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SAFETY GUIDE   
IN THE USE OF ATOMIC ENERGY "RECOMMENDED METHODS FOR CALCULATING PARAMETERS NECESSARY FOR THE DEVELOPMENT OF STANDARDS FOR PERMISSIBLE DISCHARGES OF RADIOACTIVE SUBSTANCES INTO THE ATMOSPHERE"

(RB-106-15)

I. General

1. The safety guide in the use of atomic energy "Recommended methods for calculating parameters necessary for the development and establishment of standards for maximum permissible discharges of radioactive substances to the atmosphere" (RB-106-15) (hereinafter referred to as the Safety Guide) has been developed in accordance with Article 6 of the Federal law dated November 21, 1995 No. 170-FZ "On atomic energy use" for facilitating compliance with the requirements of the Federal Rules and Regulations in radiation safety PNAE G-01-011-97 "General provisions for safety assurance of nuclear power plants. OPB-88/97" approved by the Ordnance of Gosatomnadzor of Russia dated November 14, 1997. No.9 of the Federal Rules and Regulations in the field of atomic energy use "General Provisions for the Safety of Nuclear Fuel Cycle Facilities" (NP-016-05) approved by the resolution of Rostechnadzor of December 2, 2005 No. 11 (registered by the Ministry of Justice of the Russian Federation on February 1, 2006, registration number 7433); federal rules and regulations in the use of atomic energy "General safety assurance provisions of research nuclear installations" (NP-033-11) approved by decree of Rostechnadzor N 348 dated June 30, 2011 No. 348 (registered by the Ministry of Justice of the Russian Federation on August 29, 2011, registration No. 21700) and federal norms and regulations on the use of atomic energy "Safety in handling radioactive waste. General provisions" (NP-058-14), approved by decree of Rostechnadzor N 347 dated August 5, 2014 (registered with the Ministry of Justice of the Russian Federation on November 14, 2014, registration No. 34701).

2. This Safety Guide contains the methods recommended by the Federal Environmental, Industrial and Nuclear Supervision Service for calculating parameters used to develop standards for permissible discharges of radioactive substances to the atmosphere.

3. This Safety Guide is applicable to the nuclear facilities carrying out radioactive discharges to the atmosphere and releases of radioactive substances to the atmosphere.

4. This Safety Guide is intended for use by organizations that develop standards for permissible discharges of radioactive substances into water bodies, as well as by Rostechnadzor specialists who evaluate and approve standards for permissible discharges of radioactive substances to the atmosphere.

5. The requirements of the Federal Rules and Regulations in the Field of Atomic Energy Use may be implemented through the use of methods other than those specified this Safety Guide subject to substantiation of the selected method.

II. Recommended calculation methods of radiological and meteorological parameters required for development and establishing the standards of maximum permissible discharge of radioactive substances to the atmospheric air

6. The parameters required for the development and establishment of standards for maximum permissible discharges (hereinafter - PD) of radioactive substances into the atmospheric air shall be calculated in accordance with the ratios set out in this Safety Guide.

7. For complying with the requirements of the section III of the Methodology for development and establishment of the standards for maximum permissible discharges of radioactive substances into the atmospheric air approved by the Rostechnadzor order No. 639 dated November 7, 2012 (registered by the Ministry of Justice of the Russian Federation on January 18, 2013, registration N 26595) (hereinafter the Methodology) whereby the transition function is calculated for calculation of the standards of maximum permissible discharges (hereinafter MPD) associating the dose with radionuclide emission (it shall be determined based on the items 8 - 23 of this Safety Guide)

8. The correlation for the calculation of transition function associating the activity of annual radionuclide r discharge from the i-th source with annual effective exposure dose of the public given in the item 14 of the Methodology shall be presented in the following form;

base_1_256438_32768

where: base_1_256438_32769 transition function for calculating the annual dose of external radiation from the cloud, Sv/Bq;

base_1_256438_32770 transition function for calculating the annual dose of external radiation from the radioactive contamination of the ground surface, Sv/Bq

base_1_256438_32771 transition function for calculating the annual dose of internal radiation from inhalation of radionuclides (inhalation route), Sv/Bq;

base_1_256438_32772 transition function for calculating the annual dose of internal radiation from consumption of food products containing radionuclides (peroral route), Sv/Bq;

where is the distance from the source, m;

n - rhumb number determining the propagation direction of the discharge.

9. The transition function base_1_256438_32773 shall be calculated according to the following correlation:

base_1_256438_32774

where: base_1_256438_32775 dose conversion factor during external human exposure from the cloud for the radionuclide r, (Sv·m3)/(sec·Bq);

base_1_256438_32776 average annual meteorological dilution factor in the ground layer for radionuclide r at a distance x from the i-th source in the n-th rhumb, sec/m3.

The recommended calculation procedure of the quantity base_1_256438_32777 is set forth in the items 1 and 2 of Appendix N 1 to this Safety Guide The recommended numerical values of the coefficients base_1_256438_32778 are given in the table 1 of Appendix N 2 of this Safety Guide.

10. The transition function base_1_256438_32779 shall be calculated according to the following formula:

base_1_256438_32780

where: base_1_256438_32781 average annual meteorological factor of radionuclide r dry deposition on the underlying surface at a distance x from the i-th source of discharge in n-th rhumb, m -2;

base_1_256438_32782 average annual meteorological factor of wet clearance of radionuclide r from the cloud on the underlying surface at a distance x from the i-th source of discharge in n-th rhumb, m-2;

base_1_256438_32783 dose conversion factor during external human exposure to radioactively contaminated surface without accounting for depth distribution for radionuclide r, Sv·m2)/(sec·Bq);

base_1_256438_32784 radioactive decay constant of radionuclide r, sec-1;

base_1_256438_32785 dose power decay constant base_1_256438_32786 from the contaminated earth surface by top soil shielding, diffusion deep down and clearing the radionuclides from it by various processes, except radioactive decay, sec-1 (if experimental data is not available it shall be taken as equal to 1.27·10-9 sec-1).

The recommended numerical values of the dose factors base_1_256438_32787 are given in the table 1 (Appendix N 2) of this Safety Guide. The recommended calculation procedure of the quantities base_1_256438_32788 and base_1_256438_32789 is described in the items 3 and 4 of Appendix N 1 to this Safety Guide

11. For the isotopes 234U, 235U и 238U present in the discharge, the transition function base_1_256438_32790 shall be taken as equal to zero. For all other radionuclides present in the discharge these transition functions shall be calculated according to the formulae (2) and (3) of this Safety Guide.

12. The transition function base_1_256438_32791 shall be calculated according to the following formula:

base_1_256438_32792

where: base_1_256438_32793 inhalation intensity for the persons of the age group, which is critical in conformance with SanPiN 2.6.1.2523-09 "Radiation Safety Standards. Sanitary Rules and Regulations", approved by the Decree of the Chief State Health Inspector of the Russian Federation dated July 7, 2009 No. 47 (registered by the Ministry of Justice of the Russian Federation registration No. 14534 dated August 14, 2009) (hereinafter NRB-99/2009), for radionuclide r intake due to inhalation, m3/sec;

base_1_256438_32794 dose conversion factor in inhalation of radionuclide r in accordance with the table of Appendix No. 2 to NRB-99/2009, Sv/Bq.

base_1_256438_32795 average annual meteorological dilution factor in the ground layer for radionuclide r at a distance x from the i-th source in the n-th rhumb, sec/m3.

The recommended values base_1_256438_32796 for different age groups of the population are given in the table 2 of Appendix N 2 to this Safety Guide.

13. The transition function base_1_256438_32797 for inert radioactive gases shall be calculated according to the following formula:

base_1_256438_32798

where: base_1_256438_32799 dose conversion factor on inhalation for r-th radionuclide classified in the group of inert radioactive gases, (Sv·m3)/(sec·Bq).

The recommended values base_1_256438_32800 are given in the table 6 of Appendix No. 2 to this Safety Guide.

14. The transition function base_1_256438_32801 for all the radionuclides excluding 3Н and 14С shall be calculated according to the following formula:

base_1_256438_32802

where: Ir,f - annual consumption of product f by a person from the age group, which is critical in ingestion intake of radionuclide r with food products (three groups of food products shall be highlighted viz, milk, meat, vegetables), kg/year;

base_1_256438_32803 dose conversion factor in ingestion intake of radionuclide r in accordance with the table of Appendix No. 2 to NRB-99/2009, Sv/Bq;

base_1_256438_32804 transition factor "fallout from the atmosphere" - intake in the product" of radionuclide r along the air route calculated for vegetable, milk and meat food chains, m22·year/kg;

base_1_256438_32805 transition factor "fallout from the atmosphere" - intake in the product" of radionuclide r along the root route calculated for vegetable, milk and meat food chains, m22·year/kg;

base_1_256438_32806 average annual meteorological factor of radionuclide r dry deposition on the underlying surface at a distance x from the i-th source of discharge in n-th rhumb, m -2;

base_1_256438_32807 average annual meteorological factor of wet clearance of radionuclide r from the cloud on the underlying surface at a distance x from the i-th source of discharge in n-th rhumb, m-2;

15. The transition factors for vegetable chain shall be calculated according to the following formulae:

base_1_256438_32808

base_1_256438_32809

where: base_1_256438_32810 retention factor for vegetables consumed by a person with food, shall be taken as equal to 0.3 m2/kg of wet weight;

te - the period of time (during the growing season) during which radioactive fallout is captured by the plant surface (if there are no data of local field studies, it shall be taken as equal to 30 days);

base_1_256438_32811 decay constant of radionuclide r, day-1;

base_1_256438_32812 - a constant value that characterizes the decrease in the content of radionuclides on the plant surface due to all processes, with the exception of radioactive decay (if there are no experimental data shall be taken as equal to 0.05 day-1);

base_1_256438_32813 a constant value that characterizes the decrease in the content of radionuclides in the soil root layer due to all processes, with the exception of radioactive decay (if there are no experimental data shall be taken as equal to 0.00014 day-1 for caesium and strontium isotopes, and equal to zero for the rest of radionuclides);

base_1_256438_32814 transition factor of radionuclide r from the root soil layer into the edible part of the plant, kg (of dry soil)/kg (of wet mass of the plant);

tb - parameter equal to 1.1·104 days (30 years);

base_1_256438_32815 - surface density of the topsoil (if there are no experimental data shall be taken as equal to 260 kg/m2 for soil used for pasture, and 130 kg/m2 - for soil use for growing horticultural crops);

th - time between harvesting and consumption of fruit and vegetable crops (if there are no experimental data shall be taken as equal to 90 days).

16. For the isotopes 234U, 235U and 238U present in the discharge, the transition factors for the vegetable chain shall be calculated according to the following formulae:

base_1_256438_32816

base_1_256438_32817

For the remaining radionuclides present in the discharge, the transition factors for the vegetable chain shall be calculated according to the formulae (7) and (8) to this Safety Guide.

17. The transition factors for milk and meat chains shall be calculated according to the following formulae:

base_1_256438_32818

base_1_256438_32819

base_1_256438_32820

base_1_256438_32821

where: base_1_256438_32822 decay constant, days.-1;

base_1_256438_32823 daily weight of forage consumed by dairy cattle (if there are no actual data shall be taken as equal to 16 kg (of dry matter)/day);

base_1_256438_32824 daily weight of forage consumed by meat cattle (if there are no actual data shall be taken as equal to 12 kg (of dry matter)/day);

base_1_256438_32825 activity fraction of radionuclide r, which enters a litre of milk from the daily consumption of forage by cattle, days./l;

base_1_256438_32826 activity fraction of radionuclide r, which enters a kilogram of meat from the daily consumption of forage by cattle, days./l;

tm - time between milking and milk consumption (if there are no actual data shall be taken as equal to 1 day);

tf - time between cattle slaughtering and meat consumption (if there are no actual data shall be taken as equal to 20 days);

base_1_256438_32827 transition factor "fall-out from the atmosphere - intake into the forage" of radionuclide r along the air route, m2·year/kg;

base_1_256438_32828 transition factor "fall-out from the atmosphere - intake into the forage" of radionuclide r along the root route, m2·year/kg;

18. The values base_1_256438_32829 shall be calculated according to the following formulae:

base_1_256438_32830

base_1_256438_32831

where: factor base_1_256438_32832 calculated similarly to the factor base_1_256438_32833 with the following parameters: th = 0, te = 30 days, using the parameter base_1_256438_32834 equal to 3 m2/kg (dry weight), rather than base_1_256438_32835

factor base_1_256438_32836 calculated similarly to the factor base_1_256438_32837 with the following parameters: th = 90 days, te = 30 days, using the parameter base_1_256438_32838 equal to 3 m2/kg (dry weight), rather than base_1_256438_32839

factor base_1_256438_32840 calculated similarly to the factor base_1_256438_32841 with the following parameters: th = 0, using base_1_256438_32842 rather than base_1_256438_32843

factor base_1_256438_32844 calculated similarly to the factor base_1_256438_32845 with the following parameters: th = 90 days using base_1_256438_32846 rather than base_1_256438_32847

where fp - the share of a year, for which the cattle feeds on grass (in case of the absence of data of local field studies, shall be taken as equal to 0.7);

The recommended values base_1_256438_32848 are given in the table 2 of Appendix No. 4 of this Safety Guide.

19. The annual consumptions of food products by persons from various age groups shall be considered in the calculations according to the following formula:

base_1_256438_32849

where: g - age group in accordance with NRB-99/2009 (this variable takes the following values: 2 - children of age 1 - 2 years; 3 - children of age 2 - 7 years; 4 - children of age 7 - 12 years; 5 - children of age 12 - 17 years; 6 - adults (above 17 years);

Eg - daily energy expenditure for age group g, kcal/day;

Eg=6 - daily energy expenditure for age group "adults", kcal/day;

If,g=6 - annual consumption of product f by a person from age group "adults", kg/year.

If there are no actual data, the annual consumption of food products by a person from the age group "adults" shall be taken according to the table 4 of Appendix N 2 to this Safety Guide, daily energy expenditures for the age groups in accordance with the table 5 of Appendix N 2 to this Safety Guide.

20. Within the sanitary protection zone (hereinafter SPZ) shall be taken as equal to zero base_1_256438_32850 if no permit of the State sanitary and epidemiological supervision body is available for use of the agricultural lands and positive sanitary and epidemiological report for the produced product in accordance with the item 5.4 of SP 2.6.1.2216-07 "2.6.1. Ionizing radiation, radiation safety. Sanitary protection zones and surveillance areas of radiation facilities. Operation conditions and justification of the boundaries (SP SPZ and SZ-07)" approved by the Ordnance of the Chief State Public Health Officer of the Russian Federation No. 30 dated May 29, 2007 (registered by the Ministry of Justice of the Russian Federation on June 27, 2007, registration No. 9727), and if the food products and forage for the cattle in SPZ is not produced and if cattle are not grazed in the SPZ territory.

21. The transition function linking the activity of SZ discharge from i-th source with annual effective exposure dose of the public from intake of tritium by inhalation, ingestion and through the skin covering shall be calculated according to the following formula:

base_1_256438_32851

where: base_1_256438_32852 dose factor for tritium, Sv·l/(Bq·year), which shall be taken if there are no experimental data equal to 2.6·10-8 (Sv·l)/(Bq·year);

H - absolute humidity of air, l/m3;

base_1_256438_32853 average annual meteorological dilution factor for tritium, sec/m3.

22. The transition function associating the activity of 14C discharge from the i-th source with annual effective exposure dose of the public by impact of carbon entering the human organism through the peroral route shall be determined as follows:

base_1_256438_32854

where: base_1_256438_32855 dose factor for carbon, Sv·g/(Bq·year), which shall be taken if there are no experimental data as equal to 5.6·10-5 (Sv·l)/(Bq·year);

base_1_256438_32856 parameter, which shall be taken as equal to 1.8·10-1 g/m3;

base_1_256438_32857 - average annual meteorological dilution factor for carbon, sec/m3.

23. In calculating the transition function for 3H and 154C due to discharges from the point source the jet depletion factor due to radioactive decay, dry deposition and wash-out by atmospheric precipitation in the formulae (1) and (2) of Appendix No. 1 to this Safety Guide shall be taken as equal to 1.

III. The recommendations for determining the radionuclide composition of the discharges subject to standardization for development of the maximum permissible emission limits

24. For determining radionuclides contained in the discharges and subject to standardization in accordance with the item 7 of the Procedure for establishing the sources of hazardous (contaminated) substances discharges to the atmosphere, subject to state record keeping and standardization approved by the order of the Ministry of Natural Resources and Environment of the Russian Federation N 579 (registered by the Ministry of Justice of the Russian Federation on February 9, 2011, registration No. 19753) the items of this section shall be considered.

25. The list of radionuclides subject to standardization shall be determined in several stages:

1) for each radionuclide included in the scope of discharge from this source determine the value of the ratio of maximum annual effective exposure dose of the population caused by this radionuclide to the annual effective dose caused by all the radionuclides discharged from this source;

2) perform summation of the ratios of doses in the descending order of their values until reaching the value sum greater or equal to 0.99;

3) determine the list of radionuclides subject to standardization by the number of ratios included in the list of those, the sum thereof is greater or equal to 0.99.

26. The following shall be recommended for determining the list of radionuclides subject to standardization without performing complex calculations:

1) for each radionuclide r included in the scope of discharge from the source i, calculate the ratio:

base_1_256438_32858

where: base_1_256438_32859 either base_1_256438_32860 or radionuclide r is different from 3H and 14C, or base_1_256438_32861 if the radionuclide r is 3H or 14C, Sv/year;

base_1_256438_32862 annual effective dose of the external exposure from the cloud caused by this radionuclide calculated considering the dilution in the tube, Sv/year;

base_1_256438_32863 annual effective dose of external exposure due to radioactive contamination of ground surface caused by this radionuclide calculated considering the dilution i the tube, Sv/year;

base_1_256438_32864 annual effective dose of the internal exposure from inhalation of radionuclides caused by this radionuclide calculated considering the dilution in the tube, Sv/year;

base_1_256438_32865 annual effective dose of internal exposure due to consumption of food products caused by this radionuclide calculated considering the dilution in the tube, Sv/year;

base_1_256438_32866 annual effective exposure dose caused by the action of tritium, Sv/year;

base_1_256438_32867 annual effective exposure dose caused by the carbon impact, Sv/year;

2) perform summation of the ratios of doses in the descending order of their values until reaching the value sum greater or equal to 0.99;

3) determine the list of radionuclides subject to standardization by the number of ratios included in the list of those, the sum thereof is greater or equal to 0.99.

27. The annual effective external exposure dose from the cloud for all the radionuclides, except 3H and 14C shall be calculated according to the formula:

base_1_256438_32868

where: base_1_256438_32869 dose conversion factor during external human exposure from the cloud for the radionuclide r, (Sv·m3)/(sec·Bq);

base_1_256438_32870 average annual emission rate, Bq/sec;

Wi - gas-air mixture discharge rate, m3/c

3.15·107 - second count a year.

28. The annual effective external exposure dose due to radioactive contamination of ground surface for all the radionuclides, except 3H and 14C shall be calculated according to the formula:

base_1_256438_32871

where: base_1_256438_32872 dry deposition rate of radionuclide r on the underlying surface (determine according to the recommendations of Appendix No. 3 to this Safety Guide), m/sec;

base_1_256438_32873 dose conversion factor during external human exposure to radioactively contaminated surface without accounting for depth distribution for radionuclide r, Sv·m2)/(sec·Bq);

base_1_256438_32874 radioactive decay constant of radionuclide r, sec-1;

base_1_256438_32875 average annual emission rate, Bq/sec;

Wi - gas-air mixture discharge rate, m3/c

3.15·107 - second count a year.

29. The annual effective external exposure dose due to inhalation for all the radionuclides, except 3H and 14C shall be calculated according to the formula:

base_1_256438_32876

where: base_1_256438_32877 intensity of inhalation for the persons of age group, which according to NRB-99/2009 is critical for radionuclide r intake due to inhalation, m3/sec;

base_1_256438_32878 dose conversion factor in inhalation of radionuclide r in accordance with the table of Appendix No. 2 to NRB-99/2009, Sv/Bq.

base_1_256438_32879 average annual emission rate, Bq/sec;

Wi - gas-air mixture discharge rate, m3/c

3.15·107 - second count a year.

30. The annual effective external exposure dose due to consumption of food products containing radionuclides, except 3H and 14C shall be calculated according to the formula:

base_1_256438_32880

where: base_1_256438_32881 dry deposition rate of radionuclide r on the underlying surface (determine according to the recommendations of Appendix No. 3 to this Safety Guide), m/sec;

base_1_256438_32882 average annual emission rate, Bq/sec;

Wi - gas-air mixture discharge rate, m3/c

Ir,f - annual consumption of food product f by a person from the age group, which is critical for ingestion intake of radionuclide r with the food products, kg/year;

base_1_256438_32883 dose conversion factor in ingestion intake of radionuclide r in accordance with the table of Appendix No. 2 to NRB-99/2009, Sv/Bq;

base_1_256438_32884 transition factor "fall-out from the atmosphere - air route intake into the product" of radionuclide r in the food product, m2·year/kg;

base_1_256438_32885 transition factor "fall-out from the atmosphere - root route intake into the product" of radionuclide r in the food product, m2·year/kg;

31. Annual effective dose (Sv/year) due to impact of tritium and carbon radionuclides shall be calculated according to the formulae:

base_1_256438_32886

base_1_256438_32887

where: Wi - gas-air mixture discharge rate, m3/c

base_1_256438_32888 annual discharge 3H from i-th source, Bq/year;

base_1_256438_32889 annual discharge 14C from the i-th source, Bq/year;

H - absolute humidity of air, l/m3;

base_1_256438_32890 parameter, which shall be taken as equal to 1.8·10-1 g/m3;

base_1_256438_32891 dose factor for tritium, Sv·l/(Bq·year), which shall be taken if there are no experimental data equal to 2.6·10-8 (Sv·l)/(Bq·year);

base_1_256438_32892 dose factor for carbon, Sv·g/(Bq·year), which shall be taken if there are no experimental data as equal to 5.6·10-5 (Sv·l)/(Bq·year);

IV. Recommendations for use of calculated parameters for calculation of the maximum permissible emission limits

32. Since in accordance with item 7 of the Methodology the maximum admissible discharge limits are stipulated based on the non-exceedence of the part of effective dose limit earmarked (or the limits of each of the equivalent doses), and they shall be calculated using the following correlation:

base_1_256438_32893

where: base_1_256438_32894 maximum admissible discharge limits calculated based on non-exceedence of the part of the maximum annual effective dose;

base_1_256438_32895 maximum admissible discharge limits calculated based on non-exceedence of the part of the maximum annual effective dose in the skin;

base_1_256438_32896 maximum admissible discharge limits calculated based on non-exceedence of the part of the maximum annual effective dose in the lens;

base_1_256438_32897 maximum admissible discharge limits calculated based on non-exceedence of the part of the maximum annual effective dose in the hands;

base_1_256438_32898 maximum admissible discharge limits calculated based on non-exceedence of the part of the maximum annual effective dose in the feet;

Norms base_1_256438_32899 where k - index of the organ or tissues taking the value: 1 - for skin, 2 - for eye lens, 3 - for the hands, 4 - for the feet, shall be calculated according to the formulae (28) and (29):

base_1_256438_32900

base_1_256438_32901

where: base_1_256438_32902 relative contribution of each radionuclide r in the total activity of its discharge from the i-th source, which shall be calculated according to the formula (30):

base_1_256438_32903

base_1_256438_32904 part of the effective dose limit for the public, Sv/year;

base_1_256438_32905 part of the effective dose limit in the eye lens, skin,, hands and feet respectively, Sv/year, calculated (if it was not stipulated by the agencies carrying out sanitary and epidemiological supervision) according to the formula (31):

base_1_256438_32906

where: DL - annual effective dose limit for the public in accordance with the table 3.1 NRB-99/2009;

DLk - annual effective dose limit in the k-th organ or tissue for the public in accordance with the table 3.1 NRB-99/2009;

xmax and ymax - Cartesian ordinates of the point of maximum annual effective dose, m;

base_1_256438_32907 Cartesian ordinates of the points of maximum annual effective dose in the eye lens, skin, hands and feet, m;

base_1_256438_32908 transit function associating the discharge activity with the annual effective exposure dose of the public or equivalent dose in k-th organ or tissue, depending on Cartesian ordinates and determined by the correlations:

base_1_256438_32909

base_1_256438_32910

where base_1_256438_32911 transformation operator of the axis set "distance from the source, direction" (x,n) to Cartesian ordinates set (x,y).

