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Monitoring and dose assessment of occupational internal exposure due to intakes of fission and activation products

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Monitoring and dose assessment of occupational internal exposure due to intakes of fission and activation products

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Foreword

This standard supersedes EJ/T 942-1995.

Compared with last edition, this standard has following major changes: it adopts the terms defined in GB 18871-2002, adopts the biodynamic model and dose conversion data conforming to GB 18871-2002 and gives expected fraction and other data based on the adopted ICRP biodynamic model and parameters.

In this standard, Annex A, Annex B, Annex C, Annex D and Annex E are informative Annexes.

This standard was proposed by China National Nuclear Corporation.

This standard was prepared by Institute for Standardization of Nuclear Industry.

Monitoring and dose assessment of occupational internal exposure due to intakes of fission and activation products

1 Scope

This standard specifies the methods for monitoring and dose assessment of occupational internal exposure of radiation workers due to intakes of fission and activation products.

This standard is applicable to the monitoring and dose assessment of occupational internal exposure of workers involved in nuclear reactors, spent fuel reprocessing and isotope production due to intakes of fission and activation products.

2 Normative References

The following normative documents contain provisions which through reference in this text, constitute provisions of this standard. For dated references, subsequent amendments (excluding corrections), or revisions, of any of these publications do not apply to this standard. However, parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

GB18871-2002 Basic Standards for Protection against Ionizing Radiation and Safety of Radiation Sources

GBZ 129 Specifications for Individual Monitoring of Occupational Internal Exposure

EJ 375-2005 Regulations for Individual Monitoring of Occupational Internal Exposure

ISO 20553-2006 Radiation Protection - Monitoring of Workers Occupationally Exposed to a Risk of Internal Contamination with Radioactive Material

3 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1 routine monitoring

The monitoring carried out according to a regular monitoring plan and on a prescribed schedule

3.2 task related monitoring

No routine monitoring carried out to provide relevant information for a particular operation or sometimes to provide basis for an operation

3.3 special monitoring

The monitoring carried out to solve a particular problem or when there are abnormal or suspected to have abnormal

3.4 in vivo measurement

Also known as direct measurement, it is a process that the content of radioactive material in body is measured with an instrument which directly detects the ray emitted from radioactive nuclide in the body

3.5 in vitro analysis

Also known as indirect measurement, it is a process that the radioactive nuclide in human excreta or other biological samples is measured and analyzed

3.6 personal air samples analysis

It is a process that with the personal air sampler carried by the workers, the radioactive aerosol in air in personal breathing zone is sampled and analyzed

3.7 type F material

The material absorbed into body fluids from the respiratory tract at a fast rate. All materials are absorbed into the body fluids in biological half-life in10 min

3.8 type M material

The material absorbed into body fluids from the respiratory tract at a medium rate. 10% materials are absorbed into the body fluids in biological half-life in10 min and 90% materials are absorbed into the body fluids in biological half-life of 140d

3.9 **type S material**

The relatively insoluble material absorbed into body fluids from the respiratory tract at a slow rate. 0.1% materials are absorbed into the body fluids in biological half-life in10 min and 99.9% materials are absorbed into the body fluids in biological half-life of 7000d

3.10 **investigation level**

The value of a quantity such as effective dose, intake or contamination per unit area or volume at or above which an investigation should be conducted

3.11 **recording level**

A level of dose, exposure or intake specified by the regulatory body at or above which values of dose, exposure or intake received by workers are to be entered in their individual exposure records

4 Radionuclides under Monitoring

The main radionuclides considered in the monitoring of internal exposure caused by intakes of fission and activation products are listed in Table 1. Common nuclides are ^{54}Mn, ^{59}Fe, ^{58}Co, ^{60}Co, ^{90}Sr, ^{95}Zr-^{95}Nb, ^{106}Ru-^{106}Rh, ^{110m}Ag, ^{124}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce-^{144}Pr.

Table1 Radionuclides Mainly Considered in Monitoring of Internal Exposure (Grouped by Physical Half-life $T_{1/2}$)

$T_{1/2}$<10d		10d≤$T_{1/2}$<100d		$T_{1/2}$≥100d	
Nuclide	$T_{1/2}$	Nuclide	$T_{1/2}$	Nuclide	$T_{1/2}$
^{24}Na	15h	^{59}Fe	44d	^{110m}Ag	250d
^{131}I	8d	^{125}I	60d	^{144}Ce-^{144}Pr	285d
-	-	^{124}Sb	60d	^{54}Mn	312d
-	-	^{95}Zr-^{95}Nb	64d	^{106}Ru-^{106}Rh	374d
-	-	^{58}Co	71d	^{134}Cs	2.1a
-	-	-	-	^{22}Na	2.6a
-	-	-	-	^{60}Co	5.3a
-	-	-	-	^{90}Sr	29a
-	-	-	-	^{137}Cs-^{137m}Ba	30a

5 Requirements of Monitoring

5.1 General Requirements

5.1.1 Individual internal exposure monitoring shall be carried out for all personnel who may be contaminated by radioactive materials in vivo. Routine individual internal exposure monitoring shall be carried out for personnel who may have significant intake of radioactive nuclides.

5.1.2 In the cases of equipment overhaul, accident and accident handling, individual task related internal exposure monitoring or special monitoring shall be carried out as soon as possible if the workers have had or may have significant intake.

5.2 Routine Monitoring

5.2.1 The frequency of routine monitoring is related to the retention and excretion characteristics of radionuclides, the sensitivity of measurement technologies, the type of exposure, and the acceptable errors in the estimation of intake and committed equivalent dose.

5.2.2 When determining the monitoring frequency, the underestimate of intake should be smaller than three times under the assumption that the intake occurs on the day in the middle of each monitoring interval due to the unknowing of the intake time.

5.2.3 Generally, the selection of monitoring interval shall ensure the intakes greater than 5% of annual dose limits. The monitoring interval of main nuclides is shown in Annex A.

5.3 **Task-Related Monitoring and Special Monitoring**

5.3.1 Special monitoring and task-related monitoring are related to specific events that actually occur or are suspected to occur. Data of the time of intake and about the physical and chemical status of pollutants shall be available during the monitoring.

5.3.2 Task-related monitoring shall be carried out for personnel who enter radioactive contaminated areas or places with high levels of radioactive activity in the air for a short period of time due to job demand, as well as personnel who may be exposed to internal pollution during accident intervention.

5.3.3 Special monitoring shall be conducted when significant intake is known or suspected, or after an accident or abnormal event. Special monitoring is also often carried out when the routine measurement of the excretion exceeds the level of the derived investigation, as well as the temporary sample collected such as nasal excretion and nasal swabs and other monitoring results are found abnormal.

5.3.4 Specific data relating to the exposed individual and the contaminant shall generally be known when the committed effective dose of intake radionuclides approaches or exceeds the dose limit after an accident or abnormal event, which include the physical and chemical characteristics of radioactive materials, particle size, air concentration, surface pollution level, retention characteristics of radionuclides in exposed individuals, nasal excretion samples, facial wiping samples, level of other skin pollution and external exposure dose measurement results. These data were analyzed to obtain reasonable dose results. Follow-up monitoring shall be carried out after accidents or abnormal events.

5.3.5 The wound monitoring is a kind of special monitoring. In such cases, the type and quantity of radioactive nuclides at the wounds shall be determined. If a resection operation has been performed, the tissue removed and radioactive materials left in the wounds shall be measured. Then, direct measurements, urinary or fecal excretion monitoring shall be performed as needed.

