Simulating the neutron-induced activity and dose rate of components in the reactor pressure vessel of Oskarshamn 3

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Abstract

During operation of a nuclear power plant the neutron radiation of the reactor core may induce activity in surrounding components and equipment. These may in turn become radiation hazards during decommissioning or component exchanges. To better plan for this, models of the degree of activation and subsequently, the dose are therefore of great importance. Building upon a previous study of the neutron flux around the reactor core of Oskarshamn 3, the induced activity was determined with FISPACT in 2 components above the reactor core; the steam separator and the steam dryer. These were chosen since their activation had not previously been studied in detail. The activity is simulated for 5 different cool-down times; 3 days, 1 year, 30 years, 100 years and 1000 years. Using the activity, the surface dose rate and the dose rate 1 m in air from the components is simulated in MicroShield. Due to limitations in the software, 3 simplified geometries were used, one which overestimated the dose rate, one which underestimated it and one which laid in between. The surface dose rate was highest in the steam separator and was at most 225/6.5/140 mSv/hour for the respective geometries, and the dose rate at a 1 m distance was at most 13.6/2.9/18.3 mSv/hour. The dose rate from the steam dryer was only above 0.1 mSv/hour at the surface of the component 3 days after irradiation, and was for the most part below 10 μSv/hour.

Preface

This master's thesis was written during the spring of 2024 at Lund University as the final examination of me, Simon Brandt. I'd like to thank all the people that have helped me complete this thesis; Kristina Stenström my supervisor at Lund University and Fredrik Malmros my supervisor at OKG.

List of Abbreviations

BWR = Boiling Water Reactor
CR = Control Rod
CS = Carbon Steel
FOM = Figure Of Merit
FP = Fission Product
Gy = Gray
IMP = Importance
LSODE = Livermore Solver for Ordinary Differential Equations
MCNP = Monte-Carlo N-Particle
MW_{th} = Mega-Watt thermal power
ORNL = Oak Ridge National Laboratory
O3 = Oskarshamn 3
PS = Pressure-Suppression
RPV = Reactor Pressure Vessel
SS = Stainless Steel
Sv = Sievert
WC = Water Column

Contents

1 Introduction

1.1 Background

Nuclear energy is a large and necessary part of today's energy generation. During the operation of a nuclear reactor, components close to and inside the reactor vessel are exposed to neutron radiation of varying degrees depending on their position. The neutrons can be absorbed and or cause nuclear reactions with the atoms of the component which in turn can lead to the production of radioactivity. Regardless of what radiation the radioactivity results in (α, β, γ), it will have consequences for the radiation safety of personnel working close to the reactor, as well as during handling and disposal of radioactive waste when components are exchanged and in the long run when the facility is decommissioned and dismantled. To better be able to plan and manage these activities, greater understanding and modelling of the neutron fields and their impact on components close to the reactor are needed. The degree of radioactivity depends e.g. on the neutron flux and energy, the elemental composition and density of the components, as well as the time of and since irradiation. The problem therefore has many parameters. In this thesis, the reactor that is analyzed is Oskarshamn 3 (O3) which is located in the municipality of Oskarshamn on the Swedish east coast. It is a boiling water reactor (BWR) with a thermal power of 3900 MW [1]. The steam separator and steam dryer are two components located close to the reactor core of O3 which have not been included in any detailed activation-analysis previously. These have therefore been chosen for the purposes of this report.

1.2 Purpose

Previously, studies regarding the neutron flux from O3 have been conducted using the MCNP (Monte Carlo N-Particle) transport code [2]. The purpose of this report is thus to build further upon these studies using another simulation code, FISPACT-II [3], and the software MicroShield [4] to determine:

- the radionuclide specific total activity in the steam separator and steam dryer with regard to the operation history of O3,
- what radionuclides dominate in absorbed dose to workers and the dose rate from a removed component,
- how the radiation level varies with time, as well as
- the effective dose to a worker during handling as a function of time (time during handling as well as from the time of removal).

While this report is mainly concerned with certain components of O3, the hope is that the methodology will be applicable to other components such as for example the control rods or moderator- and reactor-tank, or components in other reactors.

1.3 Disposition

In the next sections of this report the methodology used will be described. First the necessary theory is explained, after which the simulations in MCNP, i.e. the previous neutron flux studies are described. Following that, the new activation studies done in FISPACT II are described. Lastly, the calculations of dose rates and their time variance are described. In section 5, the results are compiled and in section 6 these results are discussed. Finally some conclusions are drawn in section 7. The appendix contains tables of the activation products in each part of the components for each cool-down period.

2 Theory

This section describes the theory necessary to understand the presence of a neutron flux in the reactor, the effects of this flux on surrounding components, as well as the effect these components may have on nearby workers.

2.1 Binding energy - the basis of nuclear reactions

The nucleons (protons and neutrons) of a nucleus are constantly affected by the competing forces of the attractive strong nuclear force which binds the core together, and the electrostatic repulsive Coulomb force which acts to break it apart. The strong force affects all nucleons but has a short range of interaction, acting only between closely neighboring nucleons. The Coulomb force on the other hand only acts between the positively charged protons, but the range of interaction is on the order of the nuclear radius ($R \approx 1.25 \cdot 10^{-15} A^{1/3}$ m) [5]. As such, the ratio of neutrons (N) to protons (Z) in the nucleus will need to increase as Z increases to keep the nucleus together. In other words, as Z increases the stable nuclei become increasingly neutron-rich. This leads us to the binding energy (B). The mass of a nucleus is not simply the sum of the mass of protons and neutrons of which it is composed. Some of the mass has been converted into energy which is the energy binding the core together, the *binding energy.* The atomic mass of a nuclide with mass number A and proton number Z can be expressed as

$$m(A, Z) = Zm_H + (A - Z)m_n - B/c^2 \tag{1}$$

where m_H and m_n are the atomic mass of a hydrogen atom and the mass of a neutron respectively (e.g. in atomic mass units u) and B in energy units (often in electron-volts eV). This can be thought of as the energy required to divide the nucleus back into its constituent nucleons. A more important metric however is the binding energy *per nucleon* (B/A), as this is what determines the stability of the nucleus. The more binding energy per nucleon the more stable the nucleus is. This is the driving factor of nuclear reactions since nuclei strive to have the largest binding energy possible per nucleon [6]. Figure 1 shows the average binding energy per nucleon in MeV of a number of relatively abundant isotopes. As can be seen, B/A increases sharply for nuclei with $A < 30$ and reaches a peak with ^{56}Fe, after which it declines slowly with increasing mass number.

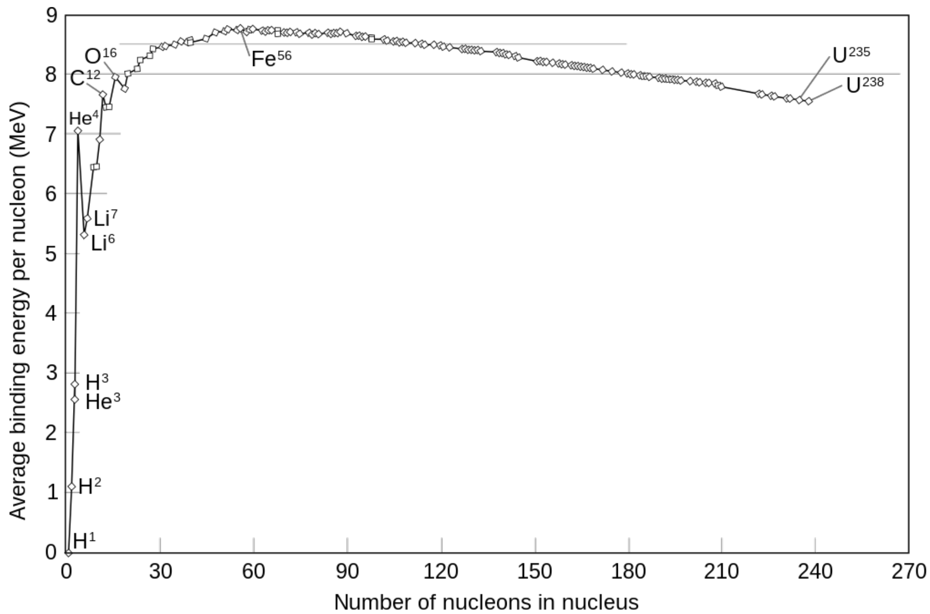


Figure 1: Average binding energy per nucleon in MeV for a number of relatively common isotopes. A few important nuclides are marked in the figure. Credit: Wikimedia Commons

2.2 Nuclear collisions

The materials of components close to the reactor are (mostly) inert prior to operation of the reactor, but due to nuclear collisions between the materials and particles resulting from the fissioning fuel (and its byproducts) they become activated. Consider first a uni-directional stream of particles moving in the same direction incident on a stationary target. The flux ϕ of this stream is defined as the number of particles per unit time and per unit area perpendicular to the motion. The speed of a particle can be derived from the equation

$$E_{kin} = \frac{mv^2}{2} \tag{2}$$

where E_{kin} is the classical kinetic energy (which is the energy we are interested in), and m is the mass of the particle. Rearranging the above expression to get v yields $v = \sqrt{2mE_{kin}}$

For a uni-directional beam of particles with speeds between v and $v + dv$, and a density of particles in the beam which is $n_p(v)$, the flux is given by

$$\phi = \int_{v}^{v+dv} v n_p(v) dv \tag{3}$$

If there are N nuclei in the target being exposed to the beam, the reaction rate of the target nuclei is given by

$$R = N\sigma\phi \tag{4}$$

where σ is the *cross-section* defined as $\sigma = \frac{\text{reaction rate per nucleus}}{\text{incident flux}}$. The cross section has the unit of area, and is most often expressed in terms of *barn* (1b = 10^{-28} m^2). In this report we are mainly concerned with the activation due to the neutron flux, thus the neutron cross-section for absorption σ_a, scattering σ_s, fission σ_f and radiative capture σ_γ for different materials are of most importance. The cross-section for different neutron interactions are greatly dependant on the neutron energy, and therefore the amount of activation due to a neutron flux can vary a lot.
The rate in equation 4 which was derived for a uni-directional beam of particles can easily be extrapolated to a beam of particles moving in any direction by defining the flux as the total path length travelled by all particles in a unit volume per unit time [6].
Considering a beam with intensity I, which is defined as

$$I = \phi S \tag{5}$$

where S is the cross-sectional area of the beam, incident on a target with thickness t, we can re-write the rate equation 4 as

$$R = N\sigma\frac{I}{S} = I\sigma n_t t \tag{6}$$

where n_t is the number of target nuclei per unit volume. If the target consists of an element with atomic mass M_A in atomic mass units, then $n_t = \rho\frac{N_A}{M_A}$ where N_A is Avogadros number. This means equation 6 can be re-written once again as

$$R = I(\rho t)\sigma\frac{N_A}{M_A} \tag{7}$$

The production rate of a radioactive isotope due to bombardment of an incident beam of particles can be deduced in a similar way as the rate of decay was previously. Consider a radioactive isotope with decay constant λ being produced at a rate P. The net increase of the isotope is

$$\frac{dN}{dt} = P - \lambda N \tag{8}$$

If P is constant this equation can be easily solved yielding

$$N(t) = \frac{P}{\lambda}(1 - e^{-\lambda t}) \tag{9}$$

Lastly, the activity due to this isotope is given by

$$\mathfrak{A}(t) = \lambda N = P(1 - e^{-\lambda t}) \tag{10}$$

Activity has the unit of Becquerel (Bq), which denotes the number of decays per second.

2.3 Radioactive decay

For an unstable nucleus there is a number of interactions besides fission that can occur. It is in some cases possible for the nucleus to decay by emitting an alpha particle (${}^{4}He_{2}^{2+}$), i.e. *α decay*. An unstable nucleus may also decay by converting one of its neutrons into a proton while simultaneously emitting an electron (and antineutrino) in a process known as *β^{-} decay*. In some cases, this leaves the nucleus in an excited state, upon which follows a *gamma emission/decay*. The nucleus may also end up in an excited state after *radiative capture* where the nucleus absorbs a neutron carrying kinetic energy. In either case the nucleus is in an excited state and de-excites by emitting one or more gamma rays, the energy of which totals the amount between the ground state of the nucleus and its excited state. The nucleus may also de-excite in a competing process called *internal conversion* by transferring its excess energy to an electron in an inner electron shell. Through this, the electron gains enough energy to escape the nucleus. If the transition energy is high enough (this being higher than twice the rest mass of the electron, i.e. 1.022 MeV) *internal pair formation* may happen instead, causing an electron-positron pair to be created[5][6].
Another form of interaction is *neutron emission* where the compound nucleus instead decays by emission of one or more neutrons, leaving the nucleus in an excited state which undergoes further decays. This process is also referred to as inelastic scattering, since the total kinetic energy of the system is not conserved (the nucleus is in an excited state). Elastic scattering may also take place, where the total kinetic energy is conserved. Elastic scattering does not require the incident neutron to be absorbed, in which case the event is called a *potential scattering*. Which decay mode is most probable is dependant on the nuclei.

2.4 Rate of radioactive decay

The rate of radioactive decay of N nuclei of the same kind is given by

$$\frac{dN}{dt} = -\lambda N \tag{11}$$

where λ is the probability per unit time that the nucleus will decay known as the *decay constant*. If the nucleus has several modes of decay λ is the sum of decay probabilities of the different modes. The solution to equation 11 is given by

$$N(t) = N(0)e^{-\lambda t} \tag{12}$$

where $N(0)$ is the initial amount of nuclei.
The *mean life* τ is defined as the average lifetime of a nucleus and is given by

$$\tau = \frac{\int t dN}{\int dN} = \frac{\int_0^\infty te^{-\lambda t}dt}{\int_0^\infty e^{-\lambda t}dt} = \frac{1}{\lambda} \tag{13}$$

while the *half-life* $t_{1/2}$ is given by

$$t_{1/2} = \frac{ln2}{\lambda} = \tau ln2 \tag{14}$$

The rate of decay of a radioactive sample is also known as the *activity* $\mathfrak{A} = \lambda N$. It has the SI unit of Becquerel (Bq) and is defined as the number of decays per second.
As stated previously the FPs of a fission event are often themselves unstable and decay further. This leads to a chain of decays. Consider for example a chain of decays where nuclide A decays into nuclide B, which further decays into nuclide C with decay constants λ_A and λ_B respectively. The variation of A with time is given by equation 12 as $N_A(t) = N_A(0)e^{-\lambda_A t}$. Since N_B depends on N_A, the rate of decay of B has an extra term. Using equation 11, $\frac{dN_B}{dt} = -\lambda_B N_B + \lambda_A N_A$. Solving for N_B and assuming $N_B(0) = 0$ yields $N_B(t) = \frac{\lambda_A}{\lambda_B - \lambda_A} N_A(0)(e^{-\lambda_A t} - e^{-\lambda_B t})$. Similar differential equations can be written for C resulting in the so-called Bateman equations. An example of the variation of A, B and C with time can be seen in Figure 2 where $\lambda_B = \frac{\lambda_A}{2}$ and C is stable ($\lambda_C = 0$).

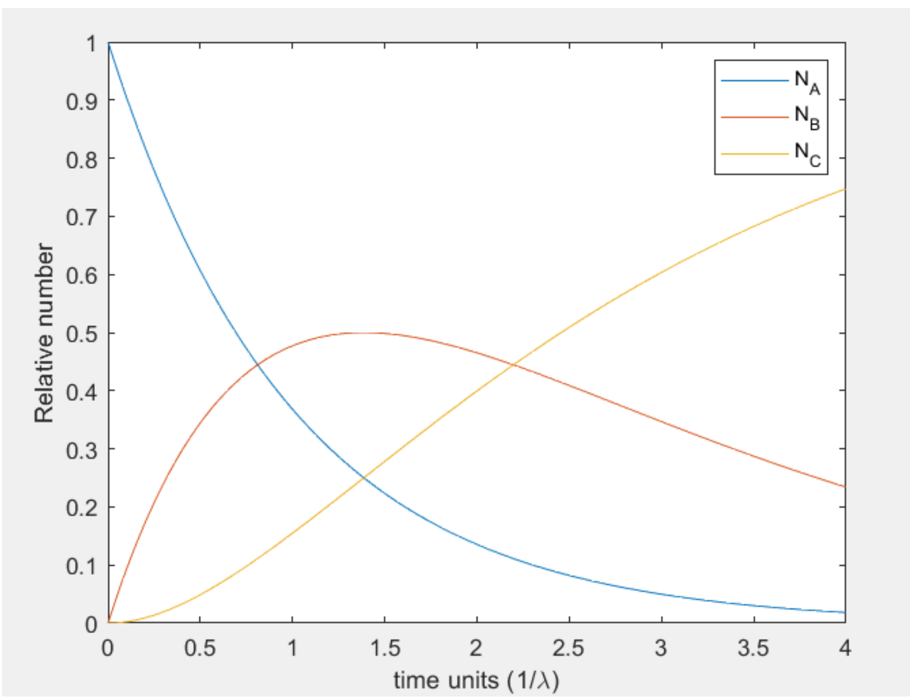


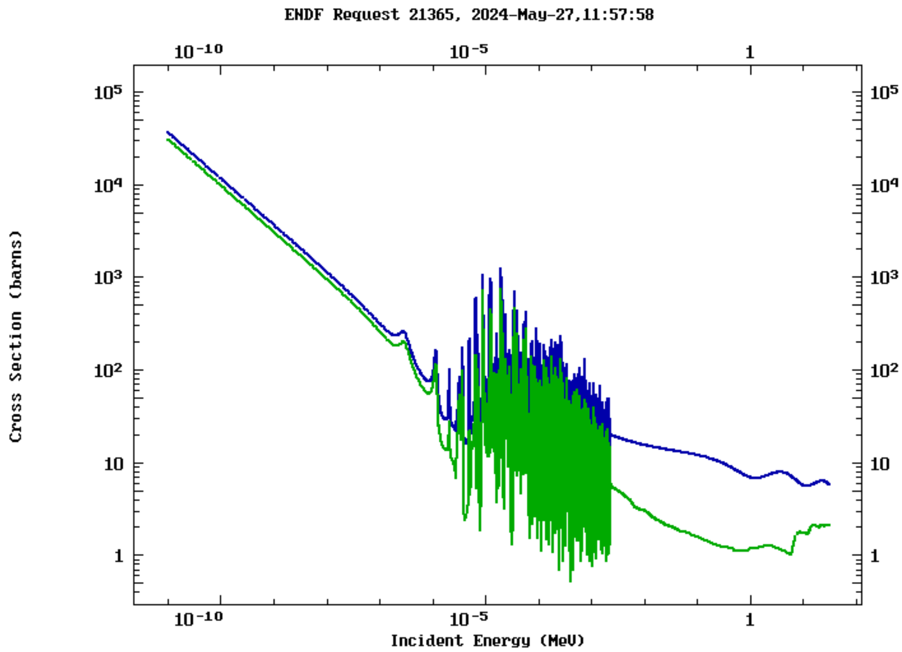
Figure 2: Variation with time of isotopes A, B and C in a decay chain A → B → C where $\lambda_B = \lambda_A/2$ and $\lambda_C = 0$.

2.5 Fission

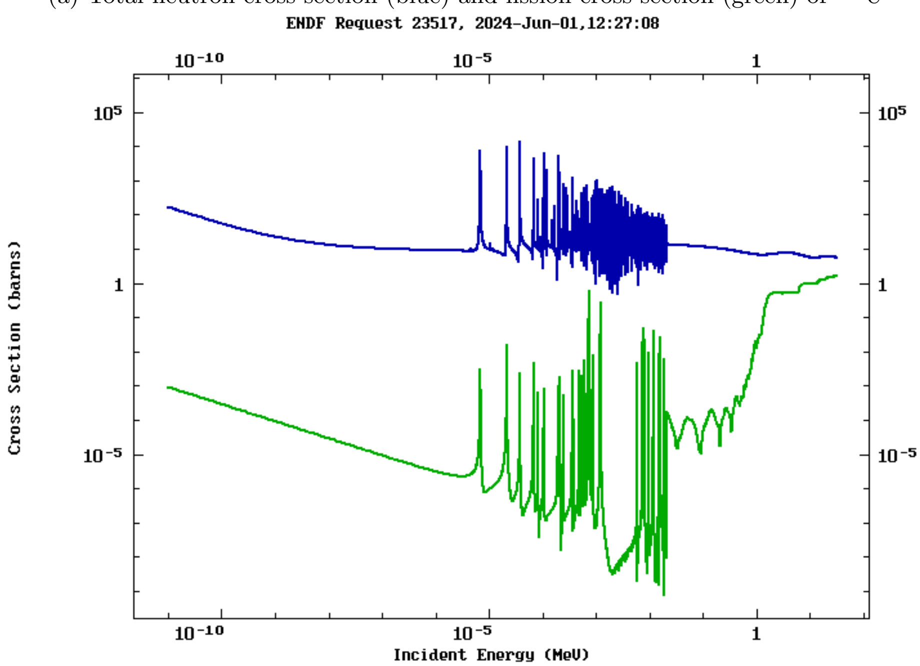
The slowly decreasing binding energy per nucleaon as mass number increases, which is seen in Figure 1 is the driving factor of fission. Fission is the process in which a heavy nucleus splits into 2 lighter nuclei with higher binding energy per nucleus, releasing in the process a number of neutrons [6]. The energy required to reach the higher B/A is released in the fission event as kinetic energy divided between the fission products (FPs). While some nuclei (e.g. ^{240}Pu or ^{252}Cf) have a high probability for spontaneous fission, most nuclei require a sufficient amount of external energy in order to fission. The minimal energy required, called the *excitation energy*, depends on the nuclear structure and can be quite large for nuclei with $Z < 90$. For nuclei with $Z > 90$, the excitation energy is about 4 - 6 MeV for nuclei with even A and in general much lower for nuclei with odd A.

Fission can also be induced when the nucleus absorbs a neutron to form a *compound nucleus*. The compound nucleus will have a lower B/A, and in some cases this will become low enough that fission occurs with high probability. If the absorbed neutron brings kinetic energy the compound nucleus will be in an excited state, and the probability for fission is increased accordingly. The probability of the neutron being absorbed is however decreased with increased kinetic energy of the neutron.

Nuclei which can undergo fission by absorbing a neutron are referred to as *fissile* [5]. This is the kind of reaction that the fuel inside a nuclear reactor experiences. In O3 (and most BWR reactors) the fuel is mainly made up of uranium-oxide (UO_2. Natural uranium consists of about 99.3 % ^{238}U and 0.7 % ^{235}U, but since ^{235}U is the fissile nuclide in the fuel, enrichment of ^{235}U is necessary. The degree of enrichment is usually between 3-5 % [7]. Figures 3a and 3b show the neutron *cross sections* σ of ^{235}U and ^{238}U as a function of incident neutron energy.



(a) Total neutron cross section (blue) and fission cross section (green) of ^{235}U



(b) Total neutron cross section (blue) and fission cross section (green) of ^{238}U

Figure 3: Neutron cross sections (total and fission) of ^{235}U and ^{238}U

As can be seen, the total neutron cross section of ^{235}U and ^{238}U is about equal for high neutron energies. For ^{235}U the total and fission cross sections increase exponentially as the neutron energy decreases, except for at some resonance energies where there are spikes in the cross section. For ^{238}U the cross section stays fairly consistent over the entire energy range (increasing by about a factor 100 over the entire energy range), with the exception of resonances. The fission cross section of ^{238}U is much lower than the total cross section except at very high neutron energies. The neutrons produced by the fission of ^{235}U are in the higher energy ranges (more on this in chapter 3.2), and so these need to be moderated (slowed down, i.e. have their energy reduced) before having a high likelihood of producing another fission reaction. In a reactor this is generally accomplished by the water flowing through the reactor. An example of the neutron life cycle inside the reactor core can be seen in Figure 4. A starting generation N of 1000 neutrons causes fast fission in the fuel, resulting in a factor $\epsilon \approx 1.03$ increase in neutrons. About 5 % of these leak out of the reactor at this point ($P_f = 0.95$ factor of remaining neutrons after fast leakage). As the neutrons lose energy, about 25 % are lost due to resonance escape (p = 0.75 factor of remaining neutrons after resonance escape), and as they reach thermal temperatures, around 4 % more have been lost due to leakage ($P_t = 0.96$ factor of remaining neutrons after thermal leakage). Of the remaining neutrons, about 70 % cause fission in the fuel (utilization factor f = 0.7), leading to a reproduction factor $\eta = 2.02$ of new fission neutrons. In total, the amount of neutrons in generation N+1 is given by equation 15. The neutrons that may cause activation in components around the core are the leakage neutrons.

$$n_{N+1} = n_N \cdot \epsilon \cdot P_f \cdot p \cdot P_t \cdot f \cdot \eta \tag{15}$$

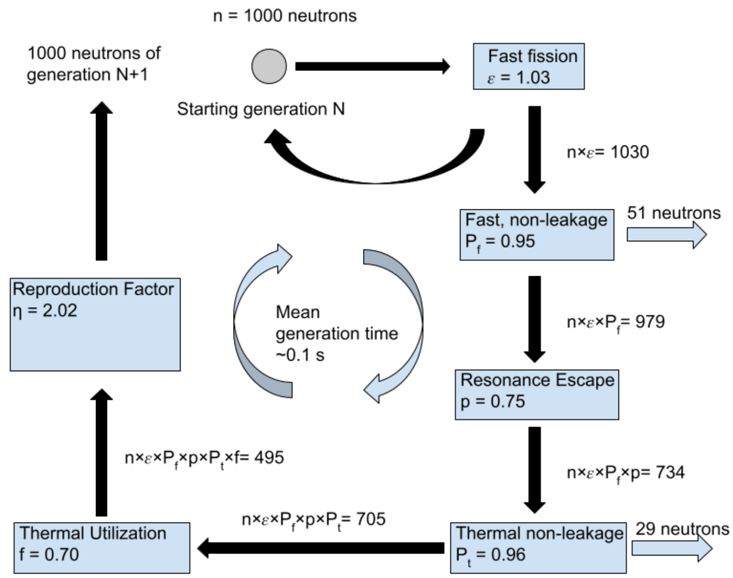


Figure 4: Neutron cycle in a BWR (reproduced from [8]).

The FPs of fissioning nuclides are most often not even in mass number, and tend to peak in the $90 < A < 100$ and $135 < A < 145$ range, see Figure 5 for an example. The FPs themselves are also most often not stable as they have a surplus of neutrons, and following fission there will therefore be a chain of decay of the FPs [6].

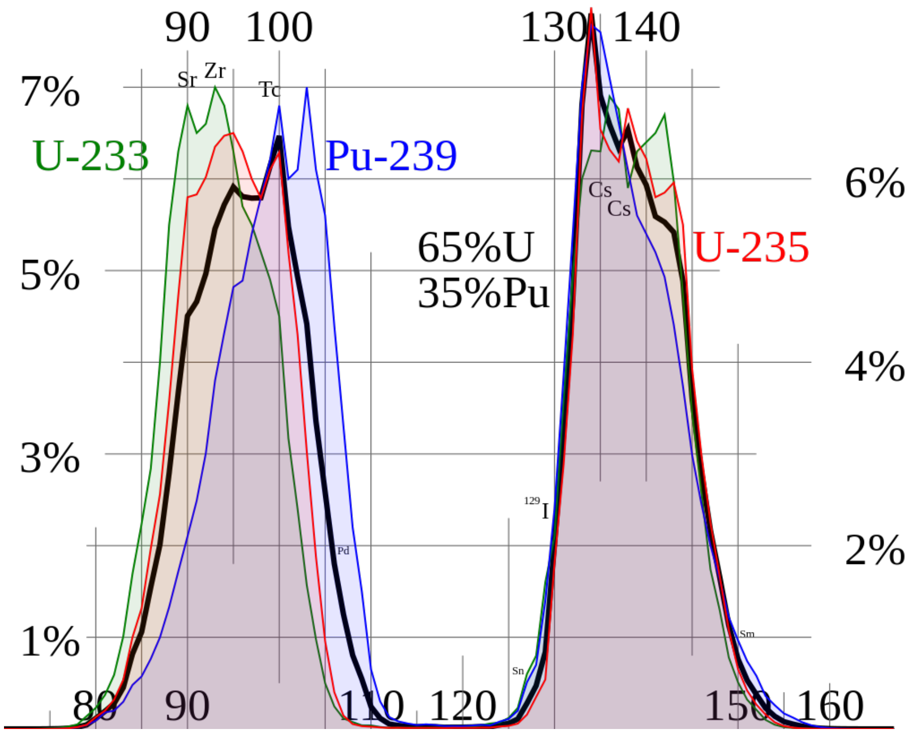


Figure 5: Fission product yield by mass of ^{235}U, ^{239}Pu and ^{233}U [9]. ^{235}U is the most interesting for us as this is the fissile nuclide used in O3.

The neutrons from fissioning fuel can be assumed to have a fission spectra well described by the normalized Maxwellian distribution:

$$M(E) = \frac{2}{\sqrt{\pi \cdot T^3}} \cdot \sqrt{E} \cdot e^{-E/T} \tag{16}$$

where E is the neutron energy (MeV). *M(E)* is the normalized spectrum (1/MeV) describing the neutron flux per energy, and T is the characteristic energy (MeV) (temperature multiplied by the Boltzmann constant in eV). For fission of ^{235}U, $T \approx 1.2895$ MeV. This is illustrated in Figure 6.

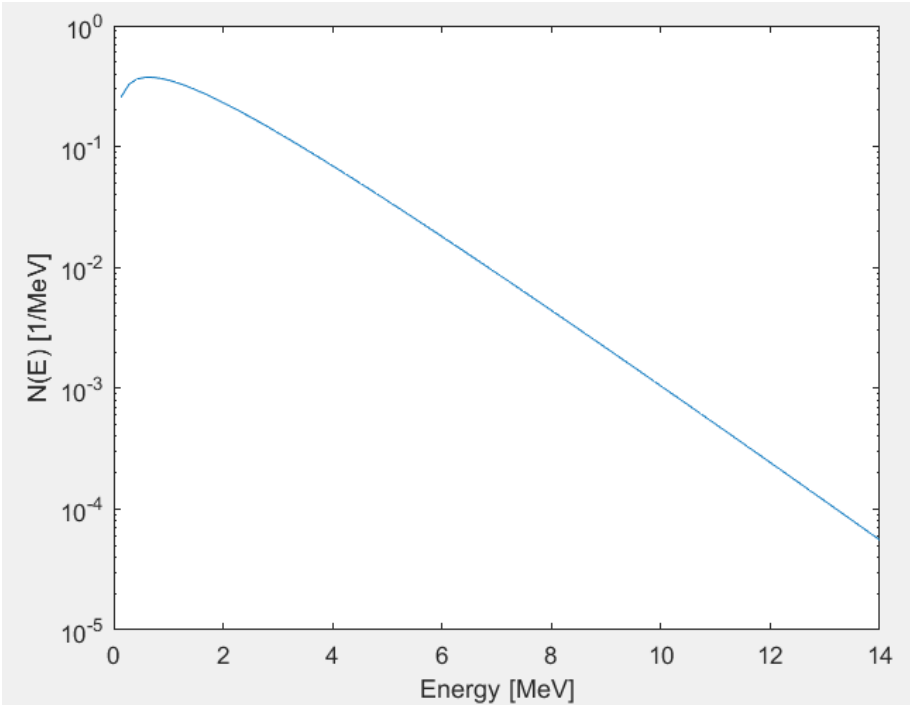


Figure 6: Spectrum for source neutrons (Maxwell, $T = 1.2895$ MeV)

In regard to the neutron flux in a BWR core, it typically varies as in Figure 7 [10].

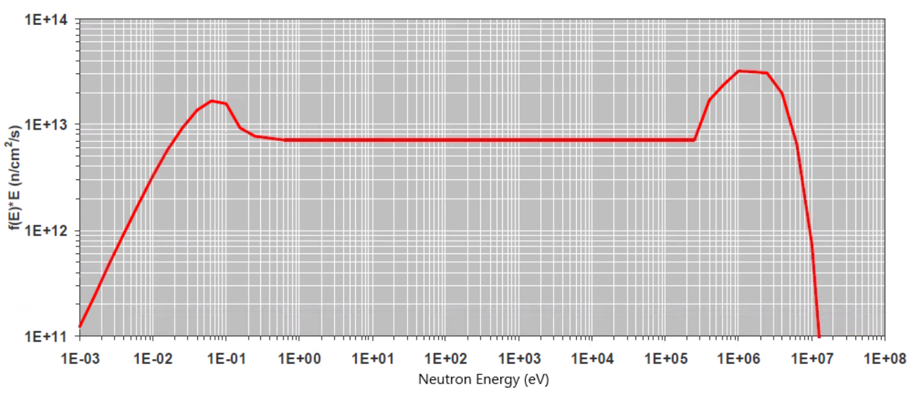


Figure 7: Typical neutron spectra of a BWR [10].

This spectrum can be divided into three parts:

- thermal neutrons with energies below 0.5 eV. These are assumed to be in thermal equilibrium with the surrounding material. Their velocity is therefore statistically distributed and their density is normally described by the Maxwellian distribution:

$$n(v) = \frac{4 \cdot n \cdot v^2}{\sqrt{\pi} v_T^3} \cdot e^{-\frac{v^2}{v_T^2}} \tag{17}$$

where *n(v)* is the neutron velocity per velocity interval, n is the total neutron density of thermal neutrons, and v_T is the most probable neutron velocity. The most probable neutron velocity is related to the mean temperature through Boltzmann's constant k as:

$$kT = E \tag{18}$$

where T is the temperature. Using equation 2 yields the velocity v_T. At room temperature, 20.4 °C, the term $kT = 0.0253$ eV and $v_T = 2.2 \cdot 10^5$ cm/s = 2200 m/s. Thermal neutrons are denoted by ϕ_{th} with unit $[\frac{\mathrm{n}}{\mathrm{cm^2 s}}]$

- epithermal neutrons were those with energies between 0.5 eV - 0.1 MeV. Epithermal neutrons are denoted by ϕ_{epi} and vary as $\phi_{epi} = \phi(E) \cdot E$ with the same unit $[\frac{\mathrm{n}}{\mathrm{cm^2 s}}]$.
- lastly the fast neutrons were those with energies in excess of 0.1 MeV. These are denoted by ϕ_{fiss} and are assumed to vary as $\phi_{fiss} = \frac{\sum_{E>E_T} \phi_i}{\int_{E_T}^{\infty} M(E) dE}$ where ϕ_i is the neutron flux per energy group $[\frac{\mathrm{n}}{\mathrm{cm^2 s}}]$, *M(E)* is the normalized energy spectrum previously defined, and E_T is the threshold energy for neutron flux weighting [MeV].

2.6 Doses and dose rates

A radiation dose depends on the intensity and energy of the radiation, the type of radiation, exposure time, the exposed area as well as the depth of energy deposition. Certain quantities exist that try to specify the dose received and its biological effect. These are the absorbed dose, the effective dose and the equivalent dose.

The *absorbed* dose is the radiation energy absorbed per unit of mass. A unit that is often used for this quantity is Gray (Gy), where 1 Gy = 1 $\frac{\mathrm{J}}{\mathrm{kg}}$. The absorbed dose is therefore $D_T = \frac{\epsilon_T}{m_T}$ where ϵ_T is the total energy deposited over the mass m_T.

The *equivalent* dose takes into account the type of radiation that is absorbed. Since radiative particles interact with matter in different ways, they cause different amounts of damage. The equivalent dose therefore utilises a weighting factor w_R multiplied to the absorbed dose to represent this. Photons (γ) and electrons (β) interact with electrons, and since body tissue mainly consists of elements with low proton number (and thus few electrons) this interaction is somewhat weak. These particles are therefore able to travel further in the tissue (although the range of electrons in tissue is still quite short), which means they deposit their energy over a larger volume/mass, and they therefore have the weighting factor $w_R = 1$. Protons are nucleons but also carry a charge and can therefore interact both via nuclear collisions and the Coulomb force. They therefore travel a shorter distance than electrons and photons, and are thus given a weighting factor of $w_R = 2$. Neutrons on the other hand are uncharged and can only interact via nuclear collisions. As they travel through matter they cause damage by causing nuclear reactions. Since the cross section of these reactions are dependant on the neutron energy, the weighting factor of neutrons depend on their energy as in equation 19 [11].

$$w_R = \begin{cases} 2.5 + 18.2\mathrm{e}^{-(ln(E_n))^2/6} & E_n < 1 \text{ MeV} \\ 5.0 + 17.0\mathrm{e}^{-(ln(2E_n))^2/6} & 1 \text{ MeV} \leq E_n \leq 50 \text{ MeV} \\ 2.5 + 3.25\mathrm{e}^{-(ln(0.04E_n))^2/6} & E_n \geq 50 \text{ MeV} \end{cases} \tag{19}$$

Alpha particles, fission fragments and heavy nuclei interact via nuclear collisions and may therefore cause nuclear interactions in the matter they travel through. They also give off more of their energy per collision, and therefore deposit their energy over a smaller volume/mass. Because of this they are given a weighting factor of $w_R = 20$. The weighting factors are summarized in Table 1 [11].

Table 1: Weighting factors of various particle types [11].

Type of radiation	energy range	weighting factor w_R
Photons, electrons	All	1
Protons	All	2
Neutrons	< 1 MeV	$2.5 + 18.2e^{-[ln(E_n)]^2/6}$
	1 MeV - 50 MeV	$5.0 + 17.0e^{-[ln(2E_n)]^2/6}$
	> 50 MeV	$2.5 + 3.25e^{-[ln(0.04E_n)]^2/6}$
Alpha particles etc.		20

The equivalent dose is given by $H_T = w_R \cdot D_{T,R}$, and if there are multiple types of radiation, the doses are summed as $H_T = \sum_R w_R \cdot D_{T,R}$. The unit of the equivalent dose is sievert (Sv). Since weighting factors are dimensionless 1 Sv = 1 $\frac{\text{J}}{\text{kg}}$.

Lastly, the *effective* dose takes into consideration in which tissue the dose was absorbed. This is since different tissue is more or less sensitive to biological damage caused by radiation. The equivalent dose is complemented by yet another weighting factor w_T to yield the effective dose E. If the radiation is deposited in multiple tissues, the doses in each tissue are summed as $E = \sum_T w_T \cdot H_T$, where w_T is the weight factor of tissue T, and the sum of all weight factors is 1. This is the same as the calculated effective dose being numerically equivalent to the equivalent dose uniformly given to the whole body. The effective dose is therefore also sometimes called the *whole-body dose*. The unit of effective dose is also the sievert (Sv) [6]. Tabulated values of w_T can also be found in [11] (page 36). Experiments have showed that the greatest damage caused to cells is

when they undergo mitosis (cell division). Due to this, tissue which have a high rate of mitosis (bone marrow, gonads) are more sensitive and subsequently have a higher weigth factor w_T than tissue with low rate of mitosis (brain, muscles, kidney, liver) [6] (chapter 7.4.3).
The dose rate specifies a radiation dose (often effective dose) that is acquired over a certain period of time, for example an hour. This quantity is important since the damage of a certain dose is lessened if the dose is spread out over longer periods of time. For example, while 10 Gy of absorbed dose would kill all cells in a given population, absorbing half the dose 24 hours apart would only kill 40 % of the same population. This is because cells are able to heal some of the biological damage caused by the radiation given enough time as long as they are not completely destroyed [6].
When it comes to radiation safety for workers, the most important type of radiation to consider, discounting neutron radiation (since most activation products don't emit neutrons), is γ-radiation as this is the most penetrating type of radiation. α-, and β-radiation are likely to be attenuated in air, or by the outer layers of skin on our bodies. Therefore the damage they can do is rather limited unless the emitting nuclides end up inside the body. Alpha radiation is also most often found in fission products and seldom in activation products, which makes it less important when discussing activation [6].
The effects of large doses of radiation on the body are well documented. It is more widely debated however what effect smaller doses have, and so, following the recommendations of the ICRP, most international agencies (including in Sweden [12]) have erred on the side of caution by setting the effective dose-limit for radiation workers to 20 mSv/year [11]. Assuming a work year consisting of 2000 work-hours this comes out to 10 μSv/hour on average. In comparison, the average effective dose received each year in the UK from natural sources such as cosmic rays, radon in building materials and foundations, as well as food and drink amounts to approximately 2.21 mSv [6].