18. The functional base_1_256438_32912 shall be calculated according to the following formulae:

base_1_256438_32913

where: base_1_256438_32914 dose factor, designed for conversion calculation of the unit radionuclide concentration in the surface air to equivalent dose intensity in k-th organ or tissue, Sv·m3/(Bq·sec);

base_1_256438_32915 dose factor, designed for conversion calculation of the unit surface concentration of radionuclide r on the ground surface to equivalent dose intensity in k-th organ or tissue, Sv·m3/(Bq·sec);

base_1_256438_32916 average annual meteorological dilution factor in the ground layer for radionuclide r at a distance x from the i-th source of discharge in the n-th rhumb, sec/m3;

base_1_256438_32917 average annual meteorological factor of radionuclide r dry deposition on the underlying surface at a distance x from the i-th source of discharge in n-th rhumb, m-2;

base_1_256438_32918 average annual meteorological factor of wet clearance of radionuclide r on the underlying surface at a distance x from the i-th source of discharge in n-th rhumb, m-2;

base_1_256438_32919 radioactive decay constant of radionuclide r, sec-1;

base_1_256438_32920 decay constant of dose rate with time from the contaminated soil layer due to all the processes, except radioactive decay leading to removal of activity from this layer, sec-1 (shall be taken as equal to 1.27 · 10-9 sec-1) if there are no experimental data.

The recommended values base_1_256438_32921 for the skin are given in the table 1 of Appendix No. 2 to this Safety Guide.

The dose factor values for the eye lens shall be conservatively taken as equal to 0.3 from the value of the relevant dose factors for the skin.

34.If the maximum design value of the annual effective exposure dose of the public caused by the discharges of all sources of the enterprise less that base_1_256438_32922recommended for calculation of the maximum permissible discharge limits use the maximum design value of the annual effective dose rather than base_1_256438_32923

35. For the case of multiple sources distant from each other at a considerable distance and differing by their characteristics the calculation of the maximum permissible discharge limits shall be made using the following algorithm:

1) define a spatial grid of coordinates and in all its nodes calculate the functional base_1_256438_32924 (using the formulae (1) - (6)) for each radionuclide r discharged from each source i;

2) multiply the calculated functionals base_1_256438_32925 in each grid node by the value of actual discharge of base_1_256438_32926r-th radionuclide from the i-th source and perform summation for all the radionuclides and sources, thereby getting the value of the annual effective dose in each spatial grid nodes;

3) select the maximum value of the annual effective dose base_1_256438_32927 and calculated the following ratio base_1_256438_32928

4) determine the quantities base_1_256438_32929 by using the following correlation:

base_1_256438_32930

5) similarly perform the calculation base_1_256438_32931by using the values base_1_256438_32932 rather than base_1_256438_32933 rather than in the formula (35) base_1_256438_32934

36. Since in accordance with the item 7 of the Methodology the maximum permissible discharge limits must be stipulated based on the performance of the fulfilment conditions of the maintenance of favorable conditions for vital activity and stable functioning of the natural environmental system, natural and natural and man-made features, and preservation of the biodiversity for compliance verification of the requirements for limiting the radionuclide content in the natural environment location, the correlations given in the items 37 and 38 of this Safety Guide shall be used.

37. The discharges of radionuclides to the atmospheric air shall not lead to restriction of the use of soil surface layer, if at any location point the following recommended condition is met:

base_1_256438_32935

where: MPDr,i -- value of maximum permissible discharge of the r-th radionuclide from the i-th source, Bq/year'

SAUUr - specific activity of radionuclide r, allowing unrestricted use of the materials stipulated in Appendix 3 to the sanitary rules and regulations SP 2.6.1.2612-10 "Main sanitary regulations for radiation safety assurance" (OSPORB-99/2010) approved by the Ordnance of the Chief State Medical Officer of the Russian Federation No. 40 dated April 26, 2010 (registered by the Ministry of Justice of the Russian Federation on August 11, 2010, registration number No. 18115);

h - thickness of the soil surface layer, shall be taken as equal to 0.1 m;

Fr,i,n (x) - average annual meteorological factor of radionuclide r dry deposition on the underlying surface at a distance x from the i-th source of discharge in n-th rhumb, m-2;

Wr,i,n (x) - average annual meteorological factor of wet clearance of radionuclide r to the underlying surface at a distance x from the i-th source of discharge in n-th rhumb, m-2;

base_1_256438_32936 radioactive decay constant of radionuclide r, sec-1;

base_1_256438_32937 decay constant of dose rate with time from the contaminated soil layer due to all the processes, except radioactive decay leading to removal of activity from this layer, sec-1 (shall be taken as equal to 1.27 · 10-9 sec-1) if there are no experimental data.

base_1_256438_32938 density of the soil surface layer (shall be taken as equal to 130 kg/m2 if there are no experimental data).

The values of SAUUr for the skin are given in the table 7 of Appendix No. 2 to this Safety Guide.

38. The discharges of radionuclides 137Cs and 90Sr in the atmospheric air shall not lead to limitation of the use of local food products if at any location point f-th local food product is manufactures, the following recommended conditions shall be met:

base_1_256438_32939

where: MPDr,i -- value of maximum permissible discharge of the r-th radionuclide from the i-th source, Bq/year'

T - time, equal to one year;

base_1_256438_32940 permitted specific activity of radionuclides 137Cs and 90Sr in f-th food product established by SanPiN 2.3.2.1078-01 "2.3.2. Food raw materials and food products. Hygienic safety requirements and nutritional value of food products" approved by the Ordnance of the Chief State Medical Officer of the Russian Federation No. 36 dated 14 November 2001 (registered by the Ministry of Justice of the Russian Federation on March 22, 2002, registration number No. 3326);

Fr,i,n (x) - average annual meteorological factor of radionuclide r dry deposition on the underlying surface at a distance x from the i-th source of discharge in n-th rhumb, m-2;

Wr,i,n (x) - average annual meteorological factor of wet clearance of radionuclide r to the underlying surface at a distance x from the i-th source of discharge in n-th rhumb, m-2;

Кr,f - transition factor "fallout from the atmosphere" - intake in the product" of radionuclide r calculated for vegetable, milk and meat food chains, m2·year/kg.

39. Calculation example of the parameters required for calculation of maximum permissible discharge limits is given in Appendix No. 4 to this Safety Guide.

V. Recommendations to establish reference levels of discharges of radioactive substances in atmospheric air

40. The calculation methods given in this Safety Guide and Methodology are characterized by the calculation error, hence for compliance control of the maximum permissible discharge limits of those radionuclides, for which following the determination of radionuclide composition of discharges from the source subject to standardization (section III of this Safety Guide) shall require the stipulation of maximum permissible discharge limits, control levels of discharges shall be set, for determining thereof the recommendations of items 41 and 42 of this section of the Safety Guide shall be followed.

1. The annual reference discharge level of r-th radionuclide from i-th source into the atmosphere, (Bq/year), shall be determined using the following correlation:

base_1_256438_32941

where: ПДВr,i is the maximum permissible release of r-radionuclide from i-source into the atmosphere, Bq/year;

X is a dimensionless value that shall be assumed to be greater than or equal to 2.

42. Monthly (Bq/month) and daily (Bq/day) reference discharge levels of r-th radionuclide from i-th source to the atmospheric air shall be determined according to the following correlations:

base_1_256438_32942

base_1_256438_32943

where base_1_256438_32944 annual control level of discharge of the r-th radionuclide, Bq/year.

Appendix No. 1   
to the safety guide in the use of atomic energy "Recommended methods for calculating the parameters necessary for development and stipulation of the limits for maximum permissible discharges of radioactive substances into the atmospheric air" approved by order of the Federal Environmental, Industrial and Nuclear Supervision Service No. 458   
dated November 11, 2015 .

RECOMMENDED CALCULATION PROCEDURE OF DRY DEPOSITION AND WET REMOVAL FACTORS

1. The Gaussian pollutant ventilation model shall be used for calculation of the average annual meteorological factor of dilution. The average annual meteorological factor of dilution in the surface air layer of the radionuclide r at a distance x from the source of discharges in the n-th rhumb under the Gaussian model of dispersion of impurity in the atmosphere is calculated by the formula

base_1_256438_32945

where: j - hierarchy number of the atmospheric stability category determined in accordance with the recommendations of Appendix No. 3 to this Safety Guide;

k - hierarchy number of wind velocity module at the weathercock height (determined in accordance with the recommendations of Appendix No. 3 to this Safety Guide);

n - rhumb number;

N - number of rhumbs;

x is the distance from the source of discharges, m;

Uj,k - wind velocity module at discharge height hs with wind velocity at the weathercock height from the hierarchy k for j-th stability category, m/sec (determined according to recommendations of Appendix No. 3 to this Safety Guide);

base_1_256438_32946 jet dispersion in the horizontal direction at distance x from the source of discharges for j-th category of atmospheric stability (determined according to the recommendations of Appendix 3 to this Safety Guide);

base_1_256438_32947 repeatability of meteorological conditions representing the probability of joint implementation of the wind direction in the rhumb n in stability category j and wind velocity hierarchy k (determined in accordance with the recommendations of Appendix No. 3 to this Safety Guide.

hs - geometric chimney height from where the discharge is made, m;

base_1_256438_32948 jet height above chimney mouth with wind velocity at weathercock height from hierarchy k for j-th category of atmospheric stability due to dynamic and thermal factors, m (determined according to the recommendations of Appendix No. 3 to this Safety Guide);

base_1_256438_32949 Jet depletion factor due to radioactive decay of radionuclide r, dry deposition and wet removal from the atmosphere to the underlying surface (determined according to recommendations of Appendix No. 3 to this Safety Guide).

Kb - share of discharges entering the zone of air shadow behind the building at low discharge, for high sources taken as equal to zero (shall be determined according to the recommendations of Appendix No. 3 to this Safety Guide);

base_1_256438_32950 "virtual" shift quantity of the dispersion characteristics of the share of discharge entering the zone of aerodynamic shadow, m (determined according to the recommendations of Appendix No. 3 to this Safety Guide).

2. If data on joint implementation of wind direction in the rhumb n at stability category j and hierarchy of wind velocity k, the dilution factor shall be calculated as follows:

base_1_256438_32951

where: j - atmospheric stability category number;

n - rhumb number;

N - number of rhumbs;

x is the distance from the source of discharges, m;

base_1_256438_32952 repeatability of wind directions;

base_1_256438_32953 average annual wind speed at the discharge height (m/s);

base_1_256438_32954 - jet dispersion in the vertical direction at distance x from the source of discharges for j-th category of atmospheric stability (determined according to the recommendations of Appendix 3 to this Safety Guide);

hs - geometric chimney height from where the discharge is made, m;

base_1_256438_32955 jet height above chimney mouth with wind velocity at weathercock height from hierarchy k for j-th category of atmospheric stability due to dynamic and thermal factors, m (determined according to the recommendations of Appendix No. 3 to this Safety Guide);

base_1_256438_32956 Jet depletion factor due to radioactive decay of radionuclide r, dry deposition and wet removal from the atmosphere to the underlying surface (determined according to recommendations of Appendix No. 3 to this Safety Guide).

Kb - share of discharges entering the zone of air shadow behind the building at low discharge, for high sources shall be taken as equal to zero (determined according to the recommendations of Appendix No. 3 to this Safety Guide);

base_1_256438_32957 value of "virtual" shift, m (shall be determined according to the recommendations of Appendix No. 3 to this Safety Guide).

3. The average annual meteorological factor of dry deposition of radionuclide r on the underlying surface at a distance x from the distributed source of discharge in the n-th rhumb shall be calculated according to the formula:

base_1_256438_32958

where: base_1_256438_32959 dry deposition rate of radionuclide r on the underlying surface (determine according to the recommendations of Appendix No. 3 to this Safety Guide), m/sec;

base_1_256438_32960 average annual meteorological dilution factor, sec/m3.

4. The average annual meteorological factor of wet clearance of radionuclide r from the cloud on the underlying surface at a distance x from the source of discharges in n-th rhumb, m-2 shall be calculated according to the formula;

base_1_256438_32961

where: base_1_256438_32962 washout constant of radionuclide r from the atmosphere by precipitations averaged for a year considering the precipitation type and duration during a year, sec-1 (shall be determined according to the recommendations of Appendix No. 3 to this Safety Guide);

base_1_256438_32963 integral over vertical coordinate z from the average annual dilution factor dependent on the height above the ground surface, which shall be determined according to the following formula:

base_1_256438_32964

where: j - hierarchy number of the atmospheric stability category (determined in accordance with the recommendations of Appendix No. 3 to this Safety Guide);

k - hierarchy number of wind velocity module at the weathercock height (determined in accordance with the recommendations of Appendix No. 3 to this Safety Guide);

n - rhumb number;

N - number of rhumbs;

x is the distance from the source of discharges, m;

Uj,k - wind velocity module at discharge height hs with wind velocity at the weathercock height from the hierarchy k for j-th stability category, m/sec (determined according to recommendations of Appendix No. 3 to this Safety Guide);

base_1_256438_32965 jet dispersion in the horizontal direction at distance x from the source of discharges for j-th category of atmospheric stability (determined according to the recommendations of Appendix 3 to this Safety Guide);

base_1_256438_32966 repeatability of meteorological conditions representing the probability of joint implementation of the wind direction in the rhumb n in stability category j and wind velocity hierarchy k (determined in accordance with the recommendations of Appendix No. 3 to this Safety Guide.

base_1_256438_32967 Jet depletion factor due to radioactive decay of radionuclide r, dry deposition and wet removal from the atmosphere to the underlying surface (determined according to recommendations of Appendix No. 3 to this Safety Guide).

5. Average annual meteorological dilution factor at a distance x from the distributed source of discharge in n-th rhumb, sec/m3 shall be determined as follows:

base_1_256438_32968

where: S - area of distributed source surface, m2;

a - half the side length of the distributed source, m;

Uk - wind velocity at weather cock height, m/sec;

x - distance from the center of the distributed source along the wind direction, m;

base_1_256438_32969 jet dispersion in the horizontal direction at distance x from the source of discharges for j-th category of atmospheric stability (determined according to the recommendations of Appendix 3 to this Safety Guide);

base_1_256438_32970 integration variable, m;

Pj(z,x) - function determined by the following correlation:

base_1_256438_32971

where: H - height of mixing layer (shall be taken as equal to 100 m);

z - height above the ground surface (shall be taken as equal to 1 m);

n - summation variable.

6. The average annual meteorological factor of wet clearance of radionuclide r from the cloud on the underlying surface at a distance x from the distributed source of discharges in n-th rhumb, m-2 shall be calculated according to the formula;

base_1_256438_32972

where: base_1_256438_32973 constant of pollutant washout from atmospheric precipitations averaged for a year considering the precipitation type and duration during a year, sec- (shall be determiend according to the recommendations of Appendix No. 3 to this Safety Guide);

Uj,k - wind velocity module at discharge height hs with wind velocity at the weathercock height from the hierarchy k for j-th stability category, m/sec (determined according to recommendations of Appendix No. 3 to this Safety Guide);

base_1_256438_32974 repeatability of meteorological conditions representing the probability of joint implementation of the wind direction in the rhumb n in stability category j and wind velocity hierarchy k (determined in accordance with the recommendations of Appendix No. 3 to this Safety Guide.

x is the distance from the source of discharges, m;

base_1_256438_32975 jet dispersion in the horizontal direction at distance x from the source of discharges for j-th category of atmospheric stability (determined according to the recommendations of Appendix 3 to this Safety Guide);

j - hierarchy number of the atmospheric stability category determined in accordance with the recommendations of Appendix No. 3 to this Safety Guide;

k - hierarchy number of wind velocity module at the weathercock height determined in accordance with the recommendations of Appendix No. 3 to this Safety Guide;

n - rhumb number.

7. The average annual meteorological factor of dry deposition of radionuclide r on the underlying surface at a distance x from the distributed source of discharge in the n-th rhumb shall be calculated according to the formula;

base_1_256438_32976

where: base_1_256438_32977 dry deposition rate of radionuclide r on the underlying surface (determine according to the recommendations of Appendix No. 3 to this Safety Guide), m/sec;

Uj,k - wind velocity module at discharge height hs with wind velocity at the weathercock height from the hierarchy k for j-th stability category, m/sec (determined according to recommendations of Appendix No. 3 to this Safety Guide);

base_1_256438_32978 repeatability of meteorological conditions representing the probability of joint implementation of the wind direction in the rhumb n in stability category j and wind velocity hierarchy k (determined in accordance with the recommendations of Appendix No. 3 to this Safety Guide.

x is the distance from the source of discharges, m;

base_1_256438_32979 jet dispersion in the horizontal direction at distance x from the source of discharges for j-th category of atmospheric stability (determined according to the recommendations of Appendix 3 to this Safety Guide);

j - hierarchy number of the atmospheric stability category determined in accordance with the recommendations of Appendix No. 3 to this Safety Guide;

k - hierarchy number of wind velocity module at the weathercock height determined in accordance with the recommendations of Appendix No. 3 to this Safety Guide);

n - rhumb number.

8. Recommendations for accounting for the initial dilution of discharge and accounting of the impact of buildings during the discharges from low sources are described in Appendix No. 3 to this Safety Guide.

Appendix No. 2   
to the safety guide in the use of atomic energy "Recommended methods for calculating the parameters necessary for development and stipulation of the limits for maximum permissible discharges of radioactive substances into the atmospheric air" approved by order of the Federal Environmental, Industrial and Nuclear Supervision Service   
No. 458 dated November 11, 2015 .

RECOMMENDED VALUES OF PARAMETERS USED IN CALCULATING HUMAN EXPOSURE DOSES

The data from the tables 1 - 6 to this Safety Guide shall be used for calculating the transition functions.