5.3.6 The monitoring after medical intervention is also a kind of special monitoring. If absorption inhibition and excretion promotion are adopted, the relevant data recommended in Annex B shall not be directly used to calculate the committed effective dose. Special monitoring plans shall be made to trace and monitor the distribution, retention and excretion of pollutants in the human body with accident intake if such treatment is conducted after accident intake, and specific estimation of the committed effective dose shall be made according to these data.

6 Method and Precautions of Monitoring

6.1 In vivo measurement, in vitro analyses of excretion or other matters, personal air samples analyses, or the combination of these techniques can be adopted as the individual monitoring for internal exposure.

6.2 The measurement techniques shall be selected based on: radiological characteristics and metabolic behavior of radioactive nuclides, measurement frequency required, the sensitivity of the relevant measuring equipment, availability and use convenience, etc.

6.3 Generally, only one measurement technique is adopted if the routine monitoring has enough sensitivity. Several measurement techniques can be used in combination in case of difficulty of measurement and dose estimation or the demand of comparison and approval.

6.4 Annex A shows the available routine individual monitoring methods for internal exposure for the main nuclides considered in the monitoring of internal exposure due to the intakes of fission and activation products.

6.5 Before in vivo measurement, related personnel shall take a shower, remove wearables including glasses and watches, and put on special measuring clothes. The contribution of skin and wound contamination shall be deducted in the whole-body measurement. The contribution of the contamination on other organs or tissues shall be deducted in the measurement of organs or tissues, and appropriate collimation and partial shielding measures can be taken when necessary.

6.6 The collection, storage, processing and analysis of urine samples shall avoid external and/or cross-contamination and loss of nuclides to be tested. For routine analysis, the urine for one day shall all be collected, and if the urine collection time is less than 24h, multiple urine samples shall be collected as much as possible, and the collected urine shall be corrected to the urine of 24h with creatinine or other materials. Tritium is an exception. In general, a small amount of urine is enough to calculate the tritium concentration in body fluid, content in the whole body, and the intake.

6.7 Feces monitoring is often used for special investigations, especially the investigations after it is known or suspected that Type M and Type S substances are inhaled. In such cases, measurement of nuclide in daily fecal excretion is useful for the assessment of the clearance from the lungs or estimating the intake. Because of the large fluctuation of nuclide in daily fecal excretion, feces samples shall be collected continuously for several days.

6.8 The representativeness and statistics of sample collection of personal air samples analysis shall be noticed to see whether the particle sizes of aerosol particles have been selected and classified. The collection, storage, handling and analysis of samples shall be free from external contamination.

7 Estimation of Dose

7.1 Biokinetic Models of Radionuclides and Default Parameters

7.1.1 The data given in Annex B are obtained based on the biokinetic models that are commonly recommended. The respiratory tract model used is "the human respiratory tract model for radiation protection" (ICRP Publication No. 66) published by the International Commission on Radiological Protection (ICRP) in 1999. According to the rate of blood uptake, the model classifies the radioactive materials deposited in the respiratory tract into three types, F, M and S. The activity median aerodynamic diameter (AMAD) of inhaled radioactive aerosol particles in the workplace is 5μm. The gastrointestinal model used was the model recommended by the ICRP in 1979 (ICRP Publication No. 30). These data are applicable to normal conditions, for example, the assessment of measurement results in routine monitoring plan.

7.1.2 Dose assessment of accident cases requires more detailed and specific information about intake routes, contaminants, and the characteristics of the exposed individual.

7.2 Intake Estimation of Routine Monitoring

7.2.1 For routine monitoring, if the time of intake is not specific, given that the intake takes place in the middle point of the monitoring interval T(d), the intake *I* can be calculated with the Formula (1) according to the measured value *M(t)* obtained at the end of the monitoring interval:

$$I=M(t)/m(T/2) \quad \text{……(1)}$$

Wherein:

I -- intake, the unit is Bq;

M(t) -- content of the whole body, an organ or tissue measured by internal exposure individual monitoring or daily excretion of urine or feces within *t* days after intake, the unit is Bq or $Bq \cdot d^{-1}$;

m(T/2) -- the expected value (dimensionless) of the content in the body or organs or the expected value (d^{-1}) of the daily excretion at T/2 days after the intake of unit activity, namely, the intake retention or excretion fractions. The measurement methods of commonly used radionuclides are shown in Annex A, and the *m(T/2)* values of commonly used radionuclides of fission and activation products are shown in Annex B.

7.2.2 The intake in previous monitoring intervals may affect measuring results in the current monitoring interval. If more than 10% of this measurement is from intake in previous monitoring intervals and the intake and dose have been estimated, the measurement results in the current monitoring interval should be corrected. A series of measurements in a routine monitoring plan can be conducted in following steps:

a) Determine the intake in the first monitoring interval;

b) Predict the proportion of the intake to the measurement results in subsequent monitoring intervals;

c) Deduct the content in organs (or daily urinaryand fecal excretion) caused by the intake from the data of each monitoring interval in future;

d) Repeat a) ~ c) in next monitoring interval.

7.2.3 In routine monitoring plans, further investigations shall be carried out if the monitoring results exceed the level of derived investigations determined in advance. The nature of the investigation will depend on the specific circumstances and the extent to which the monitoring results exceed the level of the investigation. In the investigation, the following points shall be considered:

a) Measurements shall be conducted repeatedly to confirm or improve the initial assessment;
b) Other monitoring techniques shall be adopted;
c) Working conditions and exposure shall be evaluated;
d) If the default parameters are adopted in the initial assessment, the particle size and chemical morphology of the actual pollutant shall be investigated and a more appropriate value shall be selected;
e) In the case of large doses, the staff shall be removed from radiation work and the retention and excretion characteristics of the contaminant shall be monitored to improve the dose assessment.

7.3 Estimation of Intake for Special Monitoring and Task-Related Monitoring

7.3.1 In this case, the time of intake is known. If the measurement is conducted once only, the intake I (Bq) can be calculated by Formula (2):

$$I=M(t)/m(t) \quad \text{……(2)}$$

Wherein:

I -- intake, the unit is Bq;

$M(t)$ -- content of the whole body, an organ or tissue measured by internal exposure individual monitoring or daily excretion of urine or feces within t days after intake, the unit is Bq or Bq·d^{-1};

$m(t)$ -- the expected value (dimensionless) of the content in the body or organs or the expected value (d^{-1}) of the daily excretion at t days after the intake of unit activity, namely, the intake retention or excretion fractions. The measurement methods of commonly used nuclides are shown in Annex A, and the m(t) values of commonly used nuclides of fission and activation products are shown in Annex C.

7.3.2 If multiple measurement results are obtained, the least square method can be used to estimate the optimal intake I(Bq) and as shown in Formula (3).

$$I=\sum_i [m(t_i)M(t_i)]/\sum_i m^2(t_i) \quad \text{……(3)}$$

Wherein:

$M(t_i)$ -- measured value after the t_i day of the intake, unit (Bq) or (Bq·d^{-1});

$m(t_i)$ -- expected value at the ti day after the intake, dimensionless or (d^{-1}).

7.3.3 The intake cannot be estimated with the recommended biodynamic model and its parameters if the excretion promotion is adopted. When some or all of the data about the radioactive materials in the human body can be obtained from the exposed individuals or surveys, the expected value can be estimated with part or all of the individual data. Then, the intake can be estimated according to the method in 7.3.2.