2.7 Potential activation products

This section will go through the major activation products in components inside or close to the reactor that are expected to appear in the following simulations. While components may contain fission products and major actinides due to contamination e.g. due to fuel failure, this will not be taken into account in this report. Nuclides which are not listed here may also appear. Given cross-sections are for incident thermal neutrons unless stated otherwise.

^{3}H: Tritium may be produced from neutron capture followed by alpha decay in ^{6}Li present in the concrete bioshield. The reaction has a cross section of 953 b. Tritium may also be produced by subsequent neutron captures in hydrogen and deuterium in the feed water of the reactor. Tritium decays purely by β^- emission (half life 12.33 years) with a maximum energy of 19.0 keV [13].

^{14}C: is mainly produced from trace amounts of nitrogen in various construction materials via the reaction ^{14}N(n,p)^{14}C with a cross section of 1.81 b. It may also be produced via neutron capture of ^{13}C (1.1 % abundant) via ^{13}C(n,γ)^{14}C with a cross section of 0.9 mb or via ^{12}C (98.89 % abundant) indirectly via ^{13}C (3.4 mb). ^{14}C decays purely via β^- emission (half life 5730 years) with an energy release of at most 156 keV [13].

^{36}Cl: is mainly produced via neutron capture of ^{35}Cl present in trace amounts in reactor construction materials such as aluminium or steel, or trace amounts in the feed water. The reaction has a cross section of 0.04 mb. It may also be produced via ^{39}K by neutron capture followed by alpha decay with a cross section of 2 b, although the amount of ^{39}K present is small. Lastly, ^{36}Cl may also be produced indirectly via ^{34}S. ^{36}Cl decays mainly via β^- emission (half life $3.01 \cdot 10^5$ years) with a maximum energy of 709 keV, or by electron capture with emission of some weak X-rays [13].

^{39}Ar: is mainly produced via the neutron capture followed by β^--decay in ^{39}Kr with a cross-section of about 0.1 b. ^{39}Kr is 93.3% abundant in natural potassium which in turn is present in concrete at thousands of ppm, and in stainless-, and carbon-steel at hundreds of ppm. ^{39}Ar decays by β^- emission (half-life 269 years) with a maximum energy of 565 keV [13].

^{54}Mn: is produced mainly in the reaction ^{54}Fe(n,p)^{54}Mn in the 5.8% abundant ^{54}Fe with an average cross-section of about 53 mb in the fission neutron energy spectrum. It decays via electron capture and γ-emission with an energy of 835 keV (half-life 312 days). Since iron is present in high amounts in many parts of the reactor vessel, this radionuclide will be of importance after reactor shut-down until some half-lives have passed [13].

^{55}Fe: is produced in the reaction ^{54}Fe(n,γ)^{55}Fe with a cross-section of about 2.25 b. ^{55}Fe decays by electron capture (half-life 2.73 years) to ^{55}Mn, which emits weak X-rays [13].

^{59}Ni: is produced by the ^{58}Ni(n,γ)^{59}Ni reaction with a cross-section of 4.6 b. ^{59}Ni decays by electron capture to ^{59}Co (half-life 76 000 years). ^{58}Ni which is 68.3% abundant in natural nickel can be found in all parts of the inner containment [13].

^{63}Ni: is produced by neutron capture in the 3.6% abundant isotope ^{62}Ni with a cross-section of 14.2 b. ^{63}Ni decays by β^--emission (half-life 100.1 years) with a maximum energy of 67 keV to ^{63}Cu [13].

^{60}Co: is produced by neutron capture in the 100% abundant ^{59}Co with a cross-section of 18.7 b for thermal neutrons. The cross-section of this reaction can be seen in Figure 8. ^{60}Co decays by β^--emission (half-life 5.27 years) to excited states of ^{60}Ni which subsequently emits two major γ-rays of 1.17 MeV and 1.33 MeV (with almost 100 % certainty [14]). Due to this decay mode and the high presence of ^{59}Co in carbon and stainless steels (80 - 150 ppm and 230 - 2600 ppm respectively), ^{60}Co is the dominant source of absorbed dose in reactor interior components for 10 - 50 years after shut-down [13].

^{65}Zn: is produced via neutron capture in the 49 % abundant isotope ^{64}Zn. It decays via electron capture and β^+ emission (half-life 244 days) with a maximum energy of 329 keV to stable ^{65}Cu [13].

^{93}Mo: is produced by neutron capture in the 14.8 % abundant isotope ^{92}Mo. It decays by electron capture (half-life 3500 years) to ^{93m}Nb which further decays into ^{93}Nb (half-life 15.8 years) with a γ emission of 40 keV [13].

^{94}Nb: is produced by neutron capture in the 100 % abundant stable isotope ^{93}Nb with a cross-section of about 1.15 b. It decays by β^- emission (half-life 20 300 years) with a maximum energy of 472 keV to an excited state of ^{94}Mo. The excited state is at 1.574 MeV and decays to the ground state by a subsequent γ cascade of 871 and 703 keV. Aditionally, ^{93m}Nb will also be produced [13].

^{108m}Ag: is produced by neutron capture of the 51.8 % abundant isotope ^{107}Ag. Which decays by β^+ emission to ^{108}Pd. It may also decay by electron capture (half-life 130 years) to ^{108}Ag, which further decays by β^- emission (half-life 2.4 minutes) with a maximum energy of 1.655 Mev to stable ^{108}Cd [13].

^{110m}Ag: is produced by neutron capture in the 48.2 % stable isotope ^{109}Ag. It decays by β^- emission (half life 249 days) with a maximum energy of 1.467 MeV to ^{110}Ag, which subsequently decays to ^{110}Cd via β^- emission (half-life 24.5 seconds) with a maximum energy of 2.893 MeV [13].

^{125}Sb: is produced after neutron capture of the 5.8 % abundant isotope ^{124}Sn to ^{124}Sn which decays via β^- emission (half-life 9.64 days) with a maximum energy of 2.35 MeV to ^{125}Sb. ^{125}Sb in turn decays via β^- emission (2.75 years) with a maximum energy of 622 keV and by γ emission to ^{125m}Te which in turn decays by γ emission (half-life 58 days) to stable ^{125}Te [13].

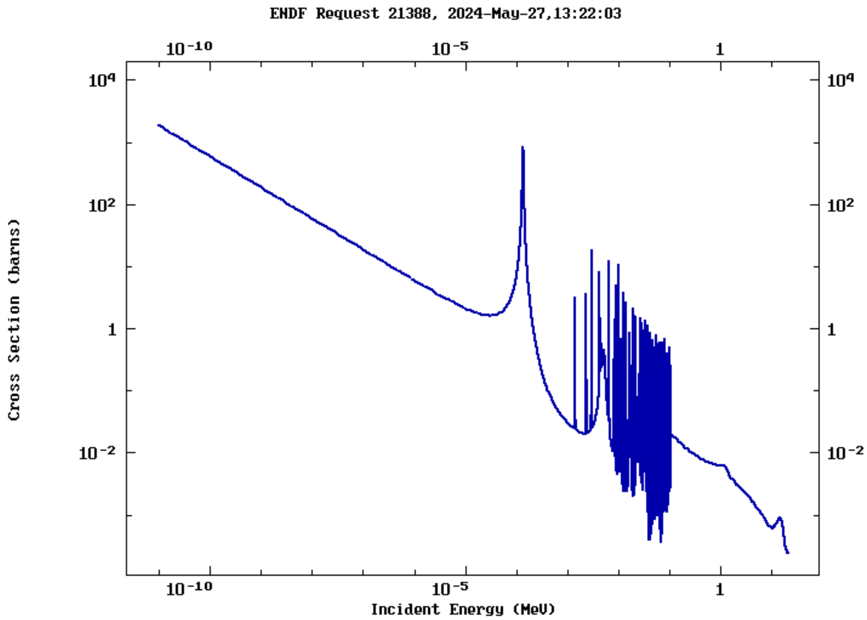


Figure 8: Neutron radiative capture cross-section for the ^{59}Co(n,γ)^{60}Co reaction [15].

3 Previous MCNP studies

In this section the previous neutron flux studies upon which this thesis builds further upon, are described. Since these studies are not publicly available, they are here described in detail. Units of measurement such as weight and length have been left out or made arbitrary as this is proprietary information.

3.1 Description of MCNP

MCNP is a general-purpose, continuous-energy, generalized-geometry, time-dependant Monte Carlo based simulation tool capable of tracking 37 particle types over a wide range of energies. The particles MCNP is capable of tracking are the lighter elementary particles, some hadrons, lighter nuclei such as the deuteron (d), triton (t) and helion (^{3}He), as well as heavy ions. Monte Carlo can be used to simulate a random walk process such as particle interactions, and is especially useful in complex problems such as in a nuclear reactor. It works by following many individual particles as they travel through a geometry. By randomly selecting numbers between 0 and 1 it is determined what (if any) and where an interaction takes place, taking into account the physics involved and material data (probabilities). Each particle is also attributed a weight (not physical weight) which denotes a ”relative importance”, as well as an amount of particles. Particles with higher weight are deemed more important, and also represent a larger amount of particles. Each cell in the geometry is in turn attributed an importance factor (IMP-factor), and as a particle travels between cells, the IMP-factors determine how the particle is affected. Traveling from a cell with lower IMP-factor to one with higher IMP-factor causes the particle to be split into 2 particles with lower weight. Travelling instead from a cell with high to low IMP-factor causes the particle to undergo a ”russian-roulette” process where it is either eliminated or followed further with increased weight. This method acts as to reduce variance in the resulting calculations [16].
The MCNP code can output various tallies normalized to be per starting particle related to particle flux and energy deposition. The output also contains an estimated relative error R. For a *well behaved* tally, R scales as $\frac{1}{\sqrt{N}}$ where N is the number of runs, and so running the simulation multiple times improves the precision of the calculations until eventually the end result is close to the true physical value. The accuracy of the calculations can be evaluated for example by comparing with real measurements [16].
A tally is well-behaved if important particle paths are sampled often enough. To keep track of this, the output also prints a *figure of merit* $FOM \equiv \frac{1}{R^2T}$ where T is the computation time in minutes. For a well-behaved tally, the FOM should be approximately constant with N, since $R^2 = \frac{1}{N}$, and N scales with T. A sharp decrease in the FOM means that a seldom sampled particle path has significantly impacted the tally result, and the relative error estimate R. The problem should in that case be redefined to more frequently sample that path [16].

3.2 Neutron flux studies

The following section is a compilation of method and results from the previously conducted neutron flux study at O3 [10]. The study was conducted in MCNP4C, and build upon the following prerequisites for source neutrons in the fuel:

- The reactor has a thermal power of $P_{th} = 3900$ MW_{th}
- 200 MeV energy released in each fission event
- Each fission yields 2.5 neutrons

To simulate the flux, the reactor was modeled in 3 steps; in the radial direction, as well as in the axial direction below and above the reactor. The fuel cartridges were divided into so called "central" and "rim" cartridges. The central cartridges were assumed to have a relative power (relative to the average) of 1.2, while the relative power of the rim cartridges are dependant on their radial distance r (in cm) from the center of the reactor core, and is about 0.2 for those furthest from the center.
The relative power also varies in the axial direction, from 0.6 at the bottom of the core it quickly rises to approximately 1.3 after which it slowly decreases to about 0.4 in the highest part of the core. The axial variation over the core can be seen in Figure 9 (arbitrary length unit).

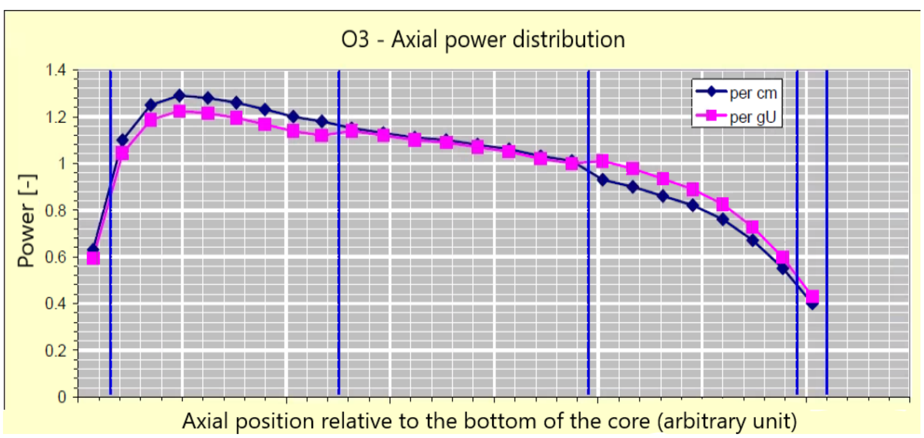


Figure 9: Axial power variation of the fuel (arbitrary length unit) [10].

The neutron flux of the reactor core was then calculated using:

- Thermal neutron fluxes in the fuel according to burn-up calculation for the equilibrium core. Burn-up is a measure of how much of energy is extracted from the primary nuclear fuel source. As the fuel undergoes fission, build-up of poisons in the fuel, e.g. FPs which absorb neutrons, act to prevent the fuel from being further utilized [17]. The equilibrium core is the state in which the criticality of the reactor is 1, i.e. each fuel fission results in 1 neutron which can cause another fission.

- Computation results for different parts of the fuel and different void percentages (the ratio of steam to water in the water flowing through the core, which will not be the same at all axial positions).
- Previous calculations of the distribution of neutron flux between different parts of the reactor core [18].
- Data of the equilibrium reactor core conditions at 3900 MW_{th}.

The flux averaged over the reactor core can be seen in Table 2.

Table 2: Average neutron flux by type in the reactor core

	Flux $[\frac{n}{\text{cm}^2\text{s}}]$
ϕ_{th}	$3.7{\cdot}10^{13}$
ϕ_{epi}	$9.0{\cdot}10^{12}$
ϕ_{fiss}	$9.5{\cdot}10^{12}$

The fluxes ϕ_{th}, ϕ_{epi} and ϕ_{fiss} are essentially an integration of the energy dependant fluxes in each region. The fluxes outside the reactor core that are calculated later will be given in the same way. Since neutron cross-sections are energy dependant, the integrated fluxes will need to be divided back into their energy dependant counterparts before they can be used to calculate nuclear processes. This is done by using the reference spectrum seen in Figure 10 [19]. The spectrum shows the neutron distribution by energy inside the fuel of a BWR, assuming the fuel consists of uranium-oxide (UO_2) enriched with gadolinium (Gd). The same integration as before is performed on this spectrum to yield ϕ_{th}, ϕ_{epi} and ϕ_{fiss}. The calculated fluxes are divided by the reference fluxes to yield scaling factors, which are in turn applied to the reference spectrum to yield an approximate flux-energy distribution.

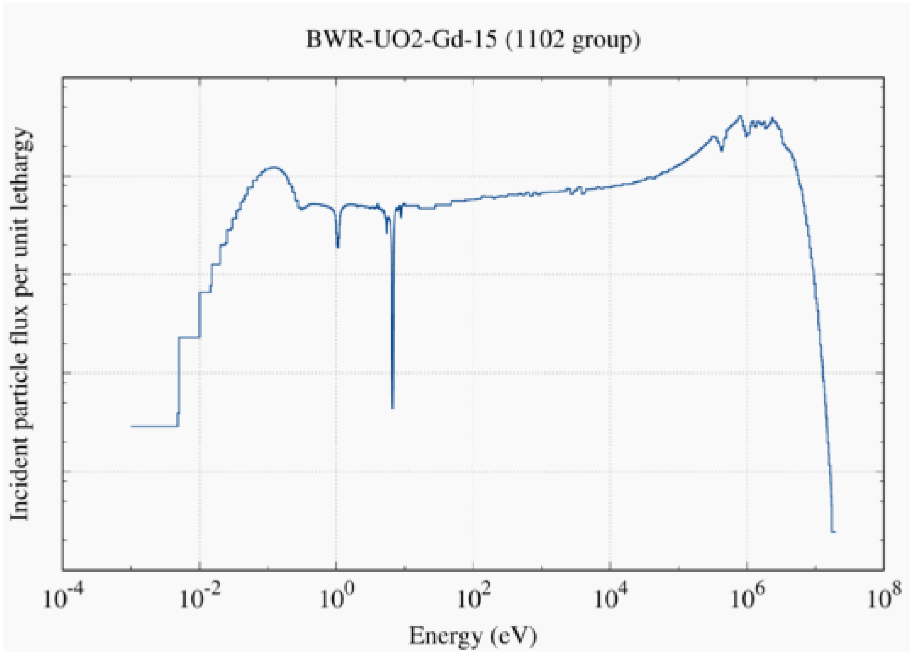


Figure 10: Reference spectrum of the neutron flux per energy in the core of a BWR (UO_2 with Gd) [19] .

The calculations in this and the following sections were conductedin the previous study using a somewhat simplified model of the reactor. Certain sections were homogenized if this was not expected to have a large impact on the results, while others were modeled more carefully. As an example carbon steel is simplified to be 100 % iron while stainless steel is taken to be composed of 18 % Cr, 8 % Ni and 54 % Fe. Another example is that the area beneath the bottom core grid and the bottom of the reactor tank composed of control rods, control rod guide tubes and water has been homogenized, but the boron carbide in the control rods has been excluded from the homogenization due to its very localized effect on the thermal neutron flux. A homogenization would result in a vast underestimation of the thermal neutron flux.
Cylindrical symmetry was also used, as only $\frac{1}{8}$ of the reactor was modeled in the azimuthal direction.

3.2.1 Axial flux above the core

Axially above the core, the reactor was modelled in MCNP in the previous work as follows:

- Top of the fuel and the central parts of the core grid, homogenized according to Table 3.

- The area between core grid and the moderator tank lid consisting of water and steam (void 70%).
- Moderator tank lid consisting of stainless steel.
- The area above the moderator tank lid up to the reactor tank lid consisting (mainly) of steam separator, steam dryer, water and steam. Some parts have been homogenized according to Table 3, while others are assumed to be all water/steam and/or steel.
- The reactor tank lid consisting of carbon steel.
- Empty space between the lid and pressure-sustainment-dome (PS-dome).
- The PS-dome consisting of carbon steel.
- Water above the PS-dome.

The model can be seen in Figure 11 with cells marked out.

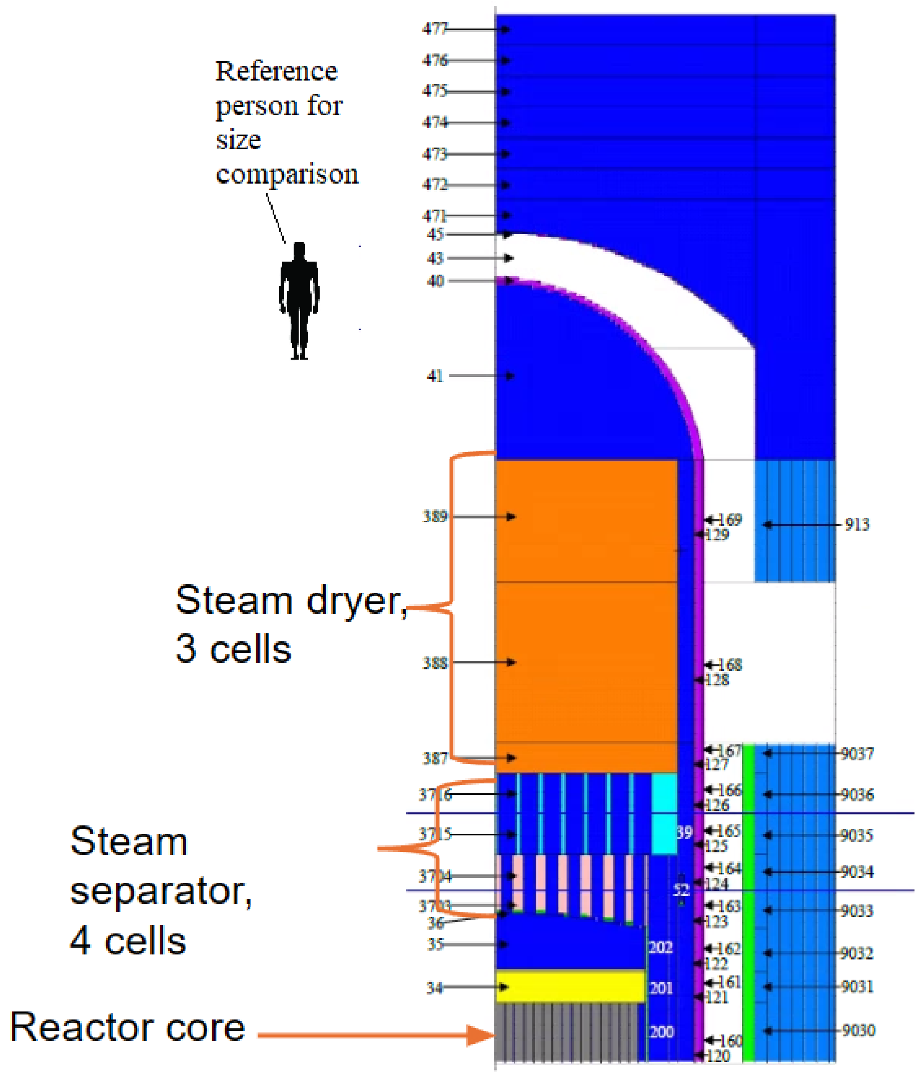


Figure 11: MCNP model above the reactor core [10].

Table 3: Material composition of the homogenized sections above the reactor core (density [g/cm^3] and atomic fraction).

	Core grid		Steam separator bottom		Steam separator top		Steam dryer	
Nuclide	Den.	At. frac.	Den.	At. frac.	Den.	At. frac.	Den.	At. frac.
H	0.023	0.427405	0.072	0.573993	0.069	0.544343	0.004	0.453679
O	0.183	0.215412	0.579	0.289292	0.553	0.274349	0.032	0.228654
Zr	0.469	0.097128						
Sn	0.007	0.001136						
Fe	0.562	0.189805	0.700	0.100221	0.935	0.132911	0.115	0.232871
Cr	0.137	0.049587	0.170	0.026183	0.227	0.034723	0.028	0.060838
Ni	0.061	0.019527	0.076	0.010310	0.101	0.013673	0.012	0.023957

Using the model described above along with the homogenization's in Table 3, the neutron fluxes in each cell were calculated. The results are compiled in Tables 4 and 5 for the sections inside and outside of the RPV respectively. In cases where the component was divided into multiple parts for computational purposes (such as e.g. the reactor tank), each part is denoted by [n] where n is a number.

Table 4: Derived neutron fluxes (thermal, epi-thermal and fast) in units of $\frac{\mathrm{n}}{\mathrm{cm}^2 s}$ at different axial positions above the reactor core inside the reactor tank.

Position	Cell	ϕ_{th}	ϕ_{epi}	ϕ_{fiss}
Inside reactor tank [1]	120	$1.25 \cdot 10^8$	$7.40 \cdot 10^6$	$3.66 \cdot 10^8$
Inside reactor tank [2]	121	$4.58 \cdot 10^7$	$2.90 \cdot 10^6$	$1.20 \cdot 10^8$
Inside reactor tank [3]	122	$8.16 \cdot 10^6$	$6.23 \cdot 10^5$	$2.11 \cdot 10^7$
Inside reactor tank [4]	123	$1.54 \cdot 10^6$	$2.19 \cdot 10^5$	$5.61 \cdot 10^6$
Inside reactor tank [5]	124	$2.33 \cdot 10^5$	$7.86 \cdot 10^4$	$1.22 \cdot 10^5$
Inside reactor tank [6]	125	$9.79 \cdot 10^4$	$2.71 \cdot 10^4$	$3.77 \cdot 10^4$
Inside reactor tank [7]	126	$5.06 \cdot 10^4$	$2.53 \cdot 10^4$	$7.61 \cdot 10^3$
Inside reactor tank [8]	127	$5.17 \cdot 10^4$	$1.19 \cdot 10^4$	$6.39 \cdot 10^3$
Inside reactor tank [9]	128	$2.17 \cdot 10^4$	$9.34 \cdot 10^3$	$6.76 \cdot 10^4$
Inside reactor tank [10]	129	$1.13 \cdot 10^4$	$4.54 \cdot 10^3$	$3.63 \cdot 10^4$
Moderator tank [1]	200	$9.69 \cdot 10^{11}$	$3.67 \cdot 10^{10}$	$4.67 \cdot 10^{11}$
Moderator tank [2]	201	$2.39 \cdot 10^{11}$	$1.33 \cdot 10^9$	$1.23 \cdot 10^{11}$
Moderator tank [3]	202	$4.58 \cdot 10^{10}$	$1.84 \cdot 10^9$	$2.48 \cdot 10^{10}$
Feed water separator	52	$5.15 \cdot 10^6$	$1.37 \cdot 10^5$	$6.09 \cdot 10^6$
Steam separator skirt	39	$5.96 \cdot 10^4$	$7.46 \cdot 10^3$	$1.02 \cdot 10^5$
Core grid + top of fuel	34	$9.58 \cdot 10^{12}$	$7.46 \cdot 10^{11}$	$4.80 \cdot 10^{12}$
Water + steam (70%)	35	$1.26 \cdot 10^{12}$	$1.38 \cdot 10^{10}$	$1.70 \cdot 10^{11}$
Moderator tank lid	36	$3.60 \cdot 10^{10}$	$8.42 \cdot 10^8$	$2.29 \cdot 10^{10}$
Steam separator bottom part [1]	3703	$6.64 \cdot 10^9$	$1.50 \cdot 10^8$	$4.10 \cdot 10^9$
Steam separator bottom part [2]	3704	$2.45 \cdot 10^8$	$5.26 \cdot 10^6$	$2.57 \cdot 10^8$
Steam separator top part [1]	3715	$5.66 \cdot 10^6$	$1.61 \cdot 10^5$	$8.31 \cdot 10^6$
Steam separator top part [2]	3716	$1.54 \cdot 10^6$	$4.75 \cdot 10^4$	$3.14 \cdot 10^6$
Steam dryer + steam [1]	387	$8.13 \cdot 10^5$	$4.29 \cdot 10^4$	$5.07 \cdot 10^6$
Steam dryer + steam [2]	388	$3.49 \cdot 10^5$	$2.52 \cdot 10^4$	$2.28 \cdot 10^6$
Steam dryer + steam [3]	389	$9.95 \cdot 10^4$	$6.71 \cdot 10^3$	$4.65 \cdot 10^5$
Reactor tank lid	40	$7.93 \cdot 10^3$	$3.25 \cdot 10^3$	$2.52 \cdot 10^4$

Table 5: Derived neutron fluxes (thermal, epi-thermal and fast) in units of $\frac{\text{n}}{\text{cm}^2 s}$ at different axial positions above the reactor core outside the reactor tank.

Position	Cell	ϕ_{th}	ϕ_{epi}	ϕ_{fiss}
Outside reactor tank [1]	160	$1.73 \cdot 10^6$	$1.45 \cdot 10^6$	$4.41 \cdot 10^7$
Outside reactor tank [2]	161	$1.81 \cdot 10^6$	$1.07 \cdot 10^6$	$1.64 \cdot 10^7$
Outside reactor tank [3]	162	$1.37 \cdot 10^6$	$6.47 \cdot 10^5$	$3.14 \cdot 10^6$
Outside reactor tank [4]	163	$8.81 \cdot 10^5$	$3.83 \cdot 10^5$	$9.67 \cdot 10^5$
Outside reactor tank [5]	164	$5.97 \cdot 10^5$	$2.48 \cdot 10^5$	$2.84 \cdot 10^5$
Outside reactor tank [6]	165	$4.11 \cdot 10^5$	$1.61 \cdot 10^5$	$1.40 \cdot 10^5$
Outside reactor tank [7]	166	$2.55 \cdot 10^5$	$1.02 \cdot 10^5$	$8.51 \cdot 10^4$
Outside reactor tank [8]	167	$1.52 \cdot 10^5$	$6.13 \cdot 10^4$	$5.02 \cdot 10^4$
Outside reactor tank [9]	168	$3.87 \cdot 10^4$	$1.61 \cdot 10^4$	$2.52 \cdot 10^4$
Outside reactor tank [10]	169	$2.54 \cdot 10^4$	$8.79 \cdot 10^3$	$9.82 \cdot 10^3$
PS-dome	45	$3.86 \cdot 10^4$	$6.22 \cdot 10^3$	$1.12 \cdot 10^4$
Water above PS-dome [1]	471	$7.37 \cdot 10^3$	$1.53 \cdot 10^2$	$6.58 \cdot 10^2$
Water above PS-dome [2]	472	$1.31 \cdot 10^0$	$1.45 \cdot 10^{-2}$	$2.40 \cdot 10^0$
Water above PS-dome [3]	473	$1.52 \cdot 10^{-2}$	$1.64 \cdot 10^{-4}$	$3.09 \cdot 10^{-2}$
Water above PS-dome [4]	474	-	-	-
Water above PS-dome [5]	475	-	-	-
Water above PS-dome [6]	476	-	-	-
Water above PS-dome [7]	477	-	-	-
Concrete [1]	9030	$1.35 \cdot 10^7$	$1.18 \cdot 10^6$	$7.54 \cdot 10^6$
Concrete [2]	9031	$1.26 \cdot 10^7$	$1.03 \cdot 10^6$	$5.16 \cdot 10^6$
Concrete [3]	9032	$7.59 \cdot 10^6$	$5.93 \cdot 10^5$	$2.10 \cdot 10^6$
Concrete [4]	9033	$4.00 \cdot 10^6$	$2.96 \cdot 10^5$	$6.16 \cdot 10^5$
Concrete [5]	9034	$2.41 \cdot 10^6$	$1.72 \cdot 10^5$	$2.19 \cdot 10^5$
Concrete [6]	9035	$1.52 \cdot 10^6$	$1.04 \cdot 10^5$	$8.59 \cdot 10^4$
Concrete [7]	9036	$9.74 \cdot 10^5$	$6.57 \cdot 10^4$	$4.44 \cdot 10^4$
Concrete [8]	9037	$5.73 \cdot 10^5$	$4.12 \cdot 10^4$	$2.68 \cdot 10^4$
Pool bottom	913	$1.23 \cdot 10^5$	$8.28 \cdot 10^3$	$7.95 \cdot 10^3$

As can be read out, the flux decreases rapidly with distance from the core inside the reactor, being almost negligible in the upper part of the RPV. The flux outside the RPV is somewhat larger in the upper regions of the model but are still negligible.

The neutron flux in the steam separator and steam dryer is visualized in Figure 12.

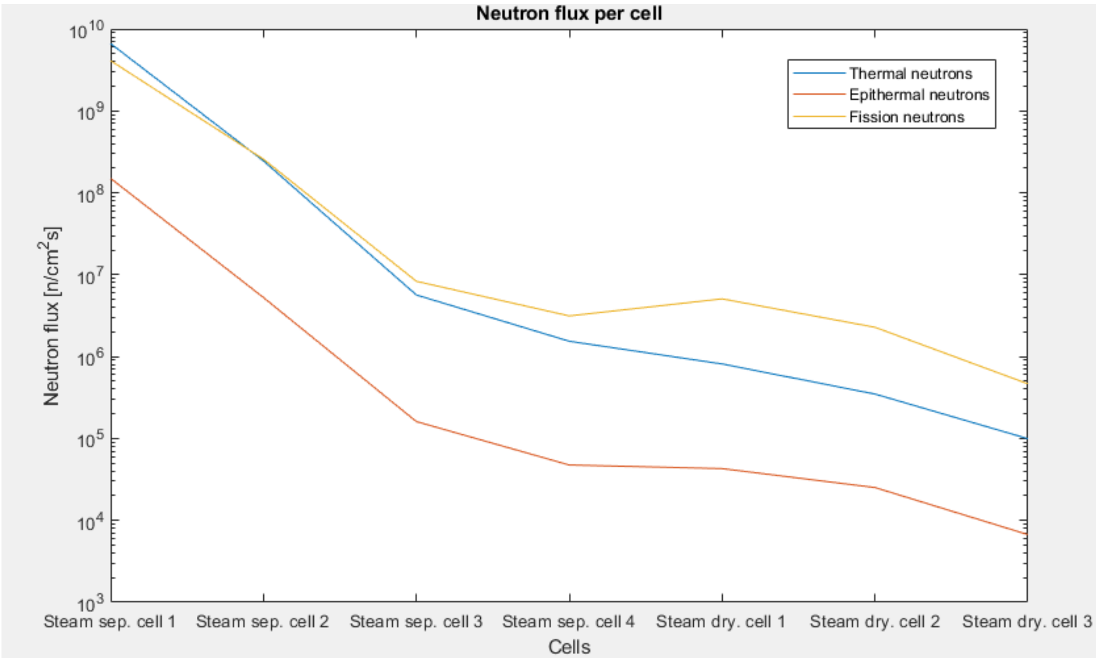


Figure 12: Neutron flux per cell (increasing distance from core) in the steam separator and steam dryer.

To achieve reasonable accuracy, 10^7 source-neutrons were simulated for both the central- and rim-cartridges. By using IMP-factors, the uncertainty was kept to $< 10\%$ in most areas except for where the neutron flux was very small, and where a slightly larger tolerance was accepted.

4 Methods

This section will describe the methods used to determine the activation and subsequent dose from the reactor components. All simulations were made using a Dell Lattitude 7330 laptop, on which simulation times rarely exceeded 5 minutes.

4.1 Description of FISPACT II

While MCNP is great for calculating the neutron flux, FISPACT-II is better used when calculating activity as it gives a detailed nuclide inventory. FISPACT II is an inventory code capable of simulating activation, transmutation and depletion of matter exposed to neutrons, deuterons, protons, alpha particles or gamma radiation. It uses the LSODE (Livermore Ordinary Differential Equation) solver to solve the inventory rate equation (expanded version of equation 8).

$$\frac{dN_i}{dt} = -N_i(\lambda_i + \sigma_i \phi) + \sum_{i \neq j} N_j(\lambda_{ji} + \sigma_{ji}\phi) \tag{20}$$

where the first term signifies the loss and the second term the production with σ_{ij} being the energy-dependant cross-section for j $\rightarrow$ i reactions and σ_i the summation of all i $\rightarrow$ j reactions, λ_{ij} decay constants (cross-sections and decay constants from nuclear libraries), and ϕ the total fluxes of incident projectiles. It can solve equation 20 during the different scenarios which constitute any number (including zero) of irradiation phases where flux amplitudes, flux spectra and cross-sections may or may not change followed by cooling, and outputs derived radiological quantities. It also computes some subsidiary calculations to perform a pathway analysis, uncertainty calculations and Monte-Carlo sensitivity. The inputs for the calculations are:

- The mass, density and elemental composition of the item to be irradiated.
- The neutron flux energy spectrum.
- The irradiation and decay time.

4.2 Activation simulations

A typical BWR reactor pressure vessel (RPV) can be seen in Figure 13 with some components specified.

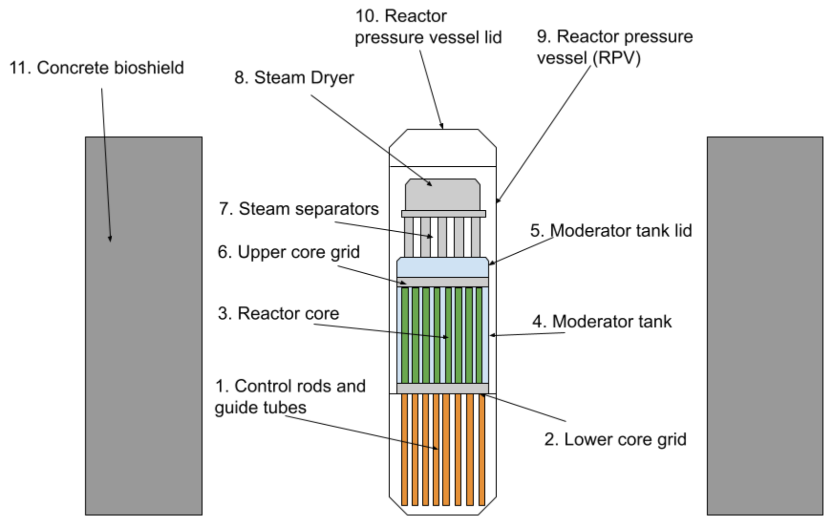


Figure 13: Example layout of typical BWR with some components specified.

A number of components are deemed interesting when it comes to radiological safety, such as:

- Fuel boxes and cartridges (3 in Figure 13).
- Control rods and guide tubes (1 in Figure 13).
- Core grids (2 and 6 in Figure 13).
- Moderator tank (4 and 5 in Figure 13).
- Steam separator and steam dryer (7 and 8 in Figure 13).
- Reactor pressure vessel (9 and 10 in Figure 13).
- Concrete bioshield (11 in Figure 13).
- Various probes inside the RPV.

Of the above listed components, all but the steam separator and dryer have been covered in previous activation studies, as these were assumed to not contain significant activation. Referring to Table 4 as well as Figure 12 however, it can be seen that the flux that these components experience is not completely negligible, especially for the steam separator as it was approximately between

$5 \cdot 10^6$ - 10^{10} $\frac{\text{n}}{\text{cm}^2 s}$ (total). These components have therefore been chosen for the activation and dose analysis of this report. The activity inventories in the components have been calculated after a decay time of 3 days, 1 year, 30 years, 100 years and a 1000 years.

The power and operational period of O3 is assumed to be 3900 MW_{th} from 2010-2045. The power upgrade to 3900 MW_{th} was in reality completed in 2009, but testing occurred during 2009-2011 and so the reactor was not working at full capacity during this time. 2010 is therefore an approximation which is not expected to significantly impact the results. The reactor is of course not working at full capacity all the time. The reactor operates in cycles of approximately one year, or 365 days. It is for computational purposes assumed to run at full power for 324 days, followed by a shut-down phase which lasts for 41 days. During this phase, the reactor power is assumed to be 0 % [20].
All activation calculations have been made using the nuclear library JEFF-3.3 [21] for the neutron cross-sections and decay constants. While not the most complete library, it offered somewhat faster computations. Comparison with the more complete library TENDL-2017 [22] showed only a marginal difference in some radionuclides, especially the important ones. As an example a separate simulation of the core grid above the reactor core 3 days after shut down (at the end of the reactors lifespan) will be used. Using JEFF-3.3 yields a total activity of $7.4642 \cdot 10^{16}$ Bq, while TENDL-2017 yields $7.4716 \cdot 10^{16}$. This is a difference of less than 1%. Looking instead at specific radionuclides, the ones most important for radiological purposes at this point are ^{60}Co, ^{59}Fe, ^{58}Co, ^{51}Cr and ^{54}Mn due to their relatively large activity and high energy γ-decay modes. The activities of these radionuclides with the different nuclear libraries and the % difference between them can be found in Table 6.

Table 6: Activity (major) in the upper core grid after 3 days of cool-down using JEFF-3.3 and TENDL-2017

Radionuclide	Activity JEFF-3.3 [Bq]	Activity TENDL-2017 [Bq]	% difference
^{60}Co	$2.8669 \cdot 10^{15}$	$2.7822 \cdot 10^{15}$	3.044
^{59}Fe	$9.9161 \cdot 10^{14}$	$9.8317 \cdot 10^{14}$	0.858
^{58}Co	$1.2077 \cdot 10^{15}$	$1.2923 \cdot 10^{15}$	7.005
^{51}Cr	$3.7457 \cdot 10^{16}$	$3.7466 \cdot 10^{16}$	0.024
^{54}Mn	$5.0233 \cdot 10^{14}$	$5.5514 \cdot 10^{14}$	10.51

As can be seen, the difference is within a few %, except for ^{58}Co and ^{54}Mn where the difference is somewhat larger at 7.005 % and 10.51 % respectively. Looking at the uncertainty estimates in these numbers given by FISPACT (calculated from estimates in the nuclear libraries) shows that for these two nuclides, JEFF-3.3 gives an uncertainty estimate of 2.578% and 2.312% respectively, while TENDL-2017 gives an uncertainty estimate of 11.74% and 11.23% respectively. This puts the JEFF-3.3 values within the uncertainty limit of TENDL-2017. The larger uncertainty in the TENDL-2017 calculation could be due to the larger

number of radionuclides included in the calculations, or that the uncertainty in the cross-sections is larger in this nuclear library. In conclusion, JEFF-3.3 should adequate to use for our calculations despite the smaller number of included radionuclides.
In the MCNP model described above, simplified materials and homogenizations were used to describe components in order to simulate the neutron flux. Since the atomic composition of a material is of great importance when determining the production of radionuclides, a more detailed material compositions for the steam dryer and separator, which is tabulated in Table 7 was used in the current work.