Table 1

RECOMMENDED VALUES OF DOSE FACTORS <\*>

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Radionuclide | base_1_256438_32980 <\*\*> base_1_256438_32981 | base_1_256438_32982 <\*\*\*> base_1_256438_32983 | base_1_256438_32984 <\*\*> base_1_256438_32985 | base_1_256438_32986 <\*\*\*> base_1_256438_32987 |
| 223Aс | 1.87·10-16 | 4.42·10-18 | 3.05·10-16 | 1.62·10-17 |
| 224Ac | 8.01·10-15 | 1.77·10-16 | 1.08·10-14 | 2.54·10-16 |
| 225Ac | 6.37·10-16 | 1.47·10-17 | 9.40·10-16 | 3.08·10-17 |
| 226Ac | 5.57·10-15 | 1.35·10-16 | 2.15·10-14 | 1.84·10-15 |
| 227Ac | 5.12·10-18 | 1.41·10-19 | 1.10·10-17 | 7.43·10-19 |
| 228Ac | 4.49·10-14 | 9.39·10-16 | 7,88·10-14 | 4,75·10-15 |
| 102Ag | 1,57·10-13 | 3,19·10-15 | 2,45·10-13 | 1,28·10-14 |
| 103Ag | 3,43·10-14 | 7,45·10-16 | 5,84·10-14 | 3,86·10-15 |
| 104Ag | 1,23·10-13 | 2,52·10-15 | 1.56·10-13 | 3,97·10-15 |
| 104mAg | 5,48·10-14 | 1,14·10-15 | 1,00·10-13 | 6,86·10-15 |
| 105Ag | 2,26·10-14 | 4,9·10-16 | 2,90·10-14 | 6,70·10-16 |
| 106Ag | 3,18·10-14 | 7,41·10-16 | 7,27·10-14 | 6,96·10-15 |
| 106mAg | 1,29·10-13 | 2,64·10-15 | 1,58·10-13 | 3,32·10-15 |
| 108Ag | 1.25·10-15 | 8.96·10-17 | 4,00·10-14 | 7,07·10-15 |
| 108mAg | 7,24·10-14 | 1,55·10-15 | 9,05·10-14 | 2,00·10-15 |
| 109mAg | 1,59·10-16 | 7,52·10-18 | 5,59·10-16 | 3,28·10-17 |
| 110Ag | 2,46·10-15 | 1,63·10-16 | 8,22·10-14 | 1,27·10-14 |
| 110mAg | 1,27·10-13 | 2,58·10-15 | 1,57·10-13 | 3,22·10-15 |
| 111Ag | 1,38·10-15 | 5,28·10-17 | 2.19·10-14 | 2,75·10-15 |
| 112Ag | 3,23·10-14 | 7,46·10-16 | 1,33·10-13 | 1,38·10-14 |
| 115Ag | 3,46·10-14 | 7,5·10-16 | 1,11·10-13 | 1,15·10-14 |
| 26Al | 1,28·10-13 | 2,47·10-15 | 1,81·10-13 | 7,88·10-15 |
| 28Al | 8,87·10-14 | 1,71·10-15 | 1,88·10-13 | 1.51·10-14 |
| 237Am | 1,55·10-14 | 3,38·10-16 | 2,14·10-14 | 4,94·10-16 |
| 238Am | 4,04·10-14 | 8,27·10-16 | 5,09·10-14 | 1.31·10-15 |
| 239Am | 9,26·10-15 | 2,08·10-16 | 1,56·10-14 | 3,39·10-16 |
| 240Am | 4,67·10-14 | 9,57·10-16 | 5,79·10-14 | 1,39·10-15 |
| 241Am | 6,74·10-16 | 2,33·10-17 | 1,28·10-15 | 8,32·10-17 |
| 242Am | 6,09·10-16 | 1,61·10-17 | 8,20·10-15 | 2,55·10-16 |
| 242mAm | 2,49·10-17 | 2,26·10-18 | 1,36·10-16 | 2,41·10-17 |
| 243Am | 1,85·10-15 | 4,79·10-17 | 2,75·10-15 | 7,60·10-17 |
| 244Am | 3,59·10-14 | 7,6·10-16 | 5,25·10-14 | 1,57·10-15 |
| 244mAm | 3,63·10-16 | 5,55·10-17 | 3,11·10-14 | 5,34·10-15 |
| 245Am | 1,45·10-15 | 4,12·10-17 | 1,62·10-14 | 1.25·10-15 |
| 246Am | 3,06·10-14 | 6,8·10-16 | 6,42·10-14 | 3,92·10-15 |
| 246mAm | 4,74·10-14 | 9,95·10-16 | 8,56·10-14 | 5,72·10-15 |
| 39Ar | 1,15·10-16 | 2,53·10-18 | 1.07·10-14 | 2,24·10-16 |
| 41Ar | 6,14·10-14 | 1,22·10-15 | 1.01·10-13 | 6,04·10-15 |
| 69As | 4,61·10-14 | 1,11·10-15 | 1,43·10-13 | 1,46·10-14 |
| 70As | 1,92·10-13 | 3,9·10-15 | 2,89·10-13 | 1,47·10-14 |
| 71As | 2,53·10-14 | 5,42·10-16 | 3,78·10-14 | 1,22·10-15 |
| 72As | 8,26·10-14 | 1,81·10-15 | 1,70·10-13 | 1.33·10-14 |
| 73As | 1,55·10-16 | 5,18·10-18 | 2,78·10-16 | 1,55·10-17 |
| 74As | 3,4·10-14 | 7,47·10-16 | 5,80·10-14 | 3,23·10-15 |
| 76As | 2,06·10-14 | 5,24·10-16 | 9,61·10-14 | 1,18·10-14 |
| 77As | 5,09·10-16 | 1,41·10-17 | 1,20·10-14 | 5,63·10-16 |
| 78As | 6,03·10-14 | 1,29·10-15 | 1,65·10-13 | 1,40·10-14 |
| 207At | 6,09·10-14 | 1,22·10-15 | 7,76·10-14 | 1,70·10-15 |
| 211At | 1,37·10-15 | 3,32·10-17 | 1,96·10-15 | 5,47·10-17 |
| 215At | 8,51·10-18 | 1,84·10-19 | 1,12·10-17 | 2,30·10-19 |
| 216At | 5,38·10-17 | 1,29·10-18 | 8,03·10-17 | 1,96·10-18 |
| 217At | 1,37·10-17 | 2,93·10-19 | 1,86·10-17 | 4,11·10-19 |
| 218At | 9,71·10-17 | 3,64·10-18 | 2,12·10-16 | 2,32·10-17 |
| 193Au | 6,03·10-15 | 1,42·10-16 | 9,16·10-15 | 1,93·10-16 |
| 194Au | 4,94·10-14 | 9,72·10-16 | 6,19·10-14 | 1,35·10-15 |
| 195Au | 2,73·10-15 | 7,05·10-17 | 4,12·10-15 | 1,09·10-16 |
| 195mAu | 8,52·10-15 | 1,84·10-16 | 1,35·10-14 | 2,42·10-16 |
| 198Au | 1,81·10-14 | 4,07·10-16 | 4,08·10-14 | 2,53·10-15 |
| 198mAu | 2,39·10-14 | 5,23·10-16 | 3,75·10-14 | 6,66·10-16 |
| 199Au | 3,67·10-15 | 7,97·10-17 | 8.23·10-15 | 1,04·10-16 |
| 200Au | 1,32·10-14 | 3,37·10-16 | 6,36·10-14 | 8,43·10-15 |
| 200mAu | 9,32·10-14 | 1,98·10-15 | 1,27·10-13 | 2,79·10-15 |
| 201Au | 2,62·10-15 | 9,03·10-17 | 2.78·10-14 | 3,95·10-15 |
| 126Ba | 6,41·10-15 | 1,51·10-16 | 9,26·10-15 | 2,66·10-16 |
| 128Ba | 2,54·10-15 | 6,78·10-17 | 3,85·10-15 | 1,17·10-16 |
| 131Ba | 1,92·10-14 | 4,29·10-16 | 2,55·10-14 | 5,89·10-16 |
| 131mBa | 2,64·10-15 | 6,7·10-17 | 3.94·10-15 | 9,99·10-17 |
| 133Ba | 1,62·10-14 | 3,73·10-16 | 2.19·10-14 | 5,13·10-16 |
| 133mBa | 2.44·10-15 | 5,97·10-17 | 1,36·10-14 | 9,65·10-17 |
| 135mBa | 2.16·10-15 | 5,38·10-17 | 1.30·10-14 | 8,86·10-17 |
| 137mBa | 2,69·10-14 | 5,79·10-16 | 3,73·10-14 | 1,65·10-15 |
| 139Ba | 2,54·10-15 | 1,46·10-16 | 6,16·10-14 | 1,03·10-14 |
| 140Ba | 8,07·10-15 | 1,9·10-16 | 2,52·10-14 | 1,95·10-15 |
| 141Ba | 3,92·10-14 | 8,86·10-16 | 1,07·10-13 | 1,06·10-14 |
| 142Ba | 4,84·10-14 | 1,01·10-15 | 8,37·10-14 | 4,80·10-15 |
| 10Be | 1,38·10-16 | 3,41·10-18 | 1,29·10-14 | 3,06·10-16 |
| 7Be | 2,19·10-15 | 4,72·10-17 | 2,74·10-15 | 5,83·10-17 |
| 200Bi | 1,08·10-13 | 2,26·10-15 | 1,43·10-13 | 4,15·10-15 |
| 201Bi | 6,08·10-14 | 1,28·10-15 | 8,99·10-14 | 4,69·10-15 |
| 202Bi | 1,24·10-13 | 2,54·10-15 | 1,57·10-13 | 3,75·10-15 |
| 203Bi | 1,13·10-13 | 2,18·10-15 | 1,39·10-13 | 3,32·10-15 |
| 205Bi | 7,98·10-14 | 1,54·10-15 | 9,7·10-14 | 2,03·10-15 |
| 206Bi | 1,51·10-13 | 3,06·10-15 | 1,90·10-13 | 4,25·10-15 |
| 207Bi | 7,04·10-14 | 1,45·10-15 | 9,31·10-14 | 3,18·10-15 |
| 210Bi | 2,58·10-16 | 3,51·10-17 | 2,30·10-14 | 3,42·10-15 |
| 210mBi | 1.12·10-14 | 2,4·10-16 | 1,63·10-14 | 3,13·10-16 |
| 211Bi | 2,04·10-15 | 4,4·10-17 | 3,07·10-15 | 5,55·10-17 |
| 212Bi | 8,95·10-15 | 2,25·10-16 | 4,05·10-14 | 5,35·10-15 |
| 213Bi | 6,16·10-15 | 1,68·10-16 | 3,39·10-14 | 4,23·10-15 |
| 214Bi | 7,25·10-14 | 1,44·10-15 | 1,28·10-13 | 8,48·10-15 |
| 245Bk | 9,26·10-15 | 2,06·10-16 | 1,58·10-14 | 3.14·10-16 |
| 246Bk | 4,27·10-14 | 8,88·10-16 | 5,31·10-14 | 1.25·10-15 |
| 247Bk | 4,2·10-15 | 9,42·10-17 | 7,43·10-15 | 1,29·10-16 |
| 249Bk | 4,68·10-19 | 5,34·10-21 | 4,07·10-17 | 3,80·10-20 |
| 250Bk | 4,12·10-14 | 8,43·10-16 | 6,43·10-14 | 2,40·10-15 |
| 74Br | 2,26·10-13 | 4,05·10-15 | 3,40·10-13 | 1,58·10-14 |
| 74mBr | 1,96·10-13 | 3,82·10-15 | 3,31·10-13 | 1.74·10-14 |
| 75Br | 5,43·10-14 | 1,22·10-15 | 1.01·10-13 | 7,59·10-15 |
| 76Br | 1,26·10-13 | 2.44·10-15 | 1,97·10-13 | 9,52·10-15 |
| 77Br | 1,4·10-14 | 2,99·10-16 | 1,77·10-14 | 4,05·10-16 |
| 80Br | 3,73·10-15 | 1,04·10-16 | 2,02·10-14 | 2,80·10-15 |
| 80mBr | 2,37·10-16 | 1,37·10-17 | 7,13·10-16 | 8,46·10-17 |
| 82Br | 1,21·10-13 | 2.48·10-15 | 1,54·10-13 | 3,05·10-15 |
| 83Br | 5,34·10-16 | 2,86·10-17 | 1.85·10-14 | 2.09·10-15 |
| 84Br | 9,02·10-14 | 1,67·10-15 | 1,88·10-13 | 1,28·10-14 |
| 11C | 4,56·10-14 | 1,01·10-15 | 7,91·10-14 | 4,15·10-15 |
| 45Ca | 1,53·10-17 | 3,77·10-20 | 1.46·10-15 | 1,61·10-19 |
| 47Ca | 5,06·10-14 | 1·10-15 | 8,02·10-14 | 3,42·10-15 |
| 49Ca | 1.66·10-13 | 2,67·10-15 | 2,46·10-13 | 1.30·10-14 |
| 104Cd | 1,04·10-14 | 2,36·10-16 | 1,38·10-14 | 3,63·10-16 |
| 107Cd | 5.11·10-16 | 2,33·10-17 | 1,50·10-15 | 1,02·10-16 |
| 109Cd | 2,28·10-16 | 1,66·10-17 | 9,95·10-16 | 8,95·10-17 |
| 113Cd | 2,53·10-17 | 5,8·10-20 | 2,41·10-15 | 2,19·10-19 |
| 113mCd | 9,06·10-17 | 1,77·10-18 | 8,48·10-15 | 1,55·10-16 |
| 115Cd | 1,05·10-14 | 2.43·10-16 | 2,97·10-14 | 2,28·10-15 |
| 115mCd | 1,48·10-15 | 9,24·10-17 | 3.99·10-14 | 7,00·10-15 |
| 117Cd | 5,14·10-14 | 1.04·10-15 | 8,79·10-14 | 5,15·10-15 |
| 117mCd | 9,89·10-14 | 1,85·10-15 | 1,29·10-13 | 3,12·10-15 |
| 134Ce | 3,52·10-16 | 2,15·10-17 | 9,60·10-16 | 5,5·10-17 |
| 135Ce | 7,93·10-14 | 1,7·10-15 | 1,10·10-13 | 2,73·10-15 |
| 137Ce | 7,3·10-16 | 2,98·10-17 | 1,45·10-15 | 6,64·10-17 |
| 137mCe | 1,83·10-15 | 4,72·10-17 | 1,20·10-14 | 7,82·10-17 |
| 139Ce | 5,97·10-15 | 1,43·10-16 | 8,94·10-15 | 2,06·10-16 |
| 141Ce | 3,1·10-15 | 6,93·10-17 | 1,02·10-14 | 1,32·10-16 |
| 143Ce | 1,21·10-14 | 3,01·10-16 | 3,96·10-14 | 3,99·10-15 |
| 144Ce | 7,63·10-16 | 1,84·10-17 | 2,93·10-15 | 2,61·10-17 |
| 244Cf | 4,74·10-18 | 8,19·10-19 | 4,65·10-17 | 9,25·10-18 |
| 246Cf | 3,92·10-18 | 5,73·10-19 | 3,35·10-17 | 6,30·10-18 |
| 248Cf | 3,25·10-18 | 5,58·10-19 | 3,17·10-17 | 6,29·10-18 |
| 249Cf | 1,45·10-14 | 3,15·10-16 | 1.91·10-14 | 4,13·10-16 |
| 250Cf | 3,09·10-18 | 5,32·10-19 | 3,02·10-17 | 5,99·10-18 |
| 251Cf | 5,01·10-15 | 1,13·10-16 | 1.12·10-14 | 1,97·10-16 |
| 252Cf | 3,63·10-18 | 5,24·10-19 | 3.08·10-17 | 5,75·10-18 |
| 253Cf | 1,75·10-17 | 5,17·10-20 | 1,66·10-15 | 2,80·10-19 |
| 254Cf | 1,01·10-20 | 1,73·10-21 | 9,83·10-20 | 1,95·10-20 |
| 36Cl | 1,66·10-16 | 1,12·10-17 | 1,47·10-14 | 1,06·10-15 |
| 38Cl | 7,58·10-14 | 1.43·10-15 | 1,94·10-13 | 1,40·10-14 |
| 39Cl | 6,9·10-14 | 1,41·10-15 | 1,36·10-13 | 1,10·10-14 |
| 238Cm | 2,85·10-15 | 6,56·10-17 | 3.94·10-15 | 1,10·10-16 |
| 240Cm | 4,17·10-18 | 7,69·10-19 | 4,68·10-17 | 1,03·10-17 |
| 241Cm | 2,11·10-14 | 4,65·10-16 | 3,14·10-14 | 7,52·10-16 |
| 242Cm | 4,02·10-18 | 7,02·10-19 | 4,29·10-17 | 9,38·10-18 |
| 243Cm | 5,3·10-15 | 1,18·10-16 | 9,79·10-15 | 1,90·10-16 |
| 244Cm | 3,4·10-18 | 6,44·10-19 | 3,91·10-17 | 8,70·10-18 |
| 245Cm | 3,49·10-15 | 8,05·10-17 | 5,36·10-15 | 1,46·10-16 |
| 246Cm | 3,1·10-18 | 5,76·10-19 | 3,49·10-17 | 7,74·10-18 |
| 247Cm | 1,38·10-14 | 2,99·10-16 | 1,79·10-14 | 3,79·10-16 |
| 248Cm | 2,35·10-18 | 4,4·10-19 | 2,67·10-17 | 5,92·10-18 |
| 249Cm | 1,02·10-15 | 3,32·10-17 | 1,59·10-14 | 1,47·10-15 |
| 55Co | 9,16·10-14 | 1,93·10-15 | 1,39·10-13 | 6,99·10-15 |
| 56Co | 1,73·10-13 | 3,23·10-15 | 2,13·10-13 | 5,22·10-15 |
| 57Co | 4,97·10-15 | 1,08·10-16 | 6,63·10-15 | 1,38·10-16 |
| 58Co | 4,44·10-14 | 9,25·10-16 | 5,58·10-14 | 1,14·10-15 |
| 58mCo | 6,06·10-20 | 6,65·10-21 | 3,05·10-19 | 3,24·10-20 |
| 60Co | 1,19·10-13 | 2,3·10-15 | 1,45·10-13 | 2,76·10-15 |
| 60mCo | 2·10-16 | 4,38·10-18 | 3,46·10-16 | 2,22·10-17 |
| 61Co | 3,74·10-15 | 1,29·10-16 | 3,24·10-14 | 4,69·10-15 |
| 62mCo | 1,3·10-13 | 2,58·10-15 | 2,25·10-13 | 1,43·10-14 |
| 48Cr | 1,87·10-14 | 4,04·10-16 | 2,40·10-14 | 4,98·10-16 |
| 49Cr | 4,68·10-14 | 1,07·10-15 | 9,65·10-14 | 8,29·10-15 |
| 51Cr | 1,38·10-15 | 2,97·10-17 | 1,75·10-15 | 3,68·10-17 |
| 125Cs | 3,01·10-14 | 6,85·10-16 | 5,97·10-14 | 4,88·10-15 |
| 126Cs | 4,96·10-14 | 1,18·10-15 | 1,62·10-13 | 1.48·10-14 |
| 127Cs | 1.78·10-14 | 3,95·10-16 | 2,38·10-14 | 6,13·10-16 |
| 128Cs | 4,06·10-14 | 9,54·10-16 | 1,07·10-13 | 1,02·10-14 |
| 129Cs | 1,13·10-14 | 2,62·10-16 | 1,52·10-14 | 3,75·10-16 |
| 130Cs | 2,3·10-14 | 5,41·10-16 | 5,48·10-14 | 5,43·10-15 |
| 131Cs | 2,38·10-16 | 1,79·10-17 | 7,84·10-16 | 5,56·10-17 |
| 132Cs | 3,11·10-14 | 6,69·10-16 | 3,92·10-14 | 9,10·10-16 |
| 134Cs | 7,06·10-14 | 1,48·10-15 | 9,45·10-14 | 217·10-15 |
| 134mCs | 7,95·10-16 | 2,25·10-17 | 2.88·10-15 | 4,14·10-17 |
| 135Cs | 9,5·10-18 | 2,69·10-20 | 9,06·10-16 | 1,27·10-19 |
| 135mCs | 7,25·10-14 | 1,51·10-15 | 9,10·10-14 | 2,37·10-15 |
| 136Cs | 9,94·10-14 | 2,03·10-15 | 1,25·10-13 | 2,54·10-15 |
| 137Cs | 9.28·10-17 | 2.99·10-18 | 8.63·10-15 | 2.75·10-16 |
| 138Cs | 1,15·10-13 | 2,26·10-15 | 2,17·10-13 | 1,52·10-14 |
| 60Cu | 1,87·10-13 | 3,64·10-15 | 2,82·10-13 | 1,44·10-14 |
| 61Cu | 3,72·10-14 | 8,21·10-16 | 6,50·10-14 | 4,15·10-15 |
| 62Cu | 4,6·10-14 | 1,11·10-15 | 1,44·10-13 | 1.48·10-14 |
| 64Cu | 8,5·10-15 | 1,83·10-16 | 1,64·10-14 | 3,93·10-16 |
| 66Cu | 4,89·10-15 | 2,03·10-16 | 7,69·10-14 | 1,19·10-14 |
| 67Cu | 4,9·10-15 | 1,05·10-16 | 1,18·10-14 | 1,61·10-16 |
| 155Dy | 2,56·10-14 | 5,38·10-16 | 3,27·10-14 | 7,27·10-16 |
| 157Dy | 1.48·10-14 | 3,33·10-16 | 1,94·10-14 | 4,29·10-16 |
| 159Dy | 9,93·10-16 | 3,87·10-17 | 1,89·10-15 | 6,59·10-17 |
| 165Dy | 1,35·10-15 | 6,91·10-17 | 2,82·10-14 | 4,41·10-15 |
| 166Dy | 1,21·10-15 | 3,51·10-17 | 5,79·10-15 | 5,18·10-17 |
| 161Er | 4,11·10-14 | 8,55·10-16 | 5,23·10-14 | 1,13·10-15 |
| 165Er | 8,96·10-16 | 3,24·10-17 | 1,61·10-15 | 5,14·10-17 |
| 169Er | 2,97·10-17 | 6,75·10-20 | 2,83·10-15 | 2,46·10-19 |
| 171Er | 1,64·10-14 | 3,85·10-16 | 4,22·10-14 | 3,34·10-15 |
| 172Er | 2.29·10-14 | 4,96·10-16 | 3,21·10-14 | 6,32·10-16 |
| 250mEs | 1,76·10-14 | 3,65·10-16 | 2,21·10-14 | 5,38·10-16 |
| 251Es | 3,65·10-15 | 8,39·10-17 | 5,35·10-15 | 1,44·10-16 |
| 253Es | 1,6·10-17 | 6,63·10-19 | 4,55·10-17 | 4,14·10-18 |
| 254Es | 1,57·10-16 | 9,76·10-18 | 5,65·10-16 | 7,85·10-17 |
| 254mEs | 2,11·10-14 | 4,58·10-16 | 3,76·10-14 | 1,77·10-15 |
| 145Eu | 6,78·10-14 | 1,34·10-15 | 8,33·10-14 | 1,87·10-15 |
| 146Eu | 1,15·10-13 | 2,35·10-15 | 1,43·10-13 | 3,34·10-15 |
| 147Eu | 2,14·10-14 | 4,62·10-16 | 2,77·10-14 | 6,17·10-16 |
| 148Eu | 9,83·10-14 | 2,06·10-15 | 1,22·10-13 | 2,67·10-15 |
| 149Eu | 1,95·10-15 | 5,66·10-17 | 3,09·10-15 | 9,07·10-17 |
| 150mEu | 2,22·10-15 | 6,78·10-17 | 2,05·10-14 | 2,40·10-15 |
| 150Eu | 6,64·10-14 | 1,42·10-15 | 8,50·10-14 | 2,00·10-15 |
| 152Eu | 5,28·10-14 | 1,08·10-15 | 6,9·10-14 | 1,75·10-15 |
| 152mEu | 1,36·10-14 | 3.35·10-16 | 4,85·10-14 | 6,11·10-15 |
| 154Eu | 5,75·10-14 | 1,17·10-15 | 8,29·10-14 | 2,91·10-15 |
| 155Eu | 2,14·10-15 | 5,35·10-17 | 3,39·10-15 | 7,04·10-17 |
| 156Eu | 6,38·10-14 | 1,24·10-15 | 9,98·10-14 | 5,05·10-15 |
| 157Eu | 1,09·10-14 | 2,76·10-16 | 3,57·10-14 | 3,35·10-15 |
| 158Eu | 5·10-14 | 1,08·10-15 | 1,21·10-13 | 1,10·10-14 |
| 18F | 4,56·10-14 | 9,82·10-16 | 6,94·10-14 | 1,65·10-15 |
| 52Fe | 3,27·10-14 | 7,11·10-16 | 5,17·10-14 | 1,87·10-15 |
| 59Fe | 5,62·10-14 | 1,1·10-15 | 7,13·10-14 | 1,34·10-15 |
| 60Fe | 1,79·10-18 | 1,17·10-20 | 1,64·10-16 | 7,20·10-20 |
| 252Fm | 3,45·10-18 | 5,41·10-19 | 2,95·10-17 | 5,32·10-18 |
| 253Fm | 3,12·10-15 | 7,14·10-17 | 4,55·10-15 | 1,18·10-16 |
| 254Fm | 4,76·10-18 | 5,99·10-19 | 3,43·10-17 | 5,66·10-18 |
| 255Fm | 8,82·10-17 | 6,29·10-18 | 3,95·10-16 | 6,07·10-17 |
| 257Fm | 4,15·10-15 | 9,5·10-17 | 7,18·10-15 | 1,65·10-16 |
| 219Fr | 1,53·10-16 | 3,3·10-18 | 2.04·10-16 | 4,34·10-18 |
| 220Fr | 4,4·10-16 | 9,87·10-18 | 8,53·10-16 | 2,11·10-17 |
| 221Fr | 1,32·10-15 | 2,84·10-17 | 2,02·10-15 | 3,67·10-17 |
| 222Fr | 5,79·10-16 | 8,74·10-17 | 4,76·10-14 | 8,43·10-15 |
| 223Fr | 2.2·10-15 | 7,76·10-17 | 2,30·10-14 | 2,72·10-15 |
| 65Ga | 5,28·10-14 | 1,21·10-15 | 1,19·10-13 | 1,09·10-14 |
| 66Ga | 1,23·10-13 | 2,25·10-15 | 2,11·10-13 | 1,09·10-14 |
| 67Ga | 6,49·10-15 | 1.41·10-16 | 8,50·10-15 | 1,74·10-16 |
| 68Ga | 4,29·10-14 | 9.99·10-16 | 1.01·10-13 | 1.00·10-14 |
| 70Ga | 8.4·10-16 | 8.48·10-17 | 4.17·10-14 | 7.55·10-15 |
| 72Ga | 1.31·10-13 | 2.48·10-15 | 1.86·10-13 | 7.19·10-15 |
| 73Ga | 1.39·10-14 | 3.35·10-16 | 4.37·10-14 | 4.64·10-15 |
| 145Gd | 1.09·10-13 | 2.09·10-15 | 1.66·10-13 | 8.38·10-15 |
| 146Gd | 8.61·10-15 | 2.22·10-16 | 1.33·10-14 | 3.14·10-16 |
| 147Gd | 5.98·10-14 | 1.25·10-15 | 7.67·10-14 | 1.62·10-15 |
| 149Gd | 1.75·10-14 | 3.92·10-16 | 2.42·10-14 | 5.19·10-16 |
| 1.51Gd | 1.88·10-15 | 5.57·10-17 | 3.25·10-15 | 8.96·10-17 |
| 153Gd | 3.11·10-15 | 9.22·10-17 | 5.00·10-15 | 1.41·10-16 |
| 159Gd | 2.16·10-15 | 6.48·10-17 | 1.91·10-14 | 1.84·10-15 |
| 66Ge | 3·10-14 | 6.5·10-16 | 4.26·10-14 | 1.31·10-15 |
| 67Ge | 6.45·10-14 | 1.46·10-15 | 1.68·10-13 | 1.48·10-14 |
| 68Ge | 1.01·10-19 | 4.1·10-20 | 6.62·10-18 | 2.90·10-18 |
| 69Ge | 3.99·10-14 | 8.39·10-16 | 5.96·10-14 | 2.82·10-15 |
| 71Ge | 1.02·10-19 | 4.15·10-20 | 6.71·10-18 | 2.93·10-18 |
| 75Ge | 1.78·10-15 | 7.2·10-17 | 2.71·10-14 | 3.94·10-15 |
| 77Ge | 4.98·10-14 | 1.09·10-15 | 1.02·10-13 | 8.23·10-15 |
| 78Ge | 1.23·10-14 | 2.67·10-16 | 2.75·10-14 | 9.56·10-16 |
| 170Hf | 2.29·10-14 | 5.11·10-16 | 3.00·10-14 | 6.60·10-16 |
| 172Hf | 3.4·10-15 | 9.92·10-17 | 5.46·10-15 | 1.50·10-16 |
| 173Hf | 1,66·10-14 | 3,73·10-16 | 2,23·10-14 | 4,78·10-16 |
| 175Hf | 1,54·10-14 | 3,45·10-16 | 2.15·10-14 | 4,36·10-16 |
| 177mHf | 9,67·10-14 | 2,1·10-15 | 1,39·10-13 | 2,65·10-15 |
| 178mHf | 1,03·10-13 | 2,22·10-15 | 1,36·10-13 | 2.88·10-15 |
| 179mHf | 3,84·10-14 | 8,42·10-16 | 5,26·10-14 | 1,06·10-15 |
| 180mHf | 4,33·10-14 | 9,46·10-16 | 5,82·10-14 | 1,21·10-15 |
| 181Hf | 2.42·10-14 | 5,25·10-16 | 3,62·10-14 | 6,82·10-16 |
| 182Hf | 1,03·10-14 | 2,23·10-16 | 1,46·10-14 | 2,77·10-16 |
| 182mHf | 4,08·10-14 | 8,78·10-16 | 5,82·10-14 | 1,37·10-15 |
| 183Hf | 3,39·10-14 | 7,52·10-16 | 6,83·10-14 | 5,06·10-15 |
| 184Hf | 1,04·10-14 | 2,46·10-16 | 3,12·10-14 | 217·10-15 |
| 193Hg | 7,7·10-15 | 1,8·10-16 | 1,26·10-14 | 3,78·10-16 |
| 193mHg | 4,69·10-14 | 9,66·10-16 | 6,21·10-14 | 1,34·10-15 |
| 194Hg | 6,23·10-19 | 2,24·10-19 | 2,65·10-17 | 1,04·10-17 |
| 195Hg | 8.38·10-15 | 1,85·10-16 | 1.11·10-14 | 2,82·10-16 |
