 Working Level Months).

RHENIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{177}Re	ALI	3×10^{9} (4×10^{9}) St. wall	1×10^{10}	1×10^{10}
	DAC	—	4×10^{6}	5×10^{6}

RHENIUM—*(cont.)*

		Oral	*Inhalation*	
		a	b	c
^{178}Re	ALI	3×10^{9} (4×10^{9}) St. wall	1×10^{10}	1×10^{10}
	DAC	—	4×10^{6}	4×10^{6}
^{181}Re	ALI	2×10^{8}	3×10^{8}	3×10^{8}
	DAC	—	1×10^{5}	1×10^{5}
^{182}Re ($T_{1/2}$=12.7 hours)	ALI	3×10^{8}	5×10^{8}	6×10^{8}
	DAC	—	2×10^{5}	2×10^{5}
^{182}Re ($T_{1/2}$=64.0 hours)	ALI	5×10^{7}	9×10^{7}	8×10^{7}
	DAC	—	4×10^{4}	3×10^{4}
$^{184}Re^{m}$	ALI	8×10^{7}	1×10^{8}	2×10^{7}
	DAC	—	5×10^{4}	7×10^{3}
^{184}Re	ALI	9×10^{7}	1×10^{8}	5×10^{7}
	DAC	—	5×10^{4}	2×10^{4}
$^{186}Re^{m}$	ALI	5×10^{7} (6×10^{7}) St. wall	6×10^{7} (8×10^{7}) St. wall	6×10^{6}
	DAC	—	3×10^{4}	2×10^{3}
^{186}Re	ALI	7×10^{7}	1×10^{8}	6×10^{7}
	DAC	—	4×10^{4}	3×10^{4}
^{187}Re	ALI	2×10^{10}	3×10^{10} (3×10^{10}) St. wall	4×10^{9}
	DAC	—	1×10^{7}	2×10^{6}
$^{188}Re^{m}$	ALI	3×10^{9}	5×10^{9}	5×10^{9}
	DAC	—	2×10^{6}	2×10^{6}
^{188}Re	ALI	6×10^{7}	1×10^{8}	1×10^{8}
	DAC	—	4×10^{4}	4×10^{4}
^{189}Re	ALI	1×10^{8}	2×10^{8}	2×10^{8}
	DAC	—	8×10^{4}	7×10^{4}

a All compounds of rhenium.
b All compounds of rhenium except those in c.
c Oxides, hydroxides and nitrates.

RHODIUM

Radionuclide		*Oral*	*Inhalation*		
		a	b	c	d
$^{99}Rh^{m}$	ALI	7×10^{8}	2×10^{9}	3×10^{9}	2×10^{9}
	DAC	—	9×10^{5}	1×10^{6}	1×10^{6}
^{99}Rh	ALI	9×10^{7}	1×10^{8}	8×10^{7}	7×10^{7}
	DAC	—	5×10^{4}	3×10^{4}	3×10^{4}
^{100}Rh	ALI	6×10^{7}	2×10^{8}	1×10^{8}	1×10^{8}
	DAC	—	8×10^{4}	6×10^{4}	6×10^{4}
$^{101}Rh^{m}$	ALI	2×10^{8}	4×10^{8}	3×10^{8}	3×10^{8}
	DAC	—	2×10^{5}	1×10^{5}	1×10^{5}
^{101}Rh	ALI	8×10^{7}	2×10^{7}	3×10^{7}	6×10^{6}
	DAC	—	8×10^{3}	1×10^{4}	2×10^{3}
$^{102}Rh^{m}$	ALI	5×10^{7} (5×10^{7}) LLI wall	2×10^{7}	1×10^{7}	4×10^{6}
	DAC	—	8×10^{3}	6×10^{3}	2×10^{3}

RHODIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*		
		a	b	c	d
^{102}Rh	ALI	2×10^{7}	3×10^{6}	7×10^{6}	2×10^{6}
	DAC	—	1×10^{3}	3×10^{3}	9×10^{2}
$^{103}Rh^{m}$	ALI	2×10^{10}	4×10^{10}	5×10^{10}	4×10^{10}
	DAC	—	2×10^{7}	2×10^{7}	2×10^{7}
^{105}Rh	ALI	1×10^{8} (1×10^{8}) LLI wall	4×10^{8}	2×10^{8}	2×10^{8}
	DAC	—	2×10^{5}	1×10^{5}	9×10^{4}
$^{106}Rh^{m}$	ALI	3×10^{8}	9×10^{8}	1×10^{9}	1×10^{9}
	DAC	—	4×10^{5}	6×10^{5}	5×10^{5}
^{107}Rh	ALI	3×10^{9} (3×10^{9}) St. wall	9×10^{9}	1×10^{10}	9×10^{9}
	DAC	—	4×10^{6}	4×10^{6}	4×10^{6}

a All compounds of rhodium.

b All compounds of rhodium except those in c and d.

c Halides.

d Oxides and hydroxides.

RUBIDIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{79}Rb	ALI	1×10^{9} (2×10^{9}) St. Wall	4×10^{9}
	DAC	—	2×10^{6}
$^{81}Rb^{m}$	ALI	9×10^{9} (1×10^{10}) St. Wall	1×10^{10}
	DAC	—	5×10^{6}
^{81}Rb	ALI	1×10^{9}	2×10^{9}
	DAC	—	8×10^{5}
$^{82}Rb^{m}$	ALI	4×10^{8}	7×10^{8}
	DAC	—	3×10^{5}
^{83}Rb	ALI	2×10^{7}	4×10^{7}
	DAC	—	2×10^{4}
^{84}Rb	ALI	2×10^{7}	3×10^{7}
	DAC	—	1×10^{4}
^{86}Rb	ALI	2×10^{7}	3×10^{7}
	DAC	—	1×10^{4}
^{87}Rb	ALI	4×10^{7}	6×10^{7}
	DAC	—	2×10^{4}
^{88}Rb	ALI	7×10^{8} (1×10^{9}) St. wall	2×10^{9}
	DAC	—	1×10^{6}
^{89}Rb	ALI	1×10^{9} (2×10^{9}) St. wall	5×10^{9}
	DAC	—	2×10^{6}

a, b All compounds of rubidium.