7.4 Estimation of Dose

7.4.1 The committed effective dose E (τ) shall be calculated by Formula (4):

$$E(\tau)=Ie(\tau) \quad \text{……(4)}$$

Wherein:

$e(\tau)$ -- conversion coefficient of the committed effective dose, that is, the committed effective dose caused by the intake per unit, the unit is Sv/Bq.

The committed effective dose coefficients for reference persons who mainly consider nuclides in the monitoring for internal exposure due to the intakes of fission and activation products are listed in Annex E.

7.4.2 The estimation of occupational exposure dose shall be based on individual monitoring. If individual monitoring is not practical or feasible, the dose of staff can be estimated based on the monitoring results of workplaces, information on the location and time of exposure upon the approval by the regulatory authorities.

7.4.3 If the estimated committed effective dose is low, like lower than 5 mSv, the default parameters recommended by ICRP can be used to estimate the committed effective dose.

7.4.4 If the estimates are high, like higher than 5 mSv, the time and route of the intake shall be investigated and analyzed, and where possible, the physical and chemical characteristics of the intake materials shall be used to estimate the committed effective dose.

7.4.5 When the intake reaches or exceeds the annual intake limit, more detailed data on the physical and chemical characteristics of the intake materials and the biokinetic parameters of the individuals are required to improve the estimation accuracy.

7.5 **Assessment of Dose**

7.5.1 The level of investigation is related to the purpose of the monitoring plan and the type of investigation to be carried out. For routine monitoring, different proportions of the annual dose limit or annual intake limit can be taken as the investigation level according to the understanding of workplace conditions and their specific situations. The record level shall be adopted with the same principle.

7.5.2 If the investigation level is set by 1/10 *ALI* and the monitoring period is *T* days, then the derived investigation level (*DIL*) of routine monitoring shall be calculated by Formula (5):

$$DIL=0.1ALI\times T/365\times m(T/2) \quad \text{(5)}$$

Further investigation shall be conducted when measurement results exceed *DIL*.

7.5.3 In general, it shall be recorded and documented when the monitoring results exceed detection limits.

7.5.4 The annual intakes estimated according to 7.2 or 7.3 and the annual committed effective dose estimated according to 7.4 can be compared respectively with the effective dose limit in the same year and the annual effective dose limit, so as to conduct the radiation protection assessment.

7.5.5 When a mixture of radionuclides is taken in, the annual intake and the committed effective dose shall be estimated for each radionuclide which is significant to the committed effective dose contribution. The annual committed effective dose due to various radionuclides can be added together to obtain the total annual committed effective dose, so as to assess the radiation protection.

Annex A
(Informative)
Individual Monitoring Methods of Main Radionuclides in Monitoring of Internal Exposure due to Intakes of Fission and Activation Products

The routine monitoring methods and maximum monitoring intervals for main radionuclides are shown in Table A.1.

Table A.1 Routine Individual Monitoring Methods and Maximum Monitoring Intervals for Main Nuclides

Nuclide	Monitoring Method	Sampling	Typical Detection Limit	Maximum Monitoring Interval (d)
^{22}Na	γ-ray spectrometry in vivo	Whole body	50 Bq	30
^{24}Na	γ-ray spectrometry in vivo	Whole body	50 Bq	-
^{54}Mn	γ-ray spectrometry in vivo	Whole body	50 Bq	90
	γ-ray spectrometry on biological samples	Urine sample	1 Bq/L	-
^{59}Fe	γ-ray spectrometry in vivo	Whole body	50 Bq	90
	γ-ray spectrometry on biological samples	Urine sample	1 Bq/L	-
^{58}Co	γ-ray spectrometry in vivo	Whole body	50 Bq	180
	γ-ray spectrometry on biological samples	Urine sample	1 Bq/L	90
^{60}Co	γ-ray spectrometry in vivo	Whole body	50 Bq	180
	γ-ray spectrometry in vivo	Lung	100 Bq	-
	γ-ray spectrometry on biological samples	Urine	1 Bq/L	180
	γ-ray spectrometry on biological samples	Feces	1 Bq/ feces sample	-
^{90}Sr	radiochemical analysis	Urine	1 Bq/L	F：30；S：180
^{95}Zr-^{95}Nb	γ-ray spectrometry in vivo	Whole body	50 Bq	-
^{106}Rn-^{106}Rh	γ-ray spectrometry in vivo	Whole body	200 Bq	-
	γ-ray spectrometry on biological samples	Urine	5 Bq/L	-
^{110m}Ag	γ-ray spectrometry in vivo	Whole body	50 Bq	180
^{124}Sb	γ-ray spectrometry in vivo	Whole body	50 Bq	-
	γ-ray spectrometry on biological samples	Urine sample	1 Bq/L	-
^{125}I	γ-ray spectrometry in vivo	Thyroid	100 Bq	120
	γ-ray spectrometry on biological samples	Urine[a]	1 Bq/L	120
^{131}I	γ-ray spectrometry in vivo	Thyroid	100 Bq	15
	γ-ray spectrometry on biological samples	Urine	1 Bq/L	15

Table A.1 (Continued)

Nuclide	Monitoring Method	Sampling	Typical Detection Limit	Maximum Monitoring Interval (d)
^{134}Cs	γ-ray spectrometry in vivo	Whole body	50 Bq	-
	γ-ray spectrometry on biological samples	Urine	1 Bq/L	-
^{137}Cs	γ-ray spectrometry in vivo	Whole body	50 Bq	180
	γ-ray spectrometry on biological samples	Urine	1 Bq/L	180
^{144}Ce	γ-ray spectrometry in vivo	Whole body	800 Bq	-
[a]In the first 4 days after iodine intake, the excretion in urine changes significantly, so avoid using urine samples in these days as measurement results to estimate intake and consider using thyroid measurement results to estimate the intake.				

Annex B
(Informative)
Expected Values in Routine Monitoring of Internal Exposure due to Intakes of Fission and Activation Products

The expected values $m(T/2)$ in routine monitoring of main radionuclides after intakes of fission and activation products are listed in Table B.1~Table B.15.

Table B.1 ^{22}Na

Absorption Type	T(d)	Whole body	Daily Urinary Excretion
F	30	1.8×10^{-1}	1.2×10^{-2}
	14	3.1×10^{-1}	2.2×10^{-2}
	7	3.8×10^{-1}	2.7×10^{-2}

Table B.2 ^{54}Mn

Absorption Type	T(d)	Whole body	Daily Urinary Excretion
F	90	8.9×10^{-2}	7.7×10^{-4}
	60	1.2×10^{-1}	1.1×10^{-3}
	30	1.7×10^{-1}	2.0×10^{-3}
	14	2.2×10^{-1}	4.3×10^{-3}
M	120	4.5×10^{-2}	1.9×10^{-4}
	90	5.5×10^{-2}	2.4×10^{-4}
	60	6.8×10^{-2}	3.1×10^{-4}
	30	8.7×10^{-2}	5.3×10^{-4}
	14	1.0×10^{-1}	1.0×10^{-3}

Table B.3 ^{59}Fe

Absorption Type	T(d)	Whole body
F	120	1.2×10^{-1}
	90	1.5×10^{-1}
	60	1.9×10^{-1}
	30	2.4×10^{-1}
	14	2.7×10^{-1}
M	120	4.3×10^{-2}
	90	5.5×10^{-2}
	60	7.2×10^{-2}
	30	9.4×10^{-2}
	14	1.1×10^{-1}

Table B.4 ^{58}Co

Absorption Type	*T*(d)	Whole body	Daily Urinary Excretion
M	120	2.3×10^{-2}	9.0×10^{-5}
	90	3.0×10^{-2}	1.3×10^{-4}
	60	4.0×10^{-2}	2.2×10^{-4}
	30	5.7×10^{-2}	5.8×10^{-4}
M	14	7.3×10^{-2}	1.2×10^{-3}
	7	1.0×10^{-1}	2.1×10^{-3}
S	180	1.7×10^{-2}	$(6.9\times10^{-6})^{a}$
	120	2.5×10^{-2}	(1.3×10^{-5})
	90	3.2×10^{-2}	2.0×10^{-5}
	60	4.0×10^{-2}	(4.2×10^{-5})
	30	5.3×10^{-2}	(1.5×10^{-4})
	14	6.5×10^{-2}	3.5×10^{-4}
	7	9.4×10^{-2}	6.5×10^{-4}
[a]The values in brackets mean that they do not meet the requirement of underestimate of intake not exceeding three times, the same for others.			