| 195mHg | 8.78·10-15 | 1,93·10-16 | 1,38·10-14 | 2,93·10-16 |
| 197Hg | 2,26·10-15 | 5,79·10-17 | 3,35·10-15 | 9,10·10-17 |
| 197mHg | 3,62·10-15 | 8,12·10-17 | 1,02·10-14 | 1,15·10-16 |
| 199mHg | 7,63·10-15 | 1,67·10-16 | 2.71·10-14 | 2,29·10-16 |
| 203Hg | 1,04·10-14 | 2.22·10-16 | 1,56·10-14 | 2,79·10-16 |
| 155Ho | 1.65·10-14 | 3,89·10-16 | 3,46·10-14 | 2,89·10-15 |
| 157Ho | 2,04·10-14 | 4,61·10-16 | 2,90·10-14 | 8,95·10-16 |
| 159Ho | 1,43·10-14 | 3,34·10-16 | 1,98·10-14 | 4,40·10-16 |
| 161Ho | 1,4·10-15 | 5,14·10-17 | 2,59·10-15 | 9,59·10-17 |
| 162Ho | 6,7·10-15 | 1,55·10-16 | 1,01·10-14 | 4,19·10-16 |
| 162mHo | 2,54·10-14 | 5,3·10-16 | 3,22·10-14 | 6,65·10-16 |
| 164Ho | 8,03·10-16 | 3,38·10-17 | 8,33·10-15 | 8,46·10-16 |
| 164mHo | 1,06·10-15 | 3,9·10-17 | 1,93·10-15 | 6,35·10-17 |
| 166Ho | 1,72·10-15 | 1,05·10-16 | 4,46·10-14 | 7,71·10-15 |
| 166mHo | 7,84·10-14 | 1,65·10-15 | 9,90·10-14 | 2,11·10-15 |
| 167Ho | 1,59·10-14 | 3,51·10-16 | 2,95·10-14 | 1,07·10-15 |
| 120I | 1.31·10-13 | 2,62·10-15 | 2,55·10-13 | 1,58·10-14 |
| 120mI | 2,49·10-13 | 5,01·10-15 | 3,86·10-13 | 1,81·10-14 |
| 121I | 1.78·10-14 | 3,96·10-16 | 2,72·10-14 | 1,16·10-15 |
| 122I | 4,31·10-14 | 1,02·10-15 | 1,25·10-13 | 1,21·10-14 |
| 123I | 6,49·10-15 | 1,53·10-16 | 9,40·10-15 | 2,33·10-16 |
| 124I | 5,04·10-14 | 1.04·10-15 | 7,39·10-14 | 3,50·10-15 |
| 125I | 3,73·10-16 | 3,14·10-17 | 1,39·10-15 | 1,13·10-16 |
| 126I | 2,01·10-14 | 4,42·10-16 | 3,37·10-14 | 1,61·10-15 |
| 128I | 4,33·10-15 | 1,71·10-16 | 5,38·10-14 | 8.78·10-15 |
| 129I | 2,81·10-16 | 1,95·10-17 | 1,10·10-15 | 5,80·10-17 |
| 130I | 9,67·10-14 | 2,05·10-15 | 1,36·10-13 | 4,29·10-15 |
| 131I | 1,69·10-14 | 3.64·10-16 | 2.98·10-14 | 6.43·10-16 |
| 132I | 1,05·10-13 | 2.2·10-15 | 1,58·10-13 | 7,54·10-15 |
| 132mI | 1,42·10-14 | 3,11·10-16 | 2,22·10-14 | 1,06·10-15 |
| 133I | 2,76·10-14 | 6,17·10-16 | 5,83·10-14 | 4,55·10-15 |
| 134I | 1,22·10-13 | 2,53·10-15 | 1,87·10-13 | 9,85·10-15 |
| 135I | 7,54·10-14 | 1,47·10-15 | 1,11·10-13 | 4,83·10-15 |
| 109In | 2.98·10-14 | 6,24·10-16 | 3,91·10-14 | 9,62·10-16 |
| 110mIn | 7,15·10-14 | 1,53·10-15 | 1,29·10-13 | 9,11·10-15 |
| 110In | 1,39·10-13 | 2.88·10-15 | 1,71·10-13 | 3,64·10-15 |
| 111In | 1,68·10-14 | 3,68·10-16 | 2.29·10-14 | 5,09·10-16 |
| 112In | 1,19·10-14 | 2,74·10-16 | 2,88·10-14 | 2,29·10-15 |
| 113mIn | 1.12·10-14 | 2.43·10-16 | 2,18·10-14 | 3,29·10-16 |
| 114In | 1,59·10-16 | 2,76·10-18 | 2,95·10-15 | 1,86·10-17 |
| 114mIn | 3,89·10-15 | 8,63·10-17 | 1,05·10-14 | 1,31·10-16 |
| 115In | 6,55·10-17 | 3,57·10-19 | 6,18·10-15 | 2,07·10-17 |
| 115mIn | 6,86·10-15 | 1,51·10-16 | 1,81·10-14 | 2,73·10-16 |
| 116mIn | 1,18·10-13 | 2,28·10-15 | 1,58·10-13 | 4,69·10-15 |
| 117In | 3,06·10-14 | 6,64·10-16 | 5,16·10-14 | 1,65·10-15 |
| 117mIn | 4,07·10-15 | 1,25·10-16 | 3,17·10-14 | 4,16·10-15 |
| 119In | 3.53·10-14 | 8,02·10-16 | 8,20·10-14 | 7.92·10-15 |
| 119mIn | 1,26·10-15 | 1,3·10-16 | 7.11·10-14 | 1,15·10-14 |
| 182Ir | 6,07·10-14 | 1,34·10-15 | 1,35·10-13 | 9,34·10-15 |
| 184Ir | 8,75·10-14 | 1.78·10-15 | 1,21·10-13 | 3,99·10-15 |
| 185Ir | 2,74·10-14 | 5,33·10-16 | 3,52·10-14 | 8,40·10-16 |
| 186Ir | 7,51·10-14 | 1,51·10-15 | 9,55·10-14 | 2,10·10-15 |
| 186mIr | 4,33·10-14 | 9,16·10-16 | 6,41·10-14 | 2,76·10-15 |
| 187Ir | 1,54·10-14 | 3,37·10-16 | 2,03·10-14 | 4,93·10-16 |
| 188Ir | 7,52·10-14 | 1,42·10-15 | 9,18·10-14 | 1.84·10-15 |
| 189Ir | 2,77·10-15 | 6,99·10-17 | 4,14·10-15 | 1,03·10-16 |
| 190Ir | 6,32·10-14 | 1,36·10-15 | 8,24·10-14 | 1,80·10-15 |
| 190mIr | 1,38·10-19 | 5,32·10-20 | 7,52·10-18 | 3,14·10-18 |
| 190nIr | 6,81·10-14 | 1,47·10-15 | 8,89·10-14 | 1,97·10-15 |
| 191mIr | 2,62·10-15 | 6,33·10-17 | 4,07·10-15 | 9,31·10-17 |
| 192nIr | 3,61·10-14 | 7,77·10-16 | 5,53·10-14 | 1,21·10-15 |
| 192mIr | 6,84·10-15 | 1,47·10-16 | 8,81·10-15 | 1,80·10-16 |
| 194Ir | 4,73·10-15 | 1,81·10-16 | 5,85·10-14 | 9,33·10-15 |
| 194mIr | 1,04·10-13 | 2,23·10-15 | 1,34·10-13 | 2,95·10-15 |
| 195Ir | 217·10-15 | 7.37·10-17 | 2.19·10-14 | 2.44·10-15 |
| 195mIr | 1.78·10-14 | 3.98·10-16 | 3.53·10-14 | 1.43·10-15 |
| 38K | 1.56·10-13 | 2.97·10-15 | 2.66·10-13 | 1.65·10-14 |
| 40K | 7.92·10-15 | 2.04·10-16 | 4.20·10-14 | 6.25·10-15 |
| 42K | 1.48·10-14 | 3.98·10-16 | 1,15·10-13 | 1.41·10-14 |
| 43K | 4.35·10-14 | 9.41·10-16 | 7.11·10-14 | 2.88·10-15 |
| 44K | 1.14·10-13 | 2.12·10-15 | 2.35·10-13 | 1.51·10-14 |
| 45K | 9.2·10-14 | 1.76·10-15 | 1.74·10-13 | 1.30·10-14 |
| 74Kr | 5.2·10-14 | 1.2·10-15 | 1.16·10-13 | 1.07·10-14 |
| 76Kr | 1.86·10-14 | 4.03·10-16 | 2.37·10-14 | 5.50·10-16 |
| 77Kr | 4.51·10-14 | 1.04·10-15 | 9.74·10-14 | 8.78·10-15 |
| 79Kr | 1.12·10-14 | 2,39·10-16 | 1,50·10-14 | 3,60·10-16 |
| 81Kr | 2,44·10-16 | 5,99·10-18 | 4,04·10-16 | 4,39·10-17 |
| 81mKr | 5,56·10-15 | 1,18·10-16 | 9,42·10-15 | 1,60·10-16 |
| 83mKr | 1,2·10-18 | 3,57·10-19 | 3,56·10-17 | 1,29·10-17 |
| 85Kr | 2,4·10-16 | 1,05·10-17 | 1,32·10-14 | 8,00·10-16 |
| 85mKr | 6,87·10-15 | 1,57·10-16 | 2,24·10-14 | 1,36·10-15 |
| 87Kr | 3,97·10-14 | 8.4·10-16 | 1,37·10-13 | 1,35·10-14 |
| 88Kr | 9,71·10-14 | 1,73·10-15 | 1,35·10-13 | 4,43·10-15 |
| 131La | 2,91·10-14 | 6,55·10-16 | 4,87·10-14 | 2,96·10-15 |
| 132La | 9,41·10-14 | 1,9·10-15 | 1,49·10-13 | 7,53·10-15 |
| 134La | 3,15·10-14 | 7,5·10-16 | 8,88·10-14 | 8,96·10-15 |
| 135La | 7,75·10-16 | 3,04·10-17 | 1,49·10-15 | 6,89·10-17 |
| 137La | 3·10-16 | 1,96·10-17 | 8,68·10-16 | 5,34·10-17 |
| 138La | 5,84·10-14 | 1,13·10-15 | 7,09·10-14 | 1,39·10-15 |
| 140La | 1,11·10-13 | 2.16·10-15 | 1.66·10-13 | 8,24·10-15 |
| 141La | 2.88·10-15 | 1,52·10-16 | 6,58·10-14 | 1.08·10-14 |
| 142La | 1,37·10-13 | 2,49·10-15 | 2,16·10-13 | 1,17·10-14 |
| 143La | 5,78·10-15 | 2,27·10-16 | 9,64·10-14 | 1,34·10-14 |
| 169Lu | 4,75·10-14 | 9.56·10-16 | 5,90·10-14 | 1,30·10-15 |
| 170Lu | 1,21·10-13 | 2,19·10-15 | 1,46·10-13 | 3,08·10-15 |
| 171Lu | 3·10-14 | 6,54·10-16 | 3,80·10-14 | 8,55·10-16 |
| 172Lu | 8,64·10-14 | 1.76·10-15 | 1,07·10-13 | 2,31·10-15 |
| 173Lu | 4,42·10-15 | 1,16·10-16 | 6,45·10-15 | 1,57·10-16 |
| 174Lu | 4,94·10-15 | 1,12·10-16 | 6,53·10-15 | 1,45·10-16 |
| 174mLu | 1.84·10-15 | 5,33·10-17 | 2,89·10-15 | 7,71·10-17 |
| 176Lu | 2,11·10-14 | 4,57·10-16 | 3,74·10-14 | 7,15·10-16 |
| 176mLu | 7,65·10-16 | 5,6·10-17 | 2,72·10-14 | 4,30·10-15 |
| 177Lu | 1,5·10-15 | 3,21·10-17 | 7,13·10-15 | 5,64·10-17 |
| 177mLu | 4,24·10-14 | 9,31·10-16 | 5,89·10-14 | 1,16·10-15 |
| 178Lu | 7,12·10-15 | 2,15·10-16 | 5,68·10-14 | 8.63·10-15 |
| 178mLu | 4,8·10-14 | 1,08·10-15 | 9,06·10-14 | 5,51·10-15 |
| 179Lu | 1,66·10-15 | 7,67·10-17 | 2,99·10-14 | 4,72·10-15 |
| 257Md | 4,52·10-15 | 1,01·10-16 | 6,20·10-15 | 1,54·10-16 |
| 258Md | 3,89·10-17 | 3,32·10-18 | 1,82·10-16 | 2,55·10-17 |
| 28Mg | 6,38·10-14 | 1,26·10-15 | 8,33·10-14 | 1,58·10-15 |
| 51Mn | 4.51·10-14 | 1,07·10-15 | 1,18·10-13 | 1,22·10-14 |
| 52Mn | 1,62·10-13 | 3,22·10-15 | 1,99·10-13 | 3,95·10-15 |
| 52mMn | 1,13·10-13 | 2,36·10-15 | 2,13·10-13 | 1,52·10-14 |
| 54Mn | 3,83·10-14 | 7,91·10-16 | 4,67·10-14 | 9,65·10-16 |
| 56Mn | 8,16·10-14 | 1.62·10-15 | 1,51·10-13 | 1,02·10-14 |
| 101Mo | 6,48·10-14 | 1.31·10-15 | 1.14·10-13 | 7,06·10-15 |
| 90Mo | 3,64·10-14 | 7,78·10-16 | 5,52·10-14 | 2,20·10-15 |
| 93Mo | 1,73·10-17 | 3,88·10-18 | 2.43·10-16 | 5,51·10-17 |
| 93mMo | 1,06·10-13 | 2,07·10-15 | 1,32·10-13 | 2,52·10-15 |
| 99Mo | 6,99·10-15 | 1,78·10-16 | 3,14·10-14 | 3,76·10-15 |
| 13N | 4,57·10-14 | 1,03·10-15 | 8.68·10-14 | 6,26·10-15 |
| 22Na | 1.02·10-13 | 2,05·10-15 | 1,33·10-13 | 2,60·10-15 |
| 24Na | 2,08·10-13 | 3,59·10-15 | 2,75·10-13 | 1,03·10-14 |
| 88Nb | 1,89·10-13 | 4,02·10-15 | 3,12·10-13 | 1.74·10-14 |
| 89mNb | 8,65·10-14 | 1,94·10-15 | 1,63·10-13 | 1,20·10-14 |
| 89Nb | 6,62·10-14 | 1,39·10-15 | 1.56·10-13 | 1,26·10-14 |
| 90Nb | 2,05·10-13 | 3,79·10-15 | 2.66·10-13 | 8,73·10-15 |
| 93mNb | 3,05·10-18 | 6,82·10-19 | 4,28·10-17 | 9,70·10-18 |
| 94Nb | 7,2·10-14 | 1,49·10-15 | 9,52·10-14 | 1,87·10-15 |
| 95Nb | 3,49·10-14 | 7,28·10-16 | 4,30·10-14 | 9,05·10-16 |
| 95mNb | 2,74·10-15 | 5,91·10-17 | 1.12·10-14 | 1,09·10-16 |
| 96Nb | 1.14·10-13 | 2,34·10-15 | 1,52·10-13 | 3,73·10-15 |
| 97Nb | 2,99·10-14 | 6,75·10-16 | 6,51·10-14 | 5,56·10-15 |
| 97mNb | 3,31·10-14 | 6,95·10-16 | 4,16·10-14 | 1,08·10-15 |
| 98mNb | 1.14·10-13 | 2,37·10-15 | 1,96·10-13 | 1,26·10-14 |
| 136Nd | 1,15·10-14 | 2,73·10-16 | 1,71·10-14 | 6,17·10-16 |
| 138Nd | 1,07·10-15 | 3,75·10-17 | 1,92·10-15 | 7,17·10-17 |
| 139Nd | 1,77·10-14 | 4,07·10-16 | 3,50·10-14 | 2,87·10-15 |
| 139mNd | 7,12·10-14 | 1,48·10-15 | 9,17·10-14 | 2,40·10-15 |
| 141Nd | 2,59·10-15 | 6,84·10-17 | 4,24·10-15 | 1,58·10-16 |
| 141mNd | 3,45·10-14 | 7,32·10-16 | 4,67·10-14 | 1,90·10-15 |
| 147Nd | 5,72·10-15 | 1,4·10-16 | 1,95·10-14 | 1,10·10-15 |
| 149Nd | 1,68·10-14 | 4,06·10-16 | 4,99·10-14 | 5,04·10-15 |
| 151Nd | 4,21·10-14 | 9,23·10-16 | 9,12·10-14 | 7,87·10-15 |
| 19Ne | 4,62·10-14 | 1,1·10-15 | 1,21·10-13 | 1,25·10-14 |
| 56Ni | 7,82·10-14 | 1.62·10-15 | 9,61·10-14 | 1,97·10-15 |
| 57Ni | 9,12·10-14 | 1.76·10-15 | 1,17·10-13 | 2,89·10-15 |
| 65Ni | 2,67·10-14 | 5,69·10-16 | 7,18·10-14 | 7,23·10-15 |
| 66Ni | 1,06·10-17 | 2,83·10-20 | 1,01·10-15 | 1,30·10-19 |
| 232Np | 5,38·10-14 | 1,13·10-15 | 6,94·10-14 | 1,67·10-15 |
| 233Np | 3,39·10-15 | 7,79·10-17 | 4,78·10-15 | 1,30·10-16 |
| 234Np | 6,83·10-14 | 1.31·10-15 | 8,41·10-14 | 2,03·10-15 |
| 235Np | 4,19·10-17 | 2,86·10-18 | 1,82·10-16 | 3,45·10-17 |
| 236Np | 4,74·10-15 | 1,11·10-16 | 9,17·10-15 | 2,38·10-16 |
| 236mNp | 1,92·10-15 | 4,38·10-17 | 5,76·10-15 | 1,12·10-16 |
| 237Np | 8,87·10-16 | 2,52·10-17 | 1,54·10-15 | 8,36·10-17 |
| 238Np | 2,56·10-14 | 5,34·10-16 | 4,31·10-14 | 2,47·10-15 |
| 239Np | 6,95·10-15 | 1,54·10-16 | 1,60·10-14 | 2,63·10-16 |
| 240Np | 5,88·10-14 | 1,24·10-15 | 9,15·10-14 | 3,12·10-15 |
| 240mNp | 1,55·10-14 | 3,87·10-16 | 5,93·10-14 | 7,44·10-15 |
| 15O | 4,59·10-14 | 1,07·10-15 | 1,04·10-13 | 1.00·10-14 |
| 180Os | 1,96·10-15 | 5,39·10-17 | 3,19·10-15 | 1,17·10-16 |
| 181Os | 5,52·10-14 | 1,13·10-15 | 7,03·10-14 | 1,68·10-15 |
| 182Os | 1,83·10-14 | 4,06·10-16 | 2,46·10-14 | 5,88·10-16 |
| 185Os | 3,18·10-14 | 6,81·10-16 | 4,01·10-14 | 9,50·10-16 |
| 189mOs | 1,24·10-19 | 4,83·10-20 | 7,16·10-18 | 3,05·10-18 |
| 190mOs | 7,03·10-14 | 1,51·10-15 | 9,12·10-14 | 2,01·10-15 |
| 191Os | 2,78·10-15 | 6,75·10-17 | 4,35·10-15 | 9,88·10-17 |
| 191mOs | 2,31·10-16 | 6,4·10-18 | 3,67·10-16 | 1,31·10-17 |
| 193Os | 3,29·10-15 | 9,59·10-17 | 2,44·10-14 | 2,81·10-15 |
| 194Os | 2,17·10-17 | 9,55·10-19 | 5,22·10-17 | 4,60·10-18 |
| 30P | 4,68·10-14 | 1,13·10-15 | 1.56·10-13 | 1,57·10-14 |
| 32P | 5,36·10-16 | 8,52·10-17 | 4.49·10-14 | 8,26·10-15 |
| 33P | 1,45·10-17 | 3,64·10-20 | 1,38·10-15 | 1,58·10-19 |
| 227Pa | 7,38·10-16 | 1,81·10-17 | 1,08·10-15 | 3,69·10-17 |
| 228Pa | 5,16·10-14 | 1,05·10-15 | 6,56·10-14 | 1,55·10-15 |
| 230Pa | 2,91·10-14 | 6,07·10-16 | 3,73·10-14 | 8,54·10-16 |
| 231Pa | 1,57·10-15 | 3,78·10-17 | 2.44·10-15 | 1,07·10-16 |
| 232Pa | 4.26·10-14 | 8,82·10-16 | 5,57·10-14 | 1,26·10-15 |
| 233Pa | 8,55·10-15 | 1,86·10-16 | 1,66·10-14 | 2,70·10-16 |
| 234Pa | 8,72·10-14 | 1,8·10-15 | 1,24·10-13 | 3,89·10-15 |
| 234mPa | 1,21·10-15 | 1,08·10-16 | 5,48·10-14 | 9,39·10-15 |
| 195mPb | 7,12·10-14 | 1,52·10-15 | 9,97·10-14 | 3.11·10-15 |
| 198Pb | 1.86·10-14 | 4,06·10-16 | 2,66·10-14 | 5,67·10-16 |
| 199Pb | 6,83·10-14 | 1,36·10-15 | 8,55·10-14 | 1,79·10-15 |
| 200Pb | 8,17·10-15 | 1,86·10-16 | 1,31·10-14 | 2,65·10-16 |
| 201Pb | 3,35·10-14 | 7,08·10-16 | 4,43·10-14 | 9,73·10-16 |
| 202Pb | 4,96·10-19 | 1,91·10-19 | 2,72·10-17 | 1,14·10-17 |
| 202mPb | 9,29·10-14 | 1,93·10-15 | 1,17·10-13 | 2,49·10-15 |
| 203Pb | 1,3·10-14 | 2,86·10-16 | 1,87·10-14 | 3,78·10-16 |
| 205Pb | 5,45·10-19 | 2,08·10-19 | 2,92·10-17 | 1,22·10-17 |
| 209Pb | 1·10-16 | 3,19·10-18 | 9,35·10-15 | 2,94·10-16 |
| 210Pb | 4,48·10-17 | 2,13·10-18 | 1,28·10-16 | 1,98·10-17 |
| 211Pb | 2,59·10-15 | 9,5·10-17 | 3,06·10-14 | 4.64·10-15 |
| 212Pb | 6,24·10-15 | 1.35·10-16 | 1,35·10-14 | 1,88·10-16 |
| 214Pb | 1,09·10-14 | 2,4·10-16 | 2,77·10-14 | 9,10·10-16 |
| 100Pd | 3,98·10-15 | 1,06·10-16 | 6,11·10-15 | 2,13·10-16 |
| 101Pd | 1,42·10-14 | 3,09·10-16 | 1,94·10-14 | 5,66·10-16 |
| 103Pd | 5,32·10-17 | 7,67·10-18 | 3,90·10-16 | 6,02·10-17 |
| 109Pd | 4,2·10-16 | 3,73·10-17 | 2.15·10-14 | 2,87·10-15 |
| 141Pm | 3,39·10-14 | 7,73·10-16 | 8,42·10-14 | 7,77·10-15 |
| 142Pm | 4,01·10-14 | 9,62·10-16 | 1,44·10-13 | 1,35·10-14 |
| 143Pm | 1,35·10-14 | 2,97·10-16 | 1,72·10-14 | 4,04·10-16 |
| 144Pm | 6,95·10-14 | 1,49·10-15 | 8,71·10-14 | 1,96·10-15 |
| 145Pm | 5,49·10-16 | 2,61·10-17 | 1,22·10-15 | 5,49·10-17 |
| 146Pm | 3,34·10-14 | 7,19·10-16 | 4,64·10-14 | 1.25·10-15 |
| 147Pm | 8,67·10-18 | 2,8·10-20 | 8,11·10-16 | 1,20·10-19 |
| 148Pm | 2,76·10-14 | 6,11·10-16 | 7,97·10-14 | 8,36·10-15 |
| 148mPm | 9,01·10-14 | 1,91·10-15 | 1,18·10-13 | 2,62·10-15 |
| 149Pm | 7,08·10-16 | 4,04·10-17 | 2.19·10-14 | 2.97·10-15 |
| 150Pm | 6,77·10-14 | 1,41·10-15 | 1,34·10-13 | 1,05·10-14 |
| 151Pm | 1,4·10-14 | 3,18·10-16 | 3,32·10-14 | 2,07·10-15 |
| 203Po | 7,59·10-14 | 1,53·10-15 | 1,00·10-13 | 2,95·10-15 |
| 205Po | 7,29·10-14 | 1,47·10-15 | 9,10·10-14 | 2,20·10-15 |
| 207Po | 6,08·10-14 | 1,24·10-15 | 7.67·10-14 | 1,89·10-15 |
| 210Po | 3,89·10-19 | 8,09·10-21 | 4,81·10-19 | 1,11·10-20 |
| 211Po | 3,56·10-16 | 7,42·10-18 | 4,47·10-16 | 1,12·10-17 |
| 214Po | 3,81·10-18 | 7,93·10-20 | 4,71·10-18 | 1,09·10-19 |
| 215Po | 7,79·10-18 | 1,68·10-19 | 1,01·10-17 | 2,15·10-19 |
| 216Po | 7,75·10-19 | 1,61·10-20 | 9,57·10-19 | 2,20·10-20 |
| 218Po | 4,21·10-19 | 8,66·10-21 | 7,56·10-19 | 1,17·10-20 |
| 136Pr | 9.72·10-14 | 2,04·10-15 | 1,69·10-13 | 1,02·10-14 |
| 137Pr | 2,2·10-14 | 4,97·10-16 | 4,01·10-14 | 2,95·10-15 |
| 138Pr | 3,72·10-14 | 8,98·10-16 | 1,25·10-13 | 1.23·10-14 |
| 138mPr | 1,13·10-13 | 2,35·10-15 | 1,52·10-13 | 5,02·10-15 |
| 139Pr | 4,75·10-15 | 1,17·10-16 | 8,75·10-15 | 5,53·10-16 |
| 142Pr | 3,5·10-15 | 1,47·10-16 | 5,67·10-14 | 9,15·10-15 |
| 143Pr | 1,94·10-16 | 2,06·10-17 | 1,76·10-14 | 2,00·10-15 |
| 144Pr | 2,65·10-15 | 1,63·10-16 | 8,43·10-14 | 1,27·10-14 |
| 144mPr | 2,2·10-16 | 1,05·10-17 | 5,08·10-16 | 2,67·10-17 |
| 145Pr | 1,12·10-15 | 9,38·10-17 | 4,44·10-14 | 7,90·10-15 |
| 147Pr | 3,9·10-14 | 8,95·10-16 | 9,75·10-14 | 9,59·10-15 |
| 186Pt | 3,27·10-14 | 7·10-16 | 4,10·10-14 | 9,05·10-16 |
| 188Pt | 7,9·10-15 | 1,82·10-16 | 1,18·10-14 | 2,42·10-16 |
| 189Pt | 1,34·10-14 | 2,99·10-16 | 1,82·10-14 | 4,59·10-16 |
| 191Pt | 1,21·10-14 | 2,78·10-16 | 1,71·10-14 | 4,00·10-16 |
| 193Pt | 4,07·10-19 | 1,54·10-19 | 2,07·10-17 | 8,51·10-18 |
| 193mPt | 3,76·10-16 | 9,31·10-18 | 3,07·10-15 | 1,82·10-17 |
| 195mPt | 2.44·10-15 | 6,19·10-17 | 5,92·10-15 | 1,02·10-16 |
| 197Pt | 9,73·10-16 | 2,39·10-17 | 1,06·10-14 | 3,33·10-16 |
| 197mPt | 3.25·10-15 | 7,28·10-17 | 1.86·10-14 | 1,26·10-16 |
| 199Pt | 9,32·10-15 | 2,47·10-16 | 4,38·10-14 | 5,67·10-15 |
| 200Pt | 2,33·10-15 | 5,46·10-17 | 1,13·10-14 | 2,90·10-16 |
| 234Pu | 2,49·10-15 | 5,78·10-17 | 3,46·10-15 | 1,01·10-16 |
| 235Pu | 3,45·10-15 | 8·10-17 | 4,78·10-15 | 1,44·10-16 |
| 236Pu | 4,68·10-18 | 7,35·10-19 | 4,83·10-17 | 1.10·10-17 |
| 237Pu | 1.76·10-15 | 4,25·10-17 | 2,54·10-15 | 9,06·10-17 |
| 238Pu | 3,5·10-18 | 6,26·10-19 | 4,09·10-17 | 9,64·10-18 |
| 239Pu | 3,48·10-18 | 2,84·10-19 | 1,86·10-17 | 3,67·10-18 |
| 240Pu | 3,42·10-18 | 6,01·10-19 | 3,92·10-17 | 9,18·10-18 |
| 241Pu | 6,33·10-20 | 1,72·10-21 | 1,17·10-19 | 7,06·10-21 |
| 242Pu | 2,9·10-18 | 4,98·10-19 | 3,27·10-17 | 7,61·10-18 |
| 243Pu | 9,61·10-16 | 2,27·10-17 | 8,15·10-15 | 1,18·10-16 |
| 244Pu | 2,08·10-18 | 4,16·10-19 | 2,69·10-17 | 6,49·10-18 |
| 245Pu | 1.86·10-14 | 4,06·10-16 | 4,00·10-14 | 2,03·10-15 |
| 246Pu | 5,35·10-15 | 1,23·10-16 | 8,82·10-15 | 1,94·10-16 |
| 222Ra | 4.03·10-16 | 8,66·10-18 | 5,51·10-16 | 1,08·10-17 |
| 223Ra | 5,47·10-15 | 1,21·10-16 | 8,87·10-15 | 1,67·10-16 |
| 224Ra | 4,29·10-16 | 9,15·10-18 | 6,35·10-16 | 1,16·10-17 |
| 225Ra | 2,4·10-16 | 1,07·10-17 | 3,01·10-15 | 3,25·10-17 |
| 226Ra | 2,84·10-16 | 6,11·10-18 | 4,79·10-16 | 8,12·10-18 |
| 227Ra | 7,01·10-15 | 1,82·10-16 | 3,19·10-14 | 3,34·10-15 |
| 79Rb | 6,08·10-14 | 1,38·10-15 | 1,28·10-13 | 1.08·10-14 |
| 80Rb | 5,77·10-14 | 1,38·10-15 | 2,11·10-13 | 1,83·10-14 |
| 81Rb | 2,73·10-14 | 5,98·10-16 | 4,46·10-14 | 1,98·10-15 |
| 81mRb | 1,63·10-16 | 4,91·10-18 | 4,01·10-16 | 4,06·10-17 |
| 82Rb | 5,01·10-14 | 1.2·10-15 | 1,58·10-13 | 1,54·10-14 |
| 82mRb | 1,34·10-13 | 2,74·10-15 | 1.68·10-13 | 3,98·10-15 |
| 83Rb | 2,21·10-14 | 4,76·10-16 | 2,77·10-14 | 6.37·10-16 |