RUTHENIUM

Radionuclide		*Oral*	*Inhalation*		
		a	b	c	d
^{94}Ru	ALI	6×10^{8}	2×10^{9}	2×10^{9}	2×10^{9}
	DAC	—	7×10^{5}	1×10^{6}	9×10^{5}
^{97}Ru	ALI	3×10^{8}	7×10^{8}	5×10^{8}	4×10^{8}
	DAC	—	3×10^{5}	2×10^{5}	2×10^{5}
^{103}Ru	ALI	7×10^{7}	6×10^{7}	4×10^{7}	2×10^{7}
	DAC	—	3×10^{4}	2×10^{4}	1×10^{4}
^{105}Ru	ALI	2×10^{8}	5×10^{8}	5×10^{8}	4×10^{8}
	DAC	—	2×10^{5}	2×10^{5}	2×10^{5}
^{106}Ru	ALI	7×10^{6} (9×10^{6}) LLI wall	3×10^{6}	2×10^{6}	4×10^{5}
	DAC	—	1×10^{3}	8×10^{2}	2×10^{2}

a All commonly occurring compounds of ruthenium.

b All compounds of ruthenium except those in c and d.

c Halides.

d Oxides and hydroxides.

SAMARIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
$^{141}Sm^{m}$	ALI	1×10^{9}	4×10^{9}
	DAC	—	2×10^{6}
^{141}Sm	ALI	2×10^{9} (2×10^{9}) St. wall	7×10^{9}
	DAC	—	3×10^{6}
^{142}Sm	ALI	3×10^{8}	1×10^{9}
	DAC	—	4×10^{5}
^{145}Sm	ALI	2×10^{8}	2×10^{7}
	DAC	—	8×10^{3}
^{146}Sm	ALI	5×10^{5} (9×10^{5}) Bone surface	1×10^{3} (2×10^{3}) Bone surface
	DAC	—	6×10^{-1}
^{147}Sm	ALI	6×10^{5} (1×10^{6}) Bone surface	1×10^{3} (3×10^{3}) Bone surface
	DAC	—	6×10^{-1}
^{151}Sm	ALI	5×10^{8} (5×10^{8}) LLI wall	4×10^{6} (7×10^{6}) Bone surface
	DAC	—	2×10^{3}
^{153}Sm	ALI	6×10^{7} (7×10^{7}) LLI wall	1×10^{8}
	DAC	—	4×10^{4}

SAMARIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*
			b
^{155}Sm	ALI	2×10^{9} (3×10^{9}) St. wall	8×10^{9}
	DAC	—	3×10^{6}
^{156}Sm	ALI	2×10^{8}	3×10^{8}
	DAC	—	1×10^{5}

a, b All compounds of samarium.

SCANDIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{43}Sc	ALI	3×10^{8}	8×10^{8}
	DAC	—	4×10^{5}
$^{44}Sc^{m}$	ALI	2×10^{7}	3×10^{7}
	DAC	—	1×10^{4}
^{44}Sc	ALI	1×10^{8}	4×10^{8}
	DAC	—	2×10^{5}
^{46}Sc	ALI	3×10^{7}	9×10^{6}
	DAC	—	4×10^{3}
^{47}Sc	ALI	8×10^{7} (1×10^{8}) LLI wall	1×10^{8}
	DAC	—	5×10^{4}
^{48}Sc	ALI	3×10^{7}	5×10^{7}
	DAC	—	2×10^{4}
^{49}Sc	ALI	8×10^{8}	2×10^{9}
	DAC	—	8×10^{5}

a All compounds of scandium.

b All commonly occurring compounds of scandium.

SELENIUM

Radionuclide		*Oral*		*Inhalation*	
		a	b	c	d
^{70}Se	ALI	6×10^{8}	4×10^{8}	1×10^{9}	2×10^{9}
	DAC	—	—	6×10^{5}	7×10^{5}
$^{73}Se^{m}$	ALI	2×10^{9}	1×10^{9}	6×10^{9}	5×10^{9}
	DAC	—	—	2×10^{6}	2×10^{6}
^{73}Se	ALI	3×10^{8}	1×10^{8}	5×10^{8}	6×10^{8}
	DAC	—	—	2×10^{5}	2×10^{5}
^{75}Se	ALI	2×10^{7}	1×10^{8}	3×10^{7}	2×10^{7}
	DAC	—	—	1×10^{4}	9×10^{3}

SELENIUM—*(cont.)*

Radionuclide		*Oral*		*Inhalation*	
		a	b	c	d
^{79}Se	ALI	2×10^{7}	2×10^{8}	3×10^{7}	2×10^{7}
	DAC	—	—	1×10^{4}	9×10^{3}
$^{81}Se^{m}$	ALI	1×10^{9}	9×10^{8}	3×10^{9}	3×10^{9}
	DAC	—	—	1×10^{6}	1×10^{6}
^{81}Se	ALI	2×10^{9} (3×10^{9}) St. wall	2×10^{9} (3×10^{9}) St. wall	8×10^{9}	9×10^{9}
	DAC	—	—	3×10^{6}	4×10^{6}
^{83}Se	ALI	2×10^{9} (2×10^{9}) St. wall	1×10^{9}	4×10^{9}	5×10^{9}
	DAC	—	—	2×10^{6}	2×10^{6}

a All compounds of selenium other than those in b.

b Elemental selenium and selenides.

c All commonly occurring inorganic compounds of selenium other than those in d.

d Oxides, hydroxides and carbides, elemental selenium.

SILICON

Radionuclide		*Oral*	*Inhalation*		
		a	b	c	d
^{31}Si	ALI	3×10^{8}	9×10^{8}	1×10^{9}	1×10^{9}
	DAC	—	4×10^{5}	5×10^{5}	4×10^{5}
^{32}Si	ALI	8×10^{7} (1×10^{8}) LLI wall	9×10^{6}	4×10^{6}	2×10^{5}
	DAC	—	4×10^{3}	2×10^{3}	8×10^{1}

a All compounds of silicon.

b All commonly occurring compounds of silicon other than those in c and d.

c Oxides, hydroxides, carbides and nitrates.

d Aluminosilicate glass.

SILVER

Radionuclide		*Oral*	*Inhalation*		
		a	b	c	d
^{102}Ag	ALI	2×10^{9} (2×10^{9}) St. wall	7×10^{9}	8×10^{9}	7×10^{9}
	DAC	—	3×10^{6}	3×10^{6}	3×10^{6}
^{103}Ag	ALI	1×10^{9}	4×10^{9}	5×10^{9}	4×10^{9}
	DAC	—	2×10^{6}	2×10^{6}	2×10^{6}
$^{104}Ag^{m}$	ALI	1×10^{9}	4×10^{9}	5×10^{9}	4×10^{9}
	DAC	—	1×10^{6}	2×10^{6}	2×10^{6}