Table B.5 ^{60}Co

Absorption Type	*T*(d)	Whole body	Daily Urinary Excretion
M	360	2.1×10^{-2}	6.2×10^{-5}
	180	3.3×10^{-2}	1.2×10^{-4}
	120	4.0×10^{-2}	1.6×10^{-4}
	90	4.6×10^{-2}	2.0×10^{-4}
	60	5.3×10^{-2}	2.9×10^{-4}
	30	6.5×10^{-2}	6.6×10^{-4}
	14	7.8×10^{-2}	1.3×10^{-3}
	7	1.1×10^{-1}	2.2×10^{-3}
S	360	3.2×10^{-2}	7.8×10^{-6}
	180	4.0×10^{-2}	1.6×10^{-5}
	120	4.5×10^{-2}	2.3×10^{-5}
	90	4.8×10^{-2}	3.1×10^{-5}
	60	5.4×10^{-2}	5.6×10^{-5}
	30	6.1×10^{-2}	1.7×10^{-4}
	14	6.9×10^{-2}	3.8×10^{-4}
	7	9.8×10^{-2}	6.7×10^{-4}

Table B.6 ^{90}Sr

Absorption Type	*T*(d)	Daily Urinary Excretion
F	360	5.6×10^{-5}
	180	1.1×10^{-4}
	120	2.2×10^{-4}
	90	(4.1×10^{-4})
	60	9.6×10^{-4}
	30	2.6×10^{-3}
	14	6.3×10^{-3}
	7	1.2×10^{-2}
S	360	3.1×10^{-6}
	180	4.7×10^{-6}
	120	6.9×10^{-6}
	90	1.0×10^{-5}
	60	1.8×10^{-5}
	30	4.0×10^{-5}
	14	9.0×10^{-5}
	7	1.6×10^{-4}

Table B.7 ^{95}Zr-^{95}Nb

Absorption Type	*T*(d)	Daily Urinary Excretion
F	360	1.1×10^{-6}
	180	3.7×10^{-6}
	120	2.1×10^{-5}
	90	9.3×10^{-5}
	60	4.6×10^{-4}
	30	2.4×10^{-3}
	14	5.7×10^{-3}
	7	8.4×10^{-3}
M	360	4.0×10^{-6}
	180	2.0×10^{-5}
	120	3.7×10^{-5}
	90	5.6×10^{-5}
	60	1.1×10^{-4}
	30	3.1×10^{-4}
	14	6.4×10^{-4}
	7	8.9×10^{-4}
S	360	2.1×10^{-7}
	180	6.8×10^{-7}
	120	1.2×10^{-6}

Table B.7 (Cont.)

Absorption Type	*T*(d)	Daily Urinary Excretion
S	90	1.8×10^{-6}
	60	3.6×10^{-6}
	30	1.2×10^{-5}
	14	2.4×10^{-5}
	7	3.5×10^{-5}

Table B.8 ^{106}Ru-^{106}Rh

Absorption Type	*T*(d)	Whole body	Daily Urinary Excretion
F	360	3.8×10^{-2}	(4.9×10^{-5})
	180	5.9×10^{-2}	(2.3×10^{-4})
	120	7.5×10^{-2}	(4.5×10^{-4})
	90	8.7×10^{-2}	7.1×10^{-4}
	60	1.1×10^{-1}	1.3×10^{-3}
	30	$l.5\times10^{-1}$	3.1×10^{-3}
	14	1.9×10^{-1}	5.4×10^{-3}
	7	2.3×10^{-1}	6.8×10^{-3}
M	360	1.9×10^{-2}	(4.3×10^{-5})
	180	3.3×10^{-2}	1.1×10^{-4}
	120	4.2×10^{-2}	1.6×10^{-4}
	90	4.9×10^{-2}	2.2×10^{-4}
	60	5.9×10^{-2}	3.2×10^{-4}
	30	7.3×10^{-2}	6.1×10^{-4}
	14	8.7×10^{-2}	9.7×10^{-4}
	7	1.2×10^{-1}	1.2×10^{-3}
S	360	2.6×10^{-2}	6.4×10^{-6}
	180	3.7×10^{-2}	(2.3×10^{-5})
	120	4.4×10^{-2}	4.2×10^{-5}
	90	4.9×10^{-2}	6.2×10^{-5}
	60	5.6×10^{-2}	1.1×10^{-4}
	30	6.6×10^{-2}	2.4×10^{-4}
	14	7.6×10^{-2}	4.1×10^{-4}
	7	$1.O\times10^{-1}$	5.1×10^{-4}

Table B.9 ^{110m}Ag

Absorption Type	*T*(d)	Whole body
F	360	$(2.6\times10^{-2})^{*}$
	180	7.3×10^{-2}
	120	1.1×10^{-1}
	90	1.4×10^{-1}
	60	1.7×10^{-1}
	30	2.2×10^{-1}
	14	2.5×10^{-1}
	7	2.8×10^{-1}
M	360	(1.6×10^{-2})
	180	3.6×10^{-2}
	120	4.9×10^{-2}
	90	5.8×10^{-2}
	60	6.9×10^{-2}
	30	8.4×10^{-2}
	14	9.6×10^{-2}
	7	1.3×10^{-1}
S	360	2.2×10^{-2}
	180	3.6×10^{-2}
	120	4.5×10^{-2}
	90	5.1×10^{-2}
	60	5.9×10^{-2}
	30	7.0×10^{-2}
	14	7.9×10^{-2}
	7	1.1×10^{-1}

Table B.10 ^{124}Sb

Absorption Type	*T*(d)	Whole body
F	120	1.4×10^{-2}
	90	1.8×10^{-2}
	60	2.5×10^{-2}
	30	5.1×10^{-2}
	14	1.1×10^{-1}
	7	1.7×10^{-1}
M	120	(1.7×10^{-2})
	90	2.3×10^{-2}
	60	3.2×10^{-2}
	30	4.7×10^{-2}
	14	6.3×10^{-2}
	7	9.5×10^{-2}

Table B.11 ^{125}I

Absorption Type	*T*(d)	Thyroid	Daily Urinary Excretion
F	120	4.7×10^{-2}	2.5×10^{-4}
	90	6.2×10^{-2}	3.1×10^{-4}
	60	8.1×10^{-2}	3.5×10^{-4}
	30	1.1×10^{-1}	3.0×10^{-4}
	14	1.3×10^{-1}	1.7×10^{-4}
	7	1.3×10^{-1}	2.0×10^{-4}
Air state	120	8.9×10^{-2}	4.6×10^{-4}
	90	1.2×10^{-1}	5.7×10^{-4}
	60	1.5×10^{-1}	6.5×10^{-4}
	30	2.0×10^{-1}	5.6×10^{-4}
	14	2.4×10^{-1}	3.3×10^{-4}
	7	2.5×10^{-1}	3.6×10^{-4}