| 84Rb | 4,18·10-14 | 8,74·10-16 | 5,71·10-14 | 1,87·10-15 |
| 86Rb | 4,94·10-15 | 1,67·10-16 | 4,85·10-14 | 7,72·10-15 |
| 87Rb | 3,3·10-17 | 7,3·10-20 | 3,15·10-15 | 2,73·10-19 |
| 88Rb | 3,33·10-14 | 7,41·10-16 | 1,83·10-13 | 1,67·10-14 |
| 89Rb | 1.01·10-13 | 1,9·710-15 | 1,87·10-13 | 1,21·10-14 |
| 177Re | 2,76·10-14 | 5,95·10-16 | 5,17·10-14 | 3,63·10-15 |
| 178Re | 5,73·10-14 | 1,15·10-15 | 1,04·10-13 | 6,37·10-15 |
| 180Re | 5,33·10-14 | 1,12·10-15 | 7.11·10-14 | 2,31·10-15 |
| 181Re | 3,37·10-14 | 7,2·10-16 | 4,76·10-14 | 9,24·10-16 |
| 182mRe | 5,39·10-14 | 1,08·10-15 | 6,71·10-14 | 1,49·10-15 |
| 182Re | 8,49·10-14 | 1,73·10-15 | 1,08·10-13 | 2,23·10-15 |
| 184Re | 3.99·10-14 | 8,37·10-16 | 5,00·10-14 | 1,10·10-15 |
| 184mRe | 1,67·10-14 | 3,59·10-16 | 2.19·10-14 | 4,64·10-16 |
| 186Re | 9,97·10-16 | 4,42·10-17 | 2,03·10-14 | 2,56·10-15 |
| 186mRe | 4,14·10-16 | 1,28·10-17 | 7,24·10-16 | 3,48·10-17 |
| 188Re | 3,13·10-15 | 1,45·10-16 | 5,35·10-14 | 8,89·10-15 |
| 188mRe | 2,56·10-15 | 6,77·10-17 | 3,91·10-15 | 9,91·10-17 |
| 189Re | 3,08·10-15 | 8,41·10-17 | 2.15·10-14 | 2,10·10-15 |
| 100Rh | 1,33·10-13 | 2,49·10-15 | 1,63·10-13 | 3,71·10-15 |
| 101Rh | 1,09·10-14 | 2,4·10-16 | 1,49·10-14 | 3,56·10-16 |
| 101mRh | 1,29·10-14 | 2,83·10-16 | 1,71·10-14 | 4.03·10-16 |
| 102Rh | 9,68·10-14 | 2,02·10-15 | 1,19·10-13 | 2,57·10-15 |
| 102mRh | 2.15·10-14 | 4,77·10-16 | 3,68·10-14 | 2,28·10-15 |
| 103mRh | 6,02·10-18 | 8,86·10-19 | 4,49·10-17 | 6,88·10-18 |
| 105Rh | 3,47·10-15 | 7,42·10-17 | 1.07·10-14 | 1,76·10-16 |
| 106Rh | 1,06·10-14 | 3,45·10-16 | 1.09·10-13 | 1,42·10-14 |
| 106mRh | 1,35·10-13 | 2,75·10-15 | 1,81·10-13 | 5,20·10-15 |
| 107Rh | 1.41·10-14 | 3,38·10-16 | 4,42·10-14 | 4,63·10-15 |
| 99Rh | 2,63·10-14 | 5,66·10-16 | 3,42·10-14 | 8,42·10-16 |
| 99mRh | 3,06·10-14 | 6,39·10-16 | 3.94·10-14 | 9,37·10-16 |
| 218Rn | 3,4·10-17 | 7,25·10-19 | 4,30·10-17 | 1,05·10-18 |
| 219Rn | 2,46·10-15 | 5,28·10-17 | 3,38·10-15 | 6,64·10-17 |
| 220Rn | 1,72·10-17 | 3,69·10-19 | 2,20·10-17 | 5,21·10-19 |
| 222Rn | 1,77·10-17 | 3,82·10-19 | 2,28·10-17 | 5,20·10-19 |
| 103Ru | 2,08·10-14 | 4,49·10-16 | 2,77·10-14 | 6,16·10-16 |
| 105Ru | 3,56·10-14 | 7,82·10-16 | 6,73·10-14 | 4,48·10-15 |
| 94Ru | 2,36·10-14 | 5·10-16 | 2,95·10-14 | 6,70·10-16 |
| 97Ru | 9,91·10-15 | 2,16·10-16 | 1,32·10-14 | 3,22·10-16 |
| 35S | 3,11·10-18 | 1,33·10-20 | 2,92·10-16 | 7,54·10-20 |
| 115Sb | 4,02·10-14 | 8,93·10-16 | 6,52·10-14 | 3,88·10-15 |
| 116Sb | 1.02·10-13 | 2,03·10-15 | 1,50·10-13 | 7,34·10-15 |
| 116mSb | 1,45·10-13 | 2,93·10-15 | 1,82·10-13 | 4,59·10-15 |
| 117Sb | 7,15·10-15 | 1,65·10-16 | 1,03·10-14 | 2,53·10-16 |
| 118mSb | 1,19·10-13 | 2,39·10-15 | 1,46·10-13 | 2,99·10-15 |
| 119Sb | 1,5·10-16 | 1,56·10-17 | 7,09·10-16 | 7,20·10-17 |
| 120Sb | 2·10-14 | 4,67·10-16 | 4,46·10-14 | 4,27·10-15 |
| 120mSb | 1.14·10-13 | 2,28·10-15 | 1,39·10-13 | 2,84·10-15 |
| 122Sb | 2,02·10-14 | 4,85·10-16 | 6,03·10-14 | 6,72·10-15 |
| 124Sb | 8,62·10-14 | 1,7·10-15 | 1,26·10-13 | 5,20·10-15 |
| 124mSb | 1,58·10-14 | 3,44·10-16 | 2,46·10-14 | 1,19·10-15 |
| 124nSb | 4,67·10-19 | 5,07·10-20 | 2,33·10-18 | 2,45·10-19 |
| 125Sb | 1,87·10-14 | 4,09·10-16 | 2,65·10-14 | 5,97·10-16 |
| 126Sb | 1,28·10-13 | 2,72·10-15 | 1,73·10-13 | 5,33·10-15 |
| 126mSb | 7,01·10-14 | 1,55·10-15 | 1,24·10-13 | 8.61·10-15 |
| 127Sb | 3,12·10-14 | 6,76·10-16 | 5,58·10-14 | 2,85·10-15 |
| 128mSb | 9,08·10-14 | 1,99·10-15 | 1,73·10-13 | 1,28·10-14 |
| 128Sb | 1,41·10-13 | 2,98·10-15 | 1,99·10-13 | 7,48·10-15 |
| 129Sb | 6,71·10-14 | 1,37·10-15 | 1,05·10-13 | 5,10·10-15 |
| 130Sb | 1,5·10-13 | 3,14·10-15 | 2,29·10-13 | 1.11·10-14 |
| 131Sb | 8,84·10-14 | 1,77·10-15 | 1,40·10-13 | 7,51·10-15 |
| 43Sc | 4,88·10-14 | 1,07·10-15 | 7,91·10-14 | 3,61·10-15 |
| 44Sc | 9,87·10-14 | 2,08·10-15 | 1,58·10-13 | 9,47·10-15 |
| 44mSc | 1,24·10-14 | 2,62·10-16 | 1,72·10-14 | 3,23·10-16 |
| 46Sc | 9,36·10-14 | 1.88·10-15 | 1,17·10-13 | 2,28·10-15 |
| 47Sc | 4,67·10-15 | 9,97·10-17 | 1,28·10-14 | 1,95·10-16 |
| 48Sc | 1,57·10-13 | 3.11·10-15 | 2,01·10-13 | 4,27·10-15 |
| 49Sc | 7,16·10-16 | 1,02·10-16 | 5,43·10-14 | 9,74·10-15 |
| 70Se | 4,4·10-14 | 9,98·10-16 | 8,36·10-14 | 6,44·10-15 |
| 73Se | 4,78·10-14 | 1,07·10-15 | 8,31·10-14 | 5,40·10-15 |
| 73mSe | 1,09·10-14 | 2,52·10-16 | 2,39·10-14 | 2,22·10-15 |
| 75Se | 1,68·10-14 | 3,61·10-16 | 2,16·10-14 | 4,76·10-16 |
| 77mSe | 3,63·10-15 | 7,77·10-17 | 6,99·10-15 | 1,10·10-16 |
| 79Se | 3,94·10-18 | 1,64·10-20 | 3,71·10-16 | 9,10·10-20 |
| 81Se | 8,69·10-16 | 8,14·10-17 | 3.94·10-14 | 7,07·10-15 |
| 81mSe | 5,48·10-16 | 1,26·10-17 | 1.40·10-15 | 4,41·10-17 |
| 83Se | 1.14·10-13 | 2,29·10-15 | 1,69·10-13 | 7,37·10-15 |
| 31Si | 4,83·10-16 | 7,14·10-17 | 3,78·10-14 | 6,86·10-15 |
| 32Si | 8,68·10-18 | 2,5·10-20 | 8,27·10-16 | 1,20·10-19 |
| 141Sm | 6,44·10-14 | 1,39·10-15 | 1,27·10-13 | 8,93·10-15 |
| 141mSm | 9,07·10-14 | 1,89·10-15 | 1,39·10-13 | 6,48·10-15 |
| 142Sm | 3,43·10-15 | 8,95·10-17 | 6,44·10-15 | 3,93·10-16 |
| 145Sm | 1,26·10-15 | 5,56·10-17 | 2,64·10-15 | 1,09·10-16 |
| 151Sm | 2,46·10-20 | 3,54·10-21 | 1,90·10-19 | 2,53·10-20 |
| 153Sm | 2,04·10-15 | 6,1·10-17 | 1,45·10-14 | 7,12·10-16 |
| 155Sm | 4,43·10-15 | 1,56·10-16 | 4,01·10-14 | 6,24·10-15 |
| 156Sm | 4,93·10-15 | 1,12·10-16 | 1,46·10-14 | 4,31·10-16 |
| 110Sn | 1,25·10-14 | 2,77·10-16 | 1,66·10-14 | 3,89·10-16 |
| 111Sn | 2,3·10-14 | 5,01·10-16 | 4,22·10-14 | 3,22·10-15 |
| 113Sn | 3,15·10-16 | 1,63·10-17 | 8,20·10-16 | 6,47·10-17 |
| 117mSn | 6,11·10-15 | 1,4·10-16 | 1,25·10-14 | 2,10·10-16 |
| 119mSn | 7,04·10-17 | 7,47·10-18 | 3,42·10-16 | 3,57·10-17 |
| 121Sn | 3,9·10-17 | 8,84·10-20 | 3,71·10-15 | 3,01·10-19 |
| 121mSn | 5,24·10-17 | 3,6·10-18 | 1,07·10-15 | 1,34·10-17 |
| 123Sn | 6,98·10-16 | 6,5·10-17 | 3,28·10-14 | 5,71·10-15 |
| 123mSn | 6,14·10-15 | 1,73·10-16 | 3,58·10-14 | 4,74·10-15 |
| 125Sn | 1,54·10-14 | 3,82·10-16 | 7,13·10-14 | 9,21·10-15 |
| 126Sn | 1.84·10-15 | 4,82·10-17 | 6,65·10-15 | 8,07·10-17 |
| 127Sn | 9,03·10-14 | 1,8·10-15 | 1,41·10-13 | 6,48·10-15 |
| 128Sn | 2,77·10-14 | 6,25·10-16 | 4,50·10-14 | 1,14·10-15 |
| 80Sr | 5·10-18 | 1,6·10-18 | 1,44·10-16 | 4,91·10-17 |
| 81Sr | 6,24·10-14 | 1.43·10-15 | 1,44·10-13 | 1,27·10-14 |
| 82Sr | 4,92·10-18 | 1,57·10-18 | 1,42·10-16 | 4,83·10-17 |
| 83Sr | 3,6·10-14 | 7,61·10-16 | 5.2·10-14 | 2,26·10-15 |
| 85Sr | 2,24·10-14 | 4,84·10-16 | 2,83·10-14 | 6,76·10-16 |
| 85mSr | 9,48·10-15 | 2,02·10-16 | 1.23·10-14 | 2,57·10-16 |
| 87mSr | 1.41·10-14 | 3,04·10-16 | 2.15·10-14 | 4,02·10-16 |
| 89Sr | 4,37·10-16 | 6,86·10-17 | 3,69·10-14 | 6,66·10-15 |
| 90Sr | 9,83·10-17 | 1,64·10-18 | 9,20·10-15 | 1,40·10-16 |
| 91Sr | 3,27·10-14 | 7,27·10-16 | 8,14·10-14 | 7,53·10-15 |
| 92Sr | 6,41·10-14 | 1,23·10-15 | 8,56·10-14 | 1,86·10-15 |
| 172Ta | 7,1·10-14 | 1,49·10-15 | 1.16·10-13 | 6,58·10-15 |
| 173Ta | 2,55·10-14 | 5,75·10-16 | 5,08·10-14 | 3,80·10-15 |
| 174Ta | 2.75·10-14 | 6,15·10-16 | 5,36·10-14 | 3,75·10-15 |
| 175Ta | 4,24·10-14 | 8,49·10-16 | 5,32·10-14 | 1.09·10-15 |
| 176Ta | 1,03·10-13 | 1,93·10-15 | 1,25·10-13 | 2,75·10-15 |
| 177Ta | 2,15·10-15 | 5,87·10-17 | 3,36·10-15 | 8,00·10-17 |
| 178Ta | 4,12·10-15 | 9,61·10-17 | 5,65·10-15 | 1.27·10-16 |
| 178mTa | 4,32·10-14 | 9,53·10-16 | 5,87·10-14 | 1,20·10-15 |
| 179Ta | 9·10-16 | 2,75-10-17 | 1,45-10-15 | 3,91-10-17 |
| 180Ta | 2,35·10-14 | 5,18·10-16 | 3,26·10-14 | 6,51·10-16 |
| 180mTa | 1.43·10-15 | 4,23·10-17 | 3,67·10-15 | 1,20·10-16 |
| 182Ta | 5,99·10-14 | 1.2·10-15 | 7,85·10-14 | 1,63·10-15 |
| 182mTa | 9,94·10-15 | 2,25·10-16 | 1,93·10-14 | 2,86·10-16 |
| 183Ta | 1,19·10-14 | 2,68·10-16 | 2,62·10-14 | 5,49·10-16 |
| 184Ta | 7,25·10-14 | 1,55·10-15 | 1.16·10-13 | 5,44·10-15 |
| 185Ta | 8.23·10-15 | 2,5·10-16 | 5,20·10-14 | 7,49·10-15 |
| 186Ta | 7,02·10-14 | 1,58·10-15 | 1,49·10-13 | 1,22·10-14 |
| 147Tb | 7,29·10-14 | 1,55·10-15 | 1,27·10-13 | 7.55·10-15 |
| 149Tb | 7,51·10-14 | 1,5·10-15 | 1.02·10-13 | 3,65·10-15 |
| 150Tb | 7,75·10-14 | 1.62·10-15 | 1.31·10-13 | 7,52·10-15 |
| 151Tb | 3,87·10-14 | 8,38·10-16 | 5,07·10-14 | 1,13·10-15 |
| 153Tb | 8,86·10-15 | 2,09·10-16 | 1.23·10-14 | 2,88·10-16 |
| 154Tb | 1.14·10-13 | 2,08·10-15 | 1,38·10-13 | 3,00·10-15 |
| 155Tb | 4,84·10-15 | 1,25·10-16 | 7,29·10-15 | 1.77·10-16 |
| 156Tb | 8,34·10-14 | 1,69·10-15 | 1,04·10-13 | 2,11·10-15 |
| 156mTb | 6,24·10-16 | 2,21·10-17 | 1,11·10-15 | 3,42·10-17 |
| 156nTb | 9,73·10-17 | 3,15·10-18 | 3,56·10-16 | 4,95·10-18 |
| 157Tb | 5,34·10-17 | 2,2·10-18 | 1,06·10-16 | 3,93·10-18 |
| 158Tb | 3,58·10-14 | 7,49·10-16 | 4,70·10-14 | 1,17·10-15 |
| 160Tb | 5,19·10-14 | 1,06·10-15 | 7,34·10-14 | 1.88·10-15 |
| 161Tb | 8,93·10-16 | 2,95·10-17 | 7,69·10-15 | 8,88·10-17 |
| 101Tc | 1,5·10-14 | 3,65·10-16 | 4,77·10-14 | 5,26·10-15 |
| 104Tc | 9,61·10-14 | 1,95·10-15 | 2,25·10-13 | 1.65·10-14 |
| 93Tc | 6,96·10-14 | 1,32·10-15 | 8,30·10-14 | 1.62·10-15 |
| 93mTc | 3.53·10-14 | 6,3·10-16 | 4,62·10-14 | 7,69·10-16 |
| 94Tc | 1,22·10-13 | 2,53·10-15 | 1,51·10-13 | 3,40·10-15 |
| 94mTc | 8,64·10-14 | 1,82·10-15 | 1,55·10-13 | 1.07·10-14 |
| 95Tc | 3,58·10-14 | 7,5·10-16 | 4,42·10-14 | 9,83·10-16 |
| 95mTc | 2,99·10-14 | 6,32·10-16 | 3,76·10-14 | 8,42·10-16 |
| 96Tc | 1.14·10-13 | 2,37·10-15 | 1,40·10-13 | 2,98·10-15 |
| 96mTc | 2.09·10-15 | 4,5·10-17 | 2,68·10-15 | 8,27·10-17 |
| 97Tc | 2,26·10-17 | 4,65·10-18 | 2,71·10-16 | 5.57·10-17 |
| 97mTc | 3,72·10-17 | 4,45·10-18 | 5,55·10-16 | 4,34·10-17 |
| 98Tc | 6,41·10-14 | 1,35·10-15 | 8,53·10-14 | 1,69·10-15 |
| 99Tc | 2,87·10-17 | 6,47·10-20 | 2,74·10-15 | 2,43·10-19 |
| 99mTc | 5,25·10-15 | 1,14·10-16 | 7,14·10-15 | 1,44·10-16 |
| 116Te | 1,98·10-15 | 6,06·10-17 | 3,37·10-15 | 1.35·10-16 |
| 121Te | 2,5·10-14 | 5,47·10-16 | 3,18·10-14 | 7,49·10-16 |
| 121mTe | 8,99·10-15 | 1,98·10-16 | 1.23·10-14 | 2,71·10-16 |
| 123Te | 1,51·10-16 | 1,42·10-17 | 6,32·10-16 | 5,71·10-17 |
| 123mTe | 5,81·10-15 | 1,32·10-16 | 8,48·10-15 | 1.87·10-16 |
| 125mTe | 3.35·10-16 | 2,66·10-17 | 1,94·10-15 | 9,45·10-17 |
| 127Te | 3,34·10-16 | 1,03·10-17 | 1,14·10-14 | 5,40·10-16 |
| 127mTe | 1,12·10-16 | 8,56·10-18 | 8,49·10-16 | 5,20·10-17 |
| 129Te | 2,86·10-15 | 1,14·10-16 | 3,57·10-14 | 5,74·10-15 |
| 129mTe | 1,56·10-15 | 5,7·10-17 | 1,49·10-14 | 2,27·10-15 |
| 131Te | 1,92·10-14 | 4,74·10-16 | 6,89·10-14 | 8,36·10-15 |
| 131mTe | 6,55·10-14 | 1,34·10-15 | 8,85·10-14 | 2,20·10-15 |
| 132Te | 9,32·10-15 | 2,12·10-16 | 1.39·10-14 | 2,99·10-16 |
| 133Te | 4,34·10-14 | 9,59·10-16 | 1,06·10-13 | 1,01·10-14 |
| 133mTe | 1,07·10-13 | 2,24·10-15 | 1.74·10-13 | 1,01·10-14 |
| 134Te | 3.94·10-14 | 8,48·10-16 | 6,35·10-14 | 2.16·10-15 |
| 226Th | 3,21·10-16 | 7,25·10-18 | 6.37·10-16 | 1,46·10-17 |
| 227Th | 4,43·10-15 | 9,81·10-17 | 6,50·10-15 | 1,56·10-16 |
| 228Th | 8,1·10-17 | 2,13·10-18 | 1.50·10-16 | 9,74·10-18 |
| 229Th | 3,36·10-15 | 7,89·10-17 | 5,41·10-15 | 1,57·10-16 |
| 230Th | 1,48·10-17 | 6,37·10-19 | 4,51·10-17 | 7,17·10-18 |
| 231Th | 4,58·10-16 | 1,55·10-17 | 2,52·10-15 | 8,58·10-17 |
| 232Th | 7,24·10-18 | 4,55·10-19 | 3,44·10-17 | 6,86·10-18 |
| 234Th | 2,94·10-16 | 7,49·10-18 | 7,50·10-16 | 1,72·10-17 |
| 44Ti | 4,7·10-15 | 1,18·10-16 | 6,79·10-15 | 1,49·10-16 |
| 45Ti | 3,89·10-14 | 8,66·10-16 | 7,07·10-14 | 4,37·10-15 |
| 194Tl | 3,41·10-14 | 7,35·10-16 | 4,41·10-14 | 9,81·10-16 |
| 194mTl | 1,03·10-13 | 2,23·10-15 | 1,47·10-13 | 5,37·10-15 |
| 195Tl | 5,94·10-14 | 1,16·10-15 | 7,52·10-14 | 1,94·10-15 |
| 197Tl | 1.78·10-14 | 3,77·10-16 | 2,43·10-14 | 6,59·10-16 |
| 198Tl | 9,47·10-14 | 1,82-10-15 | 1,16-10-13 | 2,39-10-15 |
| 198mTl | 5,26·10-14 | 1,13·10-15 | 7,40·10-14 | 1,58·10-15 |
| 199Tl | 1,02·10-14 | 2,27·10-16 | 1,49·10-14 | 3,13·10-16 |
| 200Tl | 5.98·10-14 | 1,22·10-15 | 7,50·10-14 | 1,64·10-15 |
| 201Tl | 3.25·10-15 | 7,96·10-17 | 4,89·10-15 | 1,15·10-16 |
| 202Tl | 2·10-14 | 4,4·10-16 | 2,63·10-14 | 5,70·10-16 |
| 204Tl | 1,71·10-16 | 1,08·10-17 | 1,24·10-14 | 9,54·10-16 |
| 206Tl | 3,95·10-16 | 6,07·10-17 | 3,36·10-14 | 5,89·10-15 |
| 207Tl | 4,53·10-16 | 5,56·10-17 | 3,06·10-14 | 5,21·10-15 |
| 208Tl | 1,69·10-13 | 2.97·10-15 | 2,34·10-13 | 9,77·10-15 |
| 209Tl | 9,65·10-14 | 1,92·10-15 | 1,59·10-13 | 9,87·10-15 |
| 162Tm | 8,5·10-14 | 1,63·10-15 | 1,24·10-13 | 5,30·10-15 |
| 166Tm | 8,78·10-14 | 1,7·10-15 | 1,08·10-13 | 2,42·10-15 |
| 167Tm | 5,39·10-15 | 1,31·10-16 | 1,17·10-14 | 1,76·10-16 |
| 170Tm | 3,67·10-16 | 2,64·10-17 | 1,81·10-14 | 2.12·10-15 |
| 171Tm | 1,77·10-17 | 5,55·10-19 | 3,17·10-17 | 7,91·10-19 |
| 172Tm | 2,3·10-14 | 4,87·10-16 | 5,76·10-14 | 5,72·10-15 |
| 173Tm | 1,72·10-14 | 3,88·10-16 | 3,89·10-14 | 2,29·10-15 |
| 175Tm | 4,81·10-14 | 1.04·10-15 | 9,10·10-14 | 5,87·10-15 |
| 230U | 4,56·10-17 | 1,55·10-18 | 1,07·10-16 | 1,17·10-17 |
| 231U | 2,56·10-15 | 6,4·10-17 | 3,82·10-15 | 1,60·10-16 |
| 232U | 1,17·10-17 | 8,07·10-19 | 5,92·10-17 | 1.10·10-17 |
| 233U | 1,42·10-17 | 5,99·10-19 | 4,57·10-17 | 5,94·10-18 |
| 234U | 6,11·10-18 | 5,86·10-19 | 4,25·10-17 | 9,09·10-18 |
| 235U | 6,46·10-15 | 1,4·10-16 | 8,64·10-15 | 1,94·10-16 |
| 236U | 3,86·10-18 | 5,03·10-19 | 3,57·10-17 | 8,45·10-18 |
| 237U | 5,29·10-15 | 1,23·10-16 | 9,97·10-15 | 2,07·10-16 |
| 238U | 2,5·10-18 | 4,23·10-19 | 2,91·10-17 | 7,42·10-18 |
| 239U | 2,13·10-15 | 8,25·10-17 | 2,61·10-14 | 3,64·10-15 |
| 240U | 5,87·10-17 | 3,19·10-18 | 3,12·10-15 | 3,74·10-17 |
| 47V | 4.49·10-14 | 1,05·10-15 | 1,08·10-13 | 1,09·10-14 |
| 48V | 1,36·10-13 | 2,72·10-15 | 1,72·10-13 | 3,73·10-15 |
| 176W | 5,98·10-15 | 1,54·10-16 | 8,74·10-15 | 2,01·10-16 |
| 177W | 3,91·10-14 | 8,38·10-16 | 5,11·10-14 | 1,18·10-15 |
| 178W | 3,83·10-16 | 1,14·10-17 | 6,09·10-16 | 1,69·10-17 |
| 179W | 1,5·10-15 | 4,98·10-17 | 2,58·10-15 | 8,44·10-17 |
| 181W | 1,16·10-15 | 3,44·10-17 | 1.84·10-15 | 4,79·10-17 |
| 185W | 4,97·10-17 | 1,71·10-19 | 4,52·10-15 | 1,57·10-18 |
| 187W | 2,13·10-14 | 4,68·10-16 | 4,09·10-14 | 2,03·10-15 |
| 188W | 1,1·10-16 | 1,82·10-18 | 2,91·10-15 | 2,48·10-18 |
| 120Xe | 1,79·10-14 | 4,01·10-16 | 2,40·10-14 | 6,44·10-16 |
| 121Xe | 8,62·10-14 | 1,69·10-15 | 1,40·10-13 | 7,79·10-15 |
| 122Xe | 2,19·10-15 | 6,03·10-17 | 3,36·10-15 | 1,12·10-16 |
| 123Xe | 2,82·10-14 | 6,03·10-16 | 4,52·10-14 | 2,51·10-15 |
| 125Xe | 1.08·10-14 | 2,47·10-16 | 1,50·10-14 | 3,56·10-16 |
| 127Xe | 1.12·10-14 | 2,56·10-16 | 1,57·10-14 | 3,58·10-16 |
| 129mXe | 9,14·10-16 | 4,16·10-17 | 8,29·10-15 | 1,11·10-16 |
| 131mXe | 3,49·10-16 | 1,6·10-17 | 4,82·10-15 | 4,44·10-17 |
| 133Xe | 1,33·10-15 | 3,95·10-17 | 4,97·10-15 | 6,93·10-17 |
| 133mXe | 1,28·10-15 | 3,53·10-17 | 1,04·10-14 | 6,93·10-17 |
| 135Xe | 1,1·10-14 | 2,5·10-16 | 3,12·10-14 | 2.09·10-15 |
| 135mXe | 1,9·10-14 | 4,19·10-16 | 2,97·10-14 | 1,41·10-15 |
| 138Xe | 5,48·10-14 | 1,07·10-15 | 1,07·10-13 | 7,65·10-15 |
| 86Y | 1,69·10-13 | 3,33·10-15 | 2,17·10-13 | 6,46·10-15 |
| 86mY | 9,59·10-15 | 2.04·10-16 | 1,28·10-14 | 2,91·10-16 |
| 87Y | 1,99·10-14 | 4,31·10-16 | 2,51·10-14 | 5,90·10-16 |
| 88Y | 1,3·10-13 | 2,41·10-15 | 1,54·10-13 | 2,92·10-15 |
| 90Y | 7,92·10-16 | 1,1·10-16 | 6,24·10-14 | 1,05·10-14 |
| 90mY | 2,77·10-14 | 5,97·10-16 | 3,75·10-14 | 9.99·10-16 |
| 91Y | 6,22·10-16 | 7,46·10-17 | 3,85·10-14 | 6,92·10-15 |
| 91mY | 2.37·10-14 | 5,1·10-16 | 3,11·10-14 | 9,52·10-16 |
| 92Y | 1,32·10-14 | 3,83·10-16 | 1.14·10-13 | 1.39·10-14 |
| 93Y | 5,28·10-15 | 2,1·10-16 | 8,50·10-14 | 1.23·10-14 |
| 94Y | 5,39·10-14 | 1,19·10-15 | 1,80·10-13 | 1,63·10-14 |
| 95Y | 4,66·10-14 | 9,1·10-16 | 1,59·10-13 | 1,38·10-14 |
| 162Yb | 4,92·10-15 | 1,22·10-16 | 6,99·10-15 | 1,60·10-16 |
| 166Yb | 2,35·10-15 | 7,44·10-17 | 3,88·10-15 | 1,08·10-16 |
| 167Yb | 9,48·10-15 | 2,37·10-16 | 1,38·10-14 | 3,16·10-16 |
| 169Yb | 1,13·10-14 | 2,78·10-16 | 1,73·10-14 | 3,66·10-16 |
| 175Yb | 1,75·10-15 | 3,74·10-17 | 6,93·10-15 | 5,21·10-17 |
| 177Yb | 8,82·10-15 | 2,17·10-16 | 3,60·10-14 | 4,49·10-15 |
| 178Yb | 1.62·10-15 | 3,6·10-17 | 1.07·10-14 | 3.05·10-16 |
| 62Zn | 1,92·10-14 | 4,15·10-16 | 2,52·10-14 | 5,52·10-16 |
| 63Zn | 5·10-14 | 1,16·10-15 | 1,23·10-13 | 1,19·10-14 |
| 65Zn | 2,72·10-14 | 5,41·10-16 | 3,29·10-14 | 6,52·10-16 |
| 69Zn | 1,99·10-16 | 2,08·10-17 | 1,81·10-14 | 2,02·10-15 |
| 69mZn | 1,84·10-14 | 3.98·10-16 | 2,44·10-14 | 5,64·10-16 |
| 71mZn | 6,99·10-14 | 1,54·10-15 | 1,21·10-13 | 7,85·10-15 |
| 72Zn | 6,17·10-15 | 1,34·10-16 | 1.00·10-14 | 1,72·10-16 |
| 86Zr | 1,17·10-14 | 2,56·10-16 | 1,56·10-14 | 4,22·10-16 |
| 88Zr | 1,73·10-14 | 3,77·10-16 | 2,26·10-14 | 5,21·10-16 |
| 89Zr | 5,31·10-14 | 1,1·10-15 | 7,07·10-14 | 2,13·10-15 |
| 95Zr | 3,36·10-14 | 7,04·10-16 | 4,50·10-14 | 8,91·10-16 |
| 97Zr | 8,9·10-15 | 2,5·10-16 | 5,55·10-14 | 8,27·10-15 |

