

Assessment of Radiological Effects of Operation of SMR ETE

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1 Risks associated with radiation exposure from nuclear power plant operation

1.1 Ionising radiation and its biological effects

Radiation is generally the **propagation of energy** through space. When it strikes an object, part of the energy transmitted may be transferred to the object and cause a range of physical, chemical, and biological changes.

Ionising radiation is radiation capable of directly or indirectly ionising atoms and molecules. Practical/regulatory limits vary depending on the purpose of the assessment.

Several types of ionising radiation are distinguished. Alpha radiation has high ionising power but low penetrating power and can be stopped by a sheet of paper or the skin. Beta radiation is more penetrating but can still be shielded relatively easily by thin layers of aluminium or plastic. Gamma and neutron radiation are among the most penetrating types and therefore require substantial shielding (lead, concrete, or water).

The basic types of ionising radiation are:

- **Alpha radiation** (helium particles, positive charge): high ionising power, low penetrating power, hazardous in the event of internal contamination.
- **Beta radiation** (electrons/positrons): moderate penetrating power, capable of causing superficial tissue damage, and also hazardous in the event of internal exposure.
- **Gamma radiation** (photon radiation): high penetrating power; the main source of external exposure.
- **Neutron radiation:** It is a type of **indirectly ionising particle radiation**, consisting of a stream of free neutrons with no electric charge. It is produced primarily in **nuclear reactions**, during the **fission of heavy nuclei**, in **nuclear reactors**, particle accelerators, or certain radionuclide processes.
- The **destructive effect** of ionising radiation on living matter consists in **damage to biomolecules, primarily DNA, proteins, and lipids** in the cell. This occurs in two ways: through a **direct effect**, in which electrons are ejected from chemical bonds, and an **indirect effect**, in which water molecules, which make up most of the cell content, are ionised first. This produces free radicals, particles with unpaired electrons that are highly reactive and readily react with biomolecules. Both effects usually occur simultaneously, and the type of radiation determines which is more significant. Direct effects are more significant in case of proton, neutron, and alpha radiation, while indirect effects are more significant for beta and gamma radiation.

The human body is a functional whole composed of individual tissues and organs that differ in their sensitivity to exposure to ionising radiation, known as **radiosensitivity**. A fundamental law

of radiobiology, formulated by the French radiologists **J. Bergonié** and **L. Tribondeau** as early as 1906, states that ***radiosensitivity is directly proportional to the mitotic activity of cells. Radiosensitive tissues therefore include those containing poorly differentiated and actively dividing cells, whereas tissues with differentiated cells that divide little or not at all are classified as radio-resistant.***

Some organs and tissues can be broadly ranked in order of decreasing **radiosensitivity** as follows: lymphoid organs, active bone marrow, gonads, intestine, skin and epithelial linings (pharynx, oesophagus, stomach), lens of the eye, mature cartilage and bone, respiratory system, digestive glands, endocrine glands, muscles, and the central nervous system. Children are generally more sensitive than adults.

From the perspective of the mammalian organism as a whole, the effects of ionising radiation are divided into **deterministic**, which inevitably occur when a certain radiation dose is reached, and **stochastic**, for which the probability of damage increases with increasing dose. Current terminology of the **ICRP (International Commission on Radiological Protection)** prefers the term **harmful tissue reactions**, as it better reflects the biological nature of these effects. For the sake of terminological continuity and clarity, the traditional term **deterministic effects will continue to be used in this document.**

1. Deterministic effects

- occur only after a certain threshold dose has been exceeded; for whole-body exposure, the threshold dose for deterministic effects is 0.7 Gy; for localised exposure, the threshold dose for effects such as skin damage is 3–4 Gy; fertility decreases in men at doses above 0.5 Gy and in women at doses above 2 Gy,
- examples include radiation dermatitis, acute radiation syndrome, and damage to the lens of the eye,
- Under normal operation, deterministic effects in the public are not expected in view of the calculated doses.