SILVER—*(cont.)*

Radionuclide		*Oral*	*Inhalation*		
		a	b	c	d
^{104}Ag	ALI	8×10^{8}	3×10^{9}	5×10^{9}	6×10^{9}
	DAC	—	1×10^{6}	2×10^{6}	2×10^{6}
^{105}Ag	ALI	1×10^{8}	4×10^{7}	6×10^{7}	6×10^{7}
	DAC	—	2×10^{4}	3×10^{4}	3×10^{4}
^{106}Ag^{m}	ALI	3×10^{7}	3×10^{7}	3×10^{7}	3×10^{7}
	DAC	—	1×10^{4}	1×10^{4}	1×10^{4}
^{106}Ag	ALI	2×10^{9} (2×10^{9}) St. wall	7×10^{9}	8×10^{9}	7×10^{9}
	DAC	—	3×10^{6}	3×10^{6}	3×10^{6}
^{108}Ag^{m}	ALI	2×10^{7}	7×10^{6}	9×10^{6}	9×10^{5}
	DAC	—	3×10^{3}	4×10^{3}	4×10^{2}
^{110}Ag^{m}	ALI	2×10^{7}	5×10^{6}	7×10^{6}	3×10^{6}
	DAC	—	2×10^{3}	3×10^{3}	1×10^{3}
^{111}Ag	ALI	3×10^{7} (4×10^{7}) LLI wall	6×10^{7} (6×10^{7}) Liver	3×10^{7}	3×10^{7}
	DAC	—	2×10^{4}	1×10^{4}	1×10^{4}
^{112}Ag	ALI	1×10^{8}	3×10^{8}	4×10^{8}	3×10^{8}
	DAC	—	1×10^{5}	2×10^{5}	1×10^{5}
^{115}Ag	ALI	1×10^{9} (1×10^{9}) St. wall	3×10^{9}	3×10^{9}	3×10^{9}
	DAC	—	1×10^{6}	1×10^{6}	1×10^{6}

a All compounds of silver.

b All compounds including metallic silver except those in c and d.

c Nitrates and sulphides.

d Oxides and hydroxides.

SODIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{22}Na	ALI	2×10^{7}	2×10^{7}
	DAC	—	1×10^{4}
^{24}Na	ALI	1×10^{8}	2×10^{8}
	DAC	—	8×10^{4}

a, b All compounds of sodium.

STRONTIUM

Radionuclide		*Oral*		*Inhalation*	
		a	b	c	d
^{80}Sr	ALI	2×10^{8}	2×10^{8}	4×10^{8}	5×10^{8}
	DAC	—	—	2×10^{5}	2×10^{5}
^{81}Sr	ALI	9×10^{8}	9×10^{8}	3×10^{9}	3×10^{9}
	DAC	—	—	1×10^{6}	1×10^{6}
^{83}Sr	ALI	1×10^{8}	8×10^{7}	3×10^{8}	1×10^{8}
	DAC	—	—	1×10^{5}	5×10^{4}

STRONTIUM—*(cont.)*

Radionuclide		*Oral*		*Inhalation*	
		a	b	c	d
$^{85}Sr^{m}$	ALI	8×10^{9}	8×10^{9}	2×10^{10}	3×10^{10}
	DAC	—	—	9×10^{6}	1×10^{7}
^{85}Sr	ALI	9×10^{7}	1×10^{8}	1×10^{8}	6×10^{7}
	DAC	—	—	4×10^{4}	2×10^{4}
$^{87}Sr^{m}$	ALI	2×10^{9}	1×10^{9}	5×10^{9}	6×10^{9}
	DAC	—	—	2×10^{6}	2×10^{6}
^{89}Sr	ALI	2×10^{7} (2×10^{7}) LLI wall	2×10^{7}	3×10^{7}	5×10^{6}
	DAC	—	—	1×10^{4}	2×10^{3}
^{90}Sr	ALI	1×10^{6} (1×10^{6}) Bone surface	2×10^{7}	7×10^{5} (8×10^{5}) Bone surface	1×10^{5}
	DAC	—	—	3×10^{2}	6×10^{1}
^{91}Sr	ALI	8×10^{7}	6×10^{7}	2×10^{8}	1×10^{8}
	DAC	—	—	9×10^{4}	5×10^{4}
^{92}Sr	ALI	1×10^{8}	1×10^{8}	3×10^{8}	2×10^{8}
	DAC	—	—	1×10^{5}	1×10^{5}

a Soluble salts of strontium.

b $SrTiO_3$.

c All soluble components except $SrTioO_3$.

d All insoluble components and $SrTiO_3$.

SULPHUR

Radionuclide		*Oral*		*Inhalation*	
		a	b	c	d
^{35}S	ALI	4×10^{8}	2×10^{8} (3×10^{8}) LLI wall	6×10^{8}	8×10^{7}
	DAC	—	—	3×10^{5}	3×10^{4}

Vapours (SO_2, COS, H_2S or CS_2)		
		Inhalation
^{35}S	ALI	5×10^{8}
	DAC	2×10^{5}

a All inorganic compounds of sulphur.

b Sulphur in its elemental form.

c Sulphides and sulphates except those in d.

d Elemental sulphur, sulphides of Sr, Ba, Ge, Sm, Pb, As, Sb, Bi, Cu, Ag, Au, Zn, Cd, Hg, Mo, W. Sulphates of Ca, Sr, Ba, Ra, As, Sb, Bi.

TANTALUM

Radionuclide		Oral	Inhalation	
		a	b	c
^{172}Ta	ALI	1×10^{9}	5×10^{9}	4×10^{9}
	DAC	—	2×10^{6}	2×10^{6}
^{173}Ta	ALI	2×10^{8}	7×10^{8}	6×10^{8}
	DAC	—	3×10^{5}	3×10^{5}
^{174}Ta	ALI	1×10^{9}	4×10^{9}	3×10^{9}
	DAC	—	2×10^{6}	1×10^{6}
^{175}Ta	ALI	2×10^{8}	6×10^{8}	5×10^{8}
	DAC	—	2×10^{5}	2×10^{5}
^{176}Ta	ALI	1×10^{8}	5×10^{8}	4×10^{8}
	DAC	—	2×10^{5}	2×10^{5}
^{177}Ta	ALI	4×10^{8}	7×10^{8}	7×10^{8}
	DAC	—	3×10^{5}	3×10^{5}
^{178}Ta	ALI	6×10^{8}	3×10^{9}	3×10^{9}
	DAC	—	1×10^{6}	1×10^{6}
^{179}Ta	ALI	8×10^{8}	2×10^{8}	3×10^{7}
	DAC	—	8×10^{4}	1×10^{4}
$^{180}Ta^{m}$	ALI	9×10^{8}	2×10^{9}	2×10^{9}
	DAC	—	1×10^{6}	9×10^{5}
^{180}Ta	ALI	6×10^{7}	2×10^{7}	9×10^{5}
	DAC	—	7×10^{3}	4×10^{2}
$^{182}Ta^{m}$	ALI	6×10^{9} (8×10^{9}) St. wall	2×10^{10}	2×10^{10}
	DAC	—	8×10^{6}	6×10^{6}
^{182}Ta	ALI	3×10^{7}	1×10^{7}	5×10^{6}
	DAC	—	5×10^{3}	2×10^{3}
^{183}Ta	ALI	3×10^{7} (4×10^{7}) LLI wall	4×10^{7}	4×10^{7}
	DAC	—	2×10^{4}	2×10^{4}
^{184}Ta	ALI	7×10^{7}	2×10^{8}	2×10^{8}
	DAC	—	8×10^{4}	7×10^{4}
^{185}Ta	ALI	1×10^{9}	3×10^{9}	2×10^{9}
	DAC	—	1×10^{6}	1×10^{6}
^{186}Ta	ALI	2×10^{9} (3×10^{9}) St. wall	9×10^{9}	8×10^{9}
	DAC	—	4×10^{6}	3×10^{6}

a All compounds of tantalum.

b Commonly occurring compounds of tantalum other than those in c.

c Elemental tantalum, oxides, hydroxides, halides, carbides, nitrates and nitrides.