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<\*> The values of coefficients are taken in accordance with NUREG/CR-7166 Radiological Toolbox User's Guide. - Office of Nuclear Regulatory Research, 2013.

<\*\*> The coefficients have been calculated in the assumption of semi-infinite cloud, and the activity of radionuclide 1 Bq/m3 is uniformly distributed over the volume thereof, radiation spectrum thereof corresponds to real spectrum.

<\*\*\*> The coefficients have been calculated in the assumption of a infinite flat source, and the activity of radionuclide 1 Bq/m3 is uniformly distributed over the area thereof, radiation spectrum thereof corresponds to real spectrum.

Table 2

RECOMMENDED VALUES OF INHALATION INTENSITIES FOR VARIOUS AGE GROUPS OFPOPULATION, M3/SEC

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Возрастная группа, g | 2 | 3 | 4 | 5 | 6 |
| Age | 1 - 2 years | 2 - 7 years | 7 - 12 years | 12 - 17 years | > 17 |
| Ur I, m3/sec | 6,032·10-5 | 1,016·10-4 | 1,651·10-4 | 2,317·10-4 | 2,571·10-4 |

Table 3

RECOMMENDED VALUES OF PARAMETES Fvr, Fvlr, Fmmilk,r, Ffmeat,r <\*>

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Component | Fvr | Fmmilk,r, day/l | Ffmeat,r,day/kg | Fvlr |
| Ac | 0.001 | 2·10-6 | 2·10-5 | 0.1 |
| Ag | 0.01 | 1·10-4 | 0.006 | 0.1 |
| Am | 0.002 | 2·10-5 | 1·10-4 | 0.1 |
| As | 0.08 | 1·10-4 | 0.02 | 0.2 |
| At | 0.2 | 0.01 | 0.01 | 0.9 |
| Au | 0.1 | 1·10-5 | 0.005 | 0.4 |
| Ba | 0.05 | 0.005 | 0.002 | 0.1 |
| Bi | 0.1 | 0.001 | 0.002 | 0.5 |
| Br | 0.4 | 0.02 | 0.05 | 2 |
| Cd | 0.5 | 0.02 | 0.001 | 5 |
| Ce | 0.05 | 3·10-4 | 2·10-4 | 0.1 |
| Cm | 0.001 | 2·10-6 | 2·10-5 | 0.1 |
| Co | 0.08 | 0.01 | 0.07 | 2 |
| Cr | 0.001 | 2·10-4 | 0.09 | 0.1 |
| Cs | 0.04 | 0.01 | 0.05 | 1 |
| Cu | 0.5 | 0.002 | 0.01 | 2 |
| Eu | 0.002 | 6·10-5 | 0.002 | 0.1 |
| Fe | 0.001 | 3·10-4 | 0.05 | 0.1 |
| Ga | 0.003 | 1·10-5 | 3·10-4 | 0.1 |
| Hg | 0.3 | 5·10-4 | 0.01 | 3 |
| I | 0.02 | 0.01 | 0.05 | 0.1 |
| In | 0.003 | 2·10-4 | 0.004 | 0.1 |
| Mn | 0.3 | 3·10-4 | 7·10-4 | 10 |
| Mo | 0.2 | 0.005 | 0.01 | 1 |
| Na | 0.05 | 0.25 | 0.8 | 0.6 |
| Nb | 0.01 | 4·10-6 | 3·10-6 | 0.2 |
| Ni | 0.3 | 0.2 | 0.05 | 1 |
| Np | 0.04 | 5·10-5 | 0.01 | 0.5 |
| P | 1 | 0.02 | 0.05 | 10 |
| Pa | 0.01 | 5·10-6 | 5·10-6 | 0.1 |
| Pb | 0.02 | 3·10-4 | 7·10-4 | 0.1 |
| Pd | 0.1 | 1·10-4 | 2·10-4 | 0.5 |
| Pm | 0.002 | 6·10-5 | 0.002 | 0.1 |
| Po | 0.002 | 0.003 | 0.005 | 0.1 |
| Pu | 0.001 | 3·10-6 | 2·10-4 | 0.1 |
| Ra | 0.04 | 0.001 | 0.005 | 0.4 |
| Rb | 0.2 | 0.1 | 0.03 | 2 |
| Rh | 0.2 | 5·10-4 | 0.002 | 2 |
| Ru | 0.05 | 3·10-5 | 0.05 | 0.2 |
| S | 0.6 | 0.02 | 0.2 | 6 |
| Sb | 0.001 | 2.5·10-4 | 0.005 | 0.1 |
| Se | 0.1 | 0.001 | 0.1 | 1 |
| Sn | 0.3 | 0.001 | 0.01 | 1 |
| Sr | 0.3 | 0.003 | 0.01 | 10 |
| Tc | 5 | 0.001 | 0.001 | 80 |
| Te | 1 | 0.005 | 0.07 | 10 |
| Th | 0.001 | 5·10-6 | 1·10-4 | 0.1 |
| Tl | 2 | 0.003 | 0.02 | 2 |
| U | 0.01 | 6·10-4 | 0.003 | 0.2 |
| Y | 0.003 | 6·10-5 | 0.01 | 0.1 |
| Zn | 2 | 0.01 | 0.2 | 2 |
| Zr | 0.001 | 6·10-6 | 1·10-5 | 0.1 |

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<\*> The values of the coefficients are taken in accordance with the Generic Models for use in Assessing the Impact of Discharges of Radioactive Substances to the Environment/Safety Reports.-Series N 19.-Vienna: IAEA, 2000.

Table 4

RECOMMENDED VALUES OF THE ANNUAL CONSUMPTION OF PRODUCTS FOR THE AGE GROUP "ADULTS" <\*>

|  |  |
| --- | --- |
| Product | Consumption of products, kg/year |
| Milk and milk products | 300 |
| Vegetables | 160 |
| Meat and meat products | 90 |

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<\*> SanPiN 2.3.2.1078-01 "Hygienic safety requirements and nutrition values of food products" approved by the Ordnance of the Chief State Health Inspector of the Russian Federation dated November 6, 2001 (registered by the Ministry of Justice of the Russian Federation No. 3326 dated March 22, 2002).

Table 5

RECOMMENDED VALUES OF DAILY ENERGY EXPENDITURES FOR PERSONS FROM DIFFERENT AGE GROUPS, KCAL/DAY

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Age group (g) | 2 | 3 | 4 | 5 | 6 |
| Age | 1 - 2 years | 2 - 7 years | 7 - 12 years | 12 - 17 years | > 17 |
| Energy, kcal/day | 1400 | 2000 | 2600 | 3100 | 2900 |

Table 6

VALUES OF COEFFICIENTS base_1_256438_32988 (Sv·m3)/(sec·Bq) <\*>

|  |  |
| --- | --- |
| Radionuclide | base_1_256438_32989 (Sv·m3)/(sec·Bq) |
| 37Ar | 4.75·10-20 |
| 39Ar | 1.27·10-16 |
| 41Ar | 6.13·10-14 |
| 74Kr | 5.21·10-14 |
| 76Kr | 1.85·10-14 |
| 77Kr | 4.51·10-14 |
| 79Kr | 1.12·10-14 |
| 81Kr | 2.43·10-16 |
| 83mKr | 2.43·10-18 |
| 85Kr | 2.54·10-16 |
| 85mKr | 6.83·10-15 |
| 87Kr | 3.94·10-14 |
| 88Kr | 9.72·10-14 |
| 120Xe | 1.74·10-14 |
| 121Xe | 8.68·10-14 |
| 122Xe | 2.2·10-15 |
| 123Xe | 2.78·10-14 |
| 125Xe | 1.08·10-14 |
| 127Xe | 1.12·10-14 |
| 129mXe | 9.38·10-16 |
| 131mXe | 3.70·10-16 |
| 133mXe | 1.27·10-15 |
| 133Xe | 1.40·10-15 |
| 135mXe | 1.85·10-14 |
| 135Xe | 1.11·10-14 |
| 138Xe | 5.44·10-14 |

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<\*> Values of coefficients taken in accordance with Age-dependent Doses to the Members of the Public from Intake of Radionuclides: Part 5 Compilation of Ingestion and Inhalation Coefficients//ICRP Publication 72.-Annals of the ICRP 26(1).-New York Pergamon Press, 1996.

Table 7

SPECIFIC ACTIVITY VALUES ALLOWING UNLIMITED USE OF THE MATERIALS FOR URANIUM ISOTOPES <\*>, Bq/kg

|  |  |
| --- | --- |
| Radionuclide | SAUU, Bq/kg |
| 230U | 1·10-2 |
| 231U | 1·10-1 |
| 232U | 1·10-3 |
| 233U | 1·10-2 |
| 234U | 1·10-2 |
| 235U | 1·10-2 |
| 236U | 1·10-2 |
| 237U | 1·10-1 |
| 238U | 1·10-2 |
| 239U | 1·10-1 |
| 240U | 1·100 |

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<\*> Values of the coefficient have been taken in accordance with Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards//General Safety Requirements Part 3 No.-GSR Part 3 (Interim).-IAEA, 2011.

Appendix No. 3   
to the safety guide in the use of atomic energy "Recommended methods for calculating the parameters necessary for development and stipulation of the limits for maximum permissible discharges of radioactive substances into the atmospheric air" approved by order of the Federal Environmental, Industrial and Nuclear Supervision Service No. 458   
dated November 11, 2015.