Table B.12 ^{131}I

Absorption Type	*T*(d)	Thyroid	Daily Urinary Excretion
F	30	(3.5×10^{-2})	9.8×10^{-5}
	14	7.4×10^{-2}	1.0×10^{-4}
	7	9.9×10^{-2}	1.5×10^{-4}
Air state	30	(6.6×10^{-2})	1.8×10^{-4}
	14	1.4×10^{-1}	1.9×10^{-4}
	7	1.9×10^{-1}	2.7×10^{-4}

Table B.13 ^{134}Cs

Absorption Type	*T*(d)	Whole body	Daily Urinary Excretion
F	180	2.3×10^{-1}	1.1×10^{-3}
	120	2.8×10^{-1}	1.4×10^{-3}
	90	3.1×10^{-1}	1.6×10^{-3}
	60	3.5×10^{-1}	1.8×10^{-3}
	30	3.9×10^{-1}	2.1×10^{-3}
	14	4.2×10^{-1}	3.7×10^{-3}
	7	4.4×10^{-1}	6.8×10^{-3}

Table B.14 ^{137}Cs

Absorption Type	*T*(d)	Whole body	Daily Urinary Excretion
F	360	1.4×10^{-1}	7.0×10^{-4}
	180	2.4×10^{-1}	1.2×10^{-3}
	120	3.0×10^{-1}	1.5×10^{-3}
	90	3.3×10^{-1}	1.6×10^{-3}

Table B.14 (Cont.)

Absorption Type	*T*(d)	Whole body	Daily Urinary Excretion
F	60	3.6×10^{-1}	1.8×10^{-3}
	30	3.9×10^{-1}	2.1×10^{-3}
	14	4.2×10^{-1}	3.8×10^{-3}
	7	4.4×10^{-1}	6.8×10^{-3}

Table B.15 ^{144}Ce-^{144}Pr

Absorption Type	*T*(d)	Whole body	Daily Urinary Excretion
M	360	4.0×10^{-2}	6.4×10^{-7}
	180	5.3×10^{-2}	6.9×10^{-7}
	120	5.9×10^{-2}	6.8×10^{-7}
	90	6.3×10^{-2}	6.7×10^{-7}
	60	6.9×10^{-2}	6.5×10^{-7}
	30	7.7×10^{-2}	6.1×10^{-7}
	14	8.3×10^{-2}	5.9×10^{-7}
	7	1.3×10^{-2}	5.7×10^{-7}
S	360	2.2×10^{-2}	1.5×10^{-8}
	180	3.1×10^{-2}	1.5×10^{-8}
	120	3.7×10^{-2}	1.4×10^{-8}
	90	4.2×10^{-2}	1.3×10^{-8}
	60	4.7×10^{-2}	1.2×10^{-8}
	30	5.5×10^{-2}	1.1×10^{-8}
	14	6.2×10^{-2}	1.0×10^{-8}
	7	1.1×10^{-1}	1.0×10^{-8}

Annex C
(Informative)
Expected Values in Special Monitoring of Internal Exposure due to Intakes of Fissionand Activation Products

The expected values *m(t)* in special monitoring of main radionuclides after intakes of Fissionand activation products are listed in Table C.1~Table C.16.

Table C.1 ^{22}Na

Time after Intake (d)	F	
	Whole body	Daily Urinary Excretion
1	5.9×10^{-1}	1.6×10^{-2}
2	4.8×10^{-1}	2.9×10^{-2}
3	4.2×10^{-1}	2.9×10^{-2}
4	3.8×10^{-1}	2.7×10^{-2}
5	3.5×10^{-1}	2.5×10^{-2}
6	3.3×10^{-1}	2.3×10^{-2}
7	3.1×10^{-1}	2.2×10^{-2}
8	2.9×10^{-1}	2.0×10^{-2}
9	2.7×10^{-1}	1.9×10^{-2}
10	2.5×10^{-1}	1.8×10^{-2}

Table C.2 ^{24}Na

Time after Intake (d)	F	
	Whole body	Daily Urinary Excretion
1	1.9×10^{-1}	5.4×10^{-3}
2	5.2×10^{-2}	3.2×10^{-3}
3	1.5×10^{-2}	1.0×10^{-3}
4	4.6×10^{-3}	3.2×10^{-4}
5	1.4×10^{-3}	9.8×10^{-5}
6	4.3×10^{-4}	3.0×10^{-5}
7	1.3×10^{-4}	9.3×10^{-6}
8	4.0×10^{-5}	2.9×10^{-6}
9	1.2×10^{-5}	8.8×10^{-7}
10	3.8×10^{-6}	2.7×10^{-7}

Table C.3 ^{54}Mn

Time after Intake (d)	F		M	
	Whole body	Daily Urinary Excretion	Whole body	Daily Urinary Excretion
1	5.5×10^{-1}	5.2×10^{-3}	5.0×10^{-1}	9.9×10^{-4}
2	3.9×10^{-1}	8.0×10^{-3}	2.8×10^{-1}	1.8×10^{-3}
3	3.1×10^{-1}	7.2×10^{-3}	1.8×10^{-1}	1.7×10^{-3}
4	2.7×10^{-1}	6.3×10^{-3}	1.4×10^{-1}	1.5×10^{-3}
5	2.5×10^{-1}	5.5×10^{-3}	1.2×10^{-1}	1.3×10^{-3}
6	2.3×10^{-1}	4.9×10^{-3}	1.1×10^{-1}	1.2×10^{-3}
7	2.2×10^{-1}	4.3×10^{-3}	1.0×10^{-1}	1.0×10^{-3}
8	2.1×10^{-1}	3.9×10^{-3}	1.0×10^{-1}	9.3×10^{-4}
9	2.0×10^{-1}	3.5×10^{-3}	9.9×10^{-2}	8.4×10^{-4}
10	2.0×10^{-1}	3.1×10^{-3}	9.6×10^{-2}	7.6×10^{-4}

Table C.4 ^{59}Fe

Time after Intake (d)	F		M	
	Whole body	Daily Urinary Excretion	Whole body	Daily Urinary Excretion
1	5.5×10^{-1}	6.0×10^{-4}	5.0×10^{-1}	1.3×10^{-4}
2	3.9×10^{-1}	5.2×10^{-5}	2.8×10^{-1}	1.4×10^{-5}
3	3.3×10^{-1}	3.3×10^{-5}	1.8×10^{-1}	8.6×10^{-6}
4	3.0×10^{-1}	2.3×10^{-5}	1.4×10^{-1}	6.1×10^{-6}
5	2.8×10^{-1}	1.7×10^{-5}	1.2×10^{-1}	4.6×10^{-6}
6	2.8×10^{-1}	1.3×10^{-5}	1.2×10^{-1}	3.6×10^{-6}
7	2.7×10^{-1}	1.0×10^{-5}	1.1×10^{-1}	3.0×10^{-6}
8	2.7×10^{-1}	8.3×10^{-6}	1.1×10^{-1}	2.6×10^{-6}
9	2.6×10^{-1}	7.2×10^{-6}	1.1×10^{-1}	2.3×10^{-6}
10	2.6×10^{-1}	6.3×10^{-6}	1.0×10^{-1}	2.1×10^{-6}