Table 7: Elemental composition (in wt.%) and density of stainless steel 316 L used in the steam separator/dryer.

Element	Weight %
Al	0.002
As	0.01
C	0.025
Cl	0.0001
Co	0.03
Cr	17
Cu	0.1
Fe	66.2959
Mn	1.3
Mo	2.5
N	0.04
Nb	0.01
Ni	12
O	0.01
P	0.02
S	0.015
Sb	0.001
Si	0.6
Sn	0.01
Ta	0.01
Ti	0.01
V	0.001
W	0.01
Density	7.837342 [g/cm^3]

4.2.1 Steam separator

The steam separator is a large metallic component that is situated above the moderator tank lid. It consists of several tubes which are packed into a cylindrical shape. It was exchanged during the power upgrade of O3, and is assumed to have an irradiation time of 35 years. The steam separator has been divided into

4 sections (cells 3703, 3704, 3715, 3716 in Figure 11 and Table 4), with section 1 (3703) and 2 (3704) constituting approximately 10 and 20 % respectively of the total weight, and the top 2 sections (3715, 3716) constituting 35 % each. The fluxes in Table 4 were then applied to each section and the nuclide inventory was calculated using FISPACT.

4.2.2 Steam dryer

The steam dryer is yet another large metallic component that is situated on top of the steam separator just below the reactor tank lid. It consists of a frame which holds up a package. The frame is approximately twice as heavy as the package. Just as the steam separator, this component was changed during the power upgrade of O3. The neutron flux at this level is relatively small and so the activation is not expected to be significant. The steam dryer has been divided into 3 sections (cells 387, 388, 389 in Figure 11 and Table 4). It is approximated that the bottom section (387) contains about 10 % of the frame, the middle section (388) about 51 % of the frame, and the top section (389) about 39 % of the frame and the entire package. The fluxes in Table 4 were then applied to each section, treating the frame and the package separately, and assuming the same irradiation time as for the steam separator.

4.3 Calculation of doses and dose rates

The dose rate from the components was calculated with the computer software MicroShield [4]. In MicroShield a source geometry is defined with radiation sources, shields (none in this case) and dose points. The source is specified by its dimensions, material, density, as well as the activity of the radionuclides present in it. Using this specification, MicroShield calculates the dose in the specified dose points, taking into account build-up and self shielding in the source, as well as any shielding.
Unfortunately it is not possible in MicroShield to make any detailed geometry. Due to this, the components which in reality have a complicated structure (layers of steel with air in between) have been simplified to homogenized cylinders. 3 different geometries have been used. First, the air inside the components was excluded, and the metal compressed as to keep the density the same. This meant a much lower volume than in reality. The chosen dose points were: 1 m radial distance from the source as well as 5 cm from the source (this is equivalent to the surface dose rate). The height was chosen to be at half the total height for each cell. In the second geometry, the source was kept the same as in geometry 1, but the dose points were chosen in relation to the true volume of the source, which meant they were at a much greater distance from the source. In the last geometry, the air and steel in the components were homogenized and the volume was kept true to reality. This meant that the density of the steel in the source was decreased to 0.757241 g/cm^3. The density of the air was assumed to be 0.00122 g/cm^3. Since geometry 1 produced mostly low dose rates (below 10 μSv/hour) for the steam dryer, geometry 2 and 3 were not applied to this com-

ponent. A simple schematic of the different geometries can be seen in Figure 14.

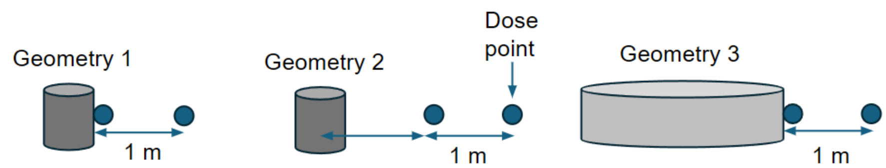


Figure 14: Schematic of the 3 geometries used in MicroShield to calculate the dose rates

In calculating the dose, only the most dose-dominant nuclides have been included. Since the dose is in all but a few cases (such as right after irradiation) dominated by a few nuclides, including additional nuclides in the calculations has a negligible effect on the dose. The dose-dominant nuclides have been identified by taking into account the specific activity of each nuclide and comparing with the energy released in its decay.
In calculating the doses, MicroShield uses the tissue weight factors in ICRP 116 [11]. Isotropic geometry was assumed, i.e. the worker was assumed to be irradiated equally in all parts of the body.

5 Results

5.1 Activation

The complete activity inventory of (non-stable) radionuclides for each components and section was extracted from the output of FISPACT. The results are compiled in the appendix. Uncertainties which were calculated by FISPACT for some nuclides are also given. The activity of ^{60}Co 3 days after irradiation in all parts of the steam separator and dryer are visualized in Figure 15.

5.1.1 Steam separator

The nuclide inventory of the steam separator cells 1-4 after 3 days, 1 year, 30 years, 100 years and 1000 years can be found in Tables 14 - 41.

5.1.2 Steam dryer

The nuclide inventory of the steam dryer package and frame after 3 days, 1 year, 30 years, 100 years and 1000 years can be found in Tables 42 - 69.

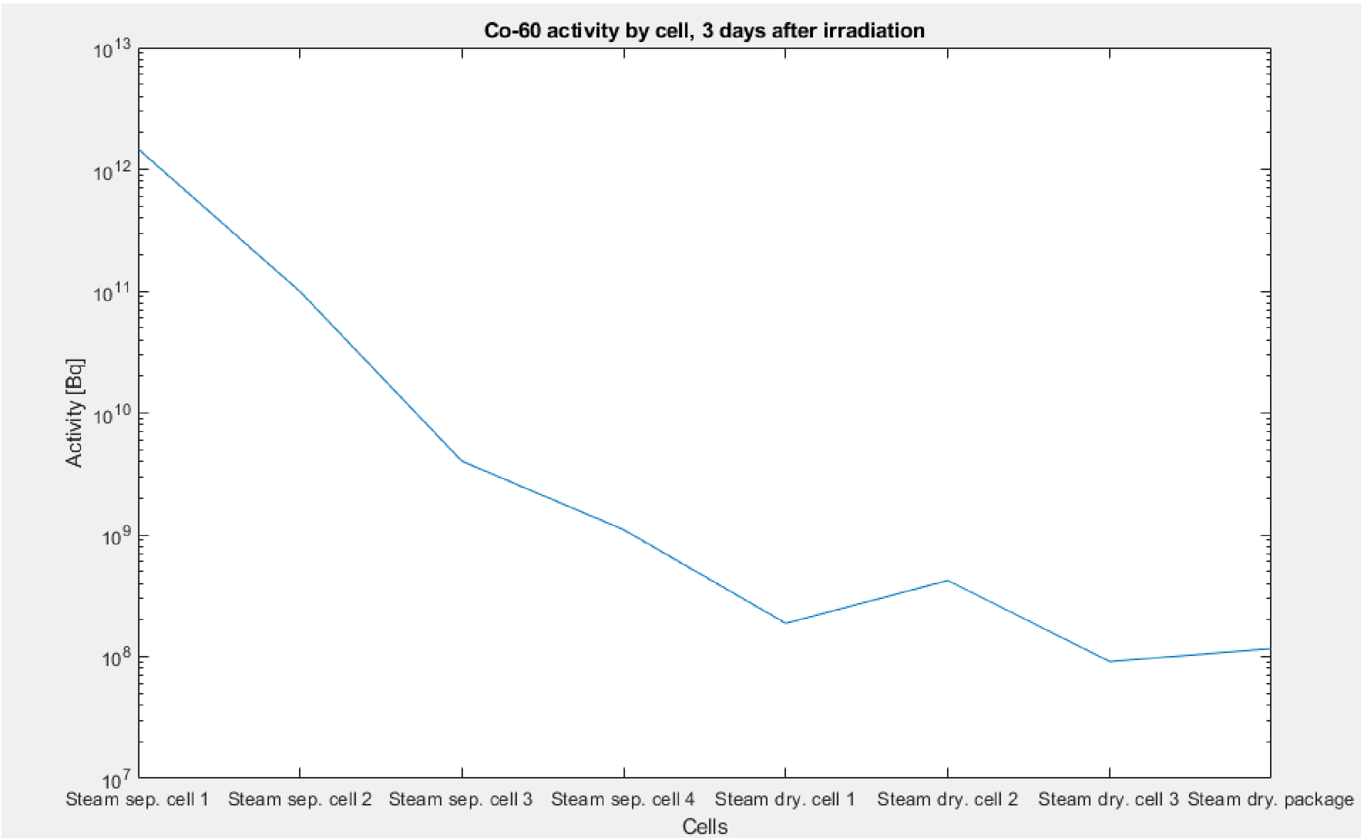


Figure 15: Activity of ^{60}Co in all parts of the components 3 days after irradiation.

5.2 Doses

The identified dose-dominant nuclides for each cooldown period (these are the same in each cell) are compiled in Table 8 below.

Table 8: Dose-dominant nuclides per cooldown period.

Cooldown time	Nuclides
3 days	^{60}Co ^{58}Co ^{59}Fe ^{51}Cr ^{54}Mn
1 year	^{60}Co ^{54}Mn ^{58}Co
30 years	^{60}Co
100 years	^{59}Ni ^{94}Nb ^{60}Co
1000 years	^{59}Ni ^{94}Nb

The total dose rate (surface and 1 m in air from the source) due to the nuclides of Table 8 were calculated in each cell for each cooldown period using geometry 1-3 (only 1 for the steam dryer), and are tabulated in Tables 9 - 12. The total dose rates from the entire components are shown in Table 13.

Table 9: Effective surface dose rate and dose rate 1 m in air from the steam separator cells for each cooldown period using geometry 1 [mSv/hr].

Cooldown period	3 days	1 year	30 years	100 years	1000 years
Cell 1					
Surface	214.3	127.3	2.704	$9.719 \cdot 10^{-4}$	$6.786 \cdot 10^{-4}$
1 m air	12.58	7.489	0.1592	$5.693 \cdot 10^{-5}$	$3.967 \cdot 10^{-5}$
Cell 2					
Surface	9.943	5.377	0.1114	$4.054 \cdot 10^{-5}$	$2.844 \cdot 10^{-5}$
1 m air	0.9339	0.5052	0.01047	$3.808 \cdot 10^{-6}$	$2.671 \cdot 10^{-6}$
Cell 3					
Surface	0.4152	0.2073	$4.195 \cdot 10^{-3}$	$1.559 \cdot 10^{-6}$	$1.102 \cdot 10^{-6}$
1 m air	0.04171	0.02083	$4.215 \cdot 10^{-4}$	$1.566 \cdot 10^{-7}$	$1.108 \cdot 10^{-7}$
Cell 4					
Surface	0.1287	0.05849	$1.147 \cdot 10^{-3}$	$4.367 \cdot 10^{-7}$	$3.155 \cdot 10^{-7}$
1 m air	0.01293	$5.877 \cdot 10^{-3}$	$1.153 \cdot 10^{-4}$	$4.387 \cdot 10^{-8}$	$3.130 \cdot 10^{-8}$

Table 10: Effective surface dose rate and dose rate 1 m in air from the steam separator cells for each cooldown period using geometry 2 [mSv/hr].

Cooldown period	3 days	1 year	30 years	100 years	1000 years
Cell 1					
Surface	6.010	3.577	0.07603	$2.292{\cdot}10^{-5}$	$1.894{\cdot}10^{-5}$
1 m air	2.712	1.615	0.03433	$1.034{\cdot}10^{-5}$	$8.545{\cdot}10^{-6}$
Cell 2					
Surface	0.4521	0.2445	$5.067{\cdot}10^{-3}$	$1.843{\cdot}10^{-6}$	$1.293{\cdot}10^{-6}$
1 m air	0.2052	0.1111	$2.301{\cdot}10^{-3}$	$8.366{\cdot}10^{-7}$	$5.867{\cdot}10^{-7}$
Cell 3					
Surface	0.02026	0.01011	$2.047{\cdot}10^{-4}$	$7.606{\cdot}10^{-8}$	$5.377{\cdot}10^{-8}$
1 m air	$9.208{\cdot}10^{-3}$	$4.600{\cdot}10^{-3}$	$9.309{\cdot}10^{-5}$	$3.457{\cdot}10^{-8}$	$2.444{\cdot}10^{-8}$
Cell 4					
Surface	$6.280{\cdot}10^{-3}$	$2.854{\cdot}10^{-3}$	$5.597{\cdot}10^{-5}$	$2.130{\cdot}10^{-8}$	$1.519{\cdot}10^{-8}$
1 m air	$2.854{\cdot}10^{-3}$	$1.298{\cdot}10^{-3}$	$2.546{\cdot}10^{-5}$	$9.683{\cdot}10^{-9}$	$6.905{\cdot}10^{-9}$

Table 11: Effective surface dose rate and dose rate 1 m in air from the steam separator cells for each cooldown period using geometry 3 [mSv/hr].

Cooldown period	3 days	1 year	30 years	100 years	1000 years
Cell 1					
Surface	131.4	76.45	1.622	$6.037{\cdot}10^{-4}$	$4.271{\cdot}10^{-4}$
1 m air	16.98	10.1	0.2126	$7.735{\cdot}10^{-5}$	$5.426{\cdot}10^{-5}$
Cell 2					
Surface	7.905	4.187	0.08652	$3.257{\cdot}10^{-5}$	$2.313{\cdot}10^{-5}$
1 m air	1.276	0.6830	0.01413	$5.229{\cdot}10^{-6}$	$3.691{\cdot}10^{-6}$
Cell 3					
Surface	0.3418	0.1671	$3.368{\cdot}10^{-3}$	$1.294{\cdot}10^{-6}$	$9.259{\cdot}10^{-7}$
1 m air	0.05718	0.02824	$5.705{\cdot}10^{-4}$	$2.156{\cdot}10^{-7}$	$1.534{\cdot}10^{-7}$
Cell 4					
Surface	0.1062	0.04719	$9.211{\cdot}10^{-4}$	$3.625{\cdot}10^{-7}$	$2.616{\cdot}10^{-7}$
1 m air	0.01775	$7.974{\cdot}10^{-3}$	$1.560{\cdot}10^{-4}$	$6.040{\cdot}10^{-8}$	$4.335{\cdot}10^{-8}$

Table 12: Effective surface dose rate and dose rate 1 m in air from the steam dryer cells for each cooldown period using geometry 1 [mSv/hr].

Cooldown period	3 days	1 year	30 years	100 years	1000 years
Frame cell 1					
Surface	0.07561	0.02283	$3.678 \cdot 10^{-4}$	$1.638 \cdot 10^{-7}$	$1.230 \cdot 10^{-7}$
1 m air	$5.582 \cdot 10^{-3}$	$1.686 \cdot 10^{-3}$	$2.716 \cdot 10^{-5}$	$1.210 \cdot 10^{-8}$	$9.078 \cdot 10^{-9}$
Frame cell 2					
Surface	0.03569	0.01062	$1.693 \cdot 10^{-4}$	$7.659 \cdot 10^{-8}$	$5.773 \cdot 10^{-8}$
1 m air	$8.618 \cdot 10^{-3}$	$2.564 \cdot 10^{-3}$	$4.090 \cdot 10^{-5}$	$1.850 \cdot 10^{-8}$	$1.394 \cdot 10^{-8}$
Frame cell 3					
Surface	$8.104 \cdot 10^{-3}$	$2.752 \cdot 10^{-3}$	$4.750 \cdot 10^{-5}$	$2.022 \cdot 10^{-8}$	$1.497 \cdot 10^{-8}$
1 m air	$1.723 \cdot 10^{-3}$	$5.851 \cdot 10^{-4}$	$1.010 \cdot 10^{-5}$	$4.301 \cdot 10^{-9}$	$3.185 \cdot 10^{-9}$
Package					
Surface	$8.271 \cdot 10^{-3}$	$2.808 \cdot 10^{-3}$	$4.847 \cdot 10^{-5}$	$2.064 \cdot 10^{-8}$	$1.528 \cdot 10^{-8}$
1 m air	$1.851 \cdot 10^{-3}$	$6.287 \cdot 10^{-4}$	$1.085 \cdot 10^{-5}$	$4.619 \cdot 10^{-9}$	$3.420 \cdot 10^{-9}$

Table 13: Effective surface dose rates and dose rates 1 m in air from the steam separator (geometry 1-3) and steam dryer (geometry 1) for each cooldown period [mSv/hr].

Cooldown period	3 days	1 year	30 years	100 years	1000 years
Steam separator geometry 1					
Surface	224.69	132.94	2.82	0.0010	$7.0846 \cdot 10^{-4}$
1 m air	13.5685	8.0209	0.1702	$6.0938 \cdot 10^{-5}$	$4.2483 \cdot 10^{-5}$
Steam separator geometry 2					
Surface	6.4886	3.8345	0.0814	$2.486 \cdot 10^{-5}$	$2.0302 \cdot 10^{-5}$
1 m air	2.9293	1.732	0.0367	$1.1221 \cdot 10^{-5}$	$9.163 \cdot 10^{-6}$
Steam separator geometry 3					
Surface	139.7530	80.8513	1.7128	$6.3793 \cdot 10^{-4}$	$4.5142 \cdot 10^{-4}$
1 m air	18.3309	10.8192	0.2275	$8.2855 \cdot 10^{-5}$	$5.8148 \cdot 10^{-5}$
Steam dryer geometry 1					
Surface	0.1277	0.0390	$6.3307 \cdot 10^{-4}$	$2.8125 \cdot 10^{-7}$	$2.1098 \cdot 10^{-7}$
1 m air	0.0178	0.0055	$8.9010 \cdot 10^{-5}$	$3.962 \cdot 10^{-8}$	$2.9623 \cdot 10^{-8}$

The dose rate in cells 1-4 of the steam separator using geometry 1 is visualized in Figure 16.

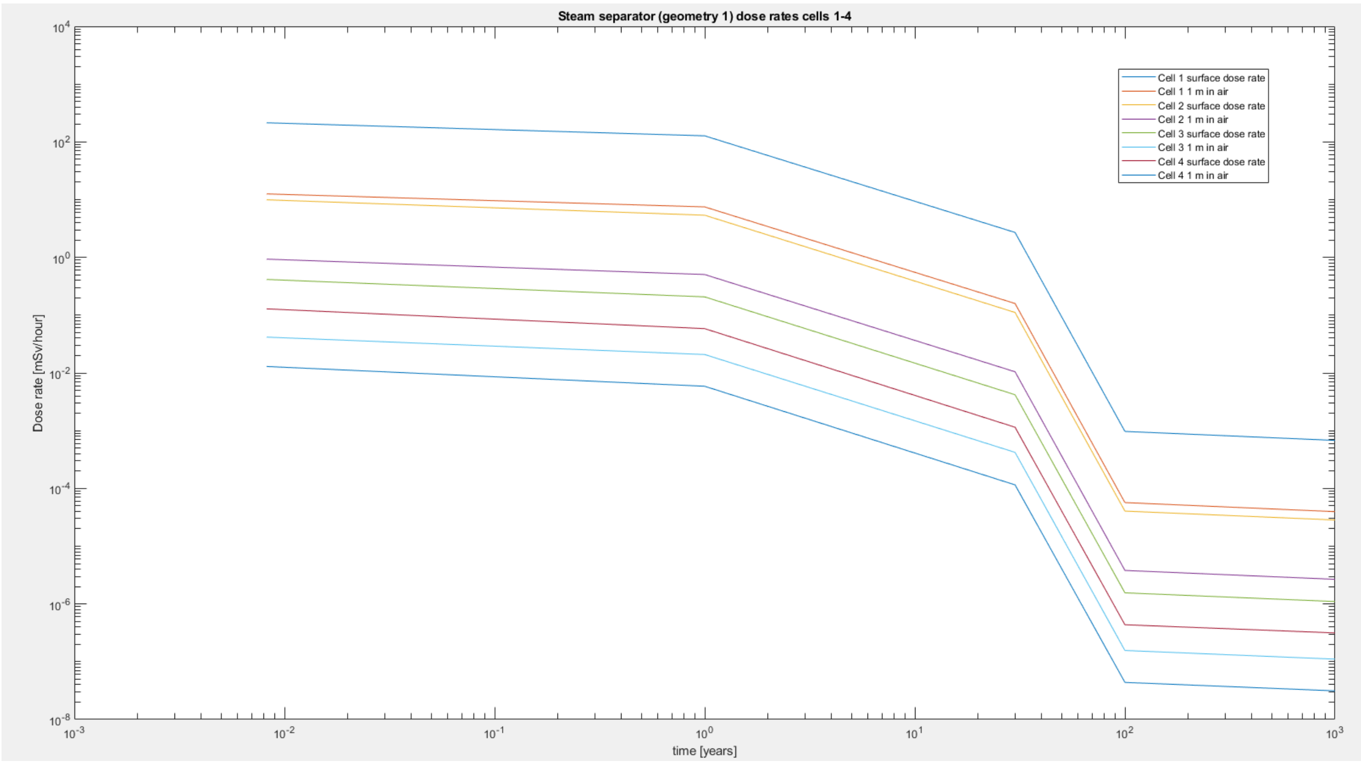


Figure 16: Dose rate of cells 1-4 of the steam separator using geometry 1.

The dose rate in cell 1 using geometry 1-3 is visualized in Figure 17.

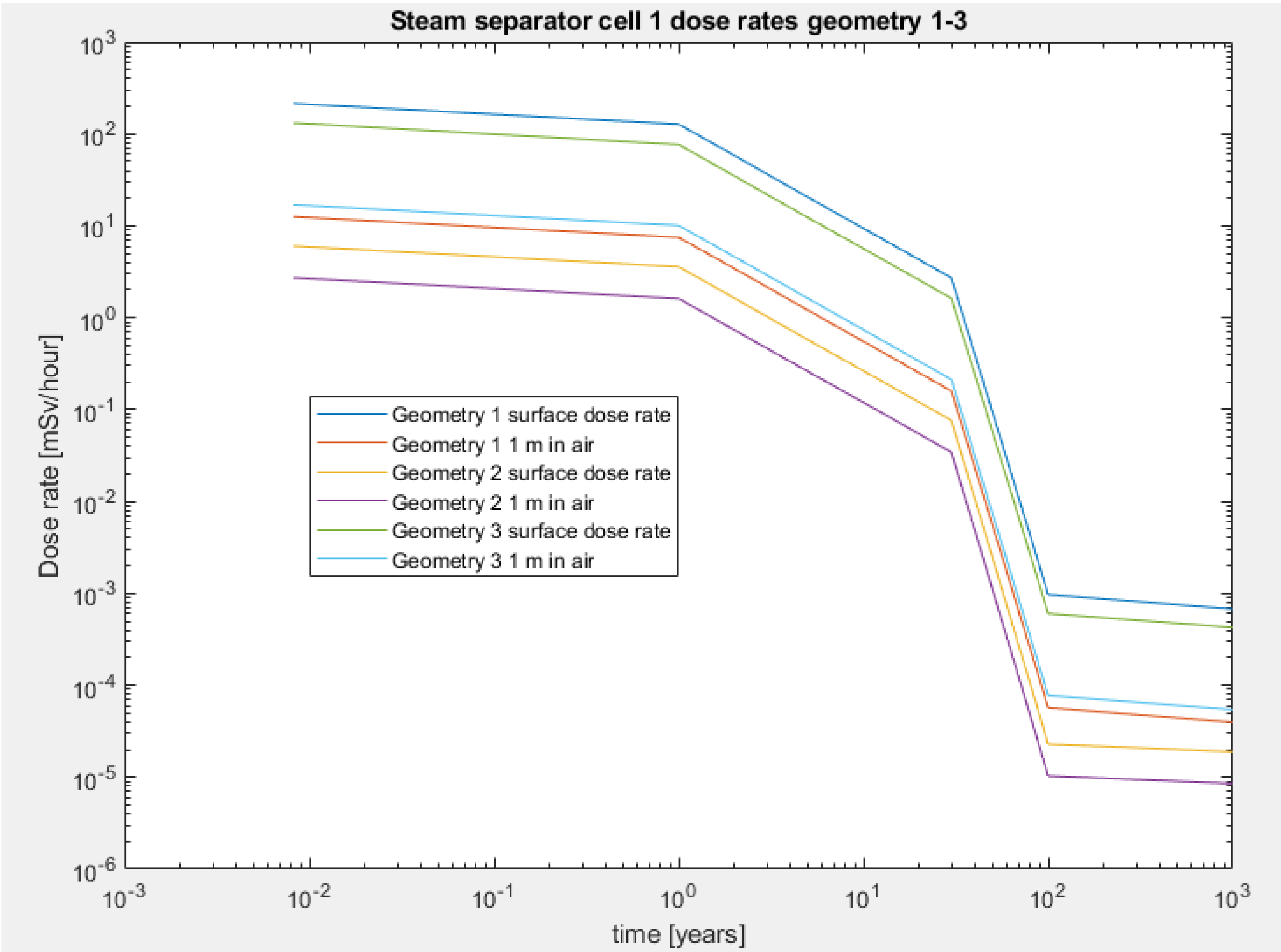


Figure 17: Dose rate of cell 1 of the steam separator using geometry 1-3.

The dose rate in cells 1-3 of the steam dryer frame and its package using geometry 1 is visualized in Figure 18.

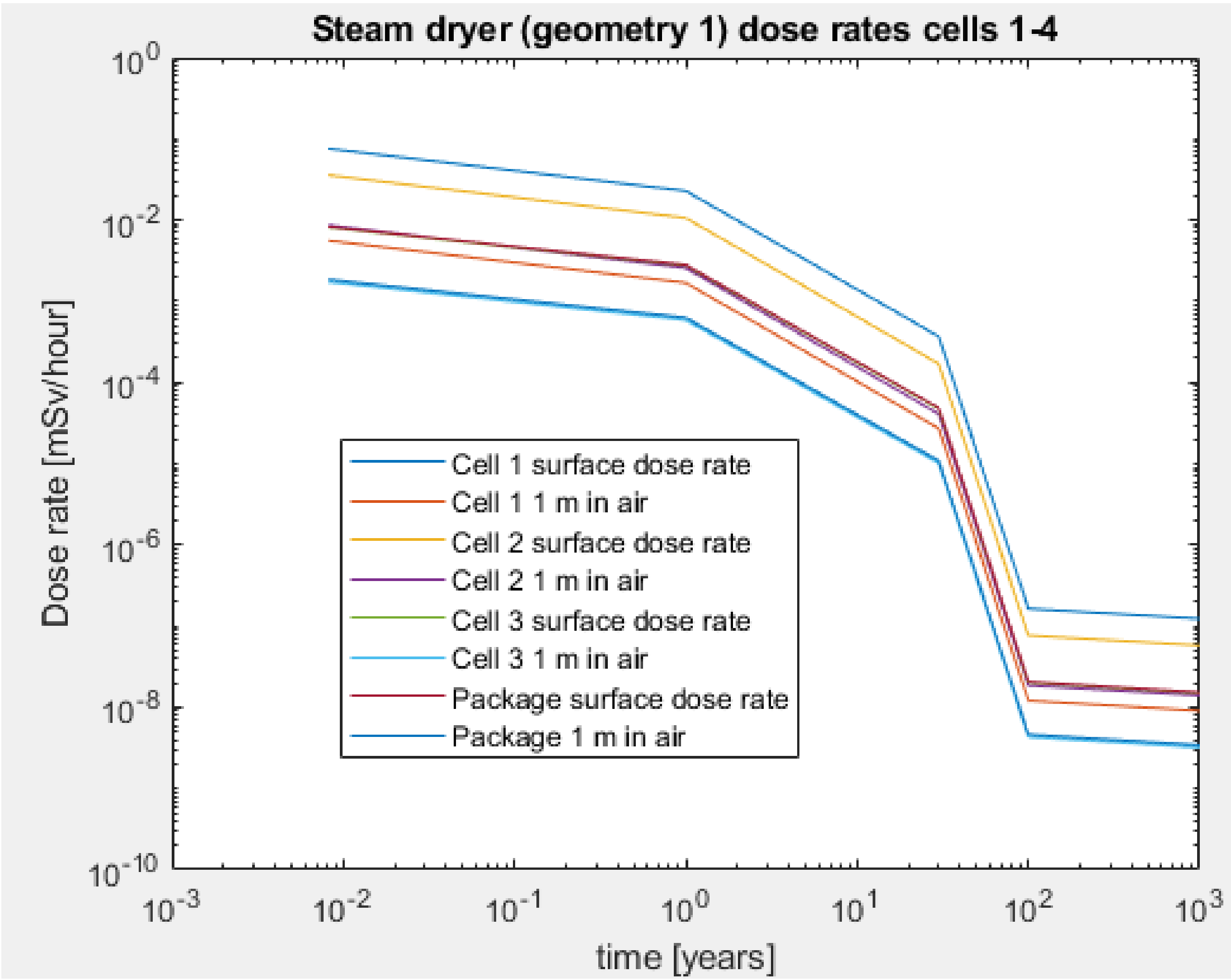


Figure 18: Dose rate of cells 1-3 of the steam dryer frame and the package using geometry 1.

6 Discussion

6.1 Activation

As can be read out in Tables 14 - 69, the activation 3 days after irradiation is significant in all parts of the components, especially so for the first 2 cells of the steam separator. An example of this is the activity of ^{60}Co, which is visualized in Figure 15. The activity starts out at $1.473 \cdot 10^{12}$ Bq in cell 1 of the steam separator, and drops of by about 1 order of magnitude for each cell in the steam separator. This decrease is expected as the distance from the reactor core increases with each cell, and subsequently the neutron flux decreases, as could be seen in Figure 12. The activity in the steam dryer appears to be somewhat constant, but one has to keep in mind that cell 1 of this component is much smaller than cells 2 and 3. The package and cell 3 of the frame occupy the same section in the MCNP model, and are of comparable size. It is therefore not strange that these exhibit comparable radionuclide activties after irradiation. The highest ^{60}Co activity in the steam dryer was stimulated to be 4.211 $\cdot 10^{8}$ Bq in the second cell of the frame.
The largest amount of activation products are those included in Table 8, along with a few others such as for example ^{3}H, ^{14}C and ^{63}Ni. These nuclides decay via β^{-} decay however and therefore don't contribute much to the dose rate to the workers. Other nuclides which have high energy γ-decays such as for example ^{26}Al (1.80865 MeV) are not present in high enough amounts to contribute much either. After 1 year of cool-down many of the short-lived nuclides have completely (or almost) disappeared. After 30 years the activity is dominated by ^{55}Fe, ^{60}Co, ^{59}Ni and ^{63}Ni, but since the decay mode of ^{60}Co emits 2 very high energy gammas with almost 100 % certainty, this results in this nuclide heavily dominating the dose rate to workers. After 100 years mostly the long lived nuclides persist, and the dose is dominated by ^{59}Ni and ^{94}Nb (with a small contribution still from ^{60}Co) as these have some γ-decay modes while also being some of the most active nuclides in the components. The same is true at the 1000 year mark. Only the long lived nuclides are present in any significant amount and the dose is still dominated by ^{59}Ni and ^{94}Nb.

6.2 Surface dose rate

Looking instead at the simulated dose rates of Tables 9 - 12, we can see that geometry 1 yields high dose rates, both surface and at a 1 m distance. This can be seen clearly in Figure 17. The surface dose rate 3 days after shut-down is above 10 μSv/hour in all parts of the steam separator and the first part of the steam dryer frame for geometry 1. The dose rate is especially large in cell 1 of the steam separator, being over 200 mSv/hour. This means a worker can only spend about 6 minutes beside this component before their yearly dose limit is used up. Luckily the reactor is unlikely to be taken apart in that short of a time-frame. Even after 1 year of cool-down however, many parts of the components exhibit large dose rates. For all but the last frame cell and package of the steam dryer, the surface dose rate is still above 10 μSv/hour. After 30 years (or slightly earlier) the surface dose rate of most cells is below the 10μSv/hour level, though not quite for cells 1 and 2 of the steam separator. After 100 years all surface dose rates are below the 10 μSv/hour. It is also worth noting that the dose is additive, and being close to more than one component cell at a time would mean exposure to all their dose rates at once. The effective dose rates from all cells in each component are therefore tabulates in Table 13. From this table it can be read out that the total surface dose rate from the steam separator is above 10μSv/hour regardless of geometry for at least 30 years. After a 100 years all surface dose rates are below that level. For the steam dryer, the dose rate is well below 10μSv/hour 30 years after irradiation. After 1 year it is approximately 39μSv/hour (decreased from 127μSv/hour 3 days after irradiation), which is still somewhat high. It is unlikely however that a worker would be in contact with all cells of the steam dryer simultaneously given their size, and so this should not be a cause for concern.

6.3 Dose rate 1 m

Looking instead at the dose rate 1 m in air from the components, this is approximately one order of magnitude smaller than the surface dose rate. 3 days after irradiation, cell 1 of the steam separator for example shows a dose rate of 12.6/2.712/16.98 mSv/hour using geometries 1-3. Even after 1 year of cool-down these dose rates have only decreased by about 40 % to 7.489/1.615/10.1 mSv/hour. The dose rate seems to decrease approximately one order of magnitude for each cell outwards from the core, and so the other cells of the components are not quite as active. Spending a whole work year close to any of the steam separator cells (except cell 4) would still put the worker above their yearly limit. The dose rates using geometry 2 are significantly lower, as is evident upon comparing Tables 9 and 10 (or by looking at Figure 17). The dose rates using geometry 3 are quite significant however and are in fact larger than those using geometry 1 which is unexpected. In cell 1 for example, the dose rate 1 m in air is still above 10 mSv/hour after a cool-down period of 1 year compared to 7.5 mSv/hour when geometry 1 was used. There are a number of possible explanations for this, one of which is simply an error in the model, either when the dose was calculated with geometry 1 or with geometry 3. A more likely reason however is that the combined effects of reduced self-shielding and buildup in the component, along with an increased surface area facing the dose point resulted in a higher calculated dose rate. The total dose rates (Table 13) show that the dose rates at a 1 m distance from the steam separator is above 10μSv/hour for at least 30 years regardless of geometry. This shows that the steam dryer should be treated with caution, as the likelihood of a worker being within 1 m of the entire component is larger that them being in contact with it for an extended period of time. The total dose rate 1 m from the steam dryer is only above 10μSv/hour 3 days after irradiation.

6.4 Uncertainty analysis

As with most studies the results should be used with caution. Especially so here, since all simulated and calculated values build upon a model of reality.

6.4.1 Neutron fluxes

Since the neutron flux study used in this report was built upon a simplified model in which certain parts of the reactor were homogenized, the derived flux will not be completely correct. The uncertainties in the values stated previously in the report are only in relation to the true value of the model, *not the true value in real life*. The calculated values are only as good as the model, and an improvement to the accuracy of the values derived in this report would therefore require an improved model of the neutron flux. Giving a number to the uncertainty in the model is not possible at this point, but some validation can be performed by comparing simulated neutron fluxes with measured ones.
This was the aim in a more recent study from Westinghouse [23]. To date, 3 in-vessel irradiation capsules have been irradiated in O3 as part of a RPV surveillance program, 2 of which have been extracted. In the study, the neutron fluence was simulated in a similar fashion to the previously described study [10], but only for fast/fission neutrons and only in some regions of the RPV. These regions included those of the irradiation capsules. The calculated fluence rates were used to calculate reaction rates of nuclides in the capsules. These were then compared to the actual reaction rates of the extracted capsules yielding an average measured-to-calculated reaction ratio of 1.16 with a standard deviation of 15.8%. The location of the third capsule which was not extracted was included in the previous study and the neutron fluence at this location are comparable in the 2 studies, though no validation exists for this capsule. Also included in the fluence calculations was the interface between the cladding and the bulk of the RPV in the radial direction. There, the calculated fluences were comparable to those of the previous study. The uncertainty of the calculated neutron fluences was determined to be 13%. While this newer study certainly doesn't completely validate the previous one [10], it does show that the calculated fluence rates are not entirely inaccurate since they are comparable in both studies in the regions that were validated in the newer study.
Going back to the original neutron fluence study [10], an important thing to note is that the reported fluxes were integrated in only 3 different energy intervals. This caused an irrevocable loss of the energy resolution in the neutron flux which is required to obtain accurate results for production of radionuclides. In this thesis, this was circumvented by applying the given fluxes to a reference neutron spectrum. This should have improved the results somewhat, but is of course still not completely accurate. Taking the production of ^{60}Co as an example, as this has great importance for the radiation protection in the intermediate term of 10 - 50 years, the cross section for neutron capture (and subsequently

production of ^{60}Co) has a peak of approximately 200 b at a neutron energy of approximately 150 eV [24] as can be seen in Figure 8. If the neutron flux between 144.5 - 158.5 eV was underestimated by, let's say, 100%, this would results in an underestimation of the ^{60}Co activity 3 days after shut-down equal to about 0.0068%. The total flux was increased by approximately 0.01%, which means the sensitivity due to "small" variations in the energy spectrum is in fact not so large.

6.4.2 Activity

Another source of error for the activation products is the fact that FISPACT only gives the uncertainty in cross-section of some nuclides. In most cases these are the same as those in Table 8, with the exception of ^{59}Ni and ^{94}Nb. As these nuclides only have a substantial effect on the dose rate after approximately 50-100 years or so however, at which point the dose rate is mostly negligible (except in some parts of the components), the absence of uncertainty estimate is not expected to significantly impact the results, unless the calculated inventory is vastly underestimated. Taking the uncertainties which were calculated for other nuclides into account however, this does not seem to be the case. The same can be said for other nuclides which have not been included in the dose rate calculations, and for which the uncertainty in cross-section is not presented.

6.4.3 Dose rates

Lastly, when calculating the doses a very simplified geometry had to be used as this was a limitation in MicroShield. As stated previously, geometry 1 removes all air inside the components and compresses them into a homogenized cylinder. Since the distance of the dose points from the source is taken from the edge of these cylinders, this results in decreased air attenuation and a decreased distance between most source points and the dose points compared to reality. Due to this, geometry 1 overestimates the dose rate. Since the dose rates of the steam dryer are quite low even while using this geometry, it was thus deemed unnecessary to apply the other geometries to it. Geometry 2 aims at taking the air attenuation into account while still keeping the density of the metal in the components true to reality. This comes at the cost of an increased distance between source and dose points however, and therefore geometry 2 underestimates the dose rate. Finally, geometry 3 uses the true volume of the components while also taking air attenuation into account. The distance between source and dose points is also fairly consistent with reality. The problem with this geometry however is the decreased density of the source metal, which results in decreased self-shielding and buildup. Despite this however, geometry 3 most likely gives the dose rates closest to the real ones.

6.4.4 Validation and improvements

Due to the above mentioned uncertainties, the results of this thesis need to be validated by measurements on the components in question before the accuracy of the derived values can be determined. Further studies could also seek to improve the previous neutron flux simulations in MCNP, mainly by making fewer homogenizations, and by keeping the energy resolution in the neutron flux spectrum. It may also be beneficial to use a better simulation tool for determining the dose rate. This could for example also be done in MCNP, or one could use ORNLs (Oak Ridge National Laboratory) SCALE6.2 [25]. Further studies could also seek to include more components in the analysis. The steam separator and steam dryer were chosen for this report as they had not been included in previous iterations of the activation analysis. Previous iterations were however not as detailed, and so it could be beneficial to again study other components.

7 Conclusions

In conclusion, the neutron flux from the reactor core resulted in significant activation in the steam separator, but not very significant activation in the steam dryer. As an example, the highest ^{60}Co activity was found in the first cell of the steam separator (which also contained the smallest amount of material) 3 days after irradiation and was $1.473 \cdot 10^{12}$ Bq. The highest activity of the same nuclide in the steam dryer was at this point only $4.211 \cdot 10^{8}$ Bq in the second cell of the frame. The dose rate to workers due to the activation was for the steam separator significant all the way up to 30 years after shut-down, but was for the steam dryer quite low even after 1 year, below 10μSv/hour in almost all cells. The peak dose rate was found in cell 1 of the steam separator (closest to the reactor core) 3 days after shut-down, and was estimated to be 214 mSv/hour at the surface and 12.6 mSv/hour 1 m in air from the component. After 1 year of cool-down the dose rate had decreased by approximately 40 % to 127 mSv/hour, which is still a significant dose rate. The dose rate decreased about one order of magnitude for each cell outwards from the reactor core, which was consistent with the activity. These values were overestimated however, and the real values are likely lower. The total dose rates at the surface and at a 1 m distance from the steam separator were at most 225/6.5/140 mSv/hour and 13.6/2.9/18.3 mSv/hour respectively for geometries 1-3. For the steam dryer they were at most 0.128 mSv/hour and 0.0178 mSv/hour respectively using geometry 1. The dose rate was for the simulated time periods dominated by a selection of the following nuclides; ^{51}Cr, ^{54}Mn, ^{59}Fe, ^{58}Co, ^{60}Co, ^{59}Ni and ^{94}Nb. The simulated values should be used with caution as there were many uncertainties in the models used to derive them. Validation by measurement on the components in question is thus required to be sure of the accuracy of the derived values.