RECOMMENDATIONS   
FOR DETERMINING THE VALUES OF PARAMETERS INCLUDED IN THE FORMULAE FOR CALCULATION OF THE DILUTION FACTORS, DRY DEPOSITION FACTORS AND WET CLEARANCE

1. The vertical dispersion of pollutant jet for all types of underlying surfaces except "mow and short grass up to 15 cm" shall be made using the Smith H Hokser parameterization of for the following correlation.

base_1_256438_32990

where f(z0,x) andj(x) shall be determined according to the below specified formulae:

base_1_256438_32991

base_1_256438_32992

The recommended values of the parameters base_1_256438_32993 used in the calculations base_1_256438_32994 depending on the atmospheric stability category are given in the table 8 of this Appendix. The recommended values of the parameters base_1_256438_32995 used in the calculations base_1_256438_32996 depending on the roughness z0 are given in the table 9 of this Appendix. The recommended values of the upper boundary base_1_256438_32997 for various categories of atmospheric stability are given in the table 10 of this Appendix. The recommended values of roughness coefficient z0 for various types of underlying surface are given in the table 11 of this Appendix.

For the "mow and low grass up to 15 cm" type underlying surface for vertical dispersion the Briggs formulae shall be used, and for accounting for the limitation of vertical dispersion the values base_1_256438_32998 from the table 10 of Appendix shall be used:

for categories A:

base_1_256438_32999

for categories B:

base_1_256438_33000

for categories C:

base_1_256438_33001

for categories D:

base_1_256438_33002

for categories E:

base_1_256438_33003

for categories F:

base_1_256438_33004

Table 8

RECOMMENDED VALUES OF PARAMETERS USED IN THE CALCULATIONS base_1_256438_33005 DEPENDING ON THE ATMOSPHERIC STABILITY CATEGORY

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Stability category | a1 | a2 | b1 | b2 |
| A | 0.112 | 5.38·10-4 | 1.06 | 0.815 |
| B | 0.130 | 6.52·10-4 | 0.950 | 0.755 |
| C | 0.112 | 9.05·10-4 | 0.920 | 0.718 |
| D | 0.098 | 1.35·10-3 | 0.889 | 0.688 |
| E | 0.080 | 1.58·10-3 | 0.892 | 0.686 |
| F | 0.0609 | 1.96·10-3 | 0.895 | 0.684 |
| G | 0.0638 | 1.36·10-3 | 0.783 | 0.672 |

Table 9

RECOMMENDED VALUES OF PARAMETERS USED IN THE CALCULATIONS base_1_256438_33006 DEPENDING ON THE ROUGHNESS COEFFICIENT base_1_256438_33007

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| base_1_256438_33008 m | c1 | d1 | c2 | d2 |
| 0.01 | 1.56 | 0.0480 | 6.25·10-4 | 0.45 |
| 0.04 | 2.02 | 0.0269 | 7.76·10-4 | 0.37 |
| 0.1 | 2.72 | 0 | 0 | 0 |
| 0.4 | 5.16 | -0.098 | 5.38·10-2 | 0.225 |
| 1.0 | 7.37 | -0.0957 | 2.33·10-4 | 0.60 |

Table 10

RECOMMENDED UPPER BOUNDARY VALUES base_1_256438_33009 FOR DIFFERENT CATEGORIES OF ATMOSPHERIC STABILITY

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Stability category | A | B | C | D | E | F | G |
| base_1_256438_33010 m | 1600 | 1200 | 800 | 400 | 250 | 200 | 160 |

Table 11

RECOMMENDED VALUES OF ROUGHNESS COEFFICIENT base_1_256438_33011 FOR VARIOUS TYPES OF UNDERLYING SURFACE

|  |  |
| --- | --- |
| Type of underlying surface | base_1_256438_33012 m |
| Snow, lawn up to 1 cm high | 0.001 |
| High grass up to 60 cm | 0.04 - 0.09 |
| Cut and low grass up to 15 cm high | 0.006 - 0.02 |
| Non-uniform surface with alternating areas of grass, shrubs, etc. | 0.1 - 0.2 |
| Park, forest up to 10 m high | 0.2 - 1.0 |
| Urban structures | 3.0 |

2. The wind velocity module at the discharge height shall be calculated according to the following correlation:

base_1_256438_33013

where: base_1_256438_33014 modulus of the surface wind speed from the gradation of wind speed k , m/sec;

h - height of discharge, m;

base_1_256438_33015 height of weather cock (recommended to take as equal to 10 m);

base_1_256438_33016 a dimensionless parameter depending on the category of atmospheric stability and the coefficient of mesoscale roughness base_1_256438_33017of the underlying surface (section A.11).

The recommended values base_1_256438_33018 used for the calculation of wind velocity change with height are given in the table 12 of this Appendix.

Table 12

RECOMMENDED VALUES OF THE PARAMETER base_1_256438_33019 USED FOR CALCULATION OF THE WIND VELOCITY CHANGE WITH HEIGHT

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Stability category | z0 = 1 cm | z0 = 10 cm | z0 = 100 cm | z0 = 300 cm |
| A | 0.05 | 0.08 | 0.16 | 0.27 |
| B | 0.06 | 0.09 | 0.17 | 0.28 |
| C | 0.06 | 0.11 | 0.20 | 0.31 |
| D | 0.12 | 0.16 | 0.27 | 0.37 |
| E | 0.34 | 0.32 | 0.38 | 0.47 |
| F | 0.53 | 0.54 | 0.61 | 0.69 |

3. Data provided by the weather stations located in the discharge location area shall be used for calculating the distribution of the repeatability base_1_256438_33020 by stability criteria j, wind directions n and wind velocity groups.

4. Since in calm conditions (k = 1) the wind direction has not been defined, the number of observations for calm conditions shall be distributed by sector of wind direction proportionately to the frequency of its distribution in light wind conditions (K = 2).

5. All the cases of implementation of category G in the calculations shall be identified as category F (stable conditions) in accordance with the formula:

base_1_256438_33021

where base_1_256438_33022 repeatability of stability category F and G depending on the wind direction and its gradation by speeds.

6. The trajectory of jet climb base_1_256438_33023 for all weather conditions shall be calculated according to Netterville formulae:

for category D (indifferent stratification of atmosphere):

base_1_256438_33024

for categories A, B and C (instability conditions):

base_1_256438_33025

for categories E, F and G (stable conditions):

base_1_256438_33026

where: x is the distance from the chimney base, m;

base_1_256438_33027 time ofcloud wind movement up to distance x, sec.

base_1_256438_33028 wind speed at the discharge height m/s;

base_1_256438_33029 dimensionless transfer constant;

f = 0,7·10-2 - characteristic frequency of turbulence spectrum in neutral atmosphere, sec-1;

base_1_256438_33030 atmospheric stability parameter sec-;

T0 - absolute temperature of atmospheric air, К;

base_1_256438_33031 gradient of potential temperature (difference of measured and adiabatic gradient of temperature), K/m;

base_1_256438_33032 initial radius of jet with Hanna correction, m;

w0 - speed of discharge gas-air mixture;

d - diameter of pipe neck, m;

base_1_256438_33033 value proportional to the kinetic energy flow of exiting discharge stream, m4/sec2;

base_1_256438_33034 value proportional to the buoyancy force flow, m4/sec2;

g = 9.8 — acceleration of gravity, m/sec2;

base_1_256438_33035 difference of temperatures of discharged T and atmospheric T0 of air, K.

Recommended parameters s and base_1_256438_33036 for various stability categories are given in the table 13.

Table 13

RECOMMENDED VALUES OF PARAMETERS s AND base_1_256438_33037 FOR VARIOUS STABILITY CATEGORIES

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Category of atmospheric stability | A | B | C | D | E | F | G |
| s, c-1 | 0.02 | 0.017 | 0.015 | 0.00 | 0.023 | 0.033 | 0.038 |
| base_1_256438_33038 | 0.25 | 0.35 | 0.45 | 0.45 | 0.25 | 0.25 | 0.25 |

7. Recommended values of dry deposition rates of radionuclides from the atmosphere on the underlying surface are given in the table 14 of this Appendix.

Table 14

RECOMMENDED VALUES OF DRY DEPOSITION RATES OF RADIONUCLIDES FROM ATMOSPHERE ON THE UNDERLYING SURFACE

|  |  |
| --- | --- |
| Substance | base_1_256438_33039 m/sec |
| Elementary iodine | 2·10-2 |
| Organic iodine compounds | 1·10-4 |
| Aerosols | 8·10-3 |
| Inert Radioactive Gases | 0 |

8. Average annual constant of radionuclide washout by the precipitations shall be calculated according to the following formula:

base_1_256438_33040

where: base_1_256438_33041 absolute washout capacity of rain for the radionuclide r, h/(mm·s);

base_1_256438_33042 relative washout capacity of rain of type s (s = 1 for liquid precipitations, s = 2 for mixed precipitations and s = 3 for solid precipitations);

base_1_256438_33043 average annual amount of precipitation of s type, mm.

The value of quantity base_1_256438_33044 for all radionuclides except inert radioactive gases shall be taken as equal to 1·10-5 h/(mm.sec), and for inert radioactive gases shall be taken as equal to zero. The following values base_1_256438_33045shall be taken for parameter: base_1_256438_33046 for liquid, base_1_256438_33047 for mixed, base_1_256438_33048 for solid precipitations. The quantity base_1_256438_33049 shall be assessed by climatic data for the location of the source of discharges.

9. The jet depletion function due to radioactive decay shall be determined by the following expression:

base_1_256438_33050

where: base_1_256438_33051 radioactive decay constant of radionuclide r, sec-1;

Uj,k - wind velocity module at discharge height, m/sec.

10. If in the discharge of the i-th source natural uranium isotopes (234U, 235U и 238U) are present, then for these radionucides take base_1_256438_33052 as equal to 1.

11. If natural uranium (234U, 235U and 238U) isotopes are present in the discharge of i-th isotope of the source, the formation of daughter products of decay of these radionuclides after discharge shall not be accounted for, and the beta-activity of daughter products of decay formed before the discharge of these radionuclide also shall be accounted for.

12. The jet depletion function due to washout by atmospheric precipitations shall be determined by the following expression:

base_1_256438_33053

13. If in the discharge of the i-th source natural uranium isotopes (234U, 235U and 238U) are present, then for these radionuclides take base_1_256438_33054 as equal to 1.

14. The depletion function following dry deposition shall be determined by the expression:

base_1_256438_33055

At the distances, where base_1_256438_33056 the following expression shall be used:

base_1_256438_33057

where: base_1_256438_33058 maximum height of the mixing layer, m (shall be taken as equal to base_1_256438_33059

xmax - distance at which base_1_256438_33060 reaches the maximum base_1_256438_33061

15. If in the discharge from the i-th source natural uranium isotopes (234U, 235U and 238U) are present, then for these radionuclides take base_1_256438_33062 as equal to 1.

16. The complete jet depletion function shall be determined by the following expression:

base_1_256438_33063

17. Parameter xв shall be determined as the root of the following equation:

base_1_256438_33064

where: j - atmospheric stability gradation category number;

Sb - cross-section of the building perpendicular to the wind direction;

U - the wind speed at the discharge height (m/sec);

base_1_256438_33065 jet dispersion in the horizontal and vertical directions, calculated for the distance xв, m.

For transverse dispersion base_1_256438_33066 the following formula shall be used:

base_1_256438_33067

The recommended values of the parameter base_1_256438_33068 for various categories of atmospheric stability are given in the table 15 of this Appendix.

Table 15

PARAMETER VALUES base_1_256438_33069FOR DIFFERENT CATEGORIES OF ATMOSPHERIC STABILITY

|  |  |  |  |
| --- | --- | --- | --- |
| Stability category | base_1_256438_33070 | Stability category | base_1_256438_33071 |
| A | 0.22 | D | 0.08 |
| B | 0.16 | E | 0.06 |
| C | 0.11 | F | 0.06 |

18. After determining xв the volumetric activities shall be calculated according to the formulae for point sources, replacing the real distances x in them from the discharge point to the detection point by the sum base_1_256438_33072

19. The calculation for the low chimneys shall be performed according to the mixed model, where the share of pollutant from the total quantity of discharge equal to 1-Kb shall be taken as discharged from the high chimney, and for the share of pollutant equal to Kb shall be taken as intake into the zone of air shadow, where the volumetric source is formed. All the discharges from the openings of the buildings and other sources of buildings located nearby shall be taken that the height thereof is below the building height, fall under its air shadow zone.

Recommended values of discharges fraction Kb falling in the air shadow area behind the building during low release depending on the dimensionless effective height of the building base_1_256438_33073 are given in the table 16 of this Appendix.

Table 16

VALUES OF DISCHARGE FRACTION KB, FALLING IN THE AIR SHADOW AREA BEHIND THE BUILDING DURING LOW DISCHARGE DEPENDING ON THE DIMENSIONLESS EFFECTIVE HEIGHT OF THE BUILDING base_1_256438_33074

|  |  |
| --- | --- |
| base_1_256438_33075 m | Kb |
| 0 | 1 |
| 0.05 | 0.984 |
| 0.1 | 0.960 |
| 0.2 | 0.906 |
| 0.3 | 0.808 |
| 0.4 | 0.662 |
| 0.5 | 0.5 |
| 0.6 | 0.338 |
| 0.7 | 0.192 |
| 0.8 | 0.094 |
| 0.9 | 0.040 |
| 0.95 | 0.014 |
| 1 | 0 |

20. The effective height of the building base_1_256438_33076 depending on the mutual location of the building and chimney shall be calculated according to the formula:

base_1_256438_33077

where: hs - geometric height of the source of discharges from the ground surface, m;

hb - building height, m;

hiz - distance from the ground level to upper boundary of the mixing flow of air behind the building, m, calculated according to the formula:

base_1_256438_33078

where b - width of perpendicular wind direction of the building cross-section, m

Appendix No. 4   
to the safety guide in the use of atomic energy "Recommended methods for calculating the parameters necessary for development and stipulation of the limits for maximum permissible discharges of radioactive substances into the atmospheric air" approved by order of the Federal Environmental, Industrial and Nuclear Supervision Service No. 458   
dated November 11, 2015.

EXAMPLE   
 OF CALCULATION OF PARAMETERS REQUIRED FOR CALCULATION OF MAXIMUM PERMISSIBLE DISCHARGE LIMITS

1. This Appendix contains an example of calculating the parameters required for calculation of the maximum permissible discharge limits using the ratios given in this Safety Guide.

2. Consider the following set of source data:

1) source of discharge - ventilation stack of height hs = 120 m, diameter of chimney mouth d = 4.48 m Discharge rate w0 = 6.26 m/sec, temperature of discharge mix T = 23 оC;

2) radionuclide composition and annual volume of discharges are given in the table 17 of this Appendix;

3) sanitary protection zone represents a circle of radius 3 km with center at the source location point; no agricultural production within the sanitary protection zone; quota of annual effective exposure dose of the public constitutes 200 μSv/year;

4) repeatability of wind directions in different rhumns and average annual wind speed at the weathercock height are given in the table 18 of this Appendix; annual atmospheric precipitations in the source location area are given in the table 19 of this Appendix. Mesoscla roughnes factor z0 = 1 cm

Table 17

RADIONUCLIDE COMPOSITION AND ANNUAL DISCHARGE VOLUMES

|  |  |
| --- | --- |
| Radionuclide | Q, Bq/year |
| 131I (gaseous form) | 1.8·1010 |
| 137Cs | 2.0·109 |

Table 18

REPEATABILITY OF WIND DIRECTIONS IN DIFFERENT RHUMBS AND AVERAGE ANNUAL WIND SPEED AT WEATHERCOCK HEIGHT (FROM WHERE WIND BLOWS)

|  |  |  |
| --- | --- | --- |
| Parameter name | | Value |
| Wind rose, % | N | 8 |
| NE | 9 |
| E | 10 |
| SE | 10 |
| S | 12 |
| SW | 21 |
| W | 17 |
| NW | 13 |
| Average annual wind velocity, m/sec | | 1.8 |

Table 19

ANNUAL ATMOSPHERIC PRECIPITATIONS IN THE SOURCE LOCATION AREA

|  |  |
| --- | --- |
| Precipitation type | Quantity, mm/year |
| Liquid | 464 |
| Solid | 180 |
| Mixed | 56 |
| Total | 700 |

The formula for calculation of the average annual meteorological dilution factor (2) of Appendix No. 1 to this Safety Guide shall take the following form considering the initial data given in the item 2 of this Appendix.

base_1_256438_33079

The calculation procedure of the quantities included in the formula (1)is described in Appendix No. 3 to this Safety Guide.

4. The Briggs parameterization described by the formulae (4) - (9) of Appendix No 3 to this Safety Guide shall be used for different categories of atmospheric stability considering the fact that it has been accepted in the initial data that the mesoscale surface roughness coefficient z0=1 cm for calculation of the vertical base_1_256438_33080 discharge jet dispersion.

The graphs of dependencies base_1_256438_33081 for various categories of atmospheric stability in the logarithm scale are given in fig.1 of this Appendix.

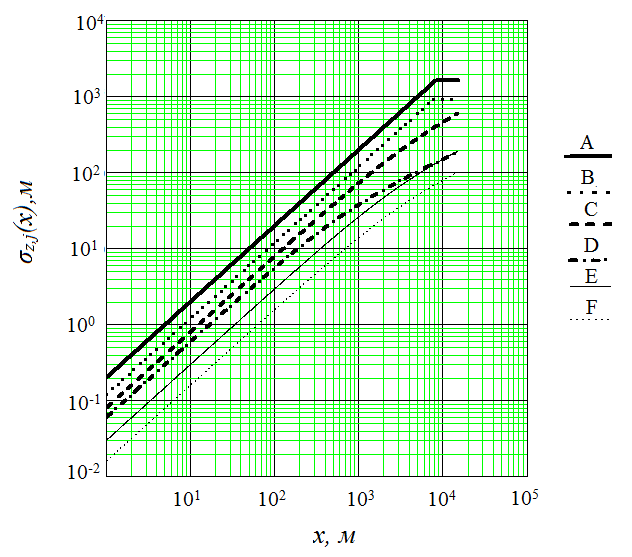


Fig. 1. Graphs of dependencies base_1_256438_33083 for various categories of atmospheric stability

5. The wind speed values base_1_256438_33084 for various stability categories calculated are given in the table 20 of this Appendix for discharge height in accordance with the formula (10) of Appendix No, 3 to this Safety Guide.

Table 20

CALCULATED VALUES OF WIND SPEED base_1_256438_33085 FOR VARIOUS STABILITY CATEGORIES

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Stability category | A | B | C | D | E | F |
| base_1_256438_33086 | 1.1 | 1.2 | 1.2 | 1.3 | 2.3 | 3.7 |

6. Jet rise above the source of discharge base_1_256438_33087 m, for various categories of atmospheric stability shall be calculated using the formulae (12) - (14) of Appendix No. 3 to this Safety Guide

The graphs of dependencies base_1_256438_33088 for various categories of atmospheric stability, built according to the formulae (12) (14) of Appendix No.3 to these Safety Guide are shown in Fig. of this Appendix.

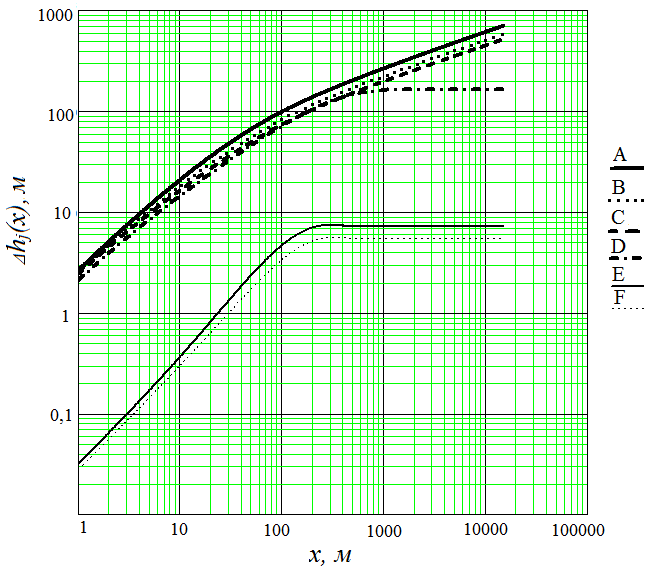


Fig. 2. Graphs of dependencies base_1_256438_33090 for various categories of atmospheric stability

7.The values of the jet depletion function base_1_256438_33091 shall be calculated using the formulae (16) - (20) of Appendix No.3 to this Safety Guide .

The average annual constant washout value of radionuclides by precipitation calculated using initial data from the table 19 of this Appendix according to the formula (15) of Appendix 3 to this Safety Guide for radionuclides 131I and 137Cs, shall constitute 1.3·10-6 с-1.

The values of dry deposition rates in accordance with the table 14 of Appendix No. 3 to this Safety Guide shall be taken as equal to 2·10-2 m/sec for 131I and 8·10-3 m/sec for 137Cs.

Given in the fig. 3 and 4 for 131I and 13Cs are the graphs of dependencies of complete jet depletion functionsbase_1_256438_33092 due to radioactive decay, washout by atmospheric precipitation and dry deposition for different categories of atmospheric stability .

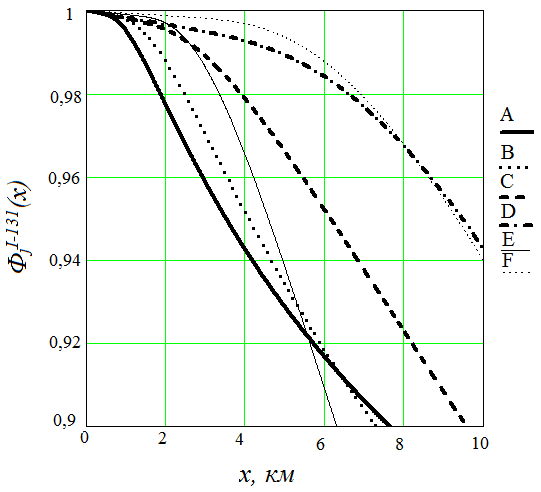


Fig. 3. Graphs of dependencies of depletion functions for 131I from the distance from the source for various categories of atmospheric stability

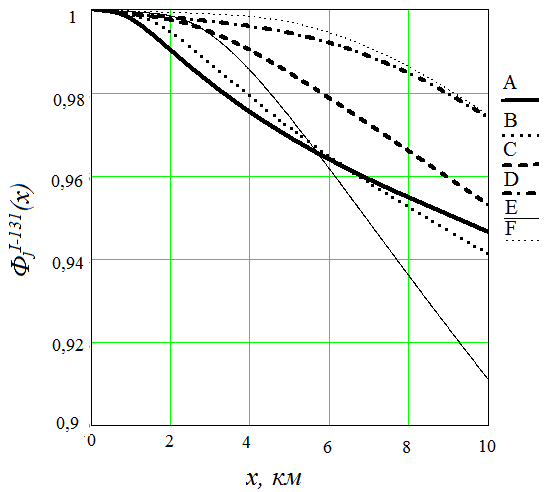


Fig. 4. Graphs of dependencies of depletion functions for 137Cs from the distance from the source for various categorie of atmospheric stability

8. The graphs of dependencies of average annual meteorological dilution factors determined by the formula (1) of item 3 of this Appendix for each of the eight wind directions given in the table 18 of this Appendix.