Table C.5 ^{58}Co

Absorption Type	Time after Intake (d)	Whole body	Lung	Daily Urinary Excretion	Daily faeca excretion
M	1	4.8×10^{-1}	5.7×10^{-2}	2.0×10^{-2}	1.0×10^{-1}
	2	2.5×10^{-1}	5.5×10^{-2}	9.0×10^{-3}	1.4×10^{-1}
	3	1.5×10^{-1}	5.3×10^{-2}	3.6×10^{-3}	7.0×10^{-2}
	4	1.0×10^{-1}	5.2×10^{-2}	2.1×10^{-3}	2.9×10^{-2}
	5	8.7×10^{-2}	5.1×10^{-2}	1.6×10^{-3}	1.2×10^{-2}
	6	7.8×10^{-2}	5.0×10^{-2}	1.4×10^{-2}	4.8×10^{-3}
	7	7.3×10^{-2}	4.8×10^{-2}	1.2×10^{-3}	2.2×10^{-3}
	8	7.0×10^{-2}	4.7×10^{-2}	1.1×10^{-3}	1.2×10^{-3}
	9	6.8×10^{-2}	4.6×10^{-2}	1.0×10^{-3}	8.0×10^{-4}
	10	6.5×10^{-2}	4.5×10^{-2}	9.1×10^{-4}	6.4×10^{-4}
S	1	4.9×10^{-1}	6.4×10^{-2}	5.6×10^{-3}	1.1×10^{-1}
	2	2.5×10^{-1}	6.1×10^{-2}	3.1×10^{-3}	1.5×10^{-1}
	3	1.4×10^{-1}	6.0×10^{-2}	1.2×10^{-3}	7.7×10^{-2}
	4	9.4×10^{-2}	5.9×10^{-2}	6.5×10^{-4}	3.2×10^{-2}
	5	7.6×10^{-2}	5.8×10^{-2}	4.8×10^{-4}	1.3×10^{-2}
	6	6.9×10^{-2}	5.7×10^{-2}	4.0×10^{-4}	5.2×10^{-3}
	7	6.5×10^{-2}	5.6×10^{-2}	3.5×10^{-4}	2.3×10^{-3}
	8	6.3×10^{-2}	5.5×10^{-2}	3.1×10^{-4}	1.2×10^{-3}
	9	6.1×10^{-2}	5.4×10^{-2}	2.8×10^{-4}	7.7×10^{-4}
	10	5.9×10^{-2}	5.2×10^{-2}	2.5×10^{-4}	6.1×10^{-4}

Table C.6 ^{60}Co

Absorption Type	Time after Intake (d)	Whole body	Lung	Daily Urinary Excretion	Daily faeca excretion
M	1	4.9×10^{-1}	5.8×10^{-2}	2.0×10^{-2}	1.0×10^{-1}
	2	2.6×10^{-1}	5.6×10^{-2}	9.2×10^{-3}	1.4×10^{-1}
	3	1.5×10^{-1}	5.5×10^{-2}	3.7×10^{-3}	7.2×10^{-2}
	4	1.1×10^{-1}	5.4×10^{-2}	2.2×10^{-3}	3.1×10^{-2}
	5	9.1×10^{-2}	5.3×10^{-2}	1.7×10^{-3}	1.2×10^{-2}
	6	8.3×10^{-2}	5.2×10^{-2}	1.5×10^{-2}	5.1×10^{-3}
	7	7.8×10^{-2}	5.2×10^{-2}	1.3×10^{-3}	2.3×10^{-3}
	8	7.6×10^{-2}	5.1×10^{-2}	1.2×10^{-3}	1.3×10^{-3}
	9	7.4×10^{-2}	5.0×10^{-2}	1.1×10^{-3}	8.7×10^{-4}
	10	7.2×10^{-2}	4.9×10^{-2}	1.0×10^{-3}	7.0×10^{-4}
S	1	4.9×10^{-1}	6.4×10^{-2}	5.7×10^{-3}	1.1×10^{-1}
	2	2.5×10^{-1}	6.3×10^{-2}	3.1×10^{-3}	1.6×10^{-1}
	3	1.4×10^{-1}	6.2×10^{-2}	1.2×10^{-3}	8.0×10^{-2}
	4	9.8×10^{-2}	6.1×10^{-2}	6.7×10^{-4}	3.4×10^{-2}
	5	8.0×10^{-2}	6.1×10^{-2}	5.0×10^{-4}	1.3×10^{-2}
	6	7.3×10^{-2}	6.0×10^{-2}	4.3×10^{-4}	5.5×10^{-3}
	7	6.9×10^{-2}	5.9×10^{-2}	3.8×10^{-4}	2.4×10^{-3}
	8	6.8×10^{-2}	5.9×10^{-2}	3.4×10^{-4}	1.3×10^{-3}
	9	6.6×10^{-2}	5.8×10^{-2}	3.1×10^{-4}	8.4×10^{-4}
	10	6.5×10^{-2}	5.8×10^{-2}	2.8×10^{-4}	6.7×10^{-4}

Table C.7 ^{90}Sr

Time after Intake (d)	F	S
	Daily Urinary Excretion	Daily Urinary Excretion
1	6.8×10^{-2}	8.1×10^{-4}
2	2.3×10^{-2}	3.4×10^{-4}
3	1.6×10^{-2}	2.2×10^{-4}
4	1.2×10^{-2}	1.6×10^{-4}
5	9.2×10^{-3}	1.3×10^{-4}
6	7.5×10^{-3}	1.1×10^{-4}
7	6.3×10^{-3}	9.0×10^{-5}
8	5.4×10^{-3}	7.7×10^{-5}
9	4.7×10^{-3}	6.8×10^{-5}
10	4.1×10^{-3}	6.1×10^{-5}

Table C.8 ^{95}Zr-^{95}Nb

Time after Intake (d)	F	M	S
	Daily Urinary Excretion	Daily Urinary Excretion	Daily Urinary Excretion
1	6.4×10^{-3}	6.6×10^{-4}	2.0×10^{-5}
2	9.9×10^{-3}	1.0×10^{-3}	3.9×10^{-5}
3	9.2×10^{-3}	9.6×10^{-4}	3.7×10^{-5}
4	8.4×10^{-3}	8.9×10^{-4}	3.5×10^{-5}
5	7.4×10^{-3}	8.0×10^{-4}	3.1×10^{-5}
6	6.6×10^{-3}	7.2×10^{-4}	2.8×10^{-5}
7	5.7×10^{-3}	6.4×10^{-4}	2.4×10^{-5}
8	5.3×10^{-3}	6.0×10^{-4}	2.3×10^{-5}
9	4.8×10^{-3}	5.5×10^{-4}	2.1×10^{-5}
10	4.3×10^{-3}	5.0×10^{-4}	1.9×10^{-5}