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9 Appendices

Tables showing the total activity [Bq] per nuclide by cell and cool-down time. Uncertainties (in the cross section) calculated by FISPACT are tabulated where available.

9.1 Steam separator

9.1.1 Cell 1 - 3 days after shut-down

Table 14: Activity in steam separator cell 1 - 3 days after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$1.266 \cdot 10^{8}$		^{58}Co	$9.016 \cdot 10^{11}$	2.573
^{10}Be	$4.511 \cdot 10^{1}$		^{58m}Co	$1.241 \cdot 10^{9}$	3.412
^{14}C	$1.741 \cdot 10^{9}$		^{60}Co	$1.473 \cdot 10^{12}$	0.000
^{26}Al	$2.555 \cdot 10^{-1}$		^{60m}Co	$1.393 \cdot 10^{0}$	
^{31}Si	$3.985 \cdot 10^{1}$		^{57}Ni	$8.884 \cdot 10^{6}$	
^{32}Si	$1.635 \cdot 10^{0}$		^{58}Ni	$1.045 \cdot 10^{-1}$	
^{32}P	$9.688 \cdot 10^{9}$	1.245	^{59}Ni	$1.590 \cdot 10^{10}$	
^{33}P	$1.389 \cdot 10^{7}$		^{63}Ni	$1.779 \cdot 10^{12}$	0.01089
^{35}S	$5.197 \cdot 10^{8}$		^{65}Ni	$6.152 \cdot 10^{2}$	0.000
^{36}Cl	$5.781 \cdot 10^{5}$		^{64}Cu	$8.479 \cdot 10^{9}$	1.577
^{37}Ar	$5.516 \cdot 10^{0}$		^{67}Cu	$8.747 \cdot 10^{0}$	
^{39}Ar	$2.875 \cdot 10^{0}$		^{64}Zn	$1.553 \cdot 10^{-6}$	
^{40}K	$3.540 \cdot 10^{-14}$		^{65}Zn	$4.325 \cdot 10^{5}$	
^{43}K	$1.117 \cdot 10^{-2}$		^{72}Ga	$4.017 \cdot 10^{3}$	
^{45}Ca	$4.514 \cdot 10^{5}$		^{71}Ge	$4.134 \cdot 10^{3}$	
^{47}Ca	$4.408 \cdot 10^{3}$		^{76}Ge	$1.584 \cdot 10^{-21}$	
^{48}Ca	$8.790 \cdot 10^{-20}$		^{73}As	$2.651 \cdot 10^{2}$	
^{44}Sc	$3.882 \cdot 10^{-1}$		^{74}As	$2.371 \cdot 10^{6}$	
^{44m}Sc	$3.664 \cdot 10^{-1}$		^{76}As	$7.539 \cdot 10^{9}$	0.2284
^{46}Sc	$1.118 \cdot 10^{7}$		^{77}As	$1.330 \cdot 10^{2}$	
^{47}Sc	$9.625 \cdot 10^{6}$		^{75}Se	$1.822 \cdot 10^{2}$	
^{48}Sc	$9.561 \cdot 10^{5}$		^{79}Se	$8.847 \cdot 10^{-9}$	
^{48}V	$6.441 \cdot 10^{3}$		^{89}Sr	$1.669 \cdot 10^{-1}$	
^{49}V	$6.921 \cdot 10^{7}$		^{90}Sr	$3.528 \cdot 10^{-4}$	
^{50}V	$1.885 \cdot 10^{-4}$		^{88}Y	$2.197 \cdot 10^{4}$	
^{50}Cr	$4.148 \cdot 10^{1}$		^{89m}Y	$1.326 \cdot 10^{7}$	
^{51}Cr	$1.769 \cdot 10^{13}$	0.01373	^{90}Y	$2.688 \cdot 10^{5}$	
^{52}Mn	$5.929 \cdot 10^{3}$		^{91}Y	$3.550 \cdot 10^{0}$	
^{53}Mn	$4.011 \cdot 10^{3}$		^{88}Zr	$2.256 \cdot 10^{4}$	
^{54}Mn	$2.827 \cdot 10^{11}$	2.314	^{89}Zr	$1.328 \cdot 10^{7}$	
^{56}Mn	$1.085 \cdot 10^{5}$	1.160	^{93}Zr	$1.936 \cdot 10^{2}$	
^{55}Fe	$1.232 \cdot 10^{13}$	7.986	^{94}Zr	$1.162 \cdot 10^{-9}$	
^{59}Fe	$3.665 \cdot 10^{11}$	5.298	^{95}Zr	$3.419 \cdot 10^{6}$	
^{60}Fe	$1.393 \cdot 10^{0}$		^{96}Zr	$8.468 \cdot 10^{-15}$	
^{56}Co	$8.572 \cdot 10^{5}$		^{97}Zr	$9.650 \cdot 10^{3}$	
^{57}Co	$1.729 \cdot 10^{9}$		^{90}Nb	$1.514 \cdot 10^{1}$	

Table 15: Activity in steam separator cell 1 - 3 days after shut-down (continued)

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{91}Nb	$2.066 \cdot 10^{6}$		^{126}Sn	$9.419 \cdot 10^{-6}$	
^{91m}Nb	$2.171 \cdot 10^{3}$		^{119}Sb	$3.930 \cdot 10^{1}$	
^{92}Nb	$1.586 \cdot 10^{3}$		^{122}Sb	$1.264 \cdot 10^{9}$	
^{92m}Nb	$2.480 \cdot 10^{6}$		^{124}Sb	$1.343 \cdot 10^{9}$	0.000
^{93m}Nb	$8.189 \cdot 10^{8}$		^{125}Sb	$6.085 \cdot 10^{7}$	
^{94}Nb	$1.238 \cdot 10^{7}$		^{126}Sb	$4.203 \cdot 10^{1}$	
^{95}Nb	$1.802 \cdot 10^{7}$		^{121}Te	$4.093 \cdot 10^{0}$	
^{95m}Nb	$3.784 \cdot 10^{4}$		^{121m}Te	$2.076 \cdot 10^{0}$	
^{96}Nb	$6.253 \cdot 10^{5}$		^{123}Te	$4.783 \cdot 10^{-12}$	
^{97}Nb	$1.040 \cdot 10^{4}$		^{123m}Te	$3.822 \cdot 10^{3}$	
^{97m}Nb	$9.180 \cdot 10^{3}$		^{125m}Te	$1.400 \cdot 10^{7}$	
^{92}Mo	$1.070 \cdot 10^{-2}$		^{176}Lu	$1.737 \cdot 10^{-10}$	
^{93}Mo	$2.257 \cdot 10^{8}$		^{177}Lu	$2.859 \cdot 10^{2}$	
^{98}Mo	$3.306 \cdot 10^{4}$		^{177m}Lu	$1.905 \cdot 10^{-1}$	
^{99}Mo	$4.666 \cdot 10^{10}$	0.000	^{175}Hf	$1.231 \cdot 10^{-3}$	
^{100}Mo	$1.807 \cdot 10^{-1}$		^{178n}Hf	$2.084 \cdot 10^{-6}$	
^{97}Tc	$1.347 \cdot 10^{-6}$		^{179n}Hf	$1.527 \cdot 10^{-2}$	
^{97m}Tc	$3.103 \cdot 10^{-2}$		^{181}Hf	$7.453 \cdot 10^{3}$	
^{98}Tc	$1.125 \cdot 10^{-3}$		^{182}Hf	$1.493 \cdot 10^{-5}$	
^{99}Tc	$1.012 \cdot 10^{7}$		^{178}Ta	$1.629 \cdot 10^{1}$	
^{99m}Tc	$4.507 \cdot 10^{10}$	0.000	^{179}Ta	$5.987 \cdot 10^{4}$	
^{103}Ru	$2.297 \cdot 10^{0}$		^{180}Ta	$6.312 \cdot 10^{4}$	
^{103m}Rh	$2.271 \cdot 10^{0}$		^{180m}Ta	$1.917 \cdot 10^{-3}$	
^{110}Pd	$3.167 \cdot 10^{-19}$		^{182}Ta	$1.043 \cdot 10^{11}$	0.000
^{109m}Ag	$1.721 \cdot 10^{4}$		^{183}Ta	$1.090 \cdot 10^{8}$	
^{108}Cd	$1.383 \cdot 10^{-14}$		^{184}Ta	$2.695 \cdot 10^{0}$	
^{109}Cd	$1.721 \cdot 10^{4}$		^{178}W	$1.628 \cdot 10^{1}$	
^{111m}Cd	$3.620 \cdot 10^{-1}$		^{181}W	$8.005 \cdot 10^{8}$	
^{113}Cd	$8.432 \cdot 10^{-12}$		^{183}W	$3.720 \cdot 10^{-2}$	
^{114}Cd	$5.488 \cdot 10^{-13}$		^{183m}W	$3.708 \cdot 10^{6}$	
^{115}Cd	$2.899 \cdot 10^{2}$		^{184}W	$2.190 \cdot 10^{-2}$	
^{116}Cd	$2.115 \cdot 10^{-16}$		^{185}W	$2.503 \cdot 10^{9}$	
^{111}In	$7.151 \cdot 10^{3}$		^{186}W	$1.378 \cdot 10^{-2}$	
^{113m}In	$7.326 \cdot 10^{7}$		^{187}W	$6.594 \cdot 10^{9}$	5.580
^{115}In	$1.301 \cdot 10^{-10}$		^{183}Re	$1.121 \cdot 10^{-1}$	
^{115m}In	$3.165 \cdot 10^{2}$		^{184}Re	$3.346 \cdot 10^{1}$	
^{113}Sn	$7.322 \cdot 10^{7}$		^{184m}Re	$5.271 \cdot 10^{0}$	
^{117m}Sn	$2.067 \cdot 10^{1}$		^{186}Re	$6.354 \cdot 10^{5}$	
^{119m}Sn	$1.411 \cdot 10^{3}$		^{186m}Re	$1.208 \cdot 10^{-1}$	
^{121}Sn	$6.323 \cdot 10^{7}$		^{187}Re	$2.656 \cdot 10^{1}$	
^{121m}Sn	$1.114 \cdot 10^{5}$		^{188}Re	$7.644 \cdot 10^{5}$	
^{123}Sn	$1.425 \cdot 10^{7}$		^{184}Os	$1.116 \cdot 10^{-18}$	
^{124}Sn	$2.564 \cdot 10^{-2}$		^{185}Os	$4.860 \cdot 10^{-3}$	
^{125}Sn	$2.930 \cdot 10^{6}$		^{186}Os	$5.500 \cdot 10^{-9}$	

9.1.2 Cell 1 - 1 year after shut-down

Table 16: Activity in steam separator cell 1 - 1 year after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$1.198 \cdot 10^{8}$		^{75}Se	$2.242 \cdot 10^{1}$	
^{10}Be	$4.511 \cdot 10^{1}$		^{79}Se	$8.847 \cdot 10^{-9}$	
^{14}C	$1.741 \cdot 10^{9}$		^{89}Sr	$1.169 \cdot 10^{-3}$	
^{26}Al	$2.555 \cdot 10^{-1}$		^{90}Sr	$3.445 \cdot 10^{-4}$	
^{32}Si	$1.632 \cdot 10^{0}$		^{88}Y	$5.790 \cdot 10^{3}$	
^{32}P	$2.257 \cdot 10^{2}$	1.245	^{91}Y	$4.872 \cdot 10^{-2}$	
^{33}P	$7.073 \cdot 10^{2}$		^{88}Zr	$1.113 \cdot 10^{3}$	
^{35}S	$2.929 \cdot 10^{7}$		^{93}Zr	$1.936 \cdot 10^{2}$	
^{36}Cl	$5.781 \cdot 10^{5}$		^{94}Zr	$1.162 \cdot 10^{-9}$	
^{37}Ar	$4.256 \cdot 10^{-3}$		^{95}Zr	$6.792 \cdot 10^{4}$	
^{39}Ar	$2.868 \cdot 10^{0}$		^{96}Zr	$8.468 \cdot 10^{-15}$	
^{40}K	$3.540 \cdot 10^{-14}$		^{91}Nb	$2.064 \cdot 10^{6}$	
^{45}Ca	$9.650 \cdot 10^{4}$		^{91m}Nb	$3.525 \cdot 10^{1}$	
^{48}Ca	$8.790 \cdot 10^{-20}$		^{92}Nb	$1.586 \cdot 10^{3}$	
^{46}Sc	$5.946 \cdot 10^{5}$		^{93m}Nb	$7.928 \cdot 10^{8}$	
^{48}V	$9.712 \cdot 10^{-4}$		^{94}Nb	$1.238 \cdot 10^{7}$	
^{49}V	$3.235 \cdot 10^{7}$		^{95}Nb	$1.579 \cdot 10^{5}$	
^{50}V	$1.885 \cdot 10^{-4}$		^{95m}Nb	$7.775 \cdot 10^{2}$	
^{50}Cr	$4.148 \cdot 10^{1}$		^{92}Mo	$1.070 \cdot 10^{-2}$	
^{51}Cr	$2.062 \cdot 10^{9}$	0.01373	^{93}Mo	$2.257 \cdot 10^{8}$	
^{53}Mn	$4.011 \cdot 10^{3}$		^{98}Mo	$3.306 \cdot 10^{4}$	
^{54}Mn	$1.266 \cdot 10^{11}$	2.314	^{100}Mo	$1.807 \cdot 10^{-1}$	
^{55}Fe	$9.592 \cdot 10^{12}$	7.986	^{97}Tc	$1.350 \cdot 10^{-6}$	
^{59}Fe	$1.303 \cdot 10^{9}$	5.298	^{97m}Tc	$1.922 \cdot 10^{-3}$	
^{60}Fe	$1.393 \cdot 10^{0}$		^{98}Tc	$1.125 \cdot 10^{-3}$	
^{56}Co	$3.328 \cdot 10^{4}$		^{99}Tc	$1.012 \cdot 10^{7}$	
^{57}Co	$6.868 \cdot 10^{8}$		^{103}Ru	$3.850 \cdot 10^{-3}$	
^{58}Co	$2.612 \cdot 10^{10}$	2.573	^{110}Pd	$3.167 \cdot 10^{-19}$	
^{60}Co	$1.293 \cdot 10^{12}$	0.000	^{109m}Ag	$9.999 \cdot 10^{3}$	
^{60m}Co	$1.393 \cdot 10^{0}$		^{108}Cd	$1.383 \cdot 10^{-14}$	
^{58}Ni	$1.045 \cdot 10^{-1}$		^{109}Cd	$9.999 \cdot 10^{3}$	
^{59}Ni	$1.590 \cdot 10^{10}$		^{113}Cd	$8.432 \cdot 10^{-12}$	
^{63}Ni	$1.767 \cdot 10^{12}$	0.01089	^{114}Cd	$5.488 \cdot 10^{-13}$	
^{64}Zn	$1.553 \cdot 10^{-6}$		^{116}Cd	$2.115 \cdot 10^{-16}$	
^{65}Zn	$1.547 \cdot 10^{5}$		^{113m}In	$8.280 \cdot 10^{6}$	
^{76}Ge	$1.584 \cdot 10^{-21}$		^{115}In	$1.301 \cdot 10^{-10}$	
^{73}As	$1.165 \cdot 10^{1}$		^{113}Sn	$8.275 \cdot 10^{6}$	
^{74}As	$1.762 \cdot 10^{0}$		^{119m}Sn	$5.992 \cdot 10^{2}$	

Table 17: Activity in steam separator cell 1 - 1 year after shut-down (continued)

Radionuclides	Activity [Bq]	Uncertainty (cross-section only) [%]
^{121}Sn	$8.512 \cdot 10^{4}$	
^{121m}Sn	$1.097 \cdot 10^{5}$	
^{123}Sn	$2.044 \cdot 10^{6}$	
^{124}Sn	$2.564 \cdot 10^{-2}$	
^{126}Sn	$9.419 \cdot 10^{-6}$	
^{124}Sb	$2.080 \cdot 10^{7}$	0.000
^{125}Sb	$4.746 \cdot 10^{7}$	
^{121}Te	$4.123 \cdot 10^{-1}$	
^{121m}Te	$4.070 \cdot 10^{-1}$	
^{123}Te	$4.795 \cdot 10^{-12}$	
^{123m}Te	$4.681 \cdot 10^{2}$	
^{125m}Te	$1.161 \cdot 10^{7}$	
^{176}Lu	$1.737 \cdot 10^{-10}$	
^{177}Lu	$9.386 \cdot 10^{-3}$	
^{177m}Lu	$3.981 \cdot 10^{-2}$	
^{178n}Hf	$2.038 \cdot 10^{-6}$	
^{179n}Hf	$1.239 \cdot 10^{-2}$	
^{181}Hf	$2.000 \cdot 10^{1}$	
^{182}Hf	$1.493 \cdot 10^{-5}$	
^{179}Ta	$3.908 \cdot 10^{4}$	
^{180m}Ta	$1.917 \cdot 10^{-3}$	
^{182}Ta	$1.170 \cdot 10^{10}$	0.000
^{181}W	$1.006 \cdot 10^{8}$	
^{183}W	$3.720 \cdot 10^{-2}$	
^{184}W	$2.190 \cdot 10^{-2}$	
^{185}W	$8.861 \cdot 10^{7}$	
^{186}W	$1.378 \cdot 10^{-2}$	
^{183}Re	$3.111 \cdot 10^{-3}$	
^{184}Re	$1.146 \cdot 10^{0}$	
^{184m}Re	$1.184 \cdot 10^{0}$	
^{186}Re	$1.208 \cdot 10^{-1}$	
^{186m}Re	$1.208 \cdot 10^{-1}$	
^{187}Re	$2.656 \cdot 10^{1}$	
^{184}Os	$1.116 \cdot 10^{-18}$	
^{185}Os	$3.349 \cdot 10^{-4}$	
^{186}Os	$5.503 \cdot 10^{-9}$	

9.1.3 Cell 1 - 30 years after shut-down

Table 18: Activity in steam separator cell 1 - 30 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$2.346 \cdot 10^{7}$		^{97}Tc	$1.350 \cdot 10^{-6}$	
^{10}Be	$4.511 \cdot 10^{1}$		^{98}Tc	$1.125 \cdot 10^{-3}$	
^{14}C	$1.735 \cdot 10^{9}$		^{99}Tc	$1.012 \cdot 10^{7}$	
^{26}Al	$2.555 \cdot 10^{-1}$		^{110}Pd	$3.167 \cdot 10^{-19}$	
^{32}Si	$1.536 \cdot 10^{0}$		^{108}Cd	$1.383 \cdot 10^{-14}$	
^{32}P	$1.536 \cdot 10^{0}$	1.245	^{109}Cd	$1.249 \cdot 10^{-3}$	
^{36}Cl	$5.780 \cdot 10^{5}$		^{113}Cd	$8.432 \cdot 10^{-12}$	
^{39}Ar	$2.661 \cdot 10^{0}$		^{114}Cd	$5.488 \cdot 10^{-13}$	
^{40}K	$3.540 \cdot 10^{-14}$		^{116}Cd	$2.115 \cdot 10^{-16}$	
^{48}Ca	$8.790 \cdot 10^{-20}$		^{115}In	$1.301 \cdot 10^{-10}$	
^{49}V	$7.038 \cdot 10^{-3}$		^{121}Sn	$5.385 \cdot 10^{4}$	
^{50}V	$1.885 \cdot 10^{-4}$		^{121m}Sn	$6.939 \cdot 10^{4}$	
^{50}Cr	$4.148 \cdot 10^{1}$		^{124}Sn	$2.564 \cdot 10^{-2}$	
^{53}Mn	$4.011 \cdot 10^{3}$		^{126}Sn	$9.418 \cdot 10^{-6}$	
^{54}Mn	$7.738 \cdot 10^{0}$	2.314	^{125}Sb	$3.248 \cdot 10^{4}$	
^{55}Fe	$6.366 \cdot 10^{9}$	7.986	^{123}Te	$4.797 \cdot 10^{-12}$	
^{60}Fe	$1.393 \cdot 10^{0}$		^{125m}Te	$7.954 \cdot 10^{3}$	
^{57}Co	$1.274 \cdot 10^{-3}$		^{176}Lu	$1.737 \cdot 10^{-10}$	
^{60}Co	$2.855 \cdot 10^{10}$	0.000	^{178n}Hf	$1.066 \cdot 10^{-6}$	
^{60m}Co	$1.393 \cdot 10^{0}$		^{179n}Hf	$1.239 \cdot 10^{-2}$	
^{58}Ni	$1.045 \cdot 10^{-1}$		^{182}Hf	$1.494 \cdot 10^{-5}$	
^{59}Ni	$1.590 \cdot 10^{10}$		^{179}Ta	$1.476 \cdot 10^{-1}$	
^{63}Ni	$1.441 \cdot 10^{12}$	0.01089	^{180m}Ta	$1.917 \cdot 10^{-3}$	
^{64}Zn	$1.553 \cdot 10^{-6}$		^{183}W	$3.720 \cdot 10^{-2}$	
^{76}Ge	$1.584 \cdot 10^{-21}$		^{184}W	$2.190 \cdot 10^{-2}$	
^{79}Se	$8.847 \cdot 10^{-9}$		^{186}W	$1.378 \cdot 10^{-2}$	
^{90}Sr	$1.714 \cdot 10^{-4}$		^{186}Re	$1.208 \cdot 10^{-1}$	
^{93}Zr	$1.936 \cdot 10^{2}$		^{186m}Re	$1.208 \cdot 10^{-1}$	
^{94}Zr	$1.162 \cdot 10^{-9}$		^{187}Re	$2.656 \cdot 10^{1}$	
^{96}Zr	$8.468 \cdot 10^{-15}$		^{184}Os	$1.116 \cdot 10^{-18}$	
^{91}Nb	$2.004 \cdot 10^{6}$		^{186}Os	$5.503 \cdot 10^{-9}$	
^{92}Nb	$1.586 \cdot 10^{3}$				
^{93m}Nb	$3.640 \cdot 10^{8}$				
^{94}Nb	$1.237 \cdot 10^{7}$				
^{92}Mo	$1.070 \cdot 10^{-2}$				
^{93}Mo	$2.242 \cdot 10^{8}$				
^{98}Mo	$3.306 \cdot 10^{4}$				
^{100}Mo	$1.807 \cdot 10^{-1}$				

9.1.4 Cell 1 - 100 years after shut-down

Table 19: Activity in steam separator cell 1 - 100 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$4.585 \cdot 10^{5}$		^{110}Pd	$3.167 \cdot 10^{-19}$	
^{10}Be	$4.511 \cdot 10^{1}$		^{108}Cd	$1.383 \cdot 10^{-14}$	
^{14}C	$1.720 \cdot 10^{9}$		^{113}Cd	$8.432 \cdot 10^{-12}$	
^{26}Al	$2.554 \cdot 10^{-1}$		^{114}Cd	$5.488 \cdot 10^{-13}$	
^{32}Si	$1.326 \cdot 10^{0}$		^{116}Cd	$2.115 \cdot 10^{-16}$	
^{32}P	$1.326 \cdot 10^{0}$	1.245	^{115}In	$1.301 \cdot 10^{-10}$	
^{36}Cl	$5.780 \cdot 10^{5}$		^{121}Sn	$1.783 \cdot 10^{4}$	
^{39}Ar	$2.222 \cdot 10^{0}$		^{121m}Sn	$2.298 \cdot 10^{4}$	
^{40}K	$3.540 \cdot 10^{-14}$		^{124}Sn	$2.564 \cdot 10^{-2}$	
^{48}Ca	$8.790 \cdot 10^{-20}$		^{126}Sn	$9.416 \cdot 10^{-6}$	
^{50}V	$1.885 \cdot 10^{-4}$		^{125}Sb	$7.472 \cdot 10^{4}$	
^{50}Cr	$4.148 \cdot 10^{1}$		^{123}Te	$4.797 \cdot 10^{-12}$	
^{53}Mn	$4.011 \cdot 10^{3}$		^{125m}Te	$1.830 \cdot 10^{-4}$	
^{55}Fe	$1.360 \cdot 10^{2}$	7.986	^{176}Lu	$1.737 \cdot 10^{-10}$	
^{60}Fe	$1.392 \cdot 10^{0}$		^{179n}Hf	$1.239 \cdot 10^{-2}$	
^{60}Co	$2.870 \cdot 10^{6}$	0.000	^{182}Hf	$1.498 \cdot 10^{-5}$	
^{60m}Co	$1.392 \cdot 10^{0}$		^{180m}Ta	$1.917 \cdot 10^{-3}$	
^{58}Ni	$1.045 \cdot 10^{-1}$		^{183}W	$3.720 \cdot 10^{-2}$	
^{59}Ni	$1.589 \cdot 10^{10}$		^{184}W	$2.190 \cdot 10^{-2}$	
^{63}Ni	$8.815 \cdot 10^{11}$	0.01089	^{186}W	$1.378 \cdot 10^{-2}$	
^{64}Zn	$1.553 \cdot 10^{-6}$		^{186}Re	$1.207 \cdot 10^{-1}$	
^{76}Ge	$1.584 \cdot 10^{-21}$		^{186m}Re	$1.207 \cdot 10^{-1}$	
^{79}Se	$8.846 \cdot 10^{-9}$		^{187}Re	$2.656 \cdot 10^{1}$	
^{90}Sr	$3.180 \cdot 10^{-5}$		^{184}Os	$1.116 \cdot 10^{-18}$	
^{93}Zr	$1.936 \cdot 10^{2}$		^{186}Os	$5.503 \cdot 10^{-9}$	
^{94}Zr	$1.162 \cdot 10^{-9}$				
^{96}Zr	$8.468 \cdot 10^{-15}$				
^{91}Nb	$1.866 \cdot 10^{6}$				
^{92}Nb	$1.586 \cdot 10^{3}$				
^{93m}Nb	$1.970 \cdot 10^{8}$				
^{94}Nb	$1.234 \cdot 10^{7}$				
^{92}Mo	$1.070 \cdot 10^{-2}$				
^{93}Mo	$2.206 \cdot 10^{8}$				
^{98}Mo	$3.306 \cdot 10^{4}$				
^{100}Mo	$1.807 \cdot 10^{-1}$				
^{97}Tc	$1.350 \cdot 10^{-6}$				
^{98}Tc	$1.125 \cdot 10^{-3}$				
^{99}Tc	$1.011 \cdot 10^{7}$				

9.1.5 Cell 1 - 1000 years after shut-down

Table 20: Activity in steam separator cell 1 - 1000 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{10}Be	$4.509 \cdot 10^{1}$		^{110}Pd	$3.167 \cdot 10^{-19}$	
^{14}C	$1.542 \cdot 10^{9}$		^{108}Cd	$1.383 \cdot 10^{-14}$	
^{26}Al	$2.552 \cdot 10^{-1}$		^{113}Cd	$8.432 \cdot 10^{-12}$	
^{32}Si	$2.002 \cdot 10^{-1}$		^{114}Cd	$5.488 \cdot 10^{-13}$	
^{32}P	$2.002 \cdot 10^{-1}$	1.245	^{116}Cd	$2.115 \cdot 10^{-16}$	
^{36}Cl	$5.768 \cdot 10^{5}$		^{115}In	$1.301 \cdot 10^{-10}$	
^{39}Ar	$2.186 \cdot 10^{-1}$		^{121}Sn	$1.203 \cdot 10^{-2}$	
^{48}Ca	$8.790 \cdot 10^{-20}$		^{121m}Sn	$1.550 \cdot 10^{-2}$	
^{50}V	$1.885 \cdot 10^{-4}$		^{124}Sn	$2.564 \cdot 10^{-2}$	
^{50}Cr	$4.148 \cdot 10^{1}$		^{126}Sn	$9.390 \cdot 10^{-6}$	
^{53}Mn	$4.011 \cdot 10^{3}$		^{123}Te	$4.797 \cdot 10^{-12}$	
^{60}Fe	$1.392 \cdot 10^{0}$		^{176}Lu	$1.737 \cdot 10^{-10}$	
^{60}Co	$1.386 \cdot 10^{0}$	0.000	^{179n}Hf	$1.239 \cdot 10^{-2}$	
^{60m}Co	$1.392 \cdot 10^{0}$		^{182}Hf	$1.546 \cdot 10^{-5}$	
^{58}Ni	$1.045 \cdot 10^{-1}$		^{180m}Ta	$1.917 \cdot 10^{-3}$	
^{59}Ni	$1.576 \cdot 10^{10}$		^{183}W	$3.720 \cdot 10^{-2}$	
^{63}Ni	$1.586 \cdot 10^{9}$	0.01089	^{184}W	$2.190 \cdot 10^{-2}$	
^{64}Zn	$1.553 \cdot 10^{-6}$		^{186}W	$1.378 \cdot 10^{-2}$	
^{76}Ge	$1.584 \cdot 10^{-21}$		^{186}Re	$1.203 \cdot 10^{-1}$	
^{79}Se	$8.831 \cdot 10^{-9}$		^{186m}Re	$1.203 \cdot 10^{-1}$	
^{93}Zr	$1.935 \cdot 10^{2}$		^{187}Re	$2.656 \cdot 10^{1}$	
^{94}Zr	$1.162 \cdot 10^{-9}$		^{184}Os	$1.116 \cdot 10^{-18}$	
^{96}Zr	$8.468 \cdot 10^{-15}$		^{186}Os	$5.503 \cdot 10^{-9}$	
^{91}Nb	$7.456 \cdot 10^{5}$				
^{92}Nb	$1.586 \cdot 10^{3}$				
^{93m}Nb	$1.532 \cdot 10^{8}$				
^{94}Nb	$1.196 \cdot 10^{7}$				
^{92}Mo	$1.070 \cdot 10^{-2}$				
^{93}Mo	$1.793 \cdot 10^{8}$				
^{98}Mo	$3.306 \cdot 10^{4}$				
^{100}Mo	$1.807 \cdot 10^{-1}$				
^{97}Tc	$1.349 \cdot 10^{-6}$				
^{98}Tc	$1.125 \cdot 10^{-3}$				
^{99}Tc	$1.008 \cdot 10^{7}$				

9.1.6 Cell 2 - 3 days after shut-down

Table 21: Activity in steam separator cell 2 - 3 days after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$1.436 \cdot 10^{7}$		^{63}Ni	$1.194 \cdot 10^{11}$	0.01849
^{10}Be	$5.143 \cdot 10^{0}$		^{65}Ni	$4.138 \cdot 10^{1}$	0.000
^{14}C	$1.185 \cdot 10^{8}$		^{64}Cu	$5.703 \cdot 10^{8}$	1.573
^{26}Al	$2.913 \cdot 10^{-2}$		^{67}Cu	$2.173 \cdot 10^{-2}$	
^{31}Si	$2.970 \cdot 10^{0}$		^{64}Zn	$1.045 \cdot 10^{-7}$	
^{32}Si	$1.165 \cdot 10^{-1}$		^{65}Zn	$1.089 \cdot 10^{3}$	
^{32}P	$7.292 \cdot 10^{8}$	1.245	^{72}Ga	$4.580 \cdot 10^{2}$	
^{33}P	$1.557 \cdot 10^{6}$		^{76}Ge	$5.013 \cdot 10^{-24}$	
^{35}S	$3.559 \cdot 10^{7}$		^{73}As	$3.023 \cdot 10^{1}$	
^{36}Cl	$3.880 \cdot 10^{4}$		^{74}As	$2.703 \cdot 10^{5}$	
^{37}Ar	$1.367 \cdot 10^{-2}$		^{76}As	$5.095 \cdot 10^{8}$	0.3795
^{39}Ar	$7.853 \cdot 10^{-3}$		^{77}As	$3.326 \cdot 10^{-1}$	
^{45}Ca	$5.146 \cdot 10^{4}$		^{75}Se	$7.670 \cdot 10^{-1}$	
^{47}Ca	$5.025 \cdot 10^{2}$		^{89}Sr	$1.521 \cdot 10^{-2}$	
^{48}Ca	$1.002 \cdot 10^{-20}$		^{90}Sr	$2.516 \cdot 10^{-6}$	
^{44m}Sc	$4.177 \cdot 10^{-2}$		^{88}Y	$2.504 \cdot 10^{3}$	
^{46}Sc	$1.354 \cdot 10^{6}$		^{89m}Y	$1.512 \cdot 10^{6}$	
^{47}Sc	$1.097 \cdot 10^{6}$		^{90}Y	$2.980 \cdot 10^{4}$	
^{48}Sc	$1.090 \cdot 10^{5}$		^{91}Y	$1.666 \cdot 10^{-1}$	
^{48}V	$7.349 \cdot 10^{2}$		^{88}Zr	$2.572 \cdot 10^{3}$	
^{49}V	$7.891 \cdot 10^{6}$		^{89}Zr	$1.514 \cdot 10^{6}$	
^{50}V	$3.355 \cdot 10^{-4}$		^{93}Zr	$2.207 \cdot 10^{1}$	
^{48}Cr	$5.452 \cdot 10^{-2}$		^{94}Zr	$1.325 \cdot 10^{-10}$	
^{50}Cr	$7.543 \cdot 10^{1}$		^{95}Zr	$3.898 \cdot 10^{5}$	
^{51}Cr	$1.188 \cdot 10^{12}$	0.01885	^{96}Zr	$9.654 \cdot 10^{-16}$	
^{52}Mn	$6.759 \cdot 10^{2}$		^{97}Zr	$1.100 \cdot 10^{3}$	
^{53}Mn	$4.574 \cdot 10^{2}$		^{90}Nb	$1.726 \cdot 10^{0}$	
^{54}Mn	$3.224 \cdot 10^{10}$	2.314	^{91}Nb	$2.356 \cdot 10^{5}$	
^{56}Mn	$7.296 \cdot 10^{3}$	1.157	^{91m}Nb	$2.431 \cdot 10^{2}$	
^{55}Fe	$8.309 \cdot 10^{11}$	7.945	^{92}Nb	$1.808 \cdot 10^{2}$	
^{59}Fe	$2.464 \cdot 10^{10}$	5.289	^{92m}Nb	$2.823 \cdot 10^{5}$	
^{60}Fe	$9.213 \cdot 10^{-3}$		^{93m}Nb	$9.038 \cdot 10^{7}$	
^{56}Co	$9.773 \cdot 10^{4}$		^{94}Nb	$8.539 \cdot 10^{5}$	
^{57}Co	$1.971 \cdot 10^{8}$		^{95}Nb	$1.986 \cdot 10^{6}$	
^{58}Co	$1.028 \cdot 10^{11}$	2.580	^{95m}Nb	$4.315 \cdot 10^{3}$	
^{58m}Co	$1.414 \cdot 10^{8}$	3.412	^{96}Nb	$7.129 \cdot 10^{4}$	
^{60}Co	$9.919 \cdot 10^{10}$	0.06409	^{97}Nb	$1.186 \cdot 10^{3}$	
^{57}Ni	$1.013 \cdot 10^{6}$		^{97m}Nb	$1.047 \cdot 10^{3}$	
^{58}Ni	$1.900 \cdot 10^{-1}$		^{92}Mo	$1.945 \cdot 10^{-2}$	
^{59}Ni	$1.069 \cdot 10^{9}$		^{93}Mo	$1.844 \cdot 10^{7}$	

Table 22: Activity in steam separator cell 2 - 3 days after shut-down (continued)

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{98}Mo	$6.011 \cdot 10^{4}$		^{121}Te	$1.736 \cdot 10^{-2}$	
^{99}Mo	$3.430 \cdot 10^{9}$	0.000	^{121m}Te	$8.804 \cdot 10^{-3}$	
^{100}Mo	$3.286 \cdot 10^{-1}$		^{123}Te	$1.215 \cdot 10^{-14}$	
^{97}Tc	$6.226 \cdot 10^{-9}$		^{123m}Te	$1.003 \cdot 10^{1}$	
^{97m}Tc	$1.430 \cdot 10^{-4}$		^{125m}Te	$9.536 \cdot 10^{5}$	
^{98}Tc	$5.186 \cdot 10^{-6}$		^{176}Lu	$2.009 \cdot 10^{-11}$	
^{99}Tc	$7.436 \cdot 10^{5}$		^{177}Lu	$2.405 \cdot 10^{1}$	
^{99m}Tc	$3.313 \cdot 10^{9}$	0.000	^{177m}Lu	$2.002 \cdot 10^{-2}$	
^{103}Ru	$2.342 \cdot 10^{-4}$		^{175}Hf	$1.404 \cdot 10^{-4}$	
^{110}Pd	$1.331 \cdot 10^{-21}$		^{179n}Hf	$2.254 \cdot 10^{-2}$	
^{109m}Ag	$1.959 \cdot 10^{3}$		^{181}Hf	$7.277 \cdot 10^{2}$	
^{108}Cd	$1.577 \cdot 10^{-15}$		^{182}Hf	$1.725 \cdot 10^{-6}$	
^{109}Cd	$1.959 \cdot 10^{3}$		^{178}Ta	$1.858 \cdot 10^{0}$	
^{113}Cd	$1.052 \cdot 10^{-12}$		^{179}Ta	$6.833 \cdot 10^{3}$	
^{114}Cd	$5.418 \cdot 10^{-14}$		^{180}Ta	$6.609 \cdot 10^{3}$	
^{115}Cd	$3.305 \cdot 10^{1}$		^{180m}Ta	$3.520 \cdot 10^{-3}$	
^{116}Cd	$2.411 \cdot 10^{-17}$		^{182}Ta	$7.009 \cdot 10^{9}$	0.000
^{111}In	$8.153 \cdot 10^{2}$		^{183}Ta	$2.707 \cdot 10^{5}$	
^{113m}In	$5.317 \cdot 10^{6}$		^{184}Ta	$3.073 \cdot 10^{-1}$	
^{115}In	$1.484 \cdot 10^{-11}$		^{178}W	$1.857 \cdot 10^{0}$	
^{115m}In	$3.608 \cdot 10^{1}$		^{181}W	$5.389 \cdot 10^{7}$	
^{113}Sn	$5.313 \cdot 10^{6}$		^{183}W	$6.764 \cdot 10^{-2}$	
^{117m}Sn	$2.356 \cdot 10^{0}$		^{183m}W	$9.204 \cdot 10^{3}$	
^{119m}Sn	$1.609 \cdot 10^{2}$		^{184}W	$3.983 \cdot 10^{-2}$	
^{121}Sn	$4.609 \cdot 10^{6}$		^{185}W	$1.713 \cdot 10^{8}$	
^{121m}Sn	$1.270 \cdot 10^{4}$		^{186}W	$2.505 \cdot 10^{-2}$	
^{123}Sn	$1.060 \cdot 10^{6}$		^{187}W	$4.424 \cdot 10^{8}$	5.579
^{124}Sn	$4.662 \cdot 10^{-2}$		^{183}Re	$4.813 \cdot 10^{-4}$	
^{125}Sn	$2.245 \cdot 10^{5}$		^{184}Re	$1.436 \cdot 10^{-1}$	
^{126}Sn	$2.667 \cdot 10^{-8}$		^{184m}Re	$2.263 \cdot 10^{-2}$	
^{119}Sb	$4.481 \cdot 10^{0}$		^{186}Re	$1.607 \cdot 10^{3}$	
^{122}Sb	$8.550 \cdot 10^{7}$		^{186m}Re	$3.184 \cdot 10^{-4}$	
^{124}Sb	$9.090 \cdot 10^{7}$	0.000	^{187}Re	$1.782 \cdot 10^{0}$	
^{125}Sb	$4.146 \cdot 10^{6}$		^{188}Re	$1.895 \cdot 10^{3}$	
^{126}Sb	$1.061 \cdot 10^{-1}$		^{186}Os	$1.391 \cdot 10^{-11}$	