2. Stochastic effects

- the probability of occurrence, rather than the severity, depends on the dose (the higher the dose, the higher the risk),
- the severity of the effect is independent of the dose – once the effect occurs (e.g. cancer), it has the same clinical severity regardless of whether it resulted from a low or high dose,
- the linear no-threshold model is a conservative regulatory model for radiation protection, rather than direct epidemiological evidence of an effect at every microdose; at low doses (in the range of **µSv/year–mSv/year**), the risk is statistically insignificant and cannot be distinguished from the natural incidence of disease.

Table 1 Comparison of deterministic and stochastic effects.

Property	Deterministic effects	Stochastic effects
Cause	Direct damage to a large number of cells	Damage to individual cells (DNA)
Threshold dose	Yes – the effect only occurs after a certain dose has been exceeded	No – the risk exists even at a very low dose
Relationship to dose	The severity of the effect increases with dose	The probability of the effect increases with dose
Severity of the effect	Depends on the dose (the higher the dose, the more severe the damage)	Independent of the dose – if the effect occurs, its severity is the same
Typical manifestations	Acute radiation syndrome, skin erythema, bone marrow damage, cataract	Cancer, genetic mutations (heritable)
Time course	Occur soon after exposure (hours, days, or weeks)	Occur after a latency period – years to decades
Description of health detriment	Specific clinical damage to tissues/organs	Increased risk of cancer or a heritable disease

The ultimate outcome of the effects of ionising radiation on cells and tissues is determined not only by the mechanisms of damage but also by the action of recovery mechanisms, known as **repair mechanisms**. Repair mechanisms play a more significant role in fractionated or protracted exposure.

At low doses, damage is often successfully repaired, whereas at high doses it accumulates and leads to cell death or mutations. The principal long-term risk is cancer.

1.2 Brief explanation of the main terms, quantities, and units

Radioactivity: A **property of substances, rather than a physical quantity**, describing the spontaneous transformation of atomic nuclei accompanied by the emission of ionising radiation (a natural phenomenon).

Activity: The number of nuclear transformations of a radionuclide per unit time. It is a **physical quantity** in the SI system.

Becquerel: The SI unit of activity. One becquerel [Bq] is equal to one nuclear transformation per second [1/s]. Specific activity is expressed in Bq per kilogram [Bq/kg], activity concentration in Bq/m³ or Bq/l, and surface activity in Bq/m² or Bq/cm².

Dose: The amount of energy imparted to a substance by ionising radiation per unit mass. It describes the magnitude of the effects of ionising radiation.

Dose rate: The rate at which the dose changes. The unit is the gray per second [Gy/s], per hour [Gy/h], etc.

Gray: The SI unit of absorbed dose; 1 gray [Gy] is the absorbed dose at which a substance with a mass of 1 kg absorbs 1 joule [J/kg] of energy from ionising radiation.

Exposure (irradiation): being subjected to ionising radiation. Exposure may be either external or internal.

Exposure pathways: Pathways by which a radioactive substance may expose a person to radiation.

Equivalent dose: A quantity that takes account of differences in the effects of different types of ionising radiation on human tissue cells, expressed as the product of the dose and the radiation weighting factor for the relevant type of radiation. The greater the ionisation density, the greater the effects of the radiation and, accordingly, the higher the radiation weighting factor. For beta, gamma, and X-ray radiation, a dose of 1 mGy corresponds to an equivalent dose of 1 mSv; for alpha particles and neutrons, depending on their energy, a dose of 1 mGy corresponds to a higher equivalent dose in accordance with the radiation weighting factors for these types of radiation.

Effective dose: A quantity used to assess the exposure of the human body as a whole, even when the body is exposed non-uniformly. Effective dose is the sum of the tissue-weighted equivalent doses in specified organs and tissues. Annual exposure limits for individuals are specified in terms of this quantity. It is expressed in sieverts.

Sievert: The SI unit of equivalent and effective dose; 1 sievert [Sv] is, like 1 Gy, equal to 1 joule per kilogram [J/