TECHNETIUM

Radionuclide		Oral	Inhalation	
		a	b	c
$^{93}Tc^{m}$	ALI	3×10^{9}	6×10^{9}	1×10^{10}
	DAC	—	2×10^{6}	5×10^{6}
^{93}Tc	ALI	1×10^{9}	3×10^{9}	4×10^{9}
	DAC	—	1×10^{6}	2×10^{6}

TECHNETIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
$^{94}Tc^{m}$	ALI	7×10^{8}	2×10^{9}	2×10^{9}
	DAC	—	7×10^{5}	9×10^{5}
^{94}Tc	ALI	3×10^{8}	7×10^{8}	9×10^{8}
	DAC	—	3×10^{5}	4×10^{5}
$^{96}Tc^{m}$	ALI	6×10^{9}	1×10^{10}	9×10^{9}
	DAC	—	4×10^{6}	4×10^{6}
^{96}Tc	ALI	7×10^{7}	1×10^{8}	8×10^{7}
	DAC	—	5×10^{4}	3×10^{4}
$^{97}Tc^{m}$	ALI	2×10^{8}	2×10^{8} (3×10^{8}) St. wall	4×10^{7}
	DAC	—	1×10^{5}	2×10^{4}
^{97}Tc	ALI	1×10^{9}	2×10^{9}	2×10^{8}
	DAC	—	8×10^{5}	9×10^{4}
^{98}Tc	ALI	4×10^{7}	6×10^{7}	1×10^{7}
	DAC	—	2×10^{4}	5×10^{3}
$^{99}Tc^{m}$	ALI	3×10^{9}	6×10^{9}	9×10^{9}
	DAC	—	2×10^{6}	4×10^{6}
^{99}Tc	ALI	1×10^{8}	2×10^{8} (2×10^{8}) St. wall	2×10^{7}
	DAC	—	8×10^{4}	1×10^{4}
^{101}Tc	ALI	3×10^{9} (5×10^{9}) St. wall	1×10^{10}	1×10^{10}
	DAC	—	5×10^{6}	6×10^{6}
^{104}Tc	ALI	8×10^{8} (1×10^{9}) St. wall	3×10^{9}	3×10^{9}
	DAC	—	1×10^{6}	1×10^{6}

a All compounds of technetium.

b All compounds of technetium except those in c.

c Oxides, hydroxides, halides and nitrates.

TELLURIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{116}Te	ALI	3×10^{8}	8×10^{8}	1×10^{9}
	DAC	—	3×10^{5}	5×10^{5}
^{121}Te	ALI	1×10^{8}	2×10^{8}	1×10^{8}
	DAC	—	6×10^{4}	5×10^{4}
$^{121}Te^{m}$	ALI	2×10^{7} (3×10^{7})	7×10^{6} (1×10^{7}) Bone surface	2×10^{7} Bone surface
	DAC	—	3×10^{3}	6×10^{3}
^{123}Te	ALI	2×10^{7} (4×10^{7}) Bone surface	7×10^{6} (2×10^{7}) Bone surface	2×10^{7} (4×10^{7}) Bone surface
	DAC	—	3×10^{3}	7×10^{3}

TELLURIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
$^{123}Te^{m}$	ALI	2×10^{7} (4×10^{7}) Bone surface	8×10^{5} (2×10^{7}) Bone surface	2×10^{7}
	DAC	—	3×10^{3}	8×10^{3}
$^{125}Te^{m}$	ALI	4×10^{7} (5×10^{7}) Bone surface	2×10^{7} (4×10^{7}) Bone surface	3×10^{7}
	DAC	—	6×10^{3}	1×10^{4}
^{127}Te	ALI	3×10^{8}	8×10^{8}	6×10^{8}
	DAC	—	3×10^{5}	3×10^{5}
$^{127}Te^{m}$	ALI	2×10^{7}	1×10^{7} (2×10^{7}) Bone surface	9×10^{6}
	DAC	—	4×10^{3}	4×10^{3}
^{129}Te	ALI	1×10^{9}	2×10^{9}	3×10^{9}
	DAC	—	1×10^{6}	1×10^{6}
$^{129}Te^{m}$	ALI	2×10^{7}	2×10^{7}	9×10^{6}
	DAC	—	1×10^{4}	4×10^{3}
^{131}Te	ALI	1×10^{8} (2×10^{8}) Thyroid	2×10^{8} (5×10^{8}) Thyroid	2×10^{8} (4×10^{8}) Thyroid
	DAC	—	8×10^{4}	8×10^{4}
$^{131}Te^{m}$	ALI	1×10^{7} (2×10^{7}) Thyroid	2×10^{7} (5×10^{7}) Thyroid	1×10^{7} (3×10^{7}) Thyroid
	DAC	—	6×10^{3}	6×10^{3}
^{132}Te	ALI	8×10^{6} (2×10^{7}) Thyroid	9×10^{6} (3×10^{7}) Thyroid	8×10^{6} (2×10^{7}) Thyroid
	DAC	—	4×10^{3}	3×10^{3}
^{133}Te	ALI	5×10^{8} (1×10^{9}) Thyroid	8×10^{8} (2×10^{9}) Thyroid	8×10^{8} (2×10^{9}) Thyroid
	DAC	—	4×10^{5}	4×10^{5}
$^{133}Te^{m}$	ALI	1×10^{8} (2×10^{8}) Thyroid	2×10^{8} (5×10^{8}) Thyroid	2×10^{8} (5×10^{8}) Thyroid
	DAC	—	8×10^{4}	8×10^{4}
^{134}Te	ALI	6×10^{8} (9×10^{8}) Thyroid	9×10^{8} (2×10^{9}) Thyroid	9×10^{8} (2×10^{9}) Thyroid
	DAC	—	4×10^{5}	4×10^{5}

a All compounds of tellurium.

b All compounds of tellurium except those in c.

c Oxides, hydroxides and nitrates.

TERBIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{147}Tb	ALI	3×10^{8}	1×10^{9}
	DAC	—	5×10^{5}

TERBIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*
		a	b
^{149}Tb	ALI	2×10^{8}	3×10^{7}
	DAC	—	1×10^{4}
^{150}Tb	ALI	2×10^{8}	8×10^{8}
	DAC	—	3×10^{5}
^{151}Tb	ALI	1×10^{8}	3×10^{8}
	DAC	—	1×10^{5}
^{153}Tb	ALI	2×10^{8}	3×10^{8}
	DAC	—	1×10^{5}
^{154}Tb	ALI	6×10^{7}	2×10^{8}
	DAC	—	7×10^{4}
^{155}Tb	ALI	2×10^{8}	3×10^{8}
	DAC	—	1×10^{5}
$^{156}Tb^{m}$	ALI	3×10^{8}	3×10^{8}
($T_{1/2}$=24.4 hours)	DAC	—	1×10^{5}
$^{156}Tb^{m}$	ALI	6×10^{8}	1×10^{9}
($T_{1/2}$=5.0 hours)	DAC	—	4×10^{5}
^{156}Tb	ALI	4×10^{7}	5×10^{7}
	DAC	—	2×10^{4}
^{157}Tb	ALI	2×10^{9} (2×10^{9}) LLI wall	1×10^{7} (2×10^{7}) Bone surface
	DAC	—	5×10^{3}
^{158}Tb	ALI	5×10^{7}	7×10^{5}
	DAC	—	3×10^{2}
^{160}Tb	ALI	3×10^{7}	8×10^{6}
	DAC	—	4×10^{3}
^{161}Tb	ALI	6×10^{7} (7×10^{7}) LLI wall	6×10^{7}
	DAC	—	2×10^{4}

a All compounds of terbium.
b All commonly occurring compounds of terbium.

THALLIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
$^{194}Tl^{m}$	ALI	2×10^{9} (3×10^{9}) St. wall	6×10^{9}
	DAC	—	2×10^{6}
^{194}Tl	ALI	9×10^{9} (1×10^{10}) St. wall	2×10^{10}
	DAC	—	9×10^{6}
^{195}Tl	ALI	2×10^{9}	5×10^{9}
	DAC	—	2×10^{6}
^{197}Tl	ALI	3×10^{9}	4×10^{9}
	DAC	—	2×10^{6}
$^{198}Tl^{m}$	ALI	1×10^{9}	2×10^{9}
	DAC	—	8×10^{5}

THALLIUM—*(cont.)*

Radionuclide		*Oral*	*Inhalation*
		a	b
^{198}Tl	ALI	7×10^{8}	1×10^{9}
	DAC	—	5×10^{5}
^{199}Tl	ALI	2×10^{9}	3×10^{9}
	DAC	—	1×10^{6}
^{200}Tl	ALI	3×10^{8}	4×10^{8}
	DAC	—	2×10^{5}
^{201}Tl	ALI	6×10^{8}	8×10^{8}
	DAC	—	3×10^{5}
^{202}Tl	ALI	1×10^{8}	2×10^{8}
	DAC	—	8×10^{4}
^{204}Tl	ALI	6×10^{7}	8×10^{7}
	DAC	—	3×10^{4}

a, b All compounds of thallium.

THORIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{226}Th	ALI	2×10^{8}	6×10^{6}	5×10^{6}
	DAC	(2×10^{8}) St. wall	2×10^{3}	2×10^{3}
^{227}Th	ALI	5×10^{6}	1×10^{4}	1×10^{4}
	DAC	—	5×10^{0}	5×10^{0}
^{228}Th	ALI	2×10^{5} (5×10^{5}) Bone surface	4×10^{2} (8×10^{2}) Bone surface	6×10^{2}
	DAC	—	2×10^{-1}	3×10^{-1}
^{229}Th	ALI	2×10^{4} (5×10^{4}) Bone surface	3×10^{1} (9×10^{1}) Bone surface	9×10^{1} (1×10^{2}) Bone surface
	DAC	—	1×10^{-2}	4×10^{-2}
^{230}Th	ALI	1×10^{5} (4×10^{5}) Bone surface	2×10^{2} (6×10^{2}) Bone surface	6×10^{2} (7×10^{2}) Bone surface
	DAC	—	1×10^{-1}	2×10^{-1}
^{231}Th	ALI	1×10^{8}	2×10^{8}	2×10^{8}
	DAC	—	1×10^{5}	1×10^{5}
^{232}Th	ALI	3×10^{4} (7×10^{4}) Bone surface	4×10^{1} (1×10^{2}) Bone surface	1×10^{2} (2×10^{2}) Bone surfce
	DAC	—	2×10^{-2}	4×10^{-2}
^{234}Th	ALI	1×10^{7} (1×10^{7}) LLI wall	7×10^{6}	6×10^{6}
	DAC	—	3×10^{3}	2×10^{3}

a All compounds of thorium.

b All compounds of thorium except those in c.

c Oxides and hydroxides.

THULIUM

Radionuclide		*Oral*	*Inhalation*
		a	b
^{162}Tm	ALI	2×10^{9} (3×10^{9}) St. wall	1×10^{10}
	DAC	—	4×10^{6}
^{166}Tm	ALI	2×10^{8}	5×10^{8}
	DAC	—	2×10^{5}
^{167}Tm	ALI	8×10^{7} (9×10^{7}) LLI wall	7×10^{7}
	DAC	—	3×10^{4}
^{170}Tm	ALI	3×10^{7} (4×10^{7}) LLI wall	8×10^{6}
	DAC	—	3×10^{3}
^{171}Tm	ALI	4×10^{8} (5×10^{8}) LLI wall	1×10^{7} (2×10^{7}) Bone surface
	DAC	—	4×10^{3}
^{172}Tm	ALI	3×10^{7} (3×10^{7}) LLI wall	4×10^{7}
	DAC	—	2×10^{4}
^{173}Tm	ALI	2×10^{8}	4×10^{8}
	DAC	—	2×10^{5}
^{175}Tm	ALI	2×10^{9} (3×10^{9}) St. wall	1×10^{10}
	DAC	—	4×10^{6}

a All compounds of thulium.

b All commonly occurring compounds of thulium.