Table C.9 ^{106}Ru-^{106}Rh

Time after Intake (d)	F		M		S	
	Whole body	Daily Urinary Excretion	Whole body	Daily Urinary Excretion	Whole body	Daily Urinary Excretion
1	5.1×10^{-1}	3.5×10^{-2}	4.9×10^{-1}	5.4×10^{-3}	4.9×10^{-1}	2.2×10^{-3}
2	3.5×10^{-1}	1.1×10^{-2}	2.7×10^{-1}	2.1×10^{-3}	2.6×10^{-1}	1.0×10^{-3}
3	2.7×10^{-1}	7.6×10^{-3}	1.6×10^{-1}	1.3×10^{-3}	1.5×10^{-1}	5.9×10^{-4}
4	2.3×10^{-1}	6.8×10^{-3}	1.2×10^{-1}	1.2×10^{-3}	1.0×10^{-1}	5.1×10^{-4}
5	2.1×10^{-1}	6.3×10^{-3}	9.9×10^{-2}	1.1×10^{-3}	8.6×10^{-2}	4.7×10^{-4}
6	2.0×10^{-1}	5.8×10^{-3}	9.1×10^{-2}	1.0×10^{-3}	7.9×10^{-2}	4.4×10^{-4}
7	1.9×10^{-1}	5.4×10^{-3}	8.7×10^{-2}	9.7×10^{-4}	7.6×10^{-2}	4.1×10^{-4}
8	1.9×10^{-1}	5.0×10^{-3}	8.4×10^{-2}	9.1×10^{-4}	7.4×10^{-2}	3.8×10^{-4}
9	1.8×10^{-1}	4.7×10^{-3}	8.2×10^{-2}	8.6×10^{-4}	7.2×10^{-2}	3.5×10^{-4}
10	1.7×10^{-1}	4.4×10^{-3}	8.0×10^{-2}	8.1×10^{-4}	7.1×10^{-2}	3.3×10^{-4}

Table C.10 ^{110m}Ag

Time after Intake (d)	F		M			S		
	Whole body	Daily Urinary Excretion	Whole body	Lung	Daily Urinary Excretion	Whole body	Lung	Daily Urinary Excretion
1	5.5×10^{-1}	5.5×10^{-2}	5.0×10^{-1}	5.8×10^{-2}	1.0×10^{-1}	4.9×10^{-1}	6.4×10^{-2}	1.1×10^{-1}
2	3.9×10^{-1}	7.8×10^{-2}	2.7×10^{-1}	5.6×10^{-2}	1.5×10^{-1}	2.6×10^{-1}	6.2×10^{-2}	1.5×10^{-1}
3	3.2×10^{-1}	4.3×10^{-2}	1.7×10^{-1}	5.5×10^{-2}	7.6×10^{-2}	1.5×10^{-1}	6.1×10^{-2}	7.9×10^{-2}
4	2.8×10^{-1}	2.1×10^{-2}	1.3×10^{-1}	5.4×10^{-2}	3.2×10^{-2}	1.1×10^{-1}	6.1×10^{-2}	3.3×10^{-2}
5	2.7×10^{-1}	1.2×10^{-2}	1.1×10^{-1}	5.3×10^{-2}	1.3×10^{-2}	9.0×10^{-2}	6.0×10^{-2}	1.4×10^{-2}
6	2.6×10^{-1}	7.6×10^{-3}	1.0×10^{-1}	5.2×10^{-2}	5.9×10^{-3}	8.3×10^{-2}	5.9×10^{-2}	5.7×10^{-3}
7	2.5×10^{-1}	5.7×10^{-3}	9.6×10^{-2}	5.1×10^{-2}	3.0×10^{-3}	7.9×10^{-2}	5.8×10^{-2}	2.7×10^{-3}
8	2.5×10^{-1}	4.8×10^{-3}	9.4×10^{-2}	5.0×10^{-2}	1.9×10^{-3}	7.7×10^{-2}	5.8×10^{-2}	1.5×10^{-3}
9	2.4×10^{-2}	4.3×10^{-3}	9.2×10^{-2}	4.9×10^{-2}	1.4×10^{-3}	7.6×10^{-2}	5.7×10^{-2}	1.1×10^{-3}
10	2.4×10^{-2}	3.9×10^{-3}	9.1×10^{-2}	4.8×10^{-2}	1.2×10^{-3}	7.5×10^{-2}	5.6×10^{-2}	8.9×10^{-4}

Table C.11 ^{124}Sb

Time after Intake (d)	F		M			
	Whole body	Daily Urinary Excretion	Whole body	Lung	Daily Urinary Excretion	Daily fecal excretion
1	4.8×10^{-1}	6.7×10^{-2}	4.9×10^{-1}	5.7×10^{-2}	7.1×10^{-3}	1.1×10^{-1}
2	3.0×10^{-1}	1.8×10^{-2}	2.5×10^{-1}	5.5×10^{-2}	2.1×10^{-3}	1.5×10^{-1}
3	2.1×10^{-1}	1.6×10^{-2}	1.4×10^{-2}	5.3×10^{-2}	1.8×10^{-3}	7.7×10^{-2}
4	1.7×10^{-1}	1.4×10^{-2}	9.5×10^{-2}	5.2×10^{-2}	1.6×10^{-3}	3.2×10^{-2}
5	1.4×10^{-1}	1.2×10^{-2}	7.6×10^{-2}	5.0×10^{-2}	1.4×10^{-3}	1.3×10^{-2}
6	1.2×10^{-1}	1.0×10^{-2}	6.7×10^{-2}	4.9×10^{-2}	1.2×10^{-3}	5.3×10^{-3}
7	1.1×10^{-1}	8.8×10^{-3}	6.3×10^{-2}	4.8×10^{-2}	1.1×10^{-3}	2.4×10^{-3}
8	9.8×10^{-2}	7.6×10^{-3}	6.0×10^{-2}	4.7×10^{-2}	9.3×10^{-4}	1.3×10^{-3}
9	8.8×10^{-2}	6.5×10^{-3}	5.7×10^{-2}	4.5×10^{-2}	8.3×10^{-4}	9.0×10^{-4}
10	7.9×10^{-2}	5.6×10^{-3}	5.5×10^{-2}	4.4×10^{-2}	7.3×10^{-4}	7.2×10^{-4}

Table C.12 ^{125}I

Time after Intake (d)	F		Air state	
	Thyroid	Daily Urinary Excretion	Thyroid	Daily Urinary Excretion
1	1.3×10^{-1}	3.0×10^{-1}	2.5×10^{-1}	5.7×10^{-1}
2	1.4×10^{-1}	2.7×10^{-2}	2.6×10^{-1}	4.9×10^{-2}
3	1.4×10^{-1}	1.7×10^{-3}	2.5×10^{-1}	3.2×10^{-3}

Table C.12 (Cont.)

Time after Intake (d)	F		Air state	
	Thyroid	Daily Urinary Excretion	Thyroid	Daily Urinary Excretion
4	1.3×10^{-1}	2.0×10^{-4}	2.5×10^{-1}	3.6×10^{-4}
5	1.3×10^{-1}	1.3×10^{-4}	2.4×10^{-1}	2.4×10^{-4}
6	1.3×10^{-1}	1.5×10^{-4}	2.4×10^{-1}	2.8×10^{-4}
7	1.3×10^{-1}	1.7×10^{-4}	2.4×10^{-1}	3.3×10^{-4}
8	1.2×10^{-1}	2.0×10^{-4}	2.3×10^{-1}	3.7×10^{-4}
9	1.2×10^{-1}	2.2×10^{-4}	2.3×10^{-1}	4.1×10^{-4}
10	1.2×10^{-1}	2.4×10^{-4}	2.2×10^{-1}	4.4×10^{-4}