9.1.7 Cell 2 - 1 year after shut-down

Table 23: Activity in steam separator cell 2 - 1 year after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$1.358 \cdot 10^{7}$		^{88}Y	$6.601 \cdot 10^{2}$	
^{10}Be	$5.143 \cdot 10^{0}$		^{91}Y	$2.287 \cdot 10^{-3}$	
^{14}C	$1.185 \cdot 10^{8}$		^{88}Zr	$1.269 \cdot 10^{2}$	
^{26}Al	$2.913 \cdot 10^{-2}$		^{93}Zr	$2.207 \cdot 10^{1}$	
^{32}Si	$1.163 \cdot 10^{-1}$		^{94}Zr	$1.325 \cdot 10^{-10}$	
^{32}P	$1.699 \cdot 10^{1}$		^{95}Zr	$7.744 \cdot 10^{3}$	
^{33}P	$7.927 \cdot 10^{1}$		^{96}Zr	$9.654 \cdot 10^{-16}$	
^{35}S	$2.006 \cdot 10^{6}$		^{91}Nb	$2.354 \cdot 10^{5}$	
^{36}Cl	$3.880 \cdot 10^{4}$		^{91m}Nb	$3.948 \cdot 10^{0}$	
^{39}Ar	$7.833 \cdot 10^{-3}$		^{92}Nb	$1.808 \cdot 10^{2}$	
^{45}Ca	$1.100 \cdot 10^{4}$		^{93m}Nb	$8.726 \cdot 10^{7}$	
^{48}Ca	$1.002 \cdot 10^{-20}$		^{94}Nb	$8.538 \cdot 10^{5}$	
^{46}Sc	$6.779 \cdot 10^{5}$		^{95}Nb	$1.795 \cdot 10^{4}$	
^{49}V	$6.689 \cdot 10^{6}$		^{95m}Nb	$7.866 \cdot 10^{1}$	
^{50}V	$3.355 \cdot 10^{-4}$		^{92}Mo	$1.945 \cdot 10^{-2}$	
^{50}Cr	$7.543 \cdot 10^{1}$		^{93}Mo	$1.844 \cdot 10^{7}$	
^{51}Cr	$1.384 \cdot 10^{8}$	0.01885	^{98}Mo	$6.011 \cdot 10^{4}$	
^{53}Mn	$4.574 \cdot 10^{3}$		^{100}Mo	$3.286 \cdot 10^{-1}$	
^{54}Mn	$1.443 \cdot 10^{10}$	2.314	^{97}Tc	$6.239 \cdot 10^{-9}$	
^{55}Fe	$6.471 \cdot 10^{12}$	7.945	^{98}Tc	$5.186 \cdot 10^{-6}$	
^{59}Fe	$8.758 \cdot 10^{7}$	5.2989	^{99}Tc	$7.437 \cdot 10^{5}$	
^{60}Fe	$9.213 \cdot 10^{-3}$		^{110}Pd	$1.331 \cdot 10^{-21}$	
^{56}Co	$3.794 \cdot 10^{3}$		^{109m}Ag	$1.138 \cdot 10^{3}$	
^{57}Co	$7.830 \cdot 10^{7}$		^{108}Cd	$1.577 \cdot 10^{-15}$	
^{58}Co	$2.978 \cdot 10^{9}$	2.580	^{109}Cd	$1.138 \cdot 10^{3}$	
^{60}Co	$8.707 \cdot 10^{10}$	0.06409	^{113}Cd	$1.052 \cdot 10^{-12}$	
^{58}Ni	$1.900 \cdot 10^{-1}$		^{114}Cd	$5.418 \cdot 10^{-14}$	
^{59}Ni	$1.069 \cdot 10^{9}$		^{116}Cd	$2.411 \cdot 10^{-17}$	
^{63}Ni	$1.186 \cdot 10^{11}$	0.01849	^{113m}In	$6.009 \cdot 10^{5}$	
^{64}Zn	$1.045 \cdot 10^{-7}$		^{115}In	$1.484 \cdot 10^{-11}$	
^{65}Zn	$3.893 \cdot 10^{2}$		^{113}Sn	$6.005 \cdot 10^{5}$	
^{76}Ge	$5.013 \cdot 10^{-24}$		^{119m}Sn	$6.832 \cdot 10^{1}$	
^{73}As	$1.328 \cdot 10^{0}$		^{121}Sn	$9.705 \cdot 10^{3}$	
^{74}As	$2.010 \cdot 10^{-1}$		^{121m}Sn	$1.251 \cdot 10^{4}$	
^{75}Se	$9.442 \cdot 10^{-2}$		^{123}Sn	$1.521 \cdot 10^{5}$	
^{90}Sr	$2.457 \cdot 10^{-6}$		^{124}Sn	$4.662 \cdot 10^{-2}$	

Table 24: Activity in steam separator cell 2 - 1 year after shut-down (continued)

Radionuclides	Activity [Bq]	Uncertainty (cross-section only) [%]
^{126}Sn	$2.667 \cdot 10^{-8}$	
^{124}Sb	$1.408 \cdot 10^{6}$	0.000
^{125}Sb	$3.234 \cdot 10^{6}$	
^{121}Te	$1.749 \cdot 10^{-3}$	
^{121m}Te	$1.726 \cdot 10^{-3}$	
^{123}Te	$1.218 \cdot 10^{-14}$	
^{123m}Te	$1.229 \cdot 10^{0}$	
^{125m}Te	$7.912 \cdot 10^{5}$	
^{176}Lu	$2.009 \cdot 10^{-11}$	
^{177}Lu	$4.184 \cdot 10^{-3}$	
^{177m}Lu	$3.981 \cdot 10^{-2}$	
^{179n}Hf	$2.252 \cdot 10^{-2}$	
^{181}Hf	$1.953 \cdot 10^{0}$	
^{182}Hf	$1.726 \cdot 10^{-6}$	
^{179}Ta	$4.459 \cdot 10^{3}$	
^{180m}Ta	$3.520 \cdot 10^{-3}$	
^{182}Ta	$7.863 \cdot 10^{8}$	0.000
^{181}W	$6.773 \cdot 10^{6}$	
^{183}W	$6.764 \cdot 10^{-2}$	
^{184}W	$3.983 \cdot 10^{-2}$	
^{185}W	$6.065 \cdot 10^{6}$	
^{186}W	$2.505 \cdot 10^{-2}$	
^{184}Re	$4.918 \cdot 10^{-3}$	
^{184m}Re	$5.081 \cdot 10^{-3}$	
^{186m}Re	$3.184 \cdot 10^{-4}$	
^{187}Re	$1.782 \cdot 10^{0}$	
^{186}Os	$1.392 \cdot 10^{-11}$	

9.1.8 Cell 2 - 30 years after shut-down

Table 25: Activity in steam separator cell 2 - 30 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$2.660 \cdot 10^{6}$		^{110}Pd	$1.331 \cdot 10^{-21}$	
^{10}Be	$5.143 \cdot 10^{0}$		^{108}Cd	$1.577 \cdot 10^{-15}$	
^{14}C	$1.180 \cdot 10^{8}$		^{109}Cd	$1.423 \cdot 10^{-4}$	
^{26}Al	$2.913 \cdot 10^{-2}$		^{113}Cd	$1.052 \cdot 10^{-12}$	
^{32}Si	$1.094 \cdot 10^{-1}$		^{114}Cd	$5.418 \cdot 10^{-14}$	
^{32}P	$1.094 \cdot 10^{-1}$		^{116}Cd	$2.411 \cdot 10^{-17}$	
^{36}Cl	$3.880 \cdot 10^{4}$		^{115}In	$1.484 \cdot 10^{-11}$	
^{39}Ar	$7.269 \cdot 10^{-3}$		^{121}Sn	$6.139 \cdot 10^{3}$	
^{48}Ca	$1.002 \cdot 10^{-20}$		^{121m}Sn	$7.911 \cdot 10^{3}$	
^{49}V	$8.036 \cdot 10^{-4}$		^{124}Sn	$4.662 \cdot 10^{-2}$	
^{50}V	$3.355 \cdot 10^{-4}$		^{126}Sn	$2.666 \cdot 10^{-8}$	
^{50}Cr	$7.543 \cdot 10^{1}$		^{125}Sb	$2.213 \cdot 10^{3}$	
^{53}Mn	$4.574 \cdot 10^{2}$		^{123}Te	$1.219 \cdot 10^{-14}$	
^{54}Mn	$8.840 \cdot 10^{-1}$	2.314	^{125m}Te	$5.420 \cdot 10^{2}$	
^{55}Fe	$4.294 \cdot 10^{8}$	7.945	^{176}Lu	$2.009 \cdot 10^{-11}$	
^{60}Fe	$9.214 \cdot 10^{-3}$		^{179n}Hf	$2.252 \cdot 10^{-2}$	
^{57}Co	$1.460 \cdot 10^{-3}$		^{182}Hf	$1.754 \cdot 10^{-6}$	
^{60}Co	$1.922 \cdot 10^{9}$	0.06409	^{179}Ta	$1.685 \cdot 10^{-2}$	
^{58}Ni	$1.900 \cdot 10^{-1}$		^{180m}Ta	$3.520 \cdot 10^{-3}$	
^{59}Ni	$1.069 \cdot 10^{9}$		^{183}W	$6.764 \cdot 10^{-2}$	
^{63}Ni	$9.676 \cdot 10^{10}$	0.01849	^{184}W	$3.983 \cdot 10^{-2}$	
^{64}Zn	$1.045 \cdot 10^{-7}$		^{186}W	$2.505 \cdot 10^{-2}$	
^{76}Ge	$5.013 \cdot 10^{-24}$		^{186m}Re	$3.184 \cdot 10^{-4}$	
^{90}Sr	$1.223 \cdot 10^{-6}$		^{187}Re	$1.782 \cdot 10^{0}$	
^{93}Zr	$2.207 \cdot 10^{1}$		^{186}Os	$1.392 \cdot 10^{-11}$	
^{94}Zr	$1.325 \cdot 10^{-10}$				
^{96}Zr	$9.654 \cdot 10^{-16}$				
^{91}Nb	$2.285 \cdot 10^{5}$				
^{92}Nb	$1.808 \cdot 10^{2}$				
^{93m}Nb	$3.620 \cdot 10^{7}$				
^{94}Nb	$8.530 \cdot 10^{5}$				
^{92}Mo	$1.945 \cdot 10^{-2}$				
^{93}Mo	$1.831 \cdot 10^{7}$				
^{98}Mo	$6.011 \cdot 10^{4}$				
^{100}Mo	$3.286 \cdot 10^{-1}$				
^{97}Tc	$6.239 \cdot 10^{-9}$				
^{98}Tc	$5.186 \cdot 10^{-6}$				
^{99}Tc	$7.436 \cdot 10^{5}$				

9.1.9 Cell 2 - 100 years after shut-down

Table 26: Activity in steam separator cell 2 - 100 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$5.198 \cdot 10^{4}$		^{110}Pd	$1.331 \cdot 10^{-21}$	
^{10}Be	$5.143 \cdot 10^{0}$		^{108}Cd	$1.577 \cdot 10^{-15}$	
^{14}C	$1.170 \cdot 10^{8}$		^{113}Cd	$1.052 \cdot 10^{-12}$	
^{26}Al	$2.912 \cdot 10^{-2}$		^{114}Cd	$5.418 \cdot 10^{-14}$	
^{32}Si	$9.445 \cdot 10^{-2}$		^{116}Cd	$2.411 \cdot 10^{-17}$	
^{32}P	$9.446 \cdot 10^{-2}$		^{115}In	$1.484 \cdot 10^{-11}$	
^{36}Cl	$3.879 \cdot 10^{4}$		^{121}Sn	$2.033 \cdot 10^{3}$	
^{39}Ar	$6.069 \cdot 10^{-3}$		^{121m}Sn	$2.620 \cdot 10^{3}$	
^{48}Ca	$1.002 \cdot 10^{-20}$		^{124}Sn	$4.662 \cdot 10^{-2}$	
^{50}V	$3.355 \cdot 10^{-4}$		^{126}Sn	$2.666 \cdot 10^{-8}$	
^{50}Cr	$7.543 \cdot 10^{1}$		^{125}Sb	$5.094 \cdot 10^{-5}$	
^{53}Mn	$4.574 \cdot 10^{2}$		^{123}Te	$1.219 \cdot 10^{-14}$	
^{55}Fe	$9.181 \cdot 10^{0}$	7.945	^{176}Lu	$2.009 \cdot 10^{-11}$	
^{60}Fe	$9.213 \cdot 10^{-3}$		^{179n}Hf	$2.252 \cdot 10^{-2}$	
^{60}Co	$1.932 \cdot 10^{5}$	0.06409	^{182}Hf	$1.823 \cdot 10^{-6}$	
^{58}Ni	$1.900 \cdot 10^{-1}$		^{180m}Ta	$3.520 \cdot 10^{-3}$	
^{59}Ni	$1.068 \cdot 10^{9}$		^{183}W	$6.764 \cdot 10^{-2}$	
^{63}Ni	$5.918 \cdot 10^{10}$	0.01849	^{184}W	$3.983 \cdot 10^{-2}$	
^{64}Zn	$1.045 \cdot 10^{-7}$		^{186}W	$2.505 \cdot 10^{-2}$	
^{76}Ge	$5.013 \cdot 10^{-24}$		^{186m}Re	$3.183 \cdot 10^{-4}$	
^{93}Zr	$2.207 \cdot 10^{1}$		^{187}Re	$1.782 \cdot 10^{0}$	
^{94}Zr	$1.325 \cdot 10^{-10}$		^{186}Os	$1.392 \cdot 10^{-11}$	
^{96}Zr	$9.654 \cdot 10^{-16}$				
^{91}Nb	$2.128 \cdot 10^{5}$				
^{92}Nb	$1.808 \cdot 10^{2}$				
^{93m}Nb	$1.641 \cdot 10^{7}$				
^{94}Nb	$8.509 \cdot 10^{5}$				
^{92}Mo	$1.945 \cdot 10^{-2}$				
^{93}Mo	$1.802 \cdot 10^{7}$				
^{98}Mo	$6.011 \cdot 10^{4}$				
^{100}Mo	$3.286 \cdot 10^{-1}$				
^{97}Tc	$6.239 \cdot 10^{-9}$				
^{98}Tc	$5.186 \cdot 10^{-6}$				
^{99}Tc	$7.434 \cdot 10^{5}$				

9.1.10 Cell 2 - 1000 years after shut-down

Table 27: Activity in steam separator cell 2 - 1000 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{10}Be	$5.141 \cdot 10^{0}$		^{110}Pd	$1.331 \cdot 10^{-21}$	
^{14}C	$1.049 \cdot 10^{8}$		^{108}Cd	$1.577 \cdot 10^{-15}$	
^{26}Al	$2.910 \cdot 10^{-2}$		^{113}Cd	$1.052 \cdot 10^{-12}$	
^{32}Si	$1.426 \cdot 10^{-2}$		^{114}Cd	$5.418 \cdot 10^{-14}$	
^{32}P	$1.426 \cdot 10^{-2}$		^{116}Cd	$2.411 \cdot 10^{-17}$	
^{36}Cl	$3.871 \cdot 10^{4}$		^{115}In	$1.484 \cdot 10^{-11}$	
^{39}Ar	$5.970 \cdot 10^{-4}$		^{121m}Sn	$1.769 \cdot 10^{-3}$	
^{48}Ca	$1.002 \cdot 10^{-20}$		^{124}Sn	$4.662 \cdot 10^{-2}$	
^{50}V	$3.355 \cdot 10^{-4}$		^{126}Sn	$2.659 \cdot 10^{-8}$	
^{50}Cr	$7.543 \cdot 10^{1}$		^{123}Te	$1.219 \cdot 10^{-14}$	
^{53}Mn	$4.573 \cdot 10^{2}$		^{176}Lu	$2.009 \cdot 10^{-11}$	
^{60}Fe	$9.209 \cdot 10^{-3}$		^{179n}Hf	$2.252 \cdot 10^{-2}$	
^{60}Co	$9.187 \cdot 10^{-3}$	0.06409	^{182}Hf	$2.700 \cdot 10^{-6}$	
^{58}Ni	$1.900 \cdot 10^{-1}$		^{180m}Ta	$3.520 \cdot 10^{-3}$	
^{59}Ni	$1.060 \cdot 10^{9}$		^{183}W	$6.764 \cdot 10^{-2}$	
^{63}Ni	$1.065 \cdot 10^{8}$	0.01849	^{184}W	$3.983 \cdot 10^{-2}$	
^{64}Zn	$1.045 \cdot 10^{-7}$		^{186}W	$2.505 \cdot 10^{-2}$	
^{76}Ge	$5.013 \cdot 10^{-24}$		^{186m}Re	$3.172 \cdot 10^{-4}$	
^{93}Zr	$2.206 \cdot 10^{1}$		^{187}Re	$1.782 \cdot 10^{0}$	
^{94}Zr	$1.325 \cdot 10^{-10}$		^{186}Os	$1.392 \cdot 10^{-11}$	
^{96}Zr	$9.654 \cdot 10^{-16}$				
^{91}Nb	$8.501 \cdot 10^{4}$				
^{92}Nb	$1.808 \cdot 10^{2}$				
^{93m}Nb	$1.252 \cdot 10^{7}$				
^{94}Nb	$8.248 \cdot 10^{5}$				
^{92}Mo	$1.945 \cdot 10^{-2}$				
^{93}Mo	$1.465 \cdot 10^{7}$				
^{98}Mo	$6.011 \cdot 10^{4}$				
^{100}Mo	$3.286 \cdot 10^{-1}$				
^{97}Tc	$6.238 \cdot 10^{-9}$				
^{98}Tc	$5.185 \cdot 10^{-6}$				
^{99}Tc	$7.413 \cdot 10^{5}$				

9.1.11 Cell 3 - 3 days after shut down

Table 28: Activity in steam separator cell 3 - 3 days after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$8.094 \cdot 10^{5}$		^{63}Ni	$4.816 \cdot 10^{9}$	0.02586
^{10}Be	$2.900 \cdot 10^{-1}$		^{65}Ni	$1.673 \cdot 10^{0}$	0.000
^{14}C	$4.838 \cdot 10^{6}$		^{64}Cu	$2.306 \cdot 10^{7}$	1.569
^{26}Al	$1.642 \cdot 10^{-3}$		^{64}Zn	$4.225 \cdot 10^{-9}$	
^{31}Si	$1.319 \cdot 10^{-1}$		^{65}Zn	$1.032 \cdot 10^{0}$	
^{32}Si	$6.462 \cdot 10^{-3}$		^{72}Ga	$2.583 \cdot 10^{1}$	
^{32}P	$3.248 \cdot 10^{7}$	1.245	^{73}As	$1.705 \cdot 10^{0}$	
^{33}P	$8.718 \cdot 10^{4}$		^{74}As	$1.524 \cdot 10^{4}$	
^{35}S	$1.462 \cdot 10^{6}$		^{76}As	$2.098 \cdot 10^{7}$	0.5192
^{36}Cl	$1.564 \cdot 10^{3}$		^{75}Se	$1.010 \cdot 10^{-3}$	
^{37}Ar	$5.516 \cdot 10^{0}$		^{89}Sr	$8.457 \cdot 10^{-4}$	
^{39}Ar	$4.815 \cdot 10^{-5}$		^{88}Y	$1.412 \cdot 10^{2}$	
^{40}K	$4.606 \cdot 10^{-10}$		^{89m}Y	$8.526 \cdot 10^{4}$	
^{45}Ca	$2.902 \cdot 10^{3}$		^{90}Y	$1.662 \cdot 10^{3}$	
^{47}Ca	$2.834 \cdot 10^{1}$		^{91}Y	$8.875 \cdot 10^{-3}$	
^{48}Ca	$5.650 \cdot 10^{-22}$		^{88}Zr	$1.450 \cdot 10^{2}$	
^{46}Sc	$7.638 \cdot 10^{4}$		^{89}Zr	$8.536 \cdot 10^{4}$	
^{47}Sc	$6.188 \cdot 10^{4}$		^{93}Zr	$1.244 \cdot 10^{0}$	
^{48}Sc	$6.145 \cdot 10^{3}$		^{94}Zr	$7.471 \cdot 10^{-12}$	
^{48}V	$4.144 \cdot 10^{1}$		^{95}Zr	$2.198 \cdot 10^{4}$	
^{49}V	$4.450 \cdot 10^{5}$		^{96}Zr	$5.444 \cdot 10^{-17}$	
^{50}V	$5.843 \cdot 10^{-4}$		^{97}Zr	$6.204 \cdot 10^{1}$	
^{50}Cr	$1.315 \cdot 10^{2}$		^{90}Nb	$9.732 \cdot 10^{-2}$	
^{51}Cr	$4.789 \cdot 10^{10}$	0.02448	^{91}Nb	$1.329 \cdot 10^{4}$	
^{52}Mn	$3.812 \cdot 10^{1}$		^{91m}Nb	$1.369 \cdot 10^{1}$	
^{53}Mn	$2.579 \cdot 10^{1}$		^{92}Nb	$1.019 \cdot 10^{1}$	
^{54}Mn	$1.818 \cdot 10^{9}$	2.314	^{92m}Nb	$1.592 \cdot 10^{4}$	
^{56}Mn	$2.951 \cdot 10^{2}$	1.160	^{93m}Nb	$5.031 \cdot 10^{6}$	
^{55}Fe	$3.366 \cdot 10^{10}$	7.905	^{94}Nb	$3.561 \cdot 10^{4}$	
^{59}Fe	$9.953 \cdot 10^{8}$	5.278	^{95}Nb	$1.119 \cdot 10^{5}$	
^{60}Fe	$3.316 \cdot 10^{-4}$		^{95m}Nb	$2.433 \cdot 10^{2}$	
^{56}Co	$5.511 \cdot 10^{3}$		^{96}Nb	$4.020 \cdot 10^{3}$	
^{57}Co	$1.112 \cdot 10^{7}$		^{97}Nb	$6.690 \cdot 10^{1}$	
^{58}Co	$5.797 \cdot 10^{9}$	2.589	^{97m}Nb	$5.902 \cdot 10^{1}$	
^{58m}Co	$7.976 \cdot 10^{6}$	3.412	^{92}Mo	$3.392 \cdot 10^{-2}$	
^{60}Co	$4.017 \cdot 10^{9}$	0.08925	^{93}Mo	$8.795 \cdot 10^{5}$	
^{57}Ni	$5.712 \cdot 10^{4}$		^{98}Mo	$1.048 \cdot 10^{5}$	
^{58}Ni	$3.314 \cdot 10^{-1}$		^{99}Mo	$1.555 \cdot 10^{8}$	0.000
^{59}Ni	$4.317 \cdot 10^{7}$		^{100}Mo	$5.730 \cdot 10^{-1}$	

Table 29: Activity in steam separator cell 3 - 3 days after shut-down (continued)

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{97}Tc	$1.019 \cdot 10^{-11}$		^{123}Te	$1.212 \cdot 10^{-17}$	
^{98}Tc	$7.603 \cdot 10^{-9}$		^{123m}Te	$1.030 \cdot 10^{-2}$	
^{99}Tc	$3.371 \cdot 10^{4}$		^{125m}Te	$4.107 \cdot 10^{4}$	
^{99m}Tc	$1.502 \cdot 10^{8}$	0.000	^{176}Lu	$1.133 \cdot 10^{-12}$	
^{109m}Ag	$1.104 \cdot 10^{2}$		^{177}Lu	$1.156 \cdot 10^{0}$	
^{108}Cd	$8.894 \cdot 10^{-17}$		^{177m}Lu	$1.122 \cdot 10^{-3}$	
^{109}Cd	$1.104 \cdot 10^{2}$		^{179n}Hf	$3.927 \cdot 10^{-2}$	
^{113}Cd	$5.952 \cdot 10^{-14}$		^{181}Hf	$4.080 \cdot 10^{1}$	
^{114}Cd	$3.033 \cdot 10^{-15}$		^{182}Hf	$1.547 \cdot 10^{-7}$	
^{115}Cd	$1.864 \cdot 10^{0}$		^{179}Ta	$3.853 \cdot 10^{2}$	
^{116}Cd	$1.360 \cdot 10^{-18}$		^{180}Ta	$3.595 \cdot 10^{2}$	
^{111}In	$4.597 \cdot 10^{1}$		^{180m}Ta	$6.140 \cdot 10^{-3}$	
^{113m}In	$2.360 \cdot 10^{5}$		^{182}Ta	$2.901 \cdot 10^{8}$	0.000
^{115}In	$8.367 \cdot 10^{-13}$		^{183}Ta	$2.661 \cdot 10^{2}$	
^{115m}In	$2.035 \cdot 10^{0}$		^{178}W	$1.047 \cdot 10^{-1}$	
^{113}Sn	$2.359 \cdot 10^{5}$		^{181}W	$2.186 \cdot 10^{6}$	
^{117m}Sn	$1.329 \cdot 10^{-1}$		^{183}W	$1.179 \cdot 10^{-1}$	
^{119m}Sn	$9.072 \cdot 10^{0}$		^{184}W	$6.944 \cdot 10^{-2}$	
^{121}Sn	$2.014 \cdot 10^{5}$		^{185}W	$7.100 \cdot 10^{6}$	
^{121m}Sn	$7.163 \cdot 10^{2}$		^{186}W	$4.368 \cdot 10^{-2}$	
^{123}Sn	$4.697 \cdot 10^{4}$		^{187}W	$1.799 \cdot 10^{7}$	5.549
^{124}Sn	$8.129 \cdot 10^{-2}$		^{186}Re	$1.561 \cdot 10^{0}$	
^{125}Sn	$1.049 \cdot 10^{4}$		^{186m}Re	$3.207 \cdot 10^{-7}$	
^{119}Sb	$2.527 \cdot 10^{-1}$		^{187}Re	$7.248 \cdot 10^{-2}$	
^{122}Sb	$3.556 \cdot 10^{6}$		^{188}Re	$1.790 \cdot 10^{0}$	
^{124}Sb	$3.782 \cdot 10^{6}$	0.000	^{186}Os	$1.377 \cdot 10^{-14}$	
^{125}Sb	$1.786 \cdot 10^{5}$				

9.1.12 Cell 3 - 1 year after shut-down

Table 30: Activity in steam separator cell 3 - 1 year after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$7.656 \cdot 10^{5}$		^{96}Zr	$5.444 \cdot 10^{-17}$	
^{10}Be	$2.900 \cdot 10^{-1}$		^{91}Nb	$1.327 \cdot 10^{4}$	
^{14}C	$4.837 \cdot 10^{6}$		^{91m}Nb	$2.224 \cdot 10^{-1}$	
^{26}Al	$1.642 \cdot 10^{-3}$		^{92}Nb	$1.019 \cdot 10^{1}$	
^{32}Si	$6.449 \cdot 10^{-3}$		^{93m}Nb	$4.852 \cdot 10^{6}$	
^{32}P	$7.600 \cdot 10^{-1}$	1.245	^{94}Nb	$3.560 \cdot 10^{4}$	
^{33}P	$4.439 \cdot 10^{0}$		^{95}Nb	$1.012 \cdot 10^{3}$	
^{35}S	$8.242 \cdot 10^{4}$		^{95m}Nb	$4.999 \cdot 10^{0}$	
^{36}Cl	$1.564 \cdot 10^{3}$		^{92}Mo	$3.392 \cdot 10^{-2}$	
^{39}Ar	$4.803 \cdot 10^{-5}$		^{93}Mo	$8.793 \cdot 10^{5}$	
^{40}K	$4.606 \cdot 10^{-10}$		^{98}Mo	$1.048 \cdot 10^{5}$	
^{45}Ca	$6.204 \cdot 10^{3}$		^{100}Mo	$5.730 \cdot 10^{-1}$	
^{48}Ca	$5.650 \cdot 10^{-22}$		^{97}Tc	$1.021 \cdot 10^{-11}$	
^{46}Sc	$3.823 \cdot 10^{3}$		^{98}Tc	$7.603 \cdot 10^{-9}$	
^{49}V	$2.080 \cdot 10^{5}$		^{99}Tc	$3.371 \cdot 10^{4}$	
^{50}V	$5.843 \cdot 10^{-4}$		^{109m}Ag	$6.414 \cdot 10^{1}$	
^{50}Cr	$1.315 \cdot 10^{2}$		^{108}Cd	$8.894 \cdot 10^{-17}$	
^{51}Cr	$5.582 \cdot 10^{6}$	0.02448	^{109}Cd	$6.414 \cdot 10^{1}$	
^{53}Mn	$2.579 \cdot 10^{1}$		^{113}Cd	$5.952 \cdot 10^{-14}$	
^{54}Mn	$8.138 \cdot 10^{8}$	2.314	^{114}Cd	$3.033 \cdot 10^{-15}$	
^{55}Fe	$2.621 \cdot 10^{10}$	7.905	^{116}Cd	$1.360 \cdot 10^{-18}$	
^{59}Fe	$3.538 \cdot 10^{6}$	5.278	^{113m}In	$2.667 \cdot 10^{4}$	
^{60}Fe	$3.316 \cdot 10^{-4}$		^{115}In	$8.367 \cdot 10^{-13}$	
^{56}Co	$2.140 \cdot 10^{2}$		^{113}Sn	$2.666 \cdot 10^{4}$	
^{57}Co	$4.416 \cdot 10^{6}$		^{119m}Sn	$3.853 \cdot 10^{0}$	
^{58}Co	$1.679 \cdot 10^{8}$	2.589	^{121}Sn	$5.473 \cdot 10^{2}$	
^{60}Co	$3.526 \cdot 10^{9}$	0.08925	^{121m}Sn	$7.052 \cdot 10^{2}$	
^{58}Ni	$3.314 \cdot 10^{-1}$		^{123}Sn	$6.735 \cdot 10^{3}$	
^{59}Ni	$4.317 \cdot 10^{7}$		^{124}Sn	$8.129 \cdot 10^{-2}$	
^{63}Ni	$4.783 \cdot 10^{9}$	0.02586	^{124}Sb	$5.859 \cdot 10^{4}$	0.000
^{64}Zn	$4.225 \cdot 10^{-9}$		^{125}Sb	$1.393 \cdot 10^{5}$	
^{65}Zn	$3.692 \cdot 10^{-1}$		^{123}Te	$1.215 \cdot 10^{-17}$	
^{73}As	$7.491 \cdot 10^{-2}$		^{123m}Te	$1.261 \cdot 10^{-3}$	
^{74}As	$1.134 \cdot 10^{-2}$		^{125m}Te	$3.408 \cdot 10^{4}$	
^{75}Se	$1.243 \cdot 10^{-4}$		^{176}Lu	$1.133 \cdot 10^{-12}$	
^{88}Y	$3.722 \cdot 10^{1}$		^{177m}Lu	$2.345 \cdot 10^{-4}$	
^{88}Zr	$7.158 \cdot 10^{0}$		^{179n}Hf	$3.927 \cdot 10^{-2}$	
^{93}Zr	$1.244 \cdot 10^{0}$		^{181}Hf	$1.095 \cdot 10^{-1}$	
^{94}Zr	$7.471 \cdot 10^{-12}$		^{182}Hf	$1.563 \cdot 10^{-7}$	
^{95}Zr	$4.367 \cdot 10^{2}$		^{179}Ta	$2.515 \cdot 10^{2}$	

Table 31: Activity in steam separator cell 3 - 1 year after shut-down (continued)

Radionuclides	Activity [Bq]	Uncertainty (cross-section only) [%]
^{180m}Ta	$6.140 \cdot 10^{-3}$	
^{182}Ta	$3.254 \cdot 10^{7}$	0.000
^{181}W	$2.747 \cdot 10^{5}$	
^{183}W	$1.179 \cdot 10^{-1}$	
^{184}W	$6.944 \cdot 10^{-2}$	
^{185}W	$2.513 \cdot 10^{5}$	
^{186}W	$4.368 \cdot 10^{-2}$	
^{186m}Re	$3.207 \cdot 10^{-7}$	
^{187}Re	$7.248 \cdot 10^{-2}$	
^{186}Os	$1.379 \cdot 10^{-14}$	

9.1.13 Cell 3 - 30 years after shut-down

Table 32: Activity in steam separator cell 3 - 30 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$1.500 \cdot 10^{5}$		^{108}Cd	$8.894 \cdot 10^{-17}$	
^{10}Be	$2.900 \cdot 10^{-1}$		^{113}Cd	$5.952 \cdot 10^{-14}$	
^{14}C	$4.820 \cdot 10^{6}$		^{114}Cd	$3.033 \cdot 10^{-15}$	
^{26}Al	$1.642 \cdot 10^{-3}$		^{116}Cd	$1.360 \cdot 10^{-18}$	
^{32}Si	$6.068 \cdot 10^{-3}$		^{115}In	$8.367 \cdot 10^{-13}$	
^{32}P	$6.068 \cdot 10^{-3}$		^{121}Sn	$3.462 \cdot 10^{2}$	
^{36}Cl	$1.564 \cdot 10^{3}$		^{121m}Sn	$4.461 \cdot 10^{2}$	
^{39}Ar	$4.457 \cdot 10^{-5}$		^{124}Sn	$8.129 \cdot 10^{-2}$	
^{40}K	$4.606 \cdot 10^{-10}$		^{125}Sb	$9.532 \cdot 10^{1}$	
^{48}Ca	$5.650 \cdot 10^{-22}$		^{123}Te	$1.216 \cdot 10^{-17}$	
^{49}V	$4.538 \cdot 10^{-5}$		^{125m}Te	$2.334 \cdot 10^{1}$	
^{50}V	$5.843 \cdot 10^{-4}$		^{176}Lu	$1.133 \cdot 10^{-12}$	
^{50}Cr	$1.315 \cdot 10^{2}$		^{176}Lu	$1.133 \cdot 10^{-12}$	
^{53}Mn	$2.579 \cdot 10^{1}$		^{179n}Hf	$3.927 \cdot 10^{-2}$	
^{54}Mn	$4.995 \cdot 10^{-2}$	2.314	^{182}Hf	$2.057 \cdot 10^{-7}$	
^{55}Fe	$1.740 \cdot 10^{7}$	7.905	^{179}Ta	$9.051 \cdot 10^{-4}$	
^{60}Fe	$3.316 \cdot 10^{-4}$		^{180m}Ta	$6.140 \cdot 10^{-3}$	
^{60}Co	$7.781 \cdot 10^{7}$	0.08925	^{183}W	$1.179 \cdot 10^{-1}$	
^{58}Ni	$3.314 \cdot 10^{-1}$		^{184}W	$6.944 \cdot 10^{-2}$	
^{59}Ni	$4.316 \cdot 10^{7}$		^{186}W	$4.368 \cdot 10^{-2}$	
^{63}Ni	$3.901 \cdot 10^{9}$	0.02586	^{186m}Re	$3.207 \cdot 10^{-7}$	
^{64}Zn	$4.225 \cdot 10^{-9}$		^{187}Re	$7.248 \cdot 10^{-2}$	
^{93}Zr	$1.244 \cdot 10^{0}$		^{186}Os	$1.401 \cdot 10^{-14}$	
^{94}Zr	$7.471 \cdot 10^{-12}$				
^{96}Zr	$5.444 \cdot 10^{-17}$				
^{91}Nb	$1.289 \cdot 10^{4}$				
^{92}Nb	$1.019 \cdot 10^{1}$				
^{93m}Nb	$1.925 \cdot 10^{6}$				
^{94}Nb	$3.557 \cdot 10^{4}$				
^{92}Mo	$3.392 \cdot 10^{-2}$				
^{93}Mo	$8.735 \cdot 10^{5}$				
^{98}Mo	$1.048 \cdot 10^{5}$				
^{100}Mo	$5.730 \cdot 10^{-1}$				
^{97}Tc	$1.021 \cdot 10^{-11}$				
^{98}Tc	$7.603 \cdot 10^{-9}$				
^{99}Tc	$3.371 \cdot 10^{4}$				

9.1.14 Cell 3 - 100 years after shut-down

Table 33: Activity in steam separator cell 3 - 100 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$2.931 \cdot 10^{3}$		^{108}Cd	$8.894 \cdot 10^{-17}$	
^{10}Be	$2.900 \cdot 10^{-1}$		^{113}Cd	$5.952 \cdot 10^{-14}$	
^{14}C	$4.780 \cdot 10^{6}$		^{114}Cd	$3.033 \cdot 10^{-15}$	
^{26}Al	$1.642 \cdot 10^{-3}$		^{116}Cd	$1.360 \cdot 10^{-18}$	
^{32}Si	$5.238 \cdot 10^{-3}$		^{115}In	$8.367 \cdot 10^{-13}$	
^{32}P	$5.238 \cdot 10^{-3}$		^{121}Sn	$1.146 \cdot 10^{2}$	
^{36}Cl	$1.563 \cdot 10^{3}$		^{121m}Sn	$1.477 \cdot 10^{2}$	
^{39}Ar	$3.721 \cdot 10^{-5}$		^{124}Sn	$8.129 \cdot 10^{-2}$	
^{40}K	$4.606 \cdot 10^{-10}$		^{123}Te	$1.216 \cdot 10^{-17}$	
^{48}Ca	$5.650 \cdot 10^{-22}$		^{176}Lu	$1.133 \cdot 10^{-12}$	
^{50}V	$5.843 \cdot 10^{-4}$		^{179n}Hf	$3.927 \cdot 10^{-2}$	
^{50}Cr	$1.315 \cdot 10^{2}$		^{182}Hf	$3.248 \cdot 10^{-7}$	
^{53}Mn	$2.579 \cdot 10^{1}$		^{180m}Ta	$6.140 \cdot 10^{-3}$	
^{55}Fe	$3.720 \cdot 10^{1}$	7.905	^{183}W	$1.179 \cdot 10^{-1}$	
^{60}Fe	$3.316 \cdot 10^{-4}$		^{184}W	$6.944 \cdot 10^{-2}$	
^{60}Co	$7.822 \cdot 10^{3}$	0.08925	^{186}W	$4.368 \cdot 10^{-2}$	
^{58}Ni	$3.314 \cdot 10^{-1}$		^{186m}Re	$3.206 \cdot 10^{-7}$	
^{59}Ni	$4.313 \cdot 10^{7}$		^{187}Re	$7.248 \cdot 10^{-2}$	
^{63}Ni	$2.386 \cdot 10^{9}$	0.02586	^{186}Os	$1.454 \cdot 10^{-14}$	
^{64}Zn	$4.225 \cdot 10^{-9}$				
^{93}Zr	$1.244 \cdot 10^{0}$				
^{94}Zr	$7.471 \cdot 10^{-12}$				
^{96}Zr	$5.444 \cdot 10^{-17}$				
^{91}Nb	$1.200 \cdot 10^{4}$				
^{92}Nb	$1.019 \cdot 10^{1}$				
^{93m}Nb	$7.926 \cdot 10^{5}$				
^{94}Nb	$3.548 \cdot 10^{4}$				
^{92}Mo	$3.392 \cdot 10^{-2}$				
^{93}Mo	$8.595 \cdot 10^{5}$				
^{98}Mo	$1.048 \cdot 10^{5}$				
^{100}Mo	$5.730 \cdot 10^{-1}$				
^{97}Tc	$1.021 \cdot 10^{-11}$				
^{98}Tc	$7.603 \cdot 10^{-9}$				
^{99}Tc	$3.370 \cdot 10^{4}$				