TIN

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{110}Sn	ALI	1×10^{8}	4×10^{8}	4×10^{8}
	DAC	—	2×10^{5}	2×10^{5}
^{111}Sn	ALI	3×10^{9}	8×10^{9}	1×10^{10}
	DAC	—	3×10^{6}	4×10^{6}
^{113}Sn	ALI	6×10^{7} (7×10^{7}) LLI wall	5×10^{7}	2×10^{7}
	DAC	—	2×10^{4}	9×10^{3}
^{117}Sn^{m}	ALI	6×10^{7} (7×10^{7}) LLI wall	5×10^{7} (8×10^{7}) Bone surface	5×10^{7}
	DAC	—	2×10^{4}	2×10^{4}
^{119}Sn^{m}	ALI	1×10^{8} (2×10^{8}) LLI wall	9×10^{7}	4×10^{7}
	DAC	—	4×10^{4}	2×10^{4}

TIN—*(cont.)*

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
$^{121}Sn^{m}$	ALI	1×10^{8} (1×10^{8}) LLI wall	3×10^{7}	2×10^{7}
	DAC	—	1×10^{4}	8×10^{3}
^{121}Sn	ALI	2×10^{8} (2×10^{8}) LLI wall	6×10^{8}	4×10^{8}
	DAC	—	2×10^{5}	2×10^{5}
$^{123}Sn^{m}$	ALI	2×10^{9}	4×10^{9}	5×10^{9}
	DAC	—	2×10^{6}	2×10^{6}
^{123}Sn	ALI	2×10^{7} (2×10^{7}) LLI wall	2×10^{7}	6×10^{6}
	DAC	—	1×10^{4}	3×10^{3}
^{125}Sn	ALI	1×10^{7} (2×10^{7}) LLI wall	3×10^{7}	1×10^{7}
	DAC	—	1×10^{4}	5×10^{3}
^{126}Sn	ALI	1×10^{7}	2×10^{6}	2×10^{6}
	DAC	—	9×10^{2}	1×10^{3}
^{127}Sn	ALI	3×10^{8}	7×10^{8}	7×10^{8}
	DAC	—	3×10^{5}	3×10^{5}
^{128}Sn	ALI	4×10^{8}	1×10^{9}	1×10^{9}
	DAC	—	4×10^{5}	6×10^{5}

a All compounds of tin.
b All compounds of tin other than those in c.
c Sulphides, oxides, hydroxides, halides, nitrates and stannic phosphate.

TITANIUM

Radionuclide		*Oral*	*Inhalation*		
		a	b	c	d
^{44}Ti	ALI	1×10^{7}	4×10^{5}	1×10^{6}	2×10^{5}
	DAC	—	2×10^{2}	4×10^{2}	9×10^{1}
^{45}Ti	ALI	3×10^{8}	9×10^{8}	1×10^{9}	1×10^{9}
	DAC	—	4×10^{5}	5×10^{5}	4×10^{5}

a All compounds of titanium.
b All commonly occurring compounds of titanium other than those in c and d.
c Oxides, hydroxides, carbides, halides and nitrates.
d $SrTiO_3$.

TUNGSTEN

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{176}W	ALI	4×10^{8}	5×10^{8}	2×10^{9}
	DAC	—	—	8×10^{5}
^{177}W	ALI	8×10^{8}	9×10^{8}	3×10^{9}
	DAC	—	—	1×10^{6}

TUNGSTEN—*(cont.)*

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{178}W	ALI	2×10^{8}	3×10^{8}	7×10^{8}
	DAC	—	—	3×10^{5}
^{179}W	ALI	2×10^{10}	2×10^{10}	6×10^{10}
	DAC	—	—	3×10^{7}
^{181}W	ALI	6×10^{8}	7×10^{8}	1×10^{9}
	DAC	—	—	5×10^{5}
^{185}W	ALI	8×10^{7} (1×10^{8}) LLI wall	1×10^{8} (1×10^{8}) LLI wall	2×10^{8}
	DAC	—	—	1×10^{5}
^{187}W	ALI	7×10^{7}	1×10^{8}	3×10^{8}
	DAC	—	—	1×10^{5}
^{188}W	ALI	1×10^{7} (2×10^{7}) LLI wall	2×10^{7} (3×10^{7}) LLI wall	5×10^{7}
	DAC	—	—	2×10^{4}

a Tungstic acid.
b All compounds of tungsten other than a.
c All compounds of tungsten.

URANIUM

Radionuclide		*Oral*		*Inhalation*		
		a	b	c	d	e
^{230}U	ALI	1×10^{5} (2×10^{5}) Bone surface	2×10^{6}	2×10^{4} (2×10^{4}) Bone surface	1×10^{4}	1×10^{4}
	DAC	—	—	6×10^{0}	5×10^{0}	4×10^{0}
^{231}U	ALI	2×10^{8} (2×10^{8}) LLI wall	2×10^{8} (2×10^{8}) LLI wall	3×10^{8}	2×10^{8}	2×10^{8}
	DAC	—	—	1×10^{5}	9×10^{4}	7×10^{4}
^{232}U	ALI	8×10^{4} (1×10^{5}) Bone surface	2×10^{6} (3×10^{6}) Bone surface	8×10^{3} (2×10^{4}) Bone surface	1×10^{4}	3×10^{2}
	DAC	—	—	3×10^{0}	6×10^{0}	1×10^{-1}
^{233}U	ALI	4×10^{5} (7×10^{5}) Bone surface	7×10^{6}	4×10^{4} (7×10^{4}) Bone surface	3×10^{4}	1×10^{3}
	DAC	—	—	2×10^{1}	1×10^{1}	6×10^{-1}
^{234}U	ALI	4×10^{5} (7×10^{5}) Bone surface	7×10^{6}	5×10^{4} (7×10^{4}) Bone surface	3×10^{4}	1×10^{3}
	DAC	—	—	2×10^{1}	1×10^{1}	6×10^{-1}
^{235}U	ALI	5×10^{5} (7×10^{5}) Bone surface	7×10^{6}	5×10^{4} (7×10^{4}) Bone surface	3×10^{4}	2×10^{3}
	DAC	—	—	2×10^{1}	1×10^{1}	6×10^{-1}

URANIUM—*(cont.)*

Radionuclide		*Oral*		*Inhalation*		
		a	b	c	d	e
^{236}U	ALI	5×10^{5} (7×10^{5}) Bone surface	8×10^{6}	5×10^{4} (7×10^{4}) Bone surface	3×10^{4}	1×10^{3}
	DAC	—	—	2×10^{1}	1×10^{1}	6×10^{-1}
^{237}U	ALI	6×10^{7} (7×10^{7}) LLI wall	6×10^{7} (7×10^{7}) LLI wall	1×10^{8}	6×10^{7}	6×10^{7}
	DAC	—	—	4×10^{4}	3×10^{4}	2×10^{4}
^{238}U	ALI	5×10^{5} (8×10^{5}) Bone surface	8×10^{6}	5×10^{4} (8×10^{4}) Bone surface	3×10^{4}	2×10^{3}
	DAC	—	—	2×10^{1}	1×10^{1}	7×10^{-1}
^{239}U	ALI	2×10^{9}	2×10^{9}	7×10^{9}	6×10^{9}	6×10^{9}
	DAC	—	—	3×10^{6}	3×10^{6}	2×10^{6}
^{240}U	ALI	5×10^{7}	5×10^{7}	1×10^{8}	1×10^{8}	9×10^{7}
	DAC	—	—	6×10^{4}	4×10^{4}	4×10^{4}

a For water-soluble inorganic compounds of uranium (hexavalent uranium).
b For relatively insoluble compounds such as UF_4, UO_2, U_3O_8 in which the uranium is usually tetravalent.
c UF_6, UO_2F_2, $UO_2(NO_3)_2$.
d UO_3, UF_4, UCl_4.
e UO_2, U_3O_8.

VANADIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{47}V	ALI	1×10^{9} (1×10^{9}) St. wall	3×10^{9}	4×10^{9}
	DAC	—	1×10^{6}	2×10^{6}
^{48}V	ALI	2×10^{7}	4×10^{7}	2×10^{7}
	DAC	—	2×10^{4}	9×10^{3}
^{49}V	ALI	3×10^{9} (3×10^{9}) LLI wall	1×10^{9} (1×10^{9}) Bone surface	7×10^{8}
	DAC	—	5×10^{5}	3×10^{5}

a All compounds of vanadium.
b All commonly occurring compounds of vanadian except those in c.
c Oxides, hydroxides, carbides and halides.

XENON (DAC only)

Radionuclide	*Semi-infinite cloud*	1000 m^3 *room*	500 m^3 *room*	100 m^3 *room*
^{120}Xe	4×10^{5}	7×10^{6}	9×10^{6}	2×10^{7}
^{121}Xe	8×10^{4}	2×10^{6} (2×10^{6}) Skin	2×10^{6} (2×10^{6}) Skin	2×10^{6} (4×10^{6}) Skin

XENON (DAC only)—*(cont.)*

Radionuclide	*Semi-infinite cloud*	1000 m³ *room*	500 m³ *room*	100 m³ *room*
^{122}Xe	3×10^{6}	4×10^{7}	5×10^{7}	9×10^{7}
^{123}Xe	2×10^{5}	5×10^{6}	6×10^{6} (7×10^{6}) Skin	6×10^{6} (1×10^{7}) Skin
^{125}Xe	6×10^{5}	1×10^{7}	1×10^{7}	2×10^{7}
^{127}Xe	5×10^{5}	1×10^{7}	1×10^{7}	2×10^{7}
$^{129}Xe^{m}$	7×10^{6}	1×10^{7} (5×10^{7}) Skin	1×10^{7} (7×10^{7}) Skin	1×10^{7} (1×10^{8}) Skin
$^{131}Xe^{m}$	1×10^{7} (2×10^{7}) Skin	2×10^{7} (1×10^{8}) Skin	2×10^{7} (2×10^{8}) Skin	2×10^{7} (3×10^{8}) Skin
$^{133}Xe^{m}$	5×10^{6}	8×10^{6} (7×10^{7}) Skin	8×10^{6} (8×10^{7}) Skin	8×10^{6} (1×10^{8}) Skin
^{133}Xe	4×10^{6}	2×10^{7} (8×10^{7}) Skin	2×10^{7} (1×10^{8}) Skin	2×10^{7} (2×10^{8}) Skin
$^{135}Xe^{m}$	3×10^{5}	7×10^{6}	9×10^{6}	1×10^{7} (2×10^{7}) Skin
^{135}Xe	5×10^{5}	4×10^{6} (1×10^{7}) Skin	4×10^{6} (2×10^{7}) Skin	4×10^{6} (3×10^{7}) Skin
^{138}Xe	1×10^{5}	2×10^{6} (3×10^{6}) Skin	2×10^{6} (4×10^{6}) Skin	2×10^{6} (7×10^{6}) Skin

The exposure in a cloud of a radioactive noble gas is limited by external irradiation, since dose-equivalent rates from gas absorbed in tissue or contained in the lungs will be negligible in comparison with the dose-equivalent rates to tissues from external irradiation. The DACs for xenon are, therefore, based on consideration of external irradiation only.

YTTERBIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
^{162}Yb	ALI	3×10^{9}	1×10^{10}	1×10^{10}
	DAC	—	5×10^{6}	4×10^{6}
^{166}Yb	ALI	5×10^{7}	7×10^{7}	7×10^{7}
	DAC	—	3×10^{4}	3×10^{4}
^{167}Yb	ALI	1×10^{10}	3×10^{10}	3×10^{10}
	DAC	—	1×10^{7}	1×10^{7}
^{169}Yb	ALI	7×10^{7}	3×10^{7}	3×10^{7}
	DAC	—	1×10^{4}	1×10^{4}
^{175}Yb	ALI	1×10^{8} (1×10^{8}) LLI wall	1×10^{8}	1×10^{8}
	DAC	—	5×10^{4}	5×10^{4}
^{177}Yb	ALI	6×10^{8}	2×10^{9}	2×10^{9}
	DAC	—	8×10^{5}	7×10^{5}
^{178}Yb	ALI	5×10^{8}	1×10^{9}	1×10^{9}
	DAC	—	6×10^{5}	6×10^{5}

a All compounds of ytterbium.

b Commonly occurring compounds of ytterbium other than those in c.

c Oxides, hydroxides and fluorides.

YTTRIUM

Radionuclide		*Oral*	*Inhalation*	
		a	b	c
$^{86}Y^{m}$	ALI	8×10^{8}	2×10^{9}	2×10^{9}
	DAC	—	9×10^{5}	8×10^{5}
^{86}Y	ALI	5×10^{7}	1×10^{8}	1×10^{8}
	DAC	—	5×10^{4}	5×10^{4}
^{87}Y	ALI	8×10^{7}	1×10^{8}	1×10^{8}
	DAC	—	5×10^{4}	5×10^{4}
^{88}Y	ALI	4×10^{7}	9×10^{6}	9×10^{6}
	DAC	—	4×10^{3}	4×10^{3}
$^{90}Y^{m}$	ALI	3×10^{8}	5×10^{8}	4×10^{8}
	DAC	—	2×10^{5}	2×10^{5}
^{90}Y	ALI	2×10^{7} (2×10^{7}) LLI wall	3×10^{7}	2×10^{7}
	DAC	—	1×10^{4}	9×10^{3}
$^{91}Y^{m}$	ALI	5×10^{9}	9×10^{9}	6×10^{9}
	DAC	—	4×10^{6}	2×10^{6}
^{91}Y	ALI	2×10^{7} (2×10^{7}) LLI wall	6×10^{6}	4×10^{6}
	DAC	—	3×10^{3}	2×10^{3}
^{92}Y	ALI	1×10^{8}	3×10^{8}	3×10^{8}
	DAC	—	1×10^{5}	1×10^{5}
^{93}Y	ALI	4×10^{7}	1×10^{8}	9×10^{7}
	DAC	—	4×10^{4}	4×10^{4}
^{94}Y	ALI	8×10^{8} (1×10^{9}) St. wall	3×10^{9}	3×10^{9}
	DAC	—	1×10^{6}	1×10^{6}
^{95}Y	ALI	1×10^{9} (2×10^{9}) St. wall	6×10^{9}	5×10^{9}
	DAC	—	2×10^{6}	2×10^{6}

a All compounds of yttrium.
b All compounds of yttrium except those in c.
c Oxides and hydroxides.