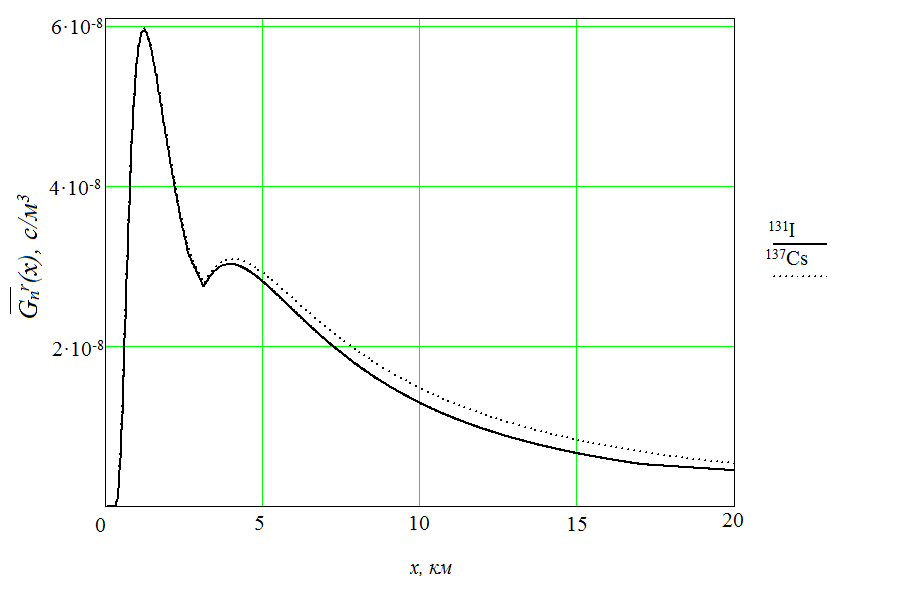


Fig. 5. Graphs of dependencies of the dilution factor from distance from the source in the southern direction

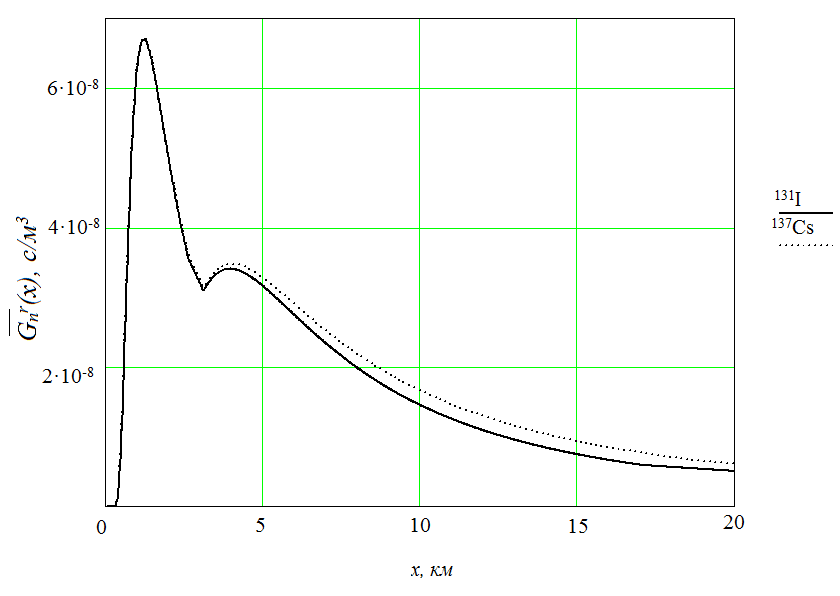


Fig. 6. Graphs of dependencies of the dilution factor from distance from the source in the south-western direction

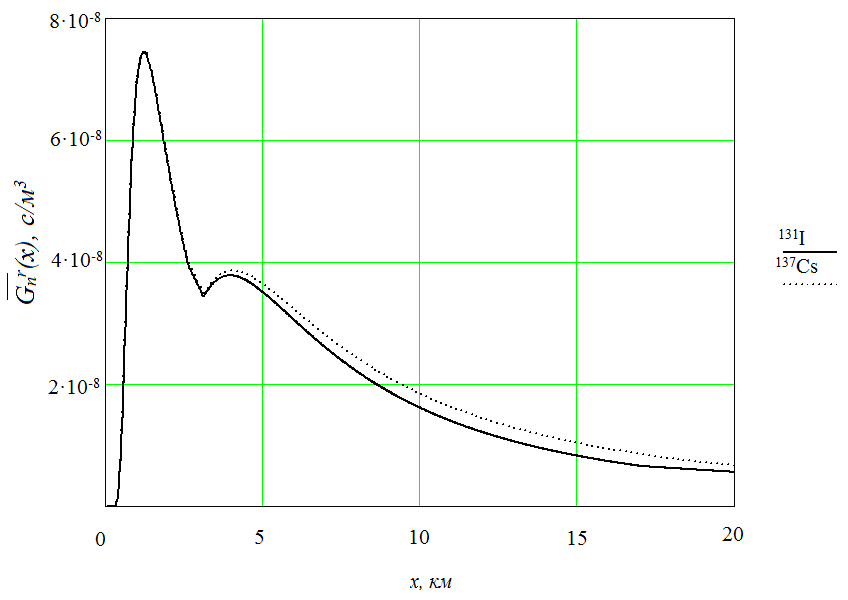


Fig. 7. Graphs of dependencies of the dilution factor from distance from the source in the western direction

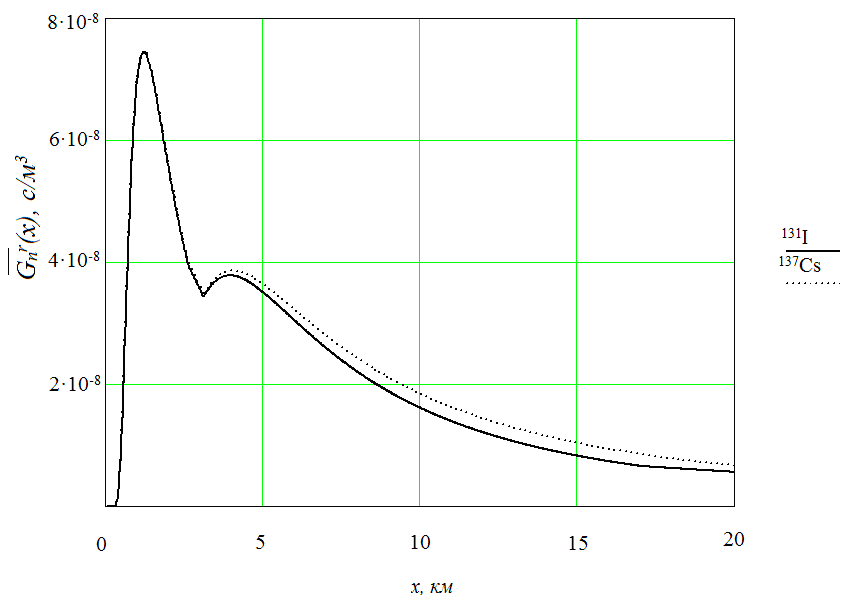


Fig. 8. Graphs of dependencies of the dilution factor from distance from the source in the north-western direction

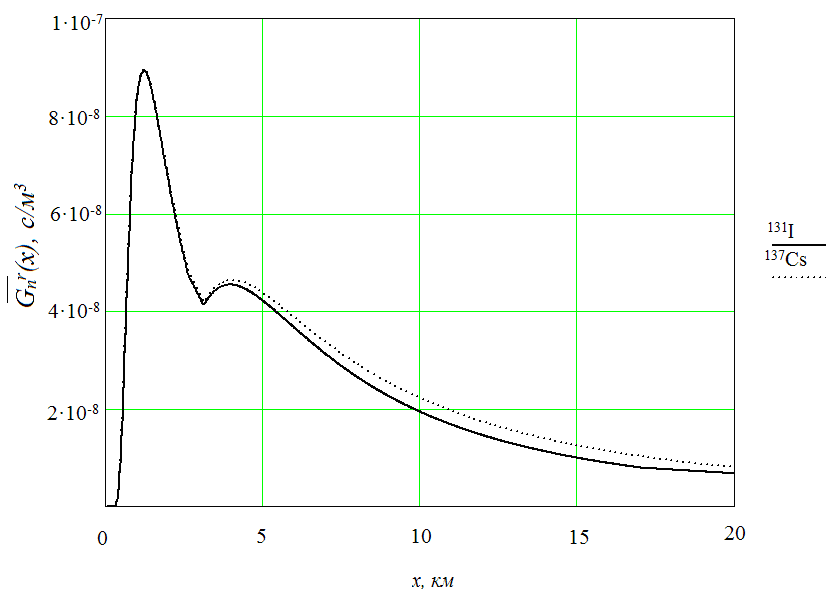


Fig. 9. Graphs of dependencies of the dilution factr from the distance from the source in the northern direction

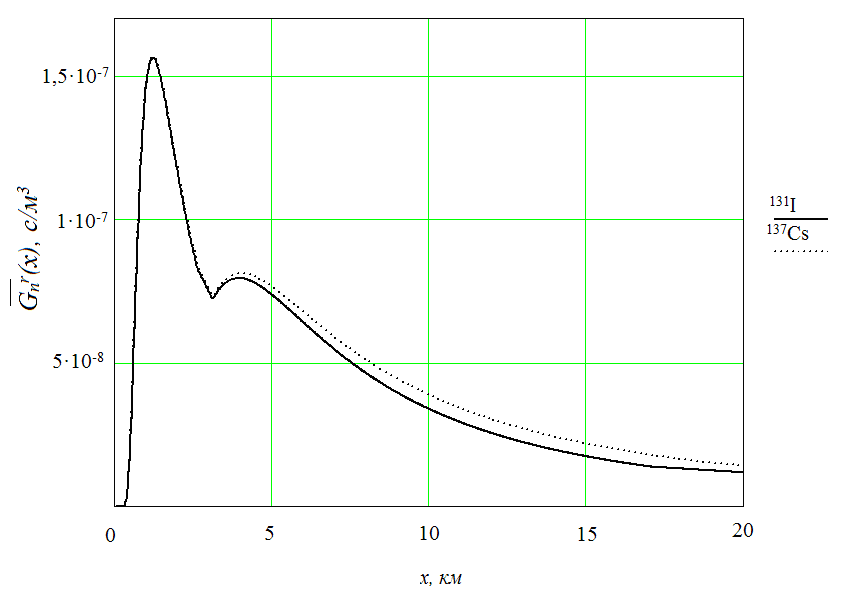


Fig. 10. Graphs of dependencies of the dilution factor from distance from the source in the north-eastern direction

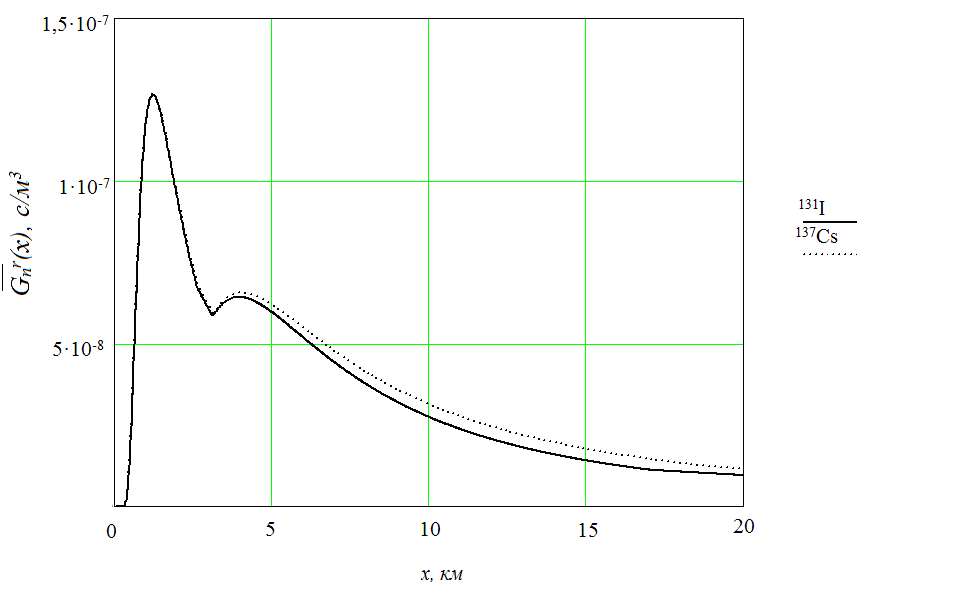


Fig. 11. Graphs of dependencies of the dilution factor from distance from the source in the eastern direction

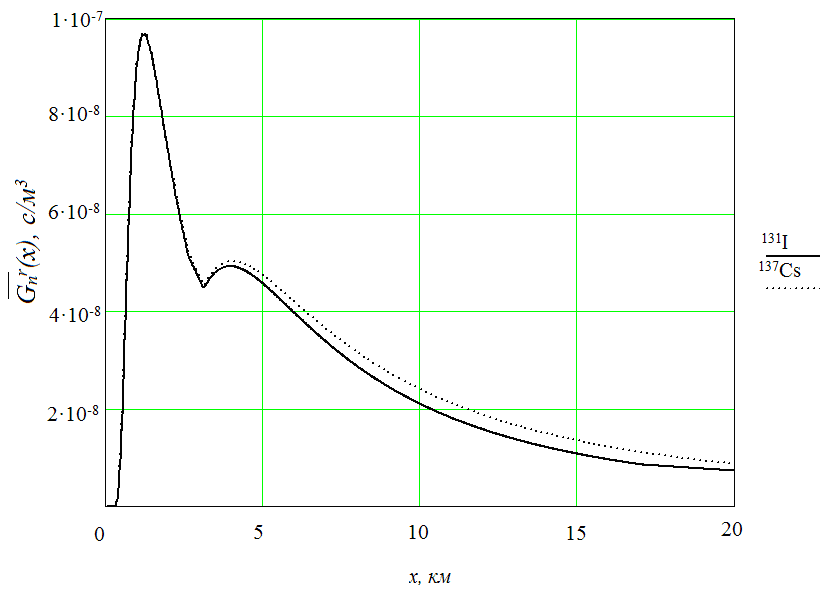


Fig. 12. Graphs of dependencies of the dilution factor from distance from the source in the south-eastern direction

It follows from the analysis of graphs presented in the fig. 5 - 12 of this Appendix that the maximum values of the dilution factors are implemented in the north-eastern direction from the source.

9. The calculated values base_1_256438_33103 for 131I and 137Cs in the south-eastern direction from the source of discharge calculated according to the formula (7) of Appendix No. 1 to this Safety Guide are given in the table 21 of this Appendix.

Table 21

CALCULATED VALUES FOR 131I AND 137Cs IN THE SOUTH-EASTERN DIRECTION FROM THE DISCHARGE SOURCE

|  |  |  |
| --- | --- | --- |
| Distance from the source x, m | base_1_256438_33104 sec/m2 | |
| 131I | 137Cs |
| 500 | 4.718·10-4 | 4.720·10-4 |
| 1000 | 2.350·10-4 | 2.356·10-4 |
| 1500 | 1.554·10-4 | 1.565·10-4 |
| 2000 | 1.154·10-4 | 1.169·10-4 |
| 3000 | 7.594·10-5 | 7.732·10-5 |
| 4000 | 5.636·10-5 | 5.758·10-5 |
| 5000 | 4.451·10-5 | 4.578·10-5 |
| 6000 | 3.655·10-5 | 3.794·10-5 |
| 7000 | 3.085·10-5 | 3.235·10-5 |
| 9000 | 2.329·10-5 | 2.494·10-5 |
| 11000 | 1.868·10-5 | 2.023·10-5 |
| 13000 | 1.550·10-5 | 1.697·10-5 |
| 15000 | 1.317·10-5 | 1.459·10-5 |

10. The average annual meteorological factors of dry deposition Fr,n (x) and wet clearance Wr,n (x) for 131I and 137Cs in the north-eastern direction from the source are presented in the tables 22 and 23 of this Appendix calculated in accordance with the formulae (5) and (6) of Appendix No. 1 to the Safety Guide.

Table 22

CALCULATED VALUES Fr,n (x) and Wr,n (x) FOR 131I

|  |  |  |
| --- | --- | --- |
| Distance from the source x, m | Fr,n (x), m-2 | Wr,n (x), m-2 |
| 500 | 4.0·10-12 | 6.1·10-10 |
| 1000 | 2.9·10-11 | 3.1·10-10 |
| 1500 | 3.0·10-9 | 2.0·10-10 |
| 2000 | 2.3·10-9 | 1.5·10-10 |
| 3000 | 1.5·10-9 | 9.9·10-11 |
| 4000 | 1.6·10-9 | 7.3·10-11 |
| 5000 | 1.5·10-9 | 5.8·10-11 |
| 6000 | 1.3·10-9 | 4.8·10-11 |
| 7000 | 1.1·10-9 | 4.0·10-11 |
| 9000 | 7.9·10-10 | 3.0·10-11 |
| 11000 | 5.9·10-10 | 2.4·10-11 |
| 13000 | 4.5·10-10 | 2.0·10-11 |
| 15000 | 3.5·10-10 | 1.7·10-11 |

Table 23

CALCULATED VALUES Fr,n (x) И Wr,n (x) FOR 137Cs

|  |  |  |
| --- | --- | --- |
| Distance from the source x, m | Fr,n (x), m-2 | Wr,n (x), m-2 |
| 500 | 1.6·10-10 | 6.1·10-10 |
| 1000 | 1.2·10-9 | 3.1·10-10 |
| 1500 | 1.2·10-9 | 2.0·10-10 |
| 2000 | 9.5·10-10 | 1.5·10-10 |
| 3000 | 6.1·10-10 | 1.0·10-10 |
| 4000 | 6.5·10-10 | 7.5·10-11 |
| 5000 | 6.1·10-10 | 5.9·10-11 |
| 6000 | 5.4·10-10 | 4.9·10-11 |
| 7000 | 4.7·10-10 | 4.2·10-11 |
| 9000 | 3.6·10-10 | 3.2·10-11 |
| 11000 | 2.7·10-10 | 2.6·10-11 |
| 13000 | 2.2·10-10 | 2.2·10-11 |
| 15000 | 1.7·10-10 | 1.9·10-11 |

11. Considering the fact that it has been accepted in the initial data that the sanitary protection zone represents a circle of radius 3 km with center at the source location, the formula (1) of section II of this Safety Guide for calculation of the transfer function relating the activity of radionuclide r discharge from the i-th source with the effective exposure dose of the public shall take the following form:

base_1_256438_33105

Transfer functions base_1_256438_33106 are calculated according to the formulae (2), (3), (4) and (5) of section II of this Safety Guide

12. The values of the parameters required for calculation of the transfer function are given in the table 24 for radionuclides 131I and 137Cs.

Table 24

VALUES OF PARAMETERS REQUIRED FOR CALCULATION OF TRANSFER FUNCTION

|  |  |  |
| --- | --- | --- |
| Radionuclide | 131I | 137Cs |
| base_1_256438_33107 | 1.61·10-14 | 9.28·10-17 |
| base_1_256438_33108 | 3.64·10-16 | 2.99·10-18 |
| base_1_256438_33109 | 7.2·10-8 | 4.6·10-9 |
| base_1_256438_33110 | 1.8·10-7 | 1.3·10-8 |
| base_1_256438_33111 | 0.02 | 0.04 |
| Fm milk, r, days./l | 0.01 | 0.01 |
| Ff meat, r, days./kg | 0.05 | 0.05 |
| base_1_256438_33112 | 0.1 | 1 |

The values of inhalation intensities for the persons from various age groups, given in the table 2 of Appendix 2 to this Safety Guide were taken for the calculation of base_1_256438_33113 from the formula (2) in accordance with the formula (4) of section II of this Safety Guide.

The values of the annual consumptions of products by the persons from the age group "adults" and values of the daily energy costs for persons from various age groups given in the tables 4 and 5 of Appendix 2 to this Safety Guide were accepted for calculation of base_1_256438_33114 from the formula (2) in accordance with the formula (5) of section II of this Safety Guide.

13. The annual consumption of food products by the persons of the critical age group Ir,f, kg/year calculated according to the formula (7) of the section II of this Safety Guide are given in the table 25 of this Appendix.

Table 25

ANNUAL CONSUMPTION OF FOOD PRODUCTS BY PERSONS OF CRITICAL AGE GROUP r,f, KG/YEAR

|  |  |  |  |
| --- | --- | --- | --- |
| Food product | | | Critical group (radionuclide, for which it shall be determined) |
| Vegetables | Meat and meat products | Milk and milk products |
| 77.2 | 43.4 | 144.8 | children 1 - 2 years (131I) |
| 160 | 90 | 300 | adults (137Cs) |

The transfer factors "fall-out from the atmosphere - intake into the product" of radionuclide r in food products f over the air route K1r,f, calculated using the formulae (7), (11) and (13) of the section II of this Safety Guide are given in the table 26.

Table 26

TRANSFER FACTORS OVER FOOD CHAINS K1r,f

|  |  |  |  |
| --- | --- | --- | --- |
| Radionuclide | K1r,f, m2·year/kg | | |
| K1r, vegetables | K1r, meat | K1r, milk |
| I-131 | 2.480·10-6 | 0.023 | 6087·10-3 |
| Cs-137 | 0.013 | 0.076 | 0.02 |

The transfer factors "fall-out from the atmosphere - intake into the product" of radionuclide r in food products f over the air route K2r,f, calculated using the formulae (8), (12) and (14) of the section II of this Safety Guide are given in the table 27.

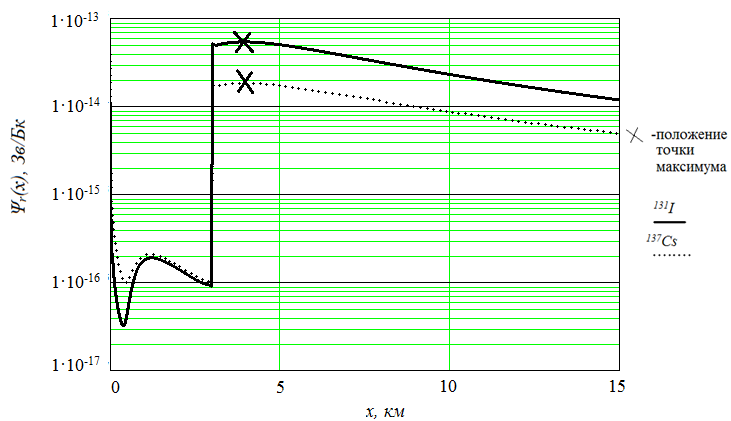
Table 27

TRANSFER FACTORS OVER FOOD CHAINS K2r,f

|  |  |  |  |
| --- | --- | --- | --- |
| Radionuclide | K2r,f, m2·year/kg | | |
| K2r, vegetables | K2r, meat | K2r, milk |
| I-131 | 1.020·10-9 | 4.692·10-6 | 1.251·10-6 |
| Cs-137 | 2.064·10-3 | 0.031 | 8.288·10-3 |

14. The maximum annual effective exposure dose of the public shall be located in that direction from the source where the wind blows often considering the data on sanitary protection zone given in the item 2 of this Appendix.

The graphs of dependencies of the transfer functions base_1_256438_33115 linking the annual effective doses with discharge 131I or 137Cs from the distance in the north-eastern direction from the source, calculated in accordance with the procedure described above in the section II of this Safety Guide are illustrated in the fig. 13 in semilogarithmic scale.



*x, km*

X - position of maximum point

*131I*

*137Cs*

Ψ*r(x), Sv/Bq*

Fig. 13. Graphs of dependencies of the transfer functions base_1_256438_33117 linking the annual effective doses with discharge 131I or 137Cs from the distance in the north-eastern direction from the source

Thus the maximum functional associating the annual effective exposure dose of the public with discharges 131l shall be implemented at a distance of 3990 m in the north-eastern direction from the source and constitute 5.422·10-14 Sv/Bq.

The maximum functional associating the annual effective exposure dose of the public with discharges 137Cs shall be implemented at a distance of3940 m in the north-eastern direction from the source and constitute 1.84·10-14 Sv/Bq.

15. The transfer function associating the annual equivalent exposure dose of skin and eye lens shall be calculated in accordance with the formula (34) of section IV of this Safety Guide.

16. The values of dose factors for the skin for radionuclides 131I and 137Cs taken from the table 1 of Appendix No. 2 to this Safety Guide are given in the table 28 of this Appendix.

Table 28

DOSE FACTORS FOR SKIN EXPOSURE

|  |  |  |
| --- | --- | --- |
| Radionuclide | base_1_256438_33118 | base_1_256438_33119 |
| 131I | 2.98·10-14 | 6.43·10-16 |
| 137Cs | 8.63·10-15 | 2.75·10-16 |

Since according to item 33 of section IV of this Safety Guide the dose factors for the eye lens may be conservatively taken proportional to the dose factors for skin with factor 0.3, the values of the transfer function for the eye lens shall be proportional to the values of transfer function for skin with the same proportionality factor.

The maximum values base_1_256438_33120 calculated at the point of maximum annual effective dose, implemented in the north-eastern direction from the source according to the formula (34) of section IV of this Safety Guide constitute 2.169·10-18 Sv/Bq for 131I and 1.765·10-16 Sv/Bq for 137Cs.

17. The contribution of annual effective dose 131 calculated in accordance with the recommendations of the section III of this Safety Guide constitute 96.9% , hence the stipulation of maximum permissible discharge limits shall be required for both the radionuclides contained in the discharge.