9.1.15 Cell 3 - 1000 years after shut-down

Table 34: Activity in steam separator cell 3 - 1000 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{10}Be	$2.899 \cdot 10^{-1}$		^{108}Cd	$8.894 \cdot 10^{-17}$	
^{14}C	$4.284 \cdot 10^{6}$		^{113}Cd	$5.952 \cdot 10^{-14}$	
^{26}Al	$1.641 \cdot 10^{-3}$		^{114}Cd	$3.033 \cdot 10^{-15}$	
^{32}Si	$7.910 \cdot 10^{-4}$		^{116}Cd	$1.360 \cdot 10^{-18}$	
^{32}P	$7.911 \cdot 10^{-4}$		^{115}In	$8.367 \cdot 10^{-13}$	
^{36}Cl	$1.560 \cdot 10^{3}$		^{121m}Sn	$1.011 \cdot 10^{-4}$	
^{39}Ar	$3.661 \cdot 10^{-6}$		^{124}Sn	$8.129 \cdot 10^{-2}$	
^{40}K	$4.606 \cdot 10^{-10}$		^{123}Te	$1.216 \cdot 10^{-17}$	
^{48}Ca	$5.650 \cdot 10^{-22}$		^{176}Lu	$1.133 \cdot 10^{-12}$	
^{50}V	$5.843 \cdot 10^{-4}$		^{179n}Hf	$3.927 \cdot 10^{-2}$	
^{50}Cr	$1.315 \cdot 10^{2}$		^{182}Hf	$1.856 \cdot 10^{-6}$	
^{53}Mn	$2.579 \cdot 10^{1}$		^{180m}Ta	$6.140 \cdot 10^{-3}$	
^{60}Fe	$3.315 \cdot 10^{-4}$		^{183}W	$1.179 \cdot 10^{-1}$	
^{60}Co	$3.307 \cdot 10^{-4}$	0.08925	^{184}W	$6.944 \cdot 10^{-2}$	
^{58}Ni	$3.314 \cdot 10^{-1}$		^{186}W	$4.368 \cdot 10^{-2}$	
^{59}Ni	$4.278 \cdot 10^{7}$		^{186m}Re	$3.195 \cdot 10^{-7}$	
^{63}Ni	$4.293 \cdot 10^{6}$	0.02586	^{187}Re	$7.248 \cdot 10^{-2}$	
^{64}Zn	$4.225 \cdot 10^{-9}$		^{186}Os	$2.135 \cdot 10^{-14}$	
^{93}Zr	$1.244 \cdot 10^{0}$				
^{94}Zr	$7.471 \cdot 10^{-12}$				
^{96}Zr	$5.444 \cdot 10^{-17}$				
^{91}Nb	$4.794 \cdot 10^{3}$				
^{92}Nb	$1.019 \cdot 10^{1}$				
^{93m}Nb	$5.971 \cdot 10^{5}$				
^{94}Nb	$3.439 \cdot 10^{4}$				
^{92}Mo	$3.392 \cdot 10^{-2}$				
^{93}Mo	$6.987 \cdot 10^{5}$				
^{98}Mo	$1.048 \cdot 10^{5}$				
^{100}Mo	$5.730 \cdot 10^{-1}$				
^{97}Tc	$1.021 \cdot 10^{-11}$				
^{98}Tc	$7.602 \cdot 10^{-9}$				
^{99}Tc	$3.360 \cdot 10^{4}$				

9.1.16 Cell 4 - 3 days after shut-down

Table 35: Activity in steam separator cell 4 - 3 days after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$3.059 \cdot 10^{5}$		^{63}Ni	$1.311 \cdot 10^{9}$	0.03589
^{10}Be	$1.096 \cdot 10^{-1}$		^{65}Ni	$4.579 \cdot 10^{-1}$	0.000
^{14}C	$1.340 \cdot 10^{6}$		^{64}Cu	$6.299 \cdot 10^{6}$	1.564
^{26}Al	$6.207 \cdot 10^{-4}$		^{64}Zn	$1.154 \cdot 10^{-9}$	
^{32}Si	$2.441 \cdot 10^{-3}$		^{65}Zn	$7.817 \cdot 10^{-2}$	
^{32}P	$9.987 \cdot 10^{6}$	1.245	^{72}Ga	$9.761 \cdot 10^{0}$	
^{33}P	$3.279 \cdot 10^{4}$		^{73}As	$6.442 \cdot 10^{-1}$	
^{35}S	$4.083 \cdot 10^{5}$		^{74}As	$5.761 \cdot 10^{3}$	
^{36}Cl	$4.256 \cdot 10^{2}$		^{76}As	$5.803 \cdot 10^{6}$	0.7066
^{39}Ar	$1.618 \cdot 10^{-5}$		^{75}Se	$1.045 \cdot 10^{-4}$	
^{40}K	$1.741 \cdot 10^{-10}$		^{89}Sr	$3.195 \cdot 10^{-4}$	
^{45}Ca	$1.097 \cdot 10^{3}$		^{88}Y	$5.337 \cdot 10^{1}$	
^{47}Ca	$1.071 \cdot 10^{1}$		^{89m}Y	$3.222 \cdot 10^{4}$	
^{48}Ca	$2.135 \cdot 10^{-22}$		^{90}Y	$6.230 \cdot 10^{2}$	
^{46}Sc	$2.886 \cdot 10^{4}$		^{91}Y	$3.351 \cdot 10^{-3}$	
^{47}Sc	$2.339 \cdot 10^{4}$		^{88}Zr	$5.481 \cdot 10^{1}$	
^{48}Sc	$2.322 \cdot 10^{3}$		^{89}Zr	$3.226 \cdot 10^{4}$	
^{48}V	$1.567 \cdot 10^{1}$		^{93}Zr	$4.703 \cdot 10^{-1}$	
^{49}V	$1.682 \cdot 10^{5}$		^{94}Zr	$2.823 \cdot 10^{-12}$	
^{50}V	$5.843 \cdot 10^{-4}$		^{95}Zr	$8.306 \cdot 10^{3}$	
^{50}Cr	$1.315 \cdot 10^{2}$		^{96}Zr	$2.057 \cdot 10^{-17}$	
^{51}Cr	$1.304 \cdot 10^{10}$	0.03259	^{97}Zr	$2.345 \cdot 10^{1}$	
^{52}Mn	$1.441 \cdot 10^{1}$		^{90}Nb	$3.678 \cdot 10^{-2}$	
^{53}Mn	$9.748 \cdot 10^{0}$		^{91}Nb	$5.021 \cdot 10^{3}$	
^{54}Mn	$6.870 \cdot 10^{8}$	2.314	^{91m}Nb	$5.175 \cdot 10^{0}$	
^{56}Mn	$8.076 \cdot 10^{1}$	1.159	^{92}Nb	$3.853 \cdot 10^{0}$	
^{55}Fe	$9.223 \cdot 10^{9}$	7.852	^{92m}Nb	$6.016 \cdot 10^{3}$	
^{59}Fe	$2.716 \cdot 10^{8}$	5.265	^{93m}Nb	$1.883 \cdot 10^{6}$	
^{60}Fe	$1.244 \cdot 10^{-4}$		^{94}Nb	$1.006 \cdot 10^{4}$	
^{56}Co	$2.083 \cdot 10^{3}$		^{95}Nb	$4.229 \cdot 10^{4}$	
^{57}Co	$4.201 \cdot 10^{6}$		^{95m}Nb	$9.195 \cdot 10^{1}$	
^{58}Co	$2.191 \cdot 10^{9}$	2.605	^{96}Nb	$1.519 \cdot 10^{3}$	
^{58m}Co	$3.014 \cdot 10^{6}$	3.412	^{97}Nb	$2.528 \cdot 10^{1}$	
^{60}Co	$1.098 \cdot 10^{9}$	0.1233	^{97m}Nb	$2.231 \cdot 10^{1}$	
^{57}Ni	$2.159 \cdot 10^{4}$		^{92}Mo	$3.392 \cdot 10^{-2}$	
^{58}Ni	$3.314 \cdot 10^{-1}$		^{93}Mo	$2.881 \cdot 10^{5}$	
^{59}Ni	$1.178 \cdot 10^{7}$		^{98}Mo	$1.048 \cdot 10^{5}$	

Table 36: Activity in steam separator cell 4 - 3 days after shut-down (continued)

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{99}Mo	$4.737 \cdot 10^{7}$	0.000	^{123}Te	$9.455 \cdot 10^{-19}$	
^{100}Mo	$5.730 \cdot 10^{-1}$		^{123m}Te	$8.333 \cdot 10^{-4}$	
^{98}Tc	$8.757 \cdot 10^{-10}$		^{125m}Te	$1.166 \cdot 10^{4}$	
^{99}Tc	$1.027 \cdot 10^{4}$		^{125m}Te	$1.166 \cdot 10^{4}$	
^{99m}Tc	$4.576 \cdot 10^{7}$	0.000	^{176}Lu	$4.283 \cdot 10^{-13}$	
^{109m}Ag	$4.171 \cdot 10^{1}$		^{177}Lu	$3.836 \cdot 10^{-1}$	
^{108}Cd	$3.361 \cdot 10^{-17}$		^{177m}Lu	$4.133 \cdot 10^{-4}$	
^{109}Cd	$4.171 \cdot 10^{1}$		^{179n}Hf	$3.927 \cdot 10^{-2}$	
^{113}Cd	$2.249 \cdot 10^{-14}$		^{181}Hf	$1.542 \cdot 10^{1}$	
^{114}Cd	$1.145 \cdot 10^{-15}$		^{182}Hf	$9.535 \cdot 10^{-8}$	
^{115}Cd	$7.044 \cdot 10^{-1}$		^{179}Ta	$1.456 \cdot 10^{2}$	
^{116}Cd	$5.138 \cdot 10^{-19}$		^{180}Ta	$1.321 \cdot 10^{2}$	
^{111}In	$1.737 \cdot 10^{1}$		^{180m}Ta	$6.140 \cdot 10^{-3}$	
^{113m}In	$7.083 \cdot 10^{4}$		^{182}Ta	$7.997 \cdot 10^{7}$	0.000
^{115}In	$3.162 \cdot 10^{-13}$		^{183}Ta	$2.217 \cdot 10^{1}$	
^{115m}In	$7.689 \cdot 10^{-1}$		^{178}W	$3.958 \cdot 10^{-2}$	
^{113}Sn	$7.079 \cdot 10^{4}$		^{181}W	$5.982 \cdot 10^{5}$	
^{117m}Sn	$5.022 \cdot 10^{-2}$		^{183}W	$1.179 \cdot 10^{-1}$	
^{119m}Sn	$3.428 \cdot 10^{0}$		^{184}W	$6.944 \cdot 10^{-2}$	
^{121}Sn	$6.030 \cdot 10^{4}$		^{185}W	$1.989 \cdot 10^{6}$	
^{121m}Sn	$2.707 \cdot 10^{2}$		^{186}W	$4.368 \cdot 10^{-2}$	
^{123}Sn	$1.431 \cdot 10^{4}$		^{187}W	$4.916 \cdot 10^{6}$	5.535
^{124}Sn	$8.129 \cdot 10^{-2}$		^{186}Re	$1.199 \cdot 10^{-1}$	
^{125}Sn	$3.306 \cdot 10^{3}$		^{186m}Re	$2.581 \cdot 10^{-8}$	
^{119}Sb	$9.549 \cdot 10^{-2}$		^{187}Re	$1.980 \cdot 10^{-2}$	
^{122}Sb	$9.883 \cdot 10^{5}$		^{188}Re	$1.336 \cdot 10^{-1}$	
^{124}Sb	$1.052 \cdot 10^{6}$	0.000	^{186}Os	$1.302 \cdot 10^{-15}$	
^{125}Sb	$5.069 \cdot 10^{4}$				

9.1.17 Cell 4 - 1 year after shut-down

Table 37: Activity in steam separator cell 4 - 1 year after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$2.893 \cdot 10^{5}$		^{88}Zr	$2.705 \cdot 10^{1}$	
^{10}Be	$1.096 \cdot 10^{-1}$		^{93}Zr	$4.703 \cdot 10^{-1}$	
^{14}C	$1.340 \cdot 10^{6}$		^{94}Zr	$2.823 \cdot 10^{-12}$	
^{26}Al	$6.207 \cdot 10^{-4}$		^{95}Zr	$1.650 \cdot 10^{2}$	
^{32}Si	$2.436 \cdot 10^{-3}$		^{96}Zr	$2.057 \cdot 10^{-17}$	
^{32}P	$2.348 \cdot 10^{-1}$	1.245	^{91}Nb	$5.016 \cdot 10^{3}$	
^{33}P	$1.670 \cdot 10^{0}$		^{91m}Nb	$8.404 \cdot 10^{-2}$	
^{35}S	$2.302 \cdot 10^{4}$		^{92}Nb	$3.853 \cdot 10^{0}$	
^{36}Cl	$4.256 \cdot 10^{2}$		^{93m}Nb	$1.815 \cdot 10^{6}$	
^{39}Ar	$1.614 \cdot 10^{-5}$		^{94}Nb	$1.006 \cdot 10^{4}$	
^{40}K	$1.741 \cdot 10^{-10}$		^{95}Nb	$3.824 \cdot 10^{2}$	
^{45}Ca	$2.345 \cdot 10^{2}$		^{95m}Nb	$1.889 \cdot 10^{0}$	
^{48}Ca	$2.135 \cdot 10^{-22}$		^{92}Mo	$3.392 \cdot 10^{-2}$	
^{46}Sc	$1.445 \cdot 10^{3}$		^{93}Mo	$2.880 \cdot 10^{5}$	
^{49}V	$7.862 \cdot 10^{4}$		^{98}Mo	$1.048 \cdot 10^{5}$	
^{50}V	$5.843 \cdot 10^{-4}$		^{100}Mo	$5.730 \cdot 10^{-1}$	
^{50}Cr	$1.315 \cdot 10^{2}$		^{98}Tc	$8.757 \cdot 10^{-10}$	
^{51}Cr	$1.520 \cdot 10^{6}$	0.03259	^{99}Tc	$1.027 \cdot 10^{4}$	
^{53}Mn	$9.748 \cdot 10^{0}$		^{109m}Ag	$2.423 \cdot 10^{1}$	
^{54}Mn	$3.075 \cdot 10^{8}$	2.314	^{108}Cd	$3.361 \cdot 10^{-17}$	
^{55}Fe	$7.183 \cdot 10^{9}$	7.852	^{109}Cd	$2.423 \cdot 10^{1}$	
^{59}Fe	$9.656 \cdot 10^{5}$	5.265	^{113}Cd	$2.249 \cdot 10^{-14}$	
^{60}Fe	$1.244 \cdot 10^{-4}$		^{114}Cd	$1.145 \cdot 10^{-15}$	
^{56}Co	$8.086 \cdot 10^{1}$		^{116}Cd	$5.138 \cdot 10^{-19}$	
^{57}Co	$1.669 \cdot 10^{6}$		^{113m}In	$8.005 \cdot 10^{3}$	
^{58}Co	$6.347 \cdot 10^{7}$	2.605	^{115}In	$3.162 \cdot 10^{-13}$	
^{60}Co	$9.642 \cdot 10^{8}$	0.1233	^{113}Sn	$8.000 \cdot 10^{3}$	
^{58}Ni	$3.314 \cdot 10^{-1}$		^{119m}Sn	$1.456 \cdot 10^{0}$	
^{59}Ni	$1.178 \cdot 10^{7}$		^{121}Sn	$3.838 \cdot 10^{2}$	
^{63}Ni	$1.302 \cdot 10^{9}$	0.03589	^{121m}Sn	$1.515 \cdot 10^{2}$	
^{64}Zn	$1.154 \cdot 10^{-9}$		^{123}Sn	$2.053 \cdot 10^{3}$	
^{65}Zn	$2.795 \cdot 10^{-2}$		^{124}Sn	$8.129 \cdot 10^{-2}$	
^{73}As	$2.831 \cdot 10^{-2}$		^{124}Sb	$1.630 \cdot 10^{4}$	0.000
^{74}As	$4.288 \cdot 10^{-3}$		^{125}Sb	$3.954 \cdot 10^{4}$	
^{88}Y	$1.407 \cdot 10^{1}$		^{123}Te	$9.481 \cdot 10^{-19}$	

Table 38: Activity in steam separator cell 4 - 1 year after shut-down (continued)

Radionuclides	Activity [Bq]	Uncertainty (cross-section only) [%]
^{123m}Te	$1.021 \cdot 10^{-4}$	
^{125m}Te	$9.674 \cdot 10^{3}$	
^{176}Lu	$4.283 \cdot 10^{-13}$	
^{177m}Lu	$8.640 \cdot 10^{-5}$	
^{179n}Hf	$3.927 \cdot 10^{-2}$	
^{181}Hf	$4.137 \cdot 10^{-2}$	
^{182}Hf	$9.704 \cdot 10^{-8}$	
^{179}Ta	$9.504 \cdot 10^{1}$	
^{180m}Ta	$6.140 \cdot 10^{-3}$	
^{182}Ta	$8.971 \cdot 10^{6}$	0.000
^{181}W	$7.518 \cdot 10^{4}$	
^{183}W	$1.179 \cdot 10^{-1}$	
^{184}W	$6.944 \cdot 10^{-2}$	
^{185}W	$7.041 \cdot 10^{4}$	
^{186}W	$4.368 \cdot 10^{-2}$	
^{186m}Re	$2.581 \cdot 10^{-8}$	
^{187}Re	$1.980 \cdot 10^{-2}$	
^{186}Os	$1.310 \cdot 10^{-15}$	

9.1.18 Cell 4 - 30 years after shut-down

Table 39: Activity in steam separator cell 4 - 30 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$5.667 \cdot 10^{4}$		^{92}Mo	$3.392 \cdot 10^{-2}$	
^{10}Be	$1.096 \cdot 10^{-1}$		^{93}Mo	$2.861 \cdot 10^{5}$	
^{14}C	$1.335 \cdot 10^{6}$		^{98}Mo	$1.048 \cdot 10^{5}$	
^{26}Al	$6.207 \cdot 10^{-4}$		^{100}Mo	$5.730 \cdot 10^{-1}$	
^{32}Si	$2.292 \cdot 10^{-3}$		^{98}Tc	$8.757 \cdot 10^{-10}$	
^{32}P	$2.293 \cdot 10^{-3}$	1.245	^{99}Tc	$1.027 \cdot 10^{4}$	
^{36}Cl	$4.256 \cdot 10^{2}$		^{108}Cd	$3.361 \cdot 10^{-17}$	
^{39}Ar	$1.498 \cdot 10^{-5}$		^{113}Cd	$2.249 \cdot 10^{-14}$	
^{40}K	$1.741 \cdot 10^{-10}$		^{114}Cd	$1.145 \cdot 10^{-15}$	
^{48}Ca	$2.135 \cdot 10^{-22}$		^{116}Cd	$5.138 \cdot 10^{-19}$	
^{50}V	$5.843 \cdot 10^{-4}$		^{115}In	$3.162 \cdot 10^{-13}$	
^{50}Cr	$1.315 \cdot 10^{2}$		^{121}Sn	$1.308 \cdot 10^{2}$	
^{53}Mn	$9.748 \cdot 10^{0}$		^{121m}Sn	$1.686 \cdot 10^{2}$	
^{54}Mn	$1.892 \cdot 10^{-2}$	2.314	^{124}Sn	$8.129 \cdot 10^{-2}$	
^{55}Fe	$4.767 \cdot 10^{6}$	7.852	^{125}Sb	$2.706 \cdot 10^{4}$	
^{60}Fe	$1.244 \cdot 10^{-4}$		^{123}Te	$9.484 \cdot 10^{-19}$	
^{60}Co	$2.128 \cdot 10^{7}$	0.1233	^{125m}Te	$6.627 \cdot 10^{0}$	
^{58}Ni	$3.314 \cdot 10^{-1}$		^{176}Lu	$4.283 \cdot 10^{-13}$	
^{59}Ni	$1.177 \cdot 10^{7}$		^{179n}Hf	$3.927 \cdot 10^{-2}$	
^{63}Ni	$1.062 \cdot 10^{9}$	0.03589	^{182}Hf	$1.464 \cdot 10^{-7}$	
^{64}Zn	$1.154 \cdot 10^{-9}$		^{179}Ta	$3.591 \cdot 10^{-4}$	
^{93}Zr	$4.703 \cdot 10^{-1}$		^{180m}Ta	$6.140 \cdot 10^{-3}$	
^{94}Zr	$2.823 \cdot 10^{-12}$		^{183}W	$1.179 \cdot 10^{-1}$	
^{96}Zr	$2.057 \cdot 10^{-17}$		^{184}W	$6.944 \cdot 10^{-2}$	
^{91}Nb	$4.870 \cdot 10^{3}$		^{186}W	$4.368 \cdot 10^{-2}$	
^{92}Nb	$3.853 \cdot 10^{0}$		^{186m}Re	$2.580 \cdot 10^{-8}$	
^{93m}Nb	$6.953 \cdot 10^{5}$		^{187}Re	$1.980 \cdot 10^{-2}$	
^{94}Nb	$1.005 \cdot 10^{4}$		^{186}Os	$1.529 \cdot 10^{-15}$	

9.1.19 Cell 4 - 100 years after shut-down

Table 40: Activity in steam separator cell 4 - 100 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$1.108 \cdot 10^{3}$		^{92}Mo	$3.392 \cdot 10^{-2}$	
^{10}Be	$1.096 \cdot 10^{-1}$		^{93}Mo	$2.815 \cdot 10^{5}$	
^{14}C	$1.324 \cdot 10^{6}$		^{98}Mo	$1.048 \cdot 10^{5}$	
^{26}Al	$6.207 \cdot 10^{-4}$		^{100}Mo	$5.730 \cdot 10^{-1}$	
^{32}Si	$1.979 \cdot 10^{-3}$		^{98}Tc	$8.756 \cdot 10^{-10}$	
^{32}P	$1.979 \cdot 10^{-3}$	1.245	^{99}Tc	$1.027 \cdot 10^{4}$	
^{36}Cl	$4.255 \cdot 10^{2}$		^{108}Cd	$3.361 \cdot 10^{-17}$	
^{39}Ar	$1.250 \cdot 10^{-5}$		^{113}Cd	$2.249 \cdot 10^{-14}$	
^{40}K	$1.741 \cdot 10^{-10}$		^{114}Cd	$1.145 \cdot 10^{-15}$	
^{48}Ca	$2.135 \cdot 10^{-22}$		^{116}Cd	$5.138 \cdot 10^{-19}$	
^{50}V	$5.843 \cdot 10^{-4}$		^{115}In	$3.162 \cdot 10^{-13}$	
^{50}Cr	$1.315 \cdot 10^{2}$		^{121}Sn	$4.333 \cdot 10^{1}$	
^{53}Mn	$9.748 \cdot 10^{0}$		^{121m}Sn	$5.583 \cdot 10^{1}$	
^{55}Fe	$1.020 \cdot 10^{-1}$	7.852	^{124}Sn	$8.129 \cdot 10^{-2}$	
^{60}Fe	$1.244 \cdot 10^{-4}$		^{123}Te	$9.484 \cdot 10^{-19}$	
^{60}Co	$2.139 \cdot 10^{3}$	0.1233	^{176}Lu	$4.283 \cdot 10^{-13}$	
^{58}Ni	$3.314 \cdot 10^{-1}$		^{179n}Hf	$3.927 \cdot 10^{-2}$	
^{59}Ni	$1.177 \cdot 10^{7}$		^{182}Hf	$2.654 \cdot 10^{-7}$	
^{63}Ni	$6.498 \cdot 10^{8}$	0.03589	^{180m}Ta	$6.140 \cdot 10^{-3}$	
^{64}Zn	$1.154 \cdot 10^{-9}$		^{183}W	$1.179 \cdot 10^{-1}$	
^{93}Zr	$4.703 \cdot 10^{-1}$		^{184}W	$6.944 \cdot 10^{-2}$	
^{94}Zr	$2.823 \cdot 10^{-12}$		^{186}W	$4.368 \cdot 10^{-2}$	
^{96}Zr	$2.057 \cdot 10^{-17}$		^{186m}Re	$2.580 \cdot 10^{-8}$	
^{91}Nb	$4.534 \cdot 10^{3}$		^{187}Re	$1.980 \cdot 10^{-2}$	
^{92}Nb	$3.853 \cdot 10^{0}$		^{186}Os	$2.059 \cdot 10^{-15}$	
^{93m}Nb	$2.628 \cdot 10^{5}$				
^{94}Nb	$1.003 \cdot 10^{4}$				

9.1.20 Cell 4 1000 years after shut-down

Table 41: Activity in steam separator cell 4 - 1000 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{10}Be	$1.096 \cdot 10^{-1}$		^{92}Mo	$3.392 \cdot 10^{-2}$	
^{14}C	$1.187 \cdot 10^{6}$		^{93}Mo	$2.289 \cdot 10^{5}$	
^{26}Al	$6.201 \cdot 10^{-4}$		^{98}Mo	$1.048 \cdot 10^{5}$	
^{32}Si	$2.988 \cdot 10^{-4}$		^{100}Mo	$5.730 \cdot 10^{-1}$	
^{36}Cl	$4.246 \cdot 10^{2}$		^{98}Tc	$8.755 \cdot 10^{-10}$	
^{39}Ar	$1.230 \cdot 10^{-6}$		^{99}Tc	$1.024 \cdot 10^{4}$	
^{40}K	$1.741 \cdot 10^{-10}$		^{108}Cd	$3.361 \cdot 10^{-17}$	
^{48}Ca	$2.135 \cdot 10^{-22}$		^{113}Cd	$2.249 \cdot 10^{-14}$	
^{50}V	$5.843 \cdot 10^{-4}$		^{114}Cd	$1.145 \cdot 10^{-15}$	
^{50}Cr	$1.315 \cdot 10^{2}$		^{116}Cd	$5.138 \cdot 10^{-19}$	
^{53}Mn	$9.746 \cdot 10^{0}$		^{115}In	$3.162 \cdot 10^{-13}$	
^{60}Fe	$1.243 \cdot 10^{-4}$		^{121m}Sn	$3.838 \cdot 10^{-5}$	
^{60}Co	$1.240 \cdot 10^{-4}$	0.1233	^{124}Sn	$8.129 \cdot 10^{-2}$	
^{58}Ni	$3.314 \cdot 10^{-1}$		^{123}Te	$9.484 \cdot 10^{-19}$	
^{59}Ni	$1.167 \cdot 10^{7}$		^{176}Lu	$4.283 \cdot 10^{-13}$	
^{63}Ni	$1.169 \cdot 10^{6}$	0.03589	^{179n}Hf	$3.927 \cdot 10^{-2}$	
^{64}Zn	$1.154 \cdot 10^{-9}$		^{182}Hf	$1.796 \cdot 10^{-6}$	
^{93}Zr	$4.701 \cdot 10^{-1}$		^{180m}Ta	$6.140 \cdot 10^{-3}$	
^{94}Zr	$2.823 \cdot 10^{-12}$		^{183}W	$1.179 \cdot 10^{-1}$	
^{96}Zr	$2.057 \cdot 10^{-17}$		^{184}W	$6.944 \cdot 10^{-2}$	
^{91}Nb	$1.812 \cdot 10^{3}$		^{186}W	$4.368 \cdot 10^{-2}$	
^{92}Nb	$3.853 \cdot 10^{0}$		^{186m}Re	$2.571 \cdot 10^{-8}$	
^{93m}Nb	$1.956 \cdot 10^{5}$		^{187}Re	$1.980 \cdot 10^{-2}$	
^{94}Nb	$9.717 \cdot 10^{3}$		^{186}Os	$8.872 \cdot 10^{-15}$	

9.2 Steam Dryer

9.2.1 Frame cell 1 - 3 days

Table 42: Activity in steam dryer frame cell 1 - 3 days after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$1.538 \cdot 10^{5}$		^{63}Ni	$2.167 \cdot 10^{8}$	0.1092
^{10}Be	$5.512 \cdot 10^{-2}$		^{65}Ni	$7.773 \cdot 10^{-2}$	0.000
^{14}C	$2.488 \cdot 10^{5}$		^{64}Cu	$1.064 \cdot 10^{6}$	1.531
^{26}Al	$3.121 \cdot 10^{-4}$		^{64}Zn	$1.949 \cdot 10^{-10}$	
^{32}Si	$1.228 \cdot 10^{-3}$		^{65}Zn	$7.918 \cdot 10^{-3}$	
^{32}P	$3.029 \cdot 10^{6}$	4.866	^{72}Ga	$4.908 \cdot 10^{0}$	
^{33}P	$1.634 \cdot 10^{4}$		^{73}As	$3.239 \cdot 10^{-1}$	
^{35}S	$7.970 \cdot 10^{4}$		^{74}As	$2.897 \cdot 10^{3}$	
^{36}Cl	$7.005 \cdot 10^{1}$		^{76}As	$1.074 \cdot 10^{6}$	1.908
^{39}Ar	$7.931 \cdot 10^{-6}$		^{89}Sr	$1.607 \cdot 10^{-4}$	
^{40}K	$8.752 \cdot 10^{-11}$		^{88}Y	$2.683 \cdot 10^{1}$	
^{45}Ca	$5.515 \cdot 10^{2}$		^{89m}Y	$1.620 \cdot 10^{4}$	
^{47}Ca	$5.385 \cdot 10^{0}$		^{90}Y	$3.088 \cdot 10^{2}$	
^{48}Ca	$1.074 \cdot 10^{-22}$		^{91}Y	$1.685 \cdot 10^{-3}$	
^{46}Sc	$1.451 \cdot 10^{4}$		^{88}Zr	$2.756 \cdot 10^{1}$	
^{47}Sc	$1.176 \cdot 10^{4}$		^{89}Zr	$1.622 \cdot 10^{4}$	
^{48}Sc	$1.168 \cdot 10^{3}$		^{93}Zr	$2.365 \cdot 10^{-1}$	
^{48}V	$7.878 \cdot 10^{0}$		^{94}Zr	$1.420 \cdot 10^{-12}$	
^{49}V	$8.455 \cdot 10^{4}$		^{95}Zr	$4.176 \cdot 10^{3}$	
^{50}V	$1.819 \cdot 10^{-4}$		^{96}Zr	$1.035 \cdot 10^{-17}$	
^{50}Cr	$4.094 \cdot 10^{1}$		^{97}Zr	$1.179 \cdot 10^{1}$	
^{51}Cr	$2.155 \cdot 10^{9}$	0.09493	^{90}Nb	$1.849 \cdot 10^{-2}$	
^{52}Mn	$7.243 \cdot 10^{0}$		^{91}Nb	$2.524 \cdot 10^{3}$	
^{53}Mn	$4.901 \cdot 10^{0}$		^{91m}Nb	$2.602 \cdot 10^{0}$	
^{54}Mn	$3.454 \cdot 10^{8}$	2.314	^{92}Nb	$1.937 \cdot 10^{0}$	
^{56}Mn	$1.371 \cdot 10^{1}$	1.152	^{92m}Nb	$3.025 \cdot 10^{3}$	
^{55}Fe	$1.593 \cdot 10^{9}$	7.490	^{93m}Nb	$9.311 \cdot 10^{5}$	
^{59}Fe	$4.559 \cdot 10^{7}$	5.174	^{94}Nb	$2.110 \cdot 10^{3}$	
^{60}Fe	$6.243 \cdot 10^{-5}$		^{95}Nb	$2.126 \cdot 10^{4}$	
^{56}Co	$1.047 \cdot 10^{3}$		^{95m}Nb	$4.623 \cdot 10^{1}$	
^{57}Co	$2.112 \cdot 10^{6}$		^{96}Nb	$7.639 \cdot 10^{2}$	
^{58}Co	$1.102 \cdot 10^{9}$	2.767	^{97}Nb	$1.271 \cdot 10^{1}$	
^{58m}Co	$1.516 \cdot 10^{6}$	3.412	^{92}Mo	$1.056 \cdot 10^{-2}$	
^{60}Co	$1.873 \cdot 10^{8}$	0.3636	^{93}Mo	$1.065 \cdot 10^{5}$	
^{57}Ni	$1.085 \cdot 10^{4}$		^{98}Mo	$3.262 \cdot 10^{4}$	
^{58}Ni	$1.032 \cdot 10^{-1}$		^{99}Mo	$1.404 \cdot 10^{7}$	0.000
^{59}Ni	$1.971 \cdot 10^{6}$		^{100}Mo	$1.783 \cdot 10^{-1}$	

Table 43: Activity in steam dryer frame cell 1 - 3 days after shut-down (continued)

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{98}Tc	$4.192 \cdot 10^{-10}$		^{123}Te	$1.183 \cdot 10^{-19}$	
^{99}Tc	$3.044 \cdot 10^{3}$		^{123m}Te	$1.258 \cdot 10^{-4}$	
^{99m}Tc	$1.356 \cdot 10^{7}$	0.000	^{125m}Te	$2.549 \cdot 10^{7}$	
^{109m}Ag	$2.096 \cdot 10^{1}$		^{176}Lu	$2.153 \cdot 10^{-13}$	
^{108}Cd	$1.690 \cdot 10^{-17}$		^{177}Lu	$1.464 \cdot 10^{-1}$	
^{109}Cd	$2.096 \cdot 10^{1}$		^{177m}Lu	$1.994 \cdot 10^{-4}$	
^{113}Cd	$1.131 \cdot 10^{-14}$		^{179n}Hf	$1.222 \cdot 10^{-2}$	
^{114}Cd	$5.744 \cdot 10^{-16}$		^{181}Hf	$7.753 \cdot 10^{0}$	
^{115}Cd	$3.542 \cdot 10^{-1}$		^{182}Hf	$3.658 \cdot 10^{-8}$	
^{116}Cd	$2.583 \cdot 10^{-19}$		^{179}Ta	$7.322 \cdot 10^{1}$	
^{111}In	$8.736 \cdot 10^{0}$		^{180}Ta	$6.323 \cdot 10^{1}$	
^{113m}In	$1.978 \cdot 10^{4}$		^{180m}Ta	$1.911 \cdot 10^{-3}$	
^{115}In	$1.590 \cdot 10^{-13}$		^{182}Ta	$1.457 \cdot 10^{7}$	0.000
^{115m}In	$3.866 \cdot 10^{-1}$		^{183}Ta	$3.256 \cdot 10^{0}$	
^{113}Sn	$1.976 \cdot 10^{4}$		^{178}W	$1.990 \cdot 10^{-2}$	
^{117m}Sn	$2.525 \cdot 10^{-2}$		^{181}W	$1.026 \cdot 10^{5}$	
^{119m}Sn	$1.724 \cdot 10^{0}$		^{183}W	$3.671 \cdot 10^{-2}$	
^{121}Sn	$1.658 \cdot 10^{4}$		^{184}W	$2.162 \cdot 10^{-2}$	
^{121m}Sn	$1.361 \cdot 10^{2}$		^{185}W	$3.976 \cdot 10^{5}$	
^{123}Sn	$4.208 \cdot 10^{3}$		^{186}W	$1.360 \cdot 10^{-2}$	
^{124}Sn	$2.530 \cdot 10^{-2}$		^{187}W	$8.365 \cdot 10^{5}$	5.416
^{125}Sn	$1.097 \cdot 10^{3}$		^{186}Re	$1.342 \cdot 10^{-2}$	
^{119}Sb	$4.801 \cdot 10^{-2}$		^{186m}Re	$3.702 \cdot 10^{-9}$	
^{122}Sb	$1.896 \cdot 10^{5}$		^{187}Re	$3.370 \cdot 10^{-3}$	
^{124}Sb	$2.030 \cdot 10^{5}$	0.000	^{188}Re	$1.235 \cdot 10^{-2}$	
^{125}Sb	$1.108 \cdot 10^{4}$		^{186}Os	$1.983 \cdot 10^{-16}$	

9.2.2 Frame cell 1 - 1 year

Table 44: Activity in steam dryer frame cell 1 - 1 year after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$1.455 \cdot 10^{5}$		^{88}Y	$7.073 \cdot 10^{0}$	
^{10}Be	$5.512 \cdot 10^{-2}$		^{88}Zr	$1.360 \cdot 10^{0}$	
^{14}C	$2.488 \cdot 10^{5}$		^{93}Zr	$2.365 \cdot 10^{-1}$	
^{26}Al	$3.121 \cdot 10^{-4}$		^{94}Zr	$1.420 \cdot 10^{-12}$	
^{32}Si	$1.225 \cdot 10^{-3}$		^{95}Zr	$8.298 \cdot 10^{1}$	
^{32}P	$7.252 \cdot 10^{-2}$	4.866	^{96}Zr	$1.035 \cdot 10^{-17}$	
^{33}P	$8.325 \cdot 10^{-1}$		^{91}Nb	$2.522 \cdot 10^{3}$	
^{35}S	$4.493 \cdot 10^{3}$		^{91m}Nb	$4.226 \cdot 10^{-2}$	
^{36}Cl	$7.005 \cdot 10^{1}$		^{92}Nb	$1.937 \cdot 10^{0}$	
^{39}Ar	$7.910 \cdot 10^{-6}$		^{93m}Nb	$8.960 \cdot 10^{5}$	
^{40}K	$8.752 \cdot 10^{-11}$		^{94}Nb	$2.110 \cdot 10^{3}$	
^{45}Ca	$1.179 \cdot 10^{2}$		^{95}Nb	$1.923 \cdot 10^{2}$	
^{48}Ca	$1.074 \cdot 10^{-22}$		^{95m}Nb	$9.500 \cdot 10^{-1}$	
^{46}Sc	$7.264 \cdot 10^{2}$		^{92}Mo	$1.056 \cdot 10^{-2}$	
^{49}V	$3.953 \cdot 10^{4}$		^{93}Mo	$1.065 \cdot 10^{5}$	
^{50}V	$1.819 \cdot 10^{-4}$		^{98}Mo	$3.262 \cdot 10^{4}$	
^{50}Cr	$4.094 \cdot 10^{1}$		^{100}Mo	$1.783 \cdot 10^{-1}$	
^{51}Cr	$2.512 \cdot 10^{5}$	0.09493	^{98}Tc	$4.192 \cdot 10^{-10}$	
^{53}Mn	$4.901 \cdot 10^{0}$		^{99}Tc	$3.044 \cdot 10^{3}$	
^{54}Mn	$1.546 \cdot 10^{8}$	2.314	^{108}Cd	$1.690 \cdot 10^{-17}$	
^{55}Fe	$1.241 \cdot 10^{9}$	7.490	^{109}Cd	$1.217 \cdot 10^{1}$	
^{59}Fe	$1.621 \cdot 10^{5}$	5.174	^{113}Cd	$1.131 \cdot 10^{-14}$	
^{60}Fe	$6.243 \cdot 10^{-5}$		^{114}Cd	$5.744 \cdot 10^{-16}$	
^{56}Co	$4.066 \cdot 10^{1}$		^{116}Cd	$2.583 \cdot 10^{-19}$	
^{57}Co	$8.391 \cdot 10^{5}$		^{113m}In	$2.235 \cdot 10^{3}$	
^{58}Co	$3.191 \cdot 10^{7}$	2.767	^{115}In	$1.590 \cdot 10^{-13}$	
^{60}Co	$1.644 \cdot 10^{8}$	0.3636	^{113}Sn	$2.234 \cdot 10^{3}$	
^{58}Ni	$1.032 \cdot 10^{-1}$		^{119m}Sn	$7.321 \cdot 10^{-1}$	
^{59}Ni	$1.971 \cdot 10^{6}$		^{121}Sn	$1.040 \cdot 10^{2}$	
^{63}Ni	$2.152 \cdot 10^{8}$	0.1092	^{121m}Sn	$1.340 \cdot 10^{2}$	
^{64}Zn	$1.949 \cdot 10^{-10}$		^{123}Sn	$6.035 \cdot 10^{2}$	
^{65}Zn	$2.832 \cdot 10^{-3}$		^{124}Sn	$2.530 \cdot 10^{-2}$	
^{73}As	$1.424 \cdot 10^{-2}$		^{124}Sb	$3.144 \cdot 10^{3}$	0.000
^{74}As	$2.161 \cdot 10^{-}3$		^{125}Sb	$8.648 \cdot 10^{3}$	

Table 45: Activity in steam dryer frame cell 1 - 1 year after shut-down (continued)

Radionuclides	Activity [Bq]	Uncertainty (cross-section only) [%]
^{123}Te	$1.186 \cdot 10^{-19}$	
^{125m}Te	$2.116 \cdot 10^{3}$	
^{176}Lu	$2.153 \cdot 10^{-13}$	
^{179n}Hf	$1.222 \cdot 10^{-2}$	
^{181}Hf	$2.080 \cdot 10^{-2}$	
^{182}Hf	$3.711 \cdot 10^{-8}$	
^{179}Ta	$4.779 \cdot 10^{1}$	
^{180m}Ta	$1.911 \cdot 10^{-3}$	
^{182}Ta	$1.634 \cdot 10^{6}$	0.000
^{181}W	$1.289 \cdot 10^{4}$	
^{183}W	$3.671 \cdot 10^{-2}$	
^{184}W	$2.162 \cdot 10^{-2}$	
^{185}W	$1.407 \cdot 10^{4}$	
^{186}W	$1.360 \cdot 10^{-2}$	
^{186m}Re	$3.702 \cdot 10^{-9}$	
^{187}Re	$3.370 \cdot 10^{-3}$	
^{186}Os	$2.007 \cdot 10^{-16}$	