ZINC

Radionuclide		*Oral*	*Inhalation*
		a	b
^{62}Zn	ALI	5×10^{7}	1×10^{8}
	DAC	—	4×10^{4}
^{63}Zn	ALI	9×10^{8} (9×10^{8}) St. wall	3×10^{9}
	DAC	—	1×10^{6}
^{65}Zn	ALI	1×10^{7}	1×10^{7}
	DAC	—	4×10^{3}

ZINC--*(cont.)*

Radionuclide		*Oral*	*Inhalation*
		a	b
$^{69}Zn^{m}$	ALI	2×10^{8}	3×10^{8}
	DAC	—	1×10^{5}
^{69}Zn	ALI	2×10^{9}	5×10^{9}
	DAC	—	2×10^{6}
$^{71}Zn^{m}$	ALI	2×10^{8}	6×10^{8}
	DAC	—	3×10^{5}
^{72}Zn	ALI	4×10^{7}	4×10^{7}
	DAC	—	2×10^{4}

a All compounds of zinc.

b. All commonly occurring compounds of zinc.

ZIRCONIUM

Radionuclide		*Oral*	*Inhalation*		
		a	b	c	d
^{86}Zr	ALI	5×10^{7}	1×10^{8}	1×10^{8}	9×10^{7}
	DAC	—	6×10^{4}	4×10^{4}	4×10^{4}
^{88}Zr	ALI	1×10^{8}	8×10^{6}	2×10^{7}	1×10^{7}
	DAC	—	3×10^{3}	7×10^{3}	5×10^{3}
^{89}Zr	ALI	6×10^{7}	1×10^{8}	9×10^{7}	9×10^{7}
	DAC	—	5×10^{4}	4×10^{4}	4×10^{4}
^{93}Zr	ALI	5×10^{7} (1×10^{8}) Bone surface	2×10^{5} (6×10^{5}) Bone surface	9×10^{5} (2×10^{6}) Bone surface	2×10^{6} (3×10^{6}) Bone surface
	DAC	—	1×10^{2}	4×10^{2}	9×10^{2}
^{95}Zr	ALI	5×10^{7}	5×10^{6} (1×10^{7}) Bone surface	1×10^{7}	1×10^{7}
	DAC	—	2×10^{3}	6×10^{3}	4×10^{3}
^{97}Zr	ALI	2×10^{7}	7×10^{7}	5×10^{7}	5×10^{7}
	DAC	—	3×10^{4}	2×10^{4}	2×10^{4}

a All compounds of zirconium.

b All compounds of zirconium except those in c and d.

c Oxides, hydroxides, halides and nitrates.

d Carbides.

FOURTH SCHEDULE

PROVISIONS OF HELSINKI DECLARATION APPLICABLE TO MEDICAL RESEARCH INVOLVING THE USE OF IONIZING RADIATION

(Regulation 19)

SECTION I

Basic Principles

(1) Biomedical research involving human subjects shall conform to generally accepted scientific principles and shall be based on adequately performed laboratory and animal experimentation and on a thorough knowledge of the scientific literature.

(2) The design and performance of each experimental procedure involving human subjects shall be clearly formulated in an experimental protocol which shall be transmitted to a specially appointed independent committee for consideration, comment and guidance.

(3) Biomedical research involving human subjects shall be conducted only by scientifically qualified persons and under the supervision of a clinically competent medical person. The responsibility for the human subject shall always rest with a medically qualified person and never rest on the subject of the research, even though the subject has given his consent.

(4) Biomedical research involving human subjects shall not legitimately be carried out unless the importance of the objective is in proportion to the inherent risk to the subject.

(5) Every biomedical research project involving human subjects shall be preceded by careful assessment of predictable risks in comparison with foreseeable benefits to the subject or to others. Concern for the interests of the subject shall always prevail over the interest of science and society.

(6) The right of the research subject to safeguard his integrity shall always be respected. Every precaution shall be taken to respect the privacy of the subject and to minimize the impact of the study on the subject's physical and mental integrity and on the personality of the subject.

(7) Doctors shall abstain from engaging in research projects involving human subjects unless they are satisfied that the hazards involved are believed to be predictable. Doctors shall cease any investigation if the hazards are found to outweigh the potential benefits.

(8) In publication of the results of his research, the doctor shall preserve the accuracy of the results. Reports of experimentation not in accordance with the principles laid down in this Declaration shall not be accepted for publication.

(9) In any research on human beings, each potential subject shall be adequately informed of the aims, methods, anticipated benefits and potential hazards of the study and the discomfort it may entail. He shall be informed that he is at liberty to abstain from participation in the study and that he is free to withdraw his consent to participation at any time. The doctor shall then obtain the subject's freely given informed consent in writing.

(10) When obtaining informed consent for the research project the doctor shall be particularly cautious if the subject is in a dependent relationship to him or may consent under duress. In that case the informed consent shall be obtained by a doctor who is not engaged in the investigation and who is completely independent of this official relationship.

(11) In case of legal incompetence, informed consent shall be obtained from the legal guardian in accordance with the law. Where physical or mental incapacity makes it impossible to obtain informed consent, or when the subject is a minor, permission from the responsible relative replaces that of the subject in accordance with the law.

(12) The research protocol shall always contain a statement of the ethical considerations involved and shall indicate that the principles enunciated in the present Declaration are complied with.

SECTION II

Principles of Medical Research Combined With Professional Care

(13) In the treatment of the sick person, the doctor shall be free to use a new diagnostic and therapeutic measure, if in his judgement it offers hope of saving life, re-establishing health or alleviating suffering.

(14) The potential benefits, hazards and discomfort of a new method shall be weighed against the advantages of the best current diagnostic and therapeutic methods.

(15) In any medical study, every patient—including those of a control group, if any—shall be assured of the best proven diagnostic and therapeutic method.

(16) The refusal of the patient to participate in a study shall never interfere with the doctor-patient relationship.

(17) If the doctor considers it essential not to obtain informed consent, the specific reasons for this proposal shall be stated in the experimental protocol for transmission to the independent committee.

(18) The doctor can combine medical research with professional care, the objective being the acquisition of new medical knowledge, only to the extent that medical research is justified by its potential diagnostic or therapeutic value for the patient.

Made the 23rd December 1987.

[LPTA. (S): TAD/016/1 Klt. 2; PN. (PU²) 425/III.]

On behalf and in the name of the Prime Minister,

KASITAH GADDAM,
Minister in the Prime Minister's Department

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