Table C.13 ^{131}I

Time after Intake (d)	F		Air state	
	Thyroid	Daily Urinary Excretion	Thyroid	Daily Urinary Excretion
1	1.2×10^{-1}	2.8×10^{-1}	2.3×10^{-1}	5.3×10^{-1}
2	1.2×10^{-1}	2.3×10^{-2}	2.2×10^{-1}	4.3×10^{-2}
3	1.1×10^{-1}	1.4×10^{-3}	2.0×10^{-1}	2.5×10^{-3}
4	9.9×10^{-2}	1.5×10^{-4}	1.9×10^{-1}	2.7×10^{-4}
5	9.0×10^{-2}	8.9×10^{-5}	1.7×10^{-1}	1.7×10^{-4}
6	8.2×10^{-2}	9.6×10^{-5}	1.5×10^{-1}	1.8×10^{-4}
7	7.4×10^{-2}	1.0×10^{-4}	1.4×10^{-1}	1.9×10^{-4}
8	6.8×10^{-2}	1.1×10^{-4}	1.3×10^{-1}	2.0×10^{-4}
9	6.2×10^{-2}	1.1×10^{-4}	1.2×10^{-1}	2.1×10^{-4}
10	5.6×10^{-2}	1.1×10^{-4}	1.1×10^{-1}	2.1×10^{-4}

Table C.14 ^{134}Cs

Time after Intake (d)	F	
	Whole body	Daily Urinary Excretion
1	6.0×10^{-1}	7.1×10^{-3}
2	5.1×10^{-1}	1.1×10^{-2}
3	4.7×10^{-1}	8.9×10^{-3}
4	4.4×10^{-1}	6.8×10^{-3}
5	4.3×10^{-1}	5.5×10^{-3}
6	4.3×10^{-1}	4.5×10^{-3}
7	4.2×10^{-1}	3.7×10^{-3}
8	4.2×10^{-1}	3.3×10^{-3}
9	4.1×10^{-1}	2.9×10^{-3}
10	4.1×10^{-1}	2.6×10^{-3}

Table C.15 ^{137}Cs

Time after Intake (d)	F	
	Whole body	Daily Urinary Excretion
1	6.0×10^{-1}	7.9×10^{-3}
2	5.0×10^{-1}	1.1×10^{-2}
3	4.6×10^{-1}	8.8×10^{-3}
4	4.4×10^{-1}	6.8×10^{-3}
5	4.3×10^{-1}	5.4×10^{-3}
6	4.3×10^{-1}	4.5×10^{-3}
7	4.2×10^{-1}	3.8×10^{-3}
8	4.2×10^{-1}	3.3×10^{-3}
9	4.1×10^{-1}	2.9×10^{-3}
10	4.1×10^{-1}	2.6×10^{-3}

Table C.16 ^{144}Ce-^{144}Pr

Time after Intake (d)	M		S	
	Whole body	Daily Urinary Excretion	Whole body	Daily Urinary Excretion
1	5.0×10^{-1}	3.2×10^{-7}	4.9×10^{-1}	4.8×10^{-9}
2	2.6×10^{-1}	5.4×10^{-7}	2.5×10^{-1}	9.3×10^{-9}
3	1.5×10^{-1}	5.6×10^{-7}	1.4×10^{-1}	9.8×10^{-9}
4	1.3×10^{-1}	5.7×10^{-7}	1.1×10^{-1}	1.0×10^{-8}
5	9.3×10^{-2}	5.7×10^{-7}	7.2×10^{-2}	1.0×10^{-8}
6	8.6×10^{-2}	5.7×10^{-7}	6.5×10^{-2}	1.0×10^{-8}
7	8.3×10^{-2}	5.9×10^{-7}	6.2×10^{-2}	1.0×10^{-8}
8	8.2×10^{-2}	5.8×10^{-7}	6.0×10^{-2}	1.0×10^{-8}
9	8.1×10^{-2}	5.9×10^{-7}	5.9×10^{-2}	1.0×10^{-8}
10	8.0×10^{-2}	5.9×10^{-7}	5.8×10^{-2}	1.0×10^{-8}

Annex D
(Informative)
Respiratory Tract Absorption Type and Gastrointestinal Tract Absorption Fraction

Table D.1 shows the respiratory tract absorption type and gastrointestinal tract absorption fraction of elements.

Table D.1 Absorption Type and Gastrointestinal Tract Absorption Fraction f_1

Elements	Compounds	Category	f_1
Na	All compounds	F	1
Mn	All unspecified compounds	F	0.1
	Oxides, hydroxides, halides, and nitrates	M	0.1
Fe	All unspecified compounds	F	0.1
	Oxides, hydroxides, and halides	M	0.1
Co	All unspecified compounds	M	0.1
	Oxides, hydroxides, halides, and nitrates	S	0.05
Sr	All unspecified compounds	F	0.3
	$SrTiO_3$	S	0.01
Zr	All unspecified compounds	F	0.002
	Oxides, hydroxides, halides, and nitrates	M	0.002
	Carbides	S	0.002
Ru	All unspecified compounds	F	0.05
	Halides	M	0.05
	Oxides and hydroxides	S	0.05
Ag	All unspecified compounds	F	0.05
	Nitrates and sulfides	M	0.05
	Oxides, hydroxides and carbides	S	0.05
Sb	All unspecified compounds	F	0.1
	Oxides, hydroxides, halides, sulfides, sulfates and nitrates	M	0.01
I	All compounds	F	1
Cs	All compounds	F	1
Ce	All other forms except the following	M	0.0005
	Oxides, hydroxides and fluorides	S	0.0005

Annex E

(Informative)

Committed Effective Dose Coefficient

The committed effective dose coefficients of main radionuclides of fissionand activation products are shown in Table E.1.

Table E.1 Committed Effective Dose Coefficient $e(50)$

Radionuclide	Inhalation (AMAD=5 μm)		Ingestion	
	Category	Sv·Bq^{-1}	f_1	Sv·Bq^{-1}
^{22}Na	F	2.0×10^{-9}	1	3.2×10^{-9}
^{24}Na	F	5.3×10^{-10}	1	4.3×10^{-10}
^{54}Mn	F	1.1×10^{-9}	0.1	7.1×10^{-10}
	M	1.2×10^{-9}		
^{59}Fe	F	3.0×10^{-9}	0.1	1.8×10^{-9}
	M	3.2×10^{-9}		
^{58}Co	M	1.4×10^{-9}	0.1	7.4×10^{-10}
	S	1.7×10^{-9}	0.05	7.0×10^{-10}
^{60}Co	M	7.1×10^{-9}	0.1	3.4×10^{-9}
	S	1.7×10^{-8}	0.05	2.5×10^{-9}
^{90}Sr	F	3.0×10^{-8}	0.3	2.8×10^{-8}
	S	7.7×10^{-8}	0.01	2.7×10^{-9}
^{95}Zr	F	3.0×10^{-9}	0.002	8.8×10^{-10}
	M	3.6×10^{-9}		
	S	4.2×10^{-9}		
^{106}Ru	F	9.8×10^{-9}	0.05	7.0×10^{-9}
	M	1.7×10^{-8}		
	S	3.5×10^{-8}		
^{110m}Ag	F	6.7×10^{-9}	0.05	2.8×10^{-9}
	M	5.9×10^{-9}		
	S	7.3×10^{-9}		
^{124}Sb	F	1.9×10^{-9}	0.1	2.5×10^{-9}
	M	4.7×10^{-9}		
^{125}I	F	7.3×10^{-9}	1	1.5×10^{-8}
^{131}I	F	1.1×10^{-8}	1	2.2×10^{-8}
^{134}Cs	F	9.6×10^{-9}	1	1.9×10^{-8}
^{137}Cs	F	6.7×10^{-9}	1	1.3×10^{-8}
^{144}Ce	M	2.3×10^{-8}	0.0005	5.2×10^{-9}
	S	2.9×10^{-8}		