9.2.3 Frame cell 1 - 30 years

Table 46: Activity in steam dryer frame cell 1 - 30 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$1.850 \cdot 10^{4}$		^{92}Mo	$1.056 \cdot 10^{-2}$	
^{10}Be	$5.511 \cdot 10^{-2}$		^{93}Mo	$1.058 \cdot 10^{5}$	
^{14}C	$2.479 \cdot 10^{5}$		^{98}Mo	$3.262 \cdot 10^{4}$	
^{26}Al	$3.121 \cdot 10^{-4}$		^{100}Mo	$1.783 \cdot 10^{-1}$	
^{32}Si	$1.153 \cdot 10^{-3}$		^{98}Tc	$4.192 \cdot 10^{-10}$	
^{32}P	$1.153 \cdot 10^{-3}$	4.866	^{99}Tc	$3.044 \cdot 10^{3}$	
^{36}Cl	$7.005 \cdot 10^{1}$		^{108}Cd	$1.690 \cdot 10^{-17}$	
^{39}Ar	$7.341 \cdot 10^{-6}$		^{113}Cd	$1.131 \cdot 10^{-14}$	
^{40}K	$8.752 \cdot 10^{-11}$		^{114}Cd	$5.744 \cdot 10^{-16}$	
^{48}Ca	$1.074 \cdot 10^{-22}$		^{116}Cd	$2.583 \cdot 10^{-19}$	
^{50}V	$1.819 \cdot 10^{-4}$		^{115}In	$1.590 \cdot 10^{-13}$	
^{50}Cr	$4.094 \cdot 10^{1}$		^{121}Sn	$6.579 \cdot 10^{1}$	
^{53}Mn	$4.901 \cdot 10^{0}$		^{121m}Sn	$8.477 \cdot 10^{1}$	
^{54}Mn	$9.551 \cdot 10^{-3}$	2.314	^{124}Sn	$2.530 \cdot 10^{-2}$	
^{55}Fe	$8.236 \cdot 10^{5}$	7.490	^{125}Sb	$5.918 \cdot 10^{0}$	
^{60}Fe	$6.243 \cdot 10^{-5}$		^{123}Te	$1.187 \cdot 10^{-19}$	
^{60}Co	$3.629 \cdot 10^{6}$	0.3636	^{125m}Te	$1.449 \cdot 10^{0}$	
^{58}Ni	$1.032 \cdot 10^{-1}$		^{176}Lu	$2.153 \cdot 10^{-13}$	
^{59}Ni	$1.971 \cdot 10^{6}$		^{179n}Hf	$1.222 \cdot 10^{-2}$	
^{63}Ni	$1.755 \cdot 10^{8}$	0.1092	^{182}Hf	$5.246 \cdot 10^{-8}$	
^{64}Zn	$1.949 \cdot 10^{-10}$		^{179}Ta	$1.806 \cdot 10^{-4}$	
^{93}Zr	$2.365 \cdot 10^{-1}$		^{180m}Ta	$1.911 \cdot 10^{-3}$	
^{94}Zr	$1.420 \cdot 10^{-12}$		^{183}W	$3.671 \cdot 10^{-2}$	
^{96}Zr	$1.035 \cdot 10^{-17}$		^{184}W	$2.162 \cdot 10^{-2}$	
^{91}Nb	$2.448 \cdot 10^{3}$		^{186}W	$1.360 \cdot 10^{-2}$	
^{92}Nb	$1.937 \cdot 10^{0}$		^{186m}Re	$3.702 \cdot 10^{-9}$	
^{93m}Nb	$3.217 \cdot 10^{5}$		^{187}Re	$3.370 \cdot 10^{-3}$	
^{94}Nb	$2.107 \cdot 10^{3}$		^{186}Os	$2.690 \cdot 10^{-16}$	

9.2.4 Frame cell 1 - 100 years

Table 47: Activity in steam dryer frame cell 1 - 100 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$5.569 \cdot 10^{2}$		^{92}Mo	$1.056 \cdot 10^{-2}$	
^{10}Be	$5.511 \cdot 10^{-2}$		^{93}Mo	$1.041 \cdot 10^{5}$	
^{14}C	$2.458 \cdot 10^{5}$		^{98}Mo	$3.262 \cdot 10^{4}$	
^{26}Al	$3.121 \cdot 10^{-4}$		^{100}Mo	$1.783 \cdot 10^{-1}$	
^{32}Si	$9.950 \cdot 10^{-4}$		^{98}Tc	$4.192 \cdot 10^{-10}$	
^{32}P	$9.951 \cdot 10^{-4}$	4.866	^{99}Tc	$3.043 \cdot 10^{3}$	
^{36}Cl	$7.004 \cdot 10^{1}$		^{108}Cd	$1.690 \cdot 10^{-17}$	
^{39}Ar	$6.129 \cdot 10^{-6}$		^{113}Cd	$1.131 \cdot 10^{-14}$	
^{40}K	$8.752 \cdot 10^{-11}$		^{114}Cd	$5.744 \cdot 10^{-16}$	
^{48}Ca	$1.074 \cdot 10^{-22}$		^{116}Cd	$2.583 \cdot 10^{-19}$	
^{50}V	$1.819 \cdot 10^{-4}$		^{115}In	$1.590 \cdot 10^{-13}$	
^{50}Cr	$4.094 \cdot 10^{1}$		^{121}Sn	$1.178 \cdot 10^{1}$	
^{53}Mn	$4.901 \cdot 10^{0}$		^{121m}Sn	$2.807 \cdot 10^{1}$	
^{55}Fe	$1.760 \cdot 10^{-2}$	7.490	^{124}Sn	$2.530 \cdot 10^{-2}$	
^{60}Fe	$6.243 \cdot 10^{-5}$		^{123}Te	$1.187 \cdot 10^{-19}$	
^{60}Co	$3.648 \cdot 10^{2}$	0.3636	^{176}Lu	$2.153 \cdot 10^{-13}$	
^{58}Ni	$1.032 \cdot 10^{-1}$		^{179n}Hf	$1.222 \cdot 10^{-2}$	
^{59}Ni	$1.969 \cdot 10^{6}$		^{182}Hf	$8.953 \cdot 10^{-8}$	
^{63}Ni	$1.074 \cdot 10^{8}$	0.1092	^{180m}Ta	$1.911 \cdot 10^{-3}$	
^{64}Zn	$1.949 \cdot 10^{-10}$		^{183}W	$3.671 \cdot 10^{-2}$	
^{93}Zr	$2.365 \cdot 10^{-1}$		^{184}W	$2.162 \cdot 10^{-2}$	
^{94}Zr	$1.420 \cdot 10^{-12}$		^{186}W	$1.360 \cdot 10^{-2}$	
^{96}Zr	$1.035 \cdot 10^{-17}$		^{186m}Re	$3.701 \cdot 10^{-9}$	
^{91}Nb	$2.280 \cdot 10^{3}$		^{187}Re	$3.370 \cdot 10^{-3}$	
^{92}Nb	$1.937 \cdot 10^{0}$		^{186}Os	$4.340 \cdot 10^{-16}$	
^{93m}Nb	$1.003 \cdot 10^{5}$				
^{94}Nb	$2.102 \cdot 10^{3}$				

9.2.5 Frame cell 1 - 1000 years

Table 48: Activity in steam dryer frame cell 1 - 1000 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{10}Be	$5.509 \cdot 10^{-2}$		^{92}Mo	$1.056 \cdot 10^{-2}$	
^{14}C	$2.203 \cdot 10^{5}$		^{93}Mo	$8.460 \cdot 10^{4}$	
^{26}Al	$3.118 \cdot 10^{-4}$		^{98}Mo	$3.262 \cdot 10^{4}$	
^{32}Si	$1.503 \cdot 10^{-4}$		^{100}Mo	$1.783 \cdot 10^{-1}$	
^{36}Cl	$6.989 \cdot 10^{1}$		^{98}Tc	$4.192 \cdot 10^{-10}$	
^{39}Ar	$6.029 \cdot 10^{-7}$		^{99}Tc	$3.043 \cdot 10^{3}$	
^{40}K	$8.752 \cdot 10^{-11}$		^{108}Cd	$1.690 \cdot 10^{-17}$	
^{48}Ca	$1.074 \cdot 10^{-22}$		^{113}Cd	$1.131 \cdot 10^{-14}$	
^{50}V	$1.819 \cdot 10^{-4}$		^{114}Cd	$5.744 \cdot 10^{-16}$	
^{50}Cr	$4.094 \cdot 10^{1}$		^{116}Cd	$2.583 \cdot 10^{-19}$	
^{53}Mn	$4.901 \cdot 10^{0}$		^{115}In	$1.590 \cdot 10^{-13}$	
^{60}Fe	$6.240 \cdot 10^{-5}$		^{121m}Sn	$1.968 \cdot 10^{-5}$	
^{60}Co	$6.226 \cdot 10^{-5}$	0.3636	^{124}Sn	$2.530 \cdot 10^{-2}$	
^{58}Ni	$1.032 \cdot 10^{-1}$		^{123}Te	$1.187 \cdot 10^{-19}$	
^{59}Ni	$1.953 \cdot 10^{6}$		^{176}Lu	$2.153 \cdot 10^{-13}$	
^{63}Ni	$1.932 \cdot 10^{5}$	0.1092	^{179n}Hf	$1.222 \cdot 10^{-2}$	
^{64}Zn	$1.949 \cdot 10^{-10}$		^{182}Hf	$5.661 \cdot 10^{-7}$	
^{93}Zr	$2.365 \cdot 10^{-1}$		^{180m}Ta	$1.911 \cdot 10^{-3}$	
^{94}Zr	$1.420 \cdot 10^{-12}$		^{183}W	$3.671 \cdot 10^{-2}$	
^{96}Zr	$1.035 \cdot 10^{-17}$		^{184}W	$2.162 \cdot 10^{-2}$	
^{91}Nb	$9.109 \cdot 10^{2}$		^{186}W	$1.360 \cdot 10^{-2}$	
^{92}Nb	$1.937 \cdot 10^{0}$		^{186m}Re	$3.688 \cdot 10^{-9}$	
^{93m}Nb	$7.339 \cdot 10^{4}$		^{187}Re	$3.370 \cdot 10^{-3}$	
^{94}Nb	$2.038 \cdot 10^{3}$		^{186}Os	$2.555 \cdot 10^{-15}$	

9.2.6 Frame cell 2 - 3 days

Table 49: Activity in steam dryer frame cell 2 - 3 days after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$3.596 \cdot 10^{5}$		^{63}Ni	$4.843 \cdot 10^{8}$	0.1143
^{10}Be	$1.289 \cdot 10^{-1}$		^{65}Ni	$1.729 \cdot 10^{-1}$	0.000
^{14}C	$5.603 \cdot 10^{5}$		^{64}Cu	$2.386 \cdot 10^{6}$	1.527
^{26}Al	$7.298 \cdot 10^{-4}$		^{64}Zn	$4.371 \cdot 10^{-10}$	
^{32}Si	$2.870 \cdot 10^{-3}$		^{65}Zn	$7.717 \cdot 10^{-3}$	
^{32}P	$6.983 \cdot 10^{6}$	4.936	^{72}Ga	$1.148 \cdot 10^{1}$	
^{33}P	$3.821 \cdot 10^{4}$		^{73}As	$7.574 \cdot 10^{-1}$	
^{35}S	$1.800 \cdot 10^{5}$		^{74}As	$6.773 \cdot 10^{3}$	
^{36}Cl	$1.565 \cdot 10^{2}$		^{76}As	$2.486 \cdot 10^{6}$	1.932
^{39}Ar	$1.848 \cdot 10^{-5}$		^{89}Sr	$3.756 \cdot 10^{-4}$	
^{40}K	$2.046 \cdot 10^{-10}$		^{88}Y	$6.274 \cdot 10^{1}$	
^{45}Ca	$1.289 \cdot 10^{3}$		^{89m}Y	$3.788 \cdot 10^{4}$	
^{47}Ca	$1.259 \cdot 10^{1}$		^{90}Y	$7.220 \cdot 10^{2}$	
^{48}Ca	$2.510 \cdot 10^{-22}$		^{91}Y	$3.938 \cdot 10^{-3}$	
^{46}Sc	$3.393 \cdot 10^{4}$		^{88}Zr	$6.443 \cdot 10^{1}$	
^{47}Sc	$2.749 \cdot 10^{4}$		^{89}Zr	$3.792 \cdot 10^{4}$	
^{48}Sc	$2.730 \cdot 10^{3}$		^{93}Zr	$5.529 \cdot 10^{-1}$	
^{48}V	$1.842 \cdot 10^{1}$		^{94}Zr	$3.319 \cdot 10^{-12}$	
^{49}V	$1.977 \cdot 10^{5}$		^{95}Zr	$9.765 \cdot 10^{3}$	
^{50}V	$9.456 \cdot 10^{-4}$		^{96}Zr	$2.419 \cdot 10^{-17}$	
^{50}Cr	$2.129 \cdot 10^{2}$		^{97}Zr	$2.757 \cdot 10^{1}$	
^{51}Cr	$4.816 \cdot 10^{9}$	0.09926	^{90}Nb	$4.324 \cdot 10^{-2}$	
^{52}Mn	$1.694 \cdot 10^{1}$		^{91}Nb	$5.903 \cdot 10^{3}$	
^{53}Mn	$1.146 \cdot 10^{1}$		^{91m}Nb	$6.084 \cdot 10^{0}$	
^{54}Mn	$8.077 \cdot 10^{8}$	2.314	^{92}Nb	$4.530 \cdot 10^{0}$	
^{56}Mn	$3.057 \cdot 10^{1}$	1.165	^{92m}Nb	$7.073 \cdot 10^{3}$	
^{55}Fe	$3.573 \cdot 10^{9}$	7.465	^{93m}Nb	$2.177 \cdot 10^{6}$	
^{59}Fe	$1.021 \cdot 10^{8}$	5.165	^{94}Nb	$4.850 \cdot 10^{3}$	
^{60}Fe	$1.459 \cdot 10^{-4}$		^{95}Nb	$4.972 \cdot 10^{4}$	
^{56}Co	$2.449 \cdot 10^{3}$		^{95m}Nb	$1.081 \cdot 10^{2}$	
^{57}Co	$4.939 \cdot 10^{6}$		^{96}Nb	$1.786 \cdot 10^{3}$	
^{58}Co	$2.576 \cdot 10^{9}$	2.778	^{97}Nb	$2.972 \cdot 10^{1}$	
^{58m}Co	$3.544 \cdot 10^{6}$	3.412	^{97m}Nb	$2.622 \cdot 10^{1}$	
^{60}Co	$4.211 \cdot 10^{8}$	0.3782	^{92}Mo	$5.490 \cdot 10^{-2}$	
^{57}Ni	$2.538 \cdot 10^{4}$		^{93}Mo	$2.487 \cdot 10^{5}$	
^{58}Ni	$5.363 \cdot 10^{-1}$		^{98}Mo	$1.696 \cdot 10^{5}$	
^{59}Ni	$4.410 \cdot 10^{6}$		^{99}Mo	$3.356 \cdot 10^{7}$	0.000

Table 50: Activity in steam dryer frame cell 2 - 3 days after shut-down (continued)

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{100}Mo	$9.273 \cdot 10^{-1}$		^{123}Te	$1.255 \cdot 10^{-19}$	
^{98}Tc	$4.509 \cdot 10^{-10}$		^{123m}Te	$1.334 \cdot 10^{-4}$	
^{99}Tc	$7.277 \cdot 10^{3}$		^{125m}Te	$6.252 \cdot 10^{3}$	
^{99m}Tc	$3.242 \cdot 10^{7}$	0.000	^{176}Lu	$5.035 \cdot 10^{-13}$	
^{109m}Ag	$4.900 \cdot 10^{1}$		^{177}Lu	$3.404 \cdot 10^{-1}$	
^{108}Cd	$3.952 \cdot 10^{-17}$		^{177m}Lu	$4.739 \cdot 10^{-4}$	
^{109}Cd	$4.900 \cdot 10^{1}$		^{179n}Hf	$6.356 \cdot 10^{-2}$	
^{113}Cd	$2.645 \cdot 10^{-14}$		^{181}Hf	$1.813 \cdot 10^{1}$	
^{114}Cd	$1.343 \cdot 10^{-15}$		^{182}Hf	$1.384 \cdot 10^{-7}$	
^{115}Cd	$8.282 \cdot 10^{-1}$		^{179}Ta	$1.712 \cdot 10^{2}$	
^{116}Cd	$6.041 \cdot 10^{-19}$		^{180}Ta	$1.479 \cdot 10^{2}$	
^{111}In	$2.043 \cdot 10^{1}$		^{180m}Ta	$9.938 \cdot 10^{-3}$	
^{113m}In	$4.678 \cdot 10^{4}$		^{182}Ta	$3.443 \cdot 10^{7}$	0.000
^{115}In	$3.717 \cdot 10^{-13}$		^{183}Ta	$5.141 \cdot 10^{0}$	
^{115m}In	$9.040 \cdot 10^{-1}$		^{178}W	$4.653 \cdot 10^{-2}$	
^{113}Sn	$4.676 \cdot 10^{4}$		^{181}W	$2.315 \cdot 10^{5}$	
^{117m}Sn	$5.904 \cdot 10^{-2}$		^{183}W	$1.909 \cdot 10^{-1}$	
^{119m}Sn	$4.031 \cdot 10^{0}$		^{184}W	$1.124 \cdot 10^{-1}$	
^{121}Sn	$3.837 \cdot 10^{4}$		^{185}W	$9.132 \cdot 10^{5}$	
^{121m}Sn	$3.183 \cdot 10^{2}$		^{186}W	$7.070 \cdot 10^{-2}$	
^{123}Sn	$9.724 \cdot 10^{3}$		^{187}W	$1.910 \cdot 10^{6}$	5.352
^{124}Sn	$1.316 \cdot 10^{-1}$		^{186}Re	$1.365 \cdot 10^{-2}$	
^{125}Sn	$2.615 \cdot 10^{3}$		^{186m}Re	$3.783 \cdot 10^{-9}$	
^{119}Sb	$1.123 \cdot 10^{-1}$		^{187}Re	$7.696 \cdot 10^{-3}$	
^{122}Sb	$4.462 \cdot 10^{5}$		^{188}Re	$1.224 \cdot 10^{-2}$	
^{124}Sb	$4.776 \cdot 10^{5}$	0.000	^{186}Os	$5.454 \cdot 10^{-16}$	
^{125}Sb	$2.718 \cdot 10^{4}$				

9.2.7 Frame cell 2 - 1 year

Table 51: Activity in steam dryer frame cell 2 - 1 year after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$3.401 \cdot 10^{5}$		^{64}Zn	$4.371 \cdot 10^{-10}$	
^{10}Be	$1.289 \cdot 10^{-1}$		^{65}Zn	$2.760 \cdot 10^{-3}$	
^{14}C	$5.602 \cdot 10^{5}$		^{73}As	$3.328 \cdot 10^{-2}$	
^{26}Al	$7.298 \cdot 10^{-4}$		^{74}As	$5.045 \cdot 10^{-3}$	
^{32}Si	$2.864 \cdot 10^{-3}$		^{88}Y	$1.654 \cdot 10^{1}$	
^{32}P	$1.660 \cdot 10^{-1}$	4.936	^{88}Zr	$3.180 \cdot 10^{0}$	
^{33}P	$1.946 \cdot 10^{0}$		^{93}Zr	$5.529 \cdot 10^{-1}$	
^{35}S	$1.015 \cdot 10^{4}$		^{94}Zr	$3.319 \cdot 10^{-12}$	
^{36}Cl	$1.565 \cdot 10^{2}$		^{95}Zr	$1.940 \cdot 10^{2}$	
^{39}Ar	$1.844 \cdot 10^{-5}$		^{96}Zr	$2.419 \cdot 10^{-17}$	
^{40}K	$2.046 \cdot 10^{-10}$		^{91}Nb	$5.897 \cdot 10^{3}$	
^{45}Ca	$2.757 \cdot 10^{2}$		^{91m}Nb	$9.881 \cdot 10^{-2}$	
^{48}Ca	$2.510 \cdot 10^{-22}$		^{92}Nb	$4.530 \cdot 10^{0}$	
^{46}Sc	$1.698 \cdot 10^{3}$		^{93m}Nb	$2.095 \cdot 10^{6}$	
^{49}V	$9.243 \cdot 10^{4}$		^{94}Nb	$4.850 \cdot 10^{3}$	
^{50}V	$9.456 \cdot 10^{-4}$		^{95}Nb	$4.496 \cdot 10^{2}$	
^{50}Cr	$2.129 \cdot 10^{2}$		^{95m}Nb	$2.221 \cdot 10^{0}$	
^{51}Cr	$5.614 \cdot 10^{5}$	0.09926	^{92}Mo	$5.490 \cdot 10^{-2}$	
^{53}Mn	$1.146 \cdot 10^{1}$		^{93}Mo	$2.487 \cdot 10^{5}$	
^{54}Mn	$3.618 \cdot 10^{8}$	2.314	^{98}Mo	$1.696 \cdot 10^{5}$	
^{55}Fe	$2.782 \cdot 10^{9}$	7.465	^{100}Mo	$9.273 \cdot 10^{-1}$	
^{59}Fe	$3.631 \cdot 10^{5}$	5.165	^{98}Tc	$4.509 \cdot 10^{-10}$	
^{60}Fe	$1.459 \cdot 10^{-4}$		^{99}Tc	$7.278 \cdot 10^{3}$	
^{56}Co	$9.507 \cdot 10^{1}$		^{109m}Ag	$2.846 \cdot 10^{1}$	
^{57}Co	$1.962 \cdot 10^{6}$		^{108}Cd	$3.952 \cdot 10^{-17}$	
^{58}Co	$7.461 \cdot 10^{7}$	2.778	^{109}Cd	$2.846 \cdot 10^{1}$	
^{60}Co	$3.697 \cdot 10^{8}$	0.3782	^{113}Cd	$2.645 \cdot 10^{-14}$	
^{58}Ni	$5.363 \cdot 10^{-1}$		^{114}Cd	$1.343 \cdot 10^{-15}$	
^{59}Ni	$4.410 \cdot 10^{6}$		^{116}Cd	$6.041 \cdot 10^{-19}$	
^{63}Ni	$4.809 \cdot 10^{8}$	0.1143	^{113m}In	$5.287 \cdot 10^{3}$	

Table 52: Activity in steam dryer frame cell 2 - 1 year after shut-down (continued)

Radionuclides	Activity [Bq]	Uncertainty (cross-section only) [%]
^{115}In	$3.717 \cdot 10^{-13}$	
^{113}Sn	$5.284 \cdot 10^{3}$	
^{119m}Sn	$1.712 \cdot 10^{0}$	
^{121}Sn	$2.432 \cdot 10^{2}$	
^{121m}Sn	$3.133 \cdot 10^{2}$	
^{123}Sn	$1.394 \cdot 10^{3}$	
^{124}Sn	$1.316 \cdot 10^{-1}$	
^{124}Sb	$7.398 \cdot 10^{3}$	0.000
^{125}Sb	$2.121 \cdot 10^{4}$	
^{123}Te	$1.259 \cdot 10^{-19}$	
^{125m}Te	$5.189 \cdot 10^{3}$	
^{176}Lu	$5.035 \cdot 10^{-13}$	
^{177m}Lu	$9.905 \cdot 10^{-5}$	
^{179n}Hf	$6.356 \cdot 10^{-2}$	
^{181}Hf	$4.864 \cdot 10^{-2}$	
^{182}Hf	$1.411 \cdot 10^{-7}$	
^{179}Ta	$1.117 \cdot 10^{2}$	
^{180m}Ta	$9.938 \cdot 10^{-3}$	
^{182}Ta	$3.862 \cdot 10^{6}$	0.000
^{181}W	$2.910 \cdot 10^{4}$	
^{183}W	$1.909 \cdot 10^{-1}$	
^{184}W	$1.124 \cdot 10^{-1}$	
^{185}W	$3.232 \cdot 10^{4}$	
^{186}W	$7.070 \cdot 10^{-2}$	
^{186m}Re	$3.783 \cdot 10^{-9}$	
^{187}Re	$7.696 \cdot 10^{-3}$	
^{186}Os	$5.576 \cdot 10^{-16}$	

9.2.8 Frame cell 2 - 30 years

Table 53: Activity in steam dryer frame cell 2 - 30 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$6.663 \cdot 10^{4}$		^{92}Mo	$5.490 \cdot 10^{-2}$	
^{10}Be	$1.289 \cdot 10^{-1}$		^{93}Mo	$2.470 \cdot 10^{5}$	
^{14}C	$5.583 \cdot 10^{5}$		^{98}Mo	$1.696 \cdot 10^{5}$	
^{26}Al	$7.298 \cdot 10^{-4}$		^{100}Mo	$9.273 \cdot 10^{-1}$	
^{32}Si	$2.695 \cdot 10^{-3}$		^{98}Tc	$4.509 \cdot 10^{-10}$	
^{32}P	$2.695 \cdot 10^{-3}$	4.936	^{99}Tc	$7.278 \cdot 10^{3}$	
^{36}Cl	$1.565 \cdot 10^{2}$		^{108}Cd	$3.952 \cdot 10^{-17}$	
^{39}Ar	$1.711 \cdot 10^{-5}$		^{113}Cd	$2.645 \cdot 10^{-14}$	
^{40}K	$2.046 \cdot 10^{-10}$		^{114}Cd	$1.343 \cdot 10^{-15}$	
^{48}Ca	$2.510 \cdot 10^{-22}$		^{116}Cd	$6.041 \cdot 10^{-19}$	
^{50}V	$9.456 \cdot 10^{-4}$		^{115}In	$3.717 \cdot 10^{-13}$	
^{50}Cr	$2.129 \cdot 10^{2}$		^{121}Sn	$1.538 \cdot 10^{2}$	
^{53}Mn	$1.146 \cdot 10^{1}$		^{121m}Sn	$1.982 \cdot 10^{2}$	
^{54}Mn	$2.223 \cdot 10^{-2}$	2.314	^{124}Sn	$1.316 \cdot 10^{-1}$	
^{55}Fe	$1.846 \cdot 10^{6}$	7.465	^{125}Sb	$1.452 \cdot 10^{1}$	
^{60}Fe	$1.459 \cdot 10^{-4}$		^{123}Te	$1.259 \cdot 10^{-19}$	
^{60}Co	$8.158 \cdot 10^{6}$	0.3782	^{125m}Te	$3.555 \cdot 10^{0}$	
^{58}Ni	$5.363 \cdot 10^{-1}$		^{176}Lu	$5.035 \cdot 10^{-13}$	
^{59}Ni	$4.408 \cdot 10^{6}$		^{179n}Hf	$6.356 \cdot 10^{-2}$	
^{63}Ni	$3.923 \cdot 10^{8}$	0.1143	^{182}Hf	$2.209 \cdot 10^{-7}$	
^{64}Zn	$4.371 \cdot 10^{-10}$		^{179}Ta	$4.222 \cdot 10^{-4}$	
^{93}Zr	$5.529 \cdot 10^{-1}$		^{180m}Ta	$9.938 \cdot 10^{-3}$	
^{94}Zr	$3.319 \cdot 10^{-12}$		^{183}W	$1.909 \cdot 10^{-1}$	
^{96}Zr	$2.419 \cdot 10^{-17}$		^{184}W	$1.124 \cdot 10^{-1}$	
^{91}Nb	$5.725 \cdot 10^{3}$		^{186}W	$7.070 \cdot 10^{-2}$	
^{92}Nb	$4.530 \cdot 10^{0}$		^{186m}Re	$3.783 \cdot 10^{-9}$	
^{93m}Nb	$7.520 \cdot 10^{5}$		^{187}Re	$7.696 \cdot 10^{-3}$	
^{94}Nb	$4.845 \cdot 10^{3}$		^{186}Os	$9.129 \cdot 10^{-16}$	

9.2.9 Frame cell 2 - 100 years

Table 54: Activity in steam dryer frame cell 2 - 100 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$1.302 \cdot 10^{3}$		^{94}Nb	$4.833 \cdot 10^{3}$	
^{10}Be	$1.289 \cdot 10^{-1}$		^{92}Mo	$5.490 \cdot 10^{-2}$	
^{14}C	$5.535 \cdot 10^{5}$		^{93}Mo	$2.431 \cdot 10^{5}$	
^{26}Al	$7.297 \cdot 10^{-4}$		^{98}Mo	$1.696 \cdot 10^{5}$	
^{32}Si	$2.326 \cdot 10^{-3}$		^{100}Mo	$9.273 \cdot 10^{-1}$	
^{32}P	$2.327 \cdot 10^{-3}$	4.936	^{98}Tc	$4.509 \cdot 10^{-10}$	
^{36}Cl	$1.565 \cdot 10^{2}$		^{99}Tc	$7.276 \cdot 10^{3}$	
^{39}Ar	$1.429 \cdot 10^{-5}$		^{108}Cd	$3.952 \cdot 10^{-17}$	
^{40}K	$2.046 \cdot 10^{-10}$		^{113}Cd	$2.645 \cdot 10^{-14}$	
^{48}Ca	$2.510 \cdot 10^{-22}$		^{114}Cd	$1.343 \cdot 10^{-15}$	
^{50}V	$9.456 \cdot 10^{-4}$		^{116}Cd	$6.041 \cdot 10^{-19}$	
^{50}Cr	$2.129 \cdot 10^{2}$		^{115}In	$3.717 \cdot 10^{-13}$	
^{53}Mn	$1.146 \cdot 10^{1}$		^{121}Sn	$5.094 \cdot 10^{1}$	
^{55}Fe	$3.958 \cdot 10^{-2}$	7.465	^{121m}Sn	$6.563 \cdot 10^{1}$	
^{60}Fe	$1.459 \cdot 10^{-4}$		^{124}Sn	$1.316 \cdot 10^{-1}$	
^{60}Co	$8.202 \cdot 10^{2}$	0.3782	^{123}Te	$1.259 \cdot 10^{-19}$	
^{58}Ni	$5.363 \cdot 10^{-1}$		^{176}Lu	$5.035 \cdot 10^{-13}$	
^{59}Ni	$4.406 \cdot 10^{6}$		^{179n}Hf	$6.356 \cdot 10^{-2}$	
^{63}Ni	$2.400 \cdot 10^{8}$	0.1143	^{182}Hf	$4.137 \cdot 10^{-7}$	
^{64}Zn	$4.371 \cdot 10^{-10}$		^{180m}Ta	$9.938 \cdot 10^{-3}$	
^{93}Zr	$5.529 \cdot 10^{-1}$		^{183}W	$1.909 \cdot 10^{-1}$	
^{94}Zr	$3.319 \cdot 10^{-12}$		^{184}W	$1.124 \cdot 10^{-1}$	
^{96}Zr	$2.419 \cdot 10^{-17}$		^{186}W	$7.070 \cdot 10^{-2}$	
^{91}Nb	$5.331 \cdot 10^{3}$		^{186m}Re	$3.782 \cdot 10^{-9}$	
^{92}Nb	$4.530 \cdot 10^{0}$		^{187}Re	$7.696 \cdot 10^{-3}$	
^{93m}Nb	$2.344 \cdot 10^{5}$		^{186}Os	$1.770 \cdot 10^{-15}$	

9.2.10 Frame cell 2 - 1000 years

Table 55: Activity in steam dryer frame cell 2 - 1000 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{10}Be	$1.288 \cdot 10^{-1}$		^{92}Mo	$5.490 \cdot 10^{-2}$	
^{14}C	$4.962 \cdot 10^{5}$		^{93}Mo	$1.976 \cdot 10^{5}$	
^{26}Al	$7.291 \cdot 10^{-4}$		^{98}Mo	$1.696 \cdot 10^{5}$	
^{32}Si	$3.513 \cdot 10^{-3}$		^{100}Mo	$9.273 \cdot 10^{-1}$	
^{36}Cl	$1.561 \cdot 10^{2}$		^{98}Tc	$4.508 \cdot 10^{-10}$	
^{39}Ar	$1.405 \cdot 10^{-5}$		^{99}Tc	$7.255 \cdot 10^{3}$	
^{40}K	$2.046 \cdot 10^{-10}$		^{108}Cd	$3.952 \cdot 10^{-17}$	
^{48}Ca	$2.510 \cdot 10^{-22}$		^{113}Cd	$2.645 \cdot 10^{-14}$	
^{50}V	$9.456 \cdot 10^{-4}$		^{114}Cd	$1.343 \cdot 10^{-15}$	
^{50}Cr	$2.129 \cdot 10^{2}$		^{116}Cd	$6.041 \cdot 10^{-19}$	
^{53}Mn	$1.146 \cdot 10^{1}$		^{115}In	$3.717 \cdot 10^{-13}$	
^{60}Fe	$1.459 \cdot 10^{-4}$		^{121m}Sn	$4.535 \cdot 10^{-5}$	
^{60}Co	$1.455 \cdot 10^{-4}$	0.3782	^{124}Sn	$1.316 \cdot 10^{-1}$	
^{58}Ni	$5.363 \cdot 10^{-1}$		^{123}Te	$1.259 \cdot 10^{-19}$	
^{59}Ni	$4.370 \cdot 10^{6}$		^{176}Lu	$5.035 \cdot 10^{-13}$	
^{63}Ni	$4.317 \cdot 10^{5}$	0.1143	^{179n}Hf	$6.356 \cdot 10^{-2}$	
^{64}Zn	$4.371 \cdot 10^{-10}$		^{182}Hf	$2.891 \cdot 10^{-7}$	
^{93}Zr	$5.527 \cdot 10^{-1}$		^{180m}Ta	$9.938 \cdot 10^{-3}$	
^{94}Zr	$3.319 \cdot 10^{-12}$		^{183}W	$1.909 \cdot 10^{-1}$	
^{96}Zr	$2.419 \cdot 10^{-17}$		^{184}W	$1.124 \cdot 10^{-1}$	
^{91}Nb	$2.130 \cdot 10^{3}$		^{186}W	$7.070 \cdot 10^{-2}$	
^{92}Nb	$4.530 \cdot 10^{0}$		^{186m}Re	$3.769 \cdot 10^{-9}$	
^{93m}Nb	$1.689 \cdot 10^{5}$		^{187}Re	$7.696 \cdot 10^{-3}$	
^{94}Nb	$4.685 \cdot 10^{3}$		^{186}Os	$1.280 \cdot 10^{-14}$	

9.2.11 Frame cell 3 - 3 days

Table 56: Activity in steam dryer frame cell 3 - 3 days after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$5.641 \cdot 10^{4}$		^{63}Ni	$1.060 \cdot 10^{8}$	0.08190
^{10}Be	$2.022 \cdot 10^{-2}$		^{64}Cu	$5.174 \cdot 10^{5}$	1.540
^{14}C	$1.167 \cdot 10^{5}$		^{64}Zn	$9.479 \cdot 10^{-11}$	
^{26}Al	$1.145 \cdot 10^{-4}$		^{65}Zn	$4.527 \cdot 10^{-4}$	
^{32}Si	$4.502 \cdot 10^{-3}$		^{72}Ga	$1.800 \cdot 10^{0}$	
^{32}P	$1.230 \cdot 10^{6}$		^{73}As	$1.188 \cdot 10^{-1}$	
^{33}P	$6.003 \cdot 10^{3}$		^{74}As	$1.062 \cdot 10^{3}$	
^{35}S	$3.676 \cdot 10^{4}$		^{76}As	$5.232 \cdot 10^{5}$	1.444
^{36}Cl	$3.431 \cdot 10^{1}$		^{88}Y	$9.842 \cdot 10^{0}$	
^{39}Ar	$2.895 \cdot 10^{-6}$		^{89m}Y	$5.942 \cdot 10^{3}$	
^{40}K	$3.210 \cdot 10^{-11}$		^{90}Y	$1.136 \cdot 10^{2}$	
^{45}Ca	$2.023 \cdot 10^{2}$		^{91}Y	$6.177 \cdot 10^{-4}$	
^{47}Ca	$1.975 \cdot 10^{0}$		^{88}Zr	$1.011 \cdot 10^{1}$	
^{48}Ca	$3.938 \cdot 10^{-23}$		^{89}Zr	$5.949 \cdot 10^{3}$	
^{46}Sc	$5.323 \cdot 10^{3}$		^{93}Zr	$8.673 \cdot 10^{-2}$	
^{47}Sc	$4.313 \cdot 10^{3}$		^{94}Zr	$5.207 \cdot 10^{-13}$	
^{48}Sc	$4.283 \cdot 10^{2}$		^{95}Zr	$1.532 \cdot 10^{3}$	
^{48}V	$2.890 \cdot 10^{0}$		^{96}Zr	$3.794 \cdot 10^{-18}$	
^{49}V	$3.101 \cdot 10^{4}$		^{97}Zr	$4.324 \cdot 10^{0}$	
^{50}V	$7.273 \cdot 10^{-4}$		^{91}Nb	$9.259 \cdot 10^{2}$	
^{50}Cr	$1.637 \cdot 10^{2}$		^{91m}Nb	$9.543 \cdot 10^{-1}$	
^{51}Cr	$1.054 \cdot 10^{9}$	0.07149	^{92}Nb	$7.105 \cdot 10^{-1}$	
^{52}Mn	$2.657 \cdot 10^{0}$		^{92m}Nb	$1.109 \cdot 10^{3}$	
^{53}Mn	$1.798 \cdot 10^{0}$		^{93m}Nb	$3.426 \cdot 10^{5}$	
^{54}Mn	$1.267 \cdot 10^{8}$	2.314	^{94}Nb	$9.689 \cdot 10^{2}$	
^{56}Mn	$6.685 \cdot 10^{0}$	1.171	^{95}Nb	$7.800 \cdot 10^{3}$	
^{55}Fe	$7.669 \cdot 10^{8}$	7.618	^{95m}Nb	$1.696 \cdot 10^{1}$	
^{59}Fe	$2.221 \cdot 10^{7}$	5.202	^{96}Nb	$2.802 \cdot 10^{2}$	
^{60}Fe	$2.289 \cdot 10^{-5}$		^{97}Nb	$4.662 \cdot 10^{0}$	
^{56}Co	$3.841 \cdot 10^{2}$		^{92}Mo	$4.223 \cdot 10^{-2}$	
^{57}Co	$7.747 \cdot 10^{5}$		^{93}Mo	$4.182 \cdot 10^{4}$	
^{58}Co	$4.040 \cdot 10^{8}$	2.703	^{98}Mo	$1.305 \cdot 10^{5}$	
^{58m}Co	$5.559 \cdot 10^{5}$	3.412	^{99}Mo	$6.080 \cdot 10^{6}$	0.000
^{60}Co	$9.100 \cdot 10^{7}$	0.2745	^{100}Mo	$7.133 \cdot 10^{-1}$	
^{57}Ni	$3.981 \cdot 10^{3}$		^{98}Tc	$1.669 \cdot 10^{-11}$	
^{58}Ni	$4.126 \cdot 10^{-1}$		^{99}Tc	$1.318 \cdot 10^{3}$	
^{59}Ni	$9.596 \cdot 10^{5}$		^{99m}Tc	$5.873 \cdot 10^{6}$	0.000

Table 57: Activity in steam dryer frame cell 3 - 3 days after shut-down (continued)

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{108}Cd	$6.199 \cdot 10^{-18}$		^{125m}Te	$1.262 \cdot 10^{3}$	
^{109}Cd	$7.687 \cdot 10^{0}$		^{176}Lu	$7.898 \cdot 10^{-14}$	
^{113}Cd	$4.149 \cdot 10^{-15}$		^{177}Lu	$5.659 \cdot 10^{-2}$	
^{114}Cd	$2.108 \cdot 10^{-16}$		^{177m}Lu	$7.590 \cdot 10^{-5}$	
^{115}Cd	$1.299 \cdot 10^{-1}$		^{179n}Hf	$4.889 \cdot 10^{-2}$	
^{116}Cd	$9.476 \cdot 10^{-20}$		^{181}Hf	$2.843 \cdot 10^{0}$	
^{111}In	$3.204 \cdot 10^{0}$		^{182}Hf	$8.050 \cdot 10^{-8}$	
^{113m}In	$8.578 \cdot 10^{3}$		^{179}Ta	$2.686 \cdot 10^{1}$	
^{115}In	$5.831 \cdot 10^{-14}$		^{180}Ta	$2.346 \cdot 10^{1}$	
^{115m}In	$1.418 \cdot 10^{-1}$		^{180m}Ta	$7.644 \cdot 10^{-3}$	
^{113}Sn	$8.573 \cdot 10^{3}$		^{182}Ta	$7.343 \cdot 10^{6}$	0.000
^{117m}Sn	$9.261 \cdot 10^{-3}$		^{183}Ta	$6.244 \cdot 10^{-1}$	
^{119m}Sn	$6.323 \cdot 10^{-1}$		^{178}W	$7.299 \cdot 10^{-3}$	
^{121}Sn	$6.986 \cdot 10^{3}$		^{181}W	$4.998 \cdot 10^{4}$	
^{121m}Sn	$4.993 \cdot 10^{1}$		^{183}W	$1.468 \cdot 10^{-1}$	
^{123}Sn	$1.732 \cdot 10^{3}$		^{184}W	$8.645 \cdot 10^{-2}$	
^{124}Sn	$1.012 \cdot 10^{-1}$		^{185}W	$1.858 \cdot 10^{5}$	
^{125}Sn	$4.583 \cdot 10^{2}$		^{186}W	$5.438 \cdot 10^{-2}$	
^{119}Sb	$1.761 \cdot 10^{-2}$		^{187}W	$4.152 \cdot 10^{5}$	5.386
^{122}Sb	$9.309 \cdot 10^{4}$		^{186m}Re	$1.969 \cdot 10^{-10}$	
^{124}Sb	$9.944 \cdot 10^{4}$		^{187}Re	$1.672 \cdot 10^{-3}$	
^{125}Sb	$5.486 \cdot 10^{3}$		^{186}Os	$3.354 \cdot 10^{-16}$	
^{123}Te	$6.936 \cdot 10^{-21}$				

9.2.12 Frame cell 3 - 1 year

Table 58: Activity in steam dryer frame cell 3 - 1 year after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$5.336 \cdot 10^{4}$		^{74}As	$7.939 \cdot 10^{-4}$	
^{10}Be	$2.022 \cdot 10^{-2}$		^{88}Y	$2.594 \cdot 10^{0}$	
^{14}C	$1.167 \cdot 10^{5}$		^{88}Zr	$4.989 \cdot 10^{-1}$	
^{26}Al	$1.145 \cdot 10^{-4}$		^{93}Zr	$8.673 \cdot 10^{-2}$	
^{32}Si	$4.493 \cdot 10^{-4}$		^{94}Zr	$5.207 \cdot 10^{-13}$	
^{32}P	$2.965 \cdot 10^{-2}$		^{95}Zr	$3.043 \cdot 10^{1}$	
^{33}P	$3.058 \cdot 10^{-1}$		^{96}Zr	$3.794 \cdot 10^{-18}$	
^{35}S	$2.072 \cdot 10^{3}$		^{91}Nb	$9.250 \cdot 10^{2}$	
^{36}Cl	$3.431 \cdot 10^{1}$		^{91m}Nb	$1.550 \cdot 10^{-2}$	
^{39}Ar	$2.888 \cdot 10^{-6}$		^{92}Nb	$7.105 \cdot 10^{-1}$	
^{40}K	$3.210 \cdot 10^{-11}$		^{93m}Nb	$3.298 \cdot 10^{5}$	
^{45}Ca	$4.324 \cdot 10^{1}$		^{94}Nb	$9.689 \cdot 10^{2}$	
^{48}Ca	$3.938 \cdot 10^{-23}$		^{95}Nb	$7.053 \cdot 10^{1}$	
^{46}Sc	$2.664 \cdot 10^{2}$		^{95m}Nb	$3.484 \cdot 10^{-1}$	
^{49}V	$1.450 \cdot 10^{4}$		^{92}Mo	$4.223 \cdot 10^{-2}$	
^{50}V	$7.273 \cdot 10^{-4}$		^{93}Mo	$4.181 \cdot 10^{4}$	
^{50}Cr	$1.637 \cdot 10^{2}$		^{98}Mo	$1.305 \cdot 10^{5}$	
^{51}Cr	$1.229 \cdot 10^{5}$	0.07149	^{100}Mo	$7.133 \cdot 10^{-1}$	
^{53}Mn	$1.798 \cdot 10^{0}$		^{98}Tc	$1.669 \cdot 10^{-11}$	
^{54}Mn	$5.672 \cdot 10^{7}$	2.314	^{99}Tc	$1.318 \cdot 10^{3}$	
^{55}Fe	$5.972 \cdot 10^{8}$	7.618	^{108}Cd	$6.199 \cdot 10^{-18}$	
^{59}Fe	$7.894 \cdot 10^{4}$	5.202	^{109}Cd	$4.465 \cdot 10^{0}$	
^{60}Fe	$2.289 \cdot 10^{-5}$		^{113}Cd	$4.149 \cdot 10^{-15}$	
^{56}Co	$1.491 \cdot 10^{1}$		^{114}Cd	$2.108 \cdot 10^{-16}$	
^{57}Co	$3.078 \cdot 10^{5}$		^{116}Cd	$9.476 \cdot 10^{-20}$	
^{58}Co	$1.170 \cdot 10^{7}$	2.703	^{113m}In	$9.695 \cdot 10^{2}$	
^{60}Co	$7.988 \cdot 10^{7}$	0.2745	^{115}In	$5.831 \cdot 10^{-14}$	
^{58}Ni	$4.126 \cdot 10^{-1}$		^{113}Sn	$9.689 \cdot 10^{2}$	
^{59}Ni	$9.596 \cdot 10^{5}$		^{119m}Sn	$2.685 \cdot 10^{-1}$	
^{63}Ni	$1.053 \cdot 10^{8}$	0.08190	^{121}Sn	$3.814 \cdot 10^{1}$	
^{64}Zn	$9.479 \cdot 10^{-11}$		^{121m}Sn	$4.915 \cdot 10^{1}$	
^{65}Zn	$1.619 \cdot 10^{-4}$		^{123}Sn	$2.484 \cdot 10^{2}$	
^{73}As	$5.221 \cdot 10^{-3}$		^{124}Sn	$1.012 \cdot 10^{-1}$	

Table 59: Activity in steam dryer frame cell 3 - 1 year after shut-down (continued)

Radionuclides	Activity [Bq]	Uncertainty (cross-section only) [%]
^{124}Sb	$1.540 \cdot 10^{3}$	
^{125}Sb	$4.280 \cdot 10^{3}$	
^{123}Te	$6.958 \cdot 10^{-21}$	
^{125m}Te	$1.047 \cdot 10^{3}$	
^{176}Lu	$7.898 \cdot 10^{-14}$	
^{179n}Hf	$4.889 \cdot 10^{-2}$	
^{181}Hf	$7.630 \cdot 10^{-3}$	
^{182}Hf	$8.259 \cdot 10^{-8}$	
^{179}Ta	$1.753 \cdot 10^{1}$	
^{180m}Ta	$7.644 \cdot 10^{-3}$	
^{182}Ta	$8.238 \cdot 10^{5}$	0.000
^{181}W	$6.281 \cdot 10^{3}$	
^{183}W	$1.468 \cdot 10^{-1}$	
^{184}W	$8.645 \cdot 10^{-2}$	
^{185}W	$6.557 \cdot 10^{3}$	
^{186}W	$5.438 \cdot 10^{-2}$	
^{186m}Re	$1.969 \cdot 10^{-10}$	
^{187}Re	$1.672 \cdot 10^{-3}$	
^{186}Os	$3.447 \cdot 10^{-16}$	

9.2.13 Frame cell 3 - 30 years

Table 60: Activity in steam dryer frame cell 3 - 30 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$1.045 \cdot 10^{4}$		^{93}Mo	$4.154 \cdot 10^{4}$	
^{10}Be	$2.022 \cdot 10^{-2}$		^{98}Mo	$1.305 \cdot 10^{5}$	
^{14}C	$1.163 \cdot 10^{5}$		^{100}Mo	$7.133 \cdot 10^{-1}$	
^{26}Al	$1.145 \cdot 10^{-4}$		^{98}Tc	$1.669 \cdot 10^{-11}$	
^{32}Si	$4.227 \cdot 10^{-4}$		^{99}Tc	$1.318 \cdot 10^{3}$	
^{36}Cl	$3.430 \cdot 10^{1}$		^{108}Cd	$6.199 \cdot 10^{-18}$	
^{39}Ar	$2.680 \cdot 10^{-6}$		^{113}Cd	$4.149 \cdot 10^{-15}$	
^{40}K	$3.210 \cdot 10^{-11}$		^{114}Cd	$2.108 \cdot 10^{-16}$	
^{48}Ca	$3.938 \cdot 10^{-23}$		^{116}Cd	$9.476 \cdot 10^{-20}$	
^{50}V	$7.273 \cdot 10^{-4}$		^{115}In	$5.831 \cdot 10^{-14}$	
^{50}Cr	$1.637 \cdot 10^{2}$		^{121}Sn	$2.413 \cdot 10^{1}$	
^{53}Mn	$1.798 \cdot 10^{0}$		^{121m}Sn	$3.109 \cdot 10^{1}$	
^{54}Mn	$3.521 \cdot 10^{-3}$	2.314	^{124}Sn	$1.012 \cdot 10^{-1}$	
^{55}Fe	$3.964 \cdot 10^{5}$	7.618	^{125}Sb	$2.929 \cdot 10^{0}$	
^{60}Fe	$2.289 \cdot 10^{-5}$		^{123}Te	$6.961 \cdot 10^{-21}$	
^{60}Co	$1.763 \cdot 10^{6}$	0.2745	^{125m}Te	$7.174 \cdot 10^{-1}$	
^{58}Ni	$4.126 \cdot 10^{-1}$		^{176}Lu	$7.898 \cdot 10^{-14}$	
^{59}Ni	$9.593 \cdot 10^{5}$		^{179n}Hf	$4.889 \cdot 10^{-2}$	
^{63}Ni	$8.596 \cdot 10^{7}$	0.08190	^{182}Hf	$1.440 \cdot 10^{-7}$	
^{64}Zn	$9.479 \cdot 10^{-11}$		^{179}Ta	$6.623 \cdot 10^{-5}$	
^{93}Zr	$8.673 \cdot 10^{-2}$		^{180m}Ta	$7.644 \cdot 10^{-3}$	
^{94}Zr	$5.207 \cdot 10^{-13}$		^{183}W	$1.468 \cdot 10^{-1}$	
^{96}Zr	$3.794 \cdot 10^{-18}$		^{184}W	$8.645 \cdot 10^{-2}$	
^{91}Nb	$8.981 \cdot 10^{2}$		^{186}W	$5.438 \cdot 10^{-2}$	
^{92}Nb	$7.105 \cdot 10^{-1}$		^{186m}Re	$1.969 \cdot 10^{-10}$	
^{93m}Nb	$1.200 \cdot 10^{5}$		^{187}Re	$1.672 \cdot 10^{-3}$	
^{94}Nb	$9.679 \cdot 10^{2}$		^{186}Os	$6.180 \cdot 10^{-16}$	
^{92}Mo	$4.223 \cdot 10^{-2}$				

9.2.14 Frame cell 3 - 100 years

Table 61: Activity in steam dryer frame cell 3 - 100 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$2.043 \cdot 10^{2}$		^{98}Mo	$1.305 \cdot 10^{5}$	
^{10}Be	$2.021 \cdot 10^{-2}$		^{100}Mo	$7.133 \cdot 10^{-1}$	
^{14}C	$1.153 \cdot 10^{5}$		^{98}Tc	$1.669 \cdot 10^{-11}$	
^{26}Al	$1.145 \cdot 10^{-4}$		^{99}Tc	$1.318 \cdot 10^{3}$	
^{32}Si	$3.649 \cdot 10^{-4}$		^{108}Cd	$6.199 \cdot 10^{-18}$	
^{36}Cl	$3.430 \cdot 10^{1}$		^{113}Cd	$4.149 \cdot 10^{-15}$	
^{39}Ar	$2.238 \cdot 10^{-6}$		^{114}Cd	$2.108 \cdot 10^{-16}$	
^{40}K	$3.210 \cdot 10^{-11}$		^{116}Cd	$9.476 \cdot 10^{-20}$	
^{48}Ca	$3.938 \cdot 10^{-23}$		^{115}In	$5.831 \cdot 10^{-14}$	
^{50}V	$7.273 \cdot 10^{-4}$		^{121}Sn	$7.978 \cdot 10^{0}$	
^{50}Cr	$1.637 \cdot 10^{2}$		^{121m}Sn	$1.030 \cdot 10^{1}$	
^{53}Mn	$1.798 \cdot 10^{0}$		^{124}Sn	$1.012 \cdot 10^{-1}$	
^{55}Fe	$8.458 \cdot 10^{-3}$	7.618	^{123}Te	$6.961 \cdot 10^{-21}$	
^{60}Fe	$2.289 \cdot 10^{-5}$		^{176}Lu	$7.898 \cdot 10^{-14}$	
^{60}Co	$1.772 \cdot 10^{2}$	0.2745	^{179n}Hf	$4.889 \cdot 10^{-2}$	
^{58}Ni	$4.126 \cdot 10^{-1}$		^{182}Hf	$2.923 \cdot 10^{-7}$	
^{59}Ni	$9.587 \cdot 10^{5}$		^{180m}Ta	$7.644 \cdot 10^{-3}$	
^{63}Ni	$5.252 \cdot 10^{7}$	0.08190	^{183}W	$1.468 \cdot 10^{-1}$	
^{64}Zn	$9.479 \cdot 10^{-11}$		^{184}W	$8.645 \cdot 10^{-2}$	
^{93}Zr	$8.673 \cdot 10^{-2}$		^{186}W	$5.438 \cdot 10^{-2}$	
^{94}Zr	$5.207 \cdot 10^{-13}$		^{186m}Re	$1.968 \cdot 10^{-10}$	
^{96}Zr	$3.794 \cdot 10^{-18}$		^{187}Re	$1.672 \cdot 10^{-3}$	
^{91}Nb	$8.362 \cdot 10^{2}$		^{186}Os	$1.278 \cdot 10^{-15}$	
^{92}Nb	$7.105 \cdot 10^{-1}$				
^{93m}Nb	$3.909 \cdot 10^{4}$				
^{94}Nb	$9.656 \cdot 10^{2}$				
^{92}Mo	$4.223 \cdot 10^{-2}$				
^{93}Mo	$4.087 \cdot 10^{4}$				

9.2.15 Frame cell 3 - 1000 years

Table 62: Activity in steam dryer frame cell 3 - 1000 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{10}Be	$2.021 \cdot 10^{-2}$		^{93}Mo	$3.323 \cdot 10^{4}$	
^{14}C	$1.033 \cdot 10^{5}$		^{98}Mo	$1.305 \cdot 10^{5}$	
^{26}Al	$1.144 \cdot 10^{-4}$		^{100}Mo	$7.133 \cdot 10^{-1}$	
^{32}Si	$5.511 \cdot 10^{-5}$		^{98}Tc	$1.669 \cdot 10^{-11}$	
^{36}Cl	$3.423 \cdot 10^{1}$		^{99}Tc	$1.314 \cdot 10^{3}$	
^{39}Ar	$2.201 \cdot 10^{-7}$		^{108}Cd	$6.199 \cdot 10^{-18}$	
^{40}K	$3.210 \cdot 10^{-11}$		^{113}Cd	$4.149 \cdot 10^{-15}$	
^{48}Ca	$3.938 \cdot 10^{-23}$		^{114}Cd	$2.108 \cdot 10^{-16}$	
^{50}V	$7.273 \cdot 10^{-4}$		^{116}Cd	$9.476 \cdot 10^{-20}$	
^{50}Cr	$1.637 \cdot 10^{2}$		^{115}In	$5.831 \cdot 10^{-14}$	
^{53}Mn	$1.797 \cdot 10^{0}$		^{121m}Sn	$7.218 \cdot 10^{6}$	
^{60}Fe	$2.288 \cdot 10^{-5}$		^{124}Sn	$1.012 \cdot 10^{-1}$	
^{60}Co	$2.283 \cdot 10^{-5}$	0.2745	^{123}Te	$6.961 \cdot 10^{-21}$	
^{58}Ni	$4.126 \cdot 10^{-1}$		^{176}Lu	$7.898 \cdot 10^{-14}$	
^{59}Ni	$9.509 \cdot 10^{5}$		^{179n}Hf	$4.889 \cdot 10^{-2}$	
^{63}Ni	$9.449 \cdot 10^{4}$	0.08190	^{182}Hf	$2.198 \cdot 10^{-6}$	
^{64}Zn	$9.479 \cdot 10^{-11}$		^{180m}Ta	$7.644 \cdot 10^{-3}$	
^{93}Zr	$8.670 \cdot 10^{-2}$		^{183}W	$1.468 \cdot 10^{-1}$	
^{94}Zr	$5.207 \cdot 10^{-13}$		^{184}W	$8.645 \cdot 10^{-2}$	
^{96}Zr	$3.794 \cdot 10^{-18}$		^{186}W	$5.438 \cdot 10^{-2}$	
^{91}Nb	$3.341 \cdot 10^{2}$		^{186m}Re	$1.96 \cdot 10^{-10}$	
^{92}Nb	$7.105 \cdot 10^{-1}$		^{187}Re	$1.672 \cdot 10^{-3}$	
^{93m}Nb	$2.839 \cdot 10^{4}$		^{186}Os	$9.759 \cdot 10^{-15}$	
^{94}Nb	$9.359 \cdot 10^{2}$				
^{92}Mo	$4.223 \cdot 10^{-2}$				

9.2.16 Package - 3 days

Table 63: Activity in steam dryer package - 3 days after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$7.193 \cdot 10^{4}$		^{63}Ni	$1.351 \cdot 10^{8}$	0.08190
^{10}Be	$2.578 \cdot 10^{-2}$		^{64}Cu	$6.597 \cdot 10^{5}$	1.540
^{14}C	$1.488 \cdot 10^{5}$		^{64}Zn	$1.209 \cdot 10^{-10}$	
^{26}Al	$1.460 \cdot 10^{-4}$		^{65}Zn	$5.772 \cdot 10^{-4}$	
^{32}Si	$5.740 \cdot 10^{-4}$		^{72}Ga	$2.295 \cdot 10^{0}$	
^{32}P	$1.569 \cdot 10^{6}$		^{73}As	$1.515 \cdot 10^{-1}$	
^{33}P	$7.654 \cdot 10^{3}$		^{74}As	$1.355 \cdot 10^{3}$	
^{35}S	$4.687 \cdot 10^{4}$		^{76}As	$6.671 \cdot 10^{5}$	1.444
^{36}Cl	$4.374 \cdot 10^{1}$		^{88}Y	$1.255 \cdot 10^{1}$	
^{39}Ar	$3.692 \cdot 10^{-6}$		^{89m}Y	$7.576 \cdot 10^{3}$	
^{40}K	$4.093 \cdot 10^{-11}$		^{90}Y	$1.448 \cdot 10^{2}$	
^{45}Ca	$2.579 \cdot 10^{2}$		^{91}Y	$7.876 \cdot 10^{-4}$	
^{47}Ca	$2.518 \cdot 10^{0}$		^{88}Zr	$1.289 \cdot 10^{1}$	
^{48}Ca	$5.021 \cdot 10^{-23}$		^{89}Zr	$7.585 \cdot 10^{3}$	
^{46}Sc	$6.787 \cdot 10^{3}$		^{93}Zr	$1.106 \cdot 10^{-1}$	
^{47}Sc	$5.499 \cdot 10^{3}$		^{94}Zr	$6.639 \cdot 10^{-13}$	
^{48}Sc	$5.460 \cdot 10^{2}$		^{95}Zr	$1.953 \cdot 10^{3}$	
^{48}V	$3.684 \cdot 10^{0}$		^{96}Zr	$4.838 \cdot 10^{-18}$	
^{49}V	$3.954 \cdot 10^{4}$		^{97}Zr	$5.513 \cdot 10^{0}$	
^{50}V	$9.274 \cdot 10^{-4}$		^{91}Nb	$1.181 \cdot 10^{3}$	
^{50}Cr	$2.088 \cdot 10^{2}$		^{91m}Nb	$1.217 \cdot 10^{0}$	
^{51}Cr	$1.344 \cdot 10^{9}$	0.07149	^{92}Nb	$9.060 \cdot 10^{-1}$	
^{52}Mn	$3.387 \cdot 10^{0}$		^{92m}Nb	$1.415 \cdot 10^{3}$	
^{53}Mn	$2.292 \cdot 10^{0}$		^{93m}Nb	$4.369 \cdot 10^{5}$	
^{54}Mn	$1.615 \cdot 10^{8}$	2.314	^{94}Nb	$1.235 \cdot 10^{3}$	
^{56}Mn	$8.552 \cdot 10^{0}$	1.171	^{95}Nb	$9.945 \cdot 10^{3}$	
^{55}Fe	$9.778 \cdot 10^{8}$	7.618	^{95m}Nb	$2.162 \cdot 10^{1}$	
^{59}Fe	$2.831 \cdot 10^{7}$	5.202	^{96}Nb	$3.573 \cdot 10^{2}$	
^{60}Fe	$2.919 \cdot 10^{-5}$		^{97}Nb	$5.945 \cdot 10^{0}$	
^{56}Co	$4.898 \cdot 10^{2}$		^{92}Mo	$5.385 \cdot 10^{-2}$	
^{57}Co	$9.878 \cdot 10^{5}$		^{93}Mo	$5.333 \cdot 10^{4}$	
^{58}Co	$5.152 \cdot 10^{8}$	2.703	^{98}Mo	$1.664 \cdot 10^{5}$	
^{58m}Co	$7.088 \cdot 10^{5}$	3.412	^{99}Mo	$7.752 \cdot 10^{6}$	0.000
^{60}Co	$1.160 \cdot 10^{8}$	0.2745	^{100}Mo	$9.095 \cdot 10^{-1}$	
^{57}Ni	$5.076 \cdot 10^{3}$		^{98}Tc	$2.128 \cdot 10^{-11}$	
^{58}Ni	$5.260 \cdot 10^{-1}$		^{99}Tc	$1.681 \cdot 10^{3}$	
^{59}Ni	$1.224 \cdot 10^{6}$		^{99m}Tc	$7.489 \cdot 10^{6}$	0.000

Table 64: Activity in steam dryer package - 3 days after shut-down (continued)

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{108}Cd	$7.903 \cdot 10^{-18}$		^{125m}Te	$1.609 \cdot 10^{3}$	
^{109}Cd	$9.801 \cdot 10^{0}$		^{176}Lu	$1.007 \cdot 10^{-13}$	
^{113}Cd	$5.290 \cdot 10^{-15}$		^{177}Lu	$7.215 \cdot 10^{-2}$	
^{114}Cd	$2.687 \cdot 10^{-16}$		^{177m}Lu	$9.678 \cdot 10^{-5}$	
^{115}Cd	$1.656 \cdot 10^{-1}$		^{179n}Hf	$6.234 \cdot 10^{-2}$	
^{116}Cd	$1.208 \cdot 10^{-19}$		^{181}Hf	$3.625 \cdot 10^{0}$	
^{111}In	$4.085 \cdot 10^{0}$		^{182}Hf	$1.026 \cdot 10^{-7}$	
^{113m}In	$1.094 \cdot 10^{4}$		^{179}Ta	$3.424 \cdot 10^{1}$	
^{115}In	$7.435 \cdot 10^{-14}$		^{180}Ta	$2.991 \cdot 10^{1}$	
^{115m}In	$1.808 \cdot 10^{-1}$		^{180m}Ta	$9.747 \cdot 10^{-3}$	
^{113}Sn	$1.093 \cdot 10^{4}$		^{182}Ta	$9.362 \cdot 10^{6}$	0.000
^{117m}Sn	$1.181 \cdot 10^{-2}$		^{183}Ta	$7.962 \cdot 10^{-1}$	
^{119m}Sn	$8.061 \cdot 10^{-1}$		^{178}W	$9.306 \cdot 10^{-3}$	
^{121}Sn	$8.908 \cdot 10^{3}$		^{181}W	$6.372 \cdot 10^{4}$	
^{121m}Sn	$6.366 \cdot 10^{1}$		^{183}W	$1.872 \cdot 10^{-1}$	
^{123}Sn	$2.209 \cdot 10^{3}$		^{184}W	$1.102 \cdot 10^{-1}$	
^{124}Sn	$1.290 \cdot 10^{-1}$		^{185}W	$2.369 \cdot 10^{5}$	
^{125}Sn	$5.843 \cdot 10^{2}$		^{186}W	$6.934 \cdot 10^{-2}$	
^{119}Sb	$2.245 \cdot 10^{-2}$		^{187}W	$5.293 \cdot 10^{5}$	5.386
^{122}Sb	$1.187 \cdot 10^{5}$		^{186m}Re	$2.511 \cdot 10^{-10}$	
^{124}Sb	$1.268 \cdot 10^{5}$		^{187}Re	$2.132 \cdot 10^{-3}$	
^{125}Sb	$6.995 \cdot 10^{3}$		^{186}Os	$4.276 \cdot 10^{-16}$	
^{123}Te	$8.844 \cdot 10^{-21}$				

9.2.17 Package - 1 year

Table 65: Activity in steam dryer package - 1 year after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$6.803 \cdot 10^{4}$		^{88}Y	$3.308 \cdot 10^{0}$	
^{10}Be	$2.578 \cdot 10^{-2}$		^{88}Zr	$6.361 \cdot 10^{-1}$	
^{14}C	$1.488 \cdot 10^{5}$		^{93}Zr	$1.106 \cdot 10^{-1}$	
^{26}Al	$1.460 \cdot 10^{-4}$		^{94}Zr	$6.639 \cdot 10^{-13}$	
^{32}Si	$5.729 \cdot 10^{-4}$		^{95}Zr	$3.880 \cdot 10^{1}$	
^{32}P	$3.775 \cdot 10^{-2}$		^{96}Zr	$4.838 \cdot 10^{-18}$	
^{33}P	$3.899 \cdot 10^{-1}$		^{91}Nb	$1.179 \cdot 10^{3}$	
^{35}S	$2.642 \cdot 10^{3}$		^{91m}Nb	$1.976 \cdot 10^{-2}$	
^{36}Cl	$4.374 \cdot 10^{1}$		^{92}Nb	$9.060 \cdot 10^{-1}$	
^{39}Ar	$3.682 \cdot 10^{-6}$		^{93m}Nb	$4.205 \cdot 10^{5}$	
^{40}K	$4.093 \cdot 10^{-11}$		^{94}Nb	$1.235 \cdot 10^{3}$	
^{45}Ca	$5.513 \cdot 10^{1}$		^{95}Nb	$8.992 \cdot 10^{1}$	
^{48}Ca	$5.021 \cdot 10^{-23}$		^{95m}Nb	$4.443 \cdot 10^{-1}$	
^{46}Sc	$3.397 \cdot 10^{3}$		^{92}Mo	$5.385 \cdot 10^{-2}$	
^{49}V	$1.849 \cdot 10^{4}$		^{93}Mo	$5.331 \cdot 10^{4}$	
^{50}V	$9.274 \cdot 10^{-4}$		^{98}Mo	$1.664 \cdot 10^{5}$	
^{50}Cr	$2.088 \cdot 10^{2}$		^{100}Mo	$9.095 \cdot 10^{-1}$	
^{51}Cr	$1.567 \cdot 10^{5}$	0.07149	^{98}Tc	$2.128 \cdot 10^{-11}$	
^{53}Mn	$2.292 \cdot 10^{0}$		^{99}Tc	$1.681 \cdot 10^{3}$	
^{54}Mn	$7.231 \cdot 10^{7}$	2.314	^{108}Cd	$7.903 \cdot 10^{-18}$	
^{55}Fe	$7.615 \cdot 10^{8}$	7.618	^{109}Cd	$5.693 \cdot 10^{0}$	
^{59}Fe	$1.007 \cdot 10^{5}$	5.202	^{113}Cd	$5.290 \cdot 10^{-15}$	
^{60}Fe	$2.919 \cdot 10^{-5}$		^{114}Cd	$2.687 \cdot 10^{-16}$	
^{56}Co	$1.901 \cdot 10^{1}$		^{116}Cd	$1.208 \cdot 10^{-19}$	
^{57}Co	$3.924 \cdot 10^{5}$		^{113m}In	$1.236 \cdot 10^{3}$	
^{58}Co	$1.492 \cdot 10^{7}$	2.703	^{115}In	$7.435 \cdot 10^{-14}$	
^{60}Co	$1.019 \cdot 10^{8}$	0.2745	^{113}Sn	$1.235 \cdot 10^{3}$	
^{58}Ni	$5.260 \cdot 10^{-1}$		^{119m}Sn	$3.424 \cdot 10^{-1}$	
^{59}Ni	$1.224 \cdot 10^{6}$		^{121}Sn	$4.863 \cdot 10^{1}$	
^{63}Ni	$1.342 \cdot 10^{8}$	0.08190	^{121m}Sn	$6.267 \cdot 10^{1}$	
^{64}Zn	$1.209 \cdot 10^{-10}$		^{123}Sn	$3.167 \cdot 10^{2}$	
^{65}Zn	$2.064 \cdot 10^{-4}$		^{124}Sn	$1.290 \cdot 10^{-1}$	
^{73}As	$6.657 \cdot 10^{-3}$		^{124}Sb	$1.964 \cdot 10^{3}$	
^{74}As	$1.012 \cdot 10^{-3}$		^{125}Sb	$5.458 \cdot 10^{3}$	

Table 66: Activity in steam dryer package - 1 year after shut-down (continued)

Radionuclides	Activity [Bq]	Uncertainty (cross-section only) [%]
^{123}Te	$8.871 \cdot 10^{-21}$	
^{125m}Te	$1.335 \cdot 10^{3}$	
^{176}Lu	$1.007 \cdot 10^{-13}$	
^{179n}Hf	$6.234 \cdot 10^{-2}$	
^{181}Hf	$9.728 \cdot 10^{-3}$	
^{182}Hf	$1.053 \cdot 10^{-7}$	
^{179}Ta	$2.235 \cdot 10^{1}$	
^{180m}Ta	$9.747 \cdot 10^{-3}$	
^{182}Ta	$1.050 \cdot 10^{6}$	0.000
^{181}W	$9.008 \cdot 10^{3}$	
^{183}W	$1.872 \cdot 10^{-1}$	
^{184}W	$1.102 \cdot 10^{-1}$	
^{185}W	$8.386 \cdot 10^{3}$	
^{186}W	$6.934 \cdot 10^{-2}$	
^{186m}Re	$2.511 \cdot 10^{-10}$	
^{187}Re	$2.132 \cdot 10^{-3}$	
^{186}Os	$4.395 \cdot 10^{-16}$	

9.2.18 Package - 30 years

Table 67: Activity in steam dryer package - 30 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$1.333 \cdot 10^{4}$		^{93}Mo	$5.296 \cdot 10^{4}$	
^{10}Be	$2.577 \cdot 10^{-2}$		^{98}Mo	$1.664 \cdot 10^{5}$	
^{14}C	$1.483 \cdot 10^{5}$		^{100}Mo	$9.095 \cdot 10^{-1}$	
^{26}Al	$1.460 \cdot 10^{-4}$		^{98}Tc	$2.128 \cdot 10^{-11}$	
^{32}Si	$5.390 \cdot 10^{-4}$		^{99}Tc	$1.681 \cdot 10^{3}$	
^{36}Cl	$4.374 \cdot 10^{1}$		^{108}Cd	$7.903 \cdot 10^{-18}$	
^{39}Ar	$3.417 \cdot 10^{-6}$		^{113}Cd	$5.290 \cdot 10^{-15}$	
^{40}K	$4.093 \cdot 10^{-11}$		^{114}Cd	$2.687 \cdot 10^{-16}$	
^{48}Ca	$5.021 \cdot 10^{-23}$		^{116}Cd	$1.208 \cdot 10^{-19}$	
^{50}V	$9.274 \cdot 10^{-4}$		^{115}In	$7.435 \cdot 10^{-14}$	
^{50}Cr	$2.088 \cdot 10^{2}$		^{121}Sn	$3.077 \cdot 10^{1}$	
^{53}Mn	$2.292 \cdot 10^{0}$		^{121m}Sn	$3.964 \cdot 10^{1}$	
^{54}Mn	$4.496 \cdot 10^{-3}$	2.314	^{124}Sn	$1.290 \cdot 10^{-1}$	
^{55}Fe	$5.054 \cdot 10^{5}$	7.618	^{125}Sb	$3.735 \cdot 10^{0}$	
^{60}Fe	$2.919 \cdot 10^{-5}$		^{123}Te	$8.875 \cdot 10^{-21}$	
^{60}Co	$2.248 \cdot 10^{6}$	0.2745	^{125m}Te	$9.147 \cdot 10^{-1}$	
^{58}Ni	$5.260 \cdot 10^{-1}$		^{176}Lu	$1.007 \cdot 10^{-13}$	
^{59}Ni	$1.223 \cdot 10^{6}$		^{179n}Hf	$6.234 \cdot 10^{-2}$	
^{63}Ni	$1.095 \cdot 10^{8}$	0.08190	^{182}Hf	$1.836 \cdot 10^{-7}$	
^{64}Zn	$1.209 \cdot 10^{-10}$		^{179}Ta	$8.444 \cdot 10^{-5}$	
^{93}Zr	$1.106 \cdot 10^{-1}$		^{180m}Ta	$9.747 \cdot 10^{-3}$	
^{94}Zr	$6.639 \cdot 10^{-13}$		^{183}W	$1.872 \cdot 10^{-1}$	
^{96}Zr	$4.838 \cdot 10^{-18}$		^{184}W	$1.102 \cdot 10^{-1}$	
^{91}Nb	$1.145 \cdot 10^{3}$		^{186}W	$6.934 \cdot 10^{-2}$	
^{92}Nb	$9.060 \cdot 10^{-1}$		^{186m}Re	$2.510 \cdot 10^{-10}$	
^{93m}Nb	$1.530 \cdot 10^{5}$		^{187}Re	$2.132 \cdot 10^{-3}$	
^{94}Nb	$1.234 \cdot 10^{3}$		^{186}Os	$7.880 \cdot 10^{-16}$	
^{92}Mo	$5.385 \cdot 10^{-2}$				

9.2.19 Package - 100 years

Table 68: Activity in steam dryer package - 100 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{3}H	$2.604 \cdot 10^{2}$		^{92}Mo	$5.385 \cdot 10^{-2}$	
^{10}Be	$2.577 \cdot 10^{-2}$		^{93}Mo	$5.211 \cdot 10^{4}$	
^{14}C	$1.470 \cdot 10^{5}$		^{98}Mo	$1.664 \cdot 10^{5}$	
^{26}Al	$1.459 \cdot 10^{-4}$		^{100}Mo	$9.095 \cdot 10^{-1}$	
^{32}Si	$4.653 \cdot 10^{-4}$		^{98}Tc	$2.128 \cdot 10^{-11}$	
^{36}Cl	$4.373 \cdot 10^{1}$		^{99}Tc	$1.680 \cdot 10^{3}$	
^{39}Ar	$2.853 \cdot 10^{-6}$		^{108}Cd	$7.903 \cdot 10^{-18}$	
^{40}K	$4.093 \cdot 10^{-11}$		^{113}Cd	$5.290 \cdot 10^{-15}$	
^{48}Ca	$5.021 \cdot 10^{-23}$		^{114}Cd	$2.687 \cdot 10^{-16}$	
^{50}V	$9.274 \cdot 10^{-4}$		^{116}Cd	$1.208 \cdot 10^{-19}$	
^{50}Cr	$2.088 \cdot 10^{2}$		^{115}In	$7.435 \cdot 10^{-14}$	
^{53}Mn	$2.292 \cdot 10^{0}$		^{121}Sn	$1.019 \cdot 10^{1}$	
^{55}Fe	$1.075 \cdot 10^{-2}$	7.618	^{121m}Sn	$1.313 \cdot 10^{1}$	
^{60}Fe	$2.919 \cdot 10^{-5}$		^{124}Sn	$1.290 \cdot 10^{-1}$	
^{60}Co	$2.259 \cdot 10^{2}$	0.2745	^{123}Te	$8.875 \cdot 10^{-21}$	
^{58}Ni	$5.260 \cdot 10^{-1}$		^{176}Lu	$1.007 \cdot 10^{-13}$	
^{59}Ni	$1.222 \cdot 10^{6}$		^{179n}Hf	$6.234 \cdot 10^{-2}$	
^{63}Ni	$6.696 \cdot 10^{7}$	0.08190	^{182}Hf	$3.726 \cdot 10^{-7}$	
^{64}Zn	$1.209 \cdot 10^{-10}$		^{180m}Ta	$9.747 \cdot 10^{-3}$	
^{93}Zr	$1.106 \cdot 10^{-1}$		^{183}W	$1.872 \cdot 10^{-1}$	
^{94}Zr	$6.639 \cdot 10^{-13}$		^{184}W	$1.102 \cdot 10^{-1}$	
^{96}Zr	$4.838 \cdot 10^{-18}$		^{186}W	$6.934 \cdot 10^{-2}$	
^{91}Nb	$1.066 \cdot 10^{3}$		^{186m}Re	$2.510 \cdot 10^{-10}$	
^{92}Nb	$9.060 \cdot 10^{-1}$		^{187}Re	$2.132 \cdot 10^{-3}$	
^{93m}Nb	$4.985 \cdot 10^{4}$		^{186}Os	$1.629 \cdot 10^{-15}$	
^{94}Nb	$1.231 \cdot 10^{3}$				

9.2.20 Package - 1000 years

Table 69: Activity in steam dryer package - 1000 years after shut-down.

Nuc.	Act. [Bq]	Uncert. [%]	Nuc.	Act. [Bq]	Uncert. [%]
^{10}Be	$2.576 \cdot 10^{-2}$		^{92}Mo	$5.385 \cdot 10^{-2}$	
^{14}C	$1.318 \cdot 10^{5}$		^{93}Mo	$4.236 \cdot 10^{4}$	
^{26}Al	$1.458 \cdot 10^{-4}$		^{98}Mo	$1.664 \cdot 10^{5}$	
^{32}Si	$7.027 \cdot 10^{-5}$		^{100}Mo	$9.095 \cdot 10^{-1}$	
^{36}Cl	$4.364 \cdot 10^{1}$		^{98}Tc	$2.128 \cdot 10^{-11}$	
^{39}Ar	$2.807 \cdot 10^{-7}$		^{99}Tc	$1.675 \cdot 10^{3}$	
^{40}K	$4.093 \cdot 10^{-11}$		^{108}Cd	$7.903 \cdot 10^{-18}$	
^{48}Ca	$5.021 \cdot 10^{-23}$		^{113}Cd	$5.290 \cdot 10^{-15}$	
^{50}V	$9.274 \cdot 10^{-4}$		^{114}Cd	$2.687 \cdot 10^{-16}$	
^{50}Cr	$2.088 \cdot 10^{2}$		^{116}Cd	$1.208 \cdot 10^{-19}$	
^{53}Mn	$2.292 \cdot 10^{0}$		^{115}In	$7.435 \cdot 10^{-14}$	
^{60}Fe	$2.917 \cdot 10^{-5}$		^{121m}Sn	$8.856 \cdot 10^{-6}$	
^{60}Co	$2.910 \cdot 10^{-5}$	0.2745	^{124}Sn	$1.290 \cdot 10^{-1}$	
^{58}Ni	$5.260 \cdot 10^{-1}$		^{123}Te	$8.875 \cdot 10^{-21}$	
^{59}Ni	$1.212 \cdot 10^{6}$		^{176}Lu	$1.007 \cdot 10^{-13}$	
^{63}Ni	$1.205 \cdot 10^{5}$	0.08190	^{179n}Hf	$6.234 \cdot 10^{-2}$	
^{64}Zn	$1.209 \cdot 10^{-10}$		^{182}Hf	$2.803 \cdot 10^{-6}$	
^{93}Zr	$1.105 \cdot 10^{-1}$		^{180m}Ta	$9.747 \cdot 10^{-3}$	
^{94}Zr	$6.639 \cdot 10^{-13}$		^{183}W	$1.872 \cdot 10^{-1}$	
^{96}Zr	$4.838 \cdot 10^{-18}$		^{184}W	$1.102 \cdot 10^{-1}$	
^{91}Nb	$4.260 \cdot 10^{2}$		^{186}W	$6.934 \cdot 10^{-2}$	
^{92}Nb	$9.059 \cdot 10^{-1}$		^{186m}Re	$2.501 \cdot 10^{-10}$	
^{93m}Nb	$3.620 \cdot 10^{4}$		^{187}Re	$2.132 \cdot 10^{-3}$	
^{94}Nb	$1.193 \cdot 10^{3}$		^{186}Os	$1.244 \cdot 10^{-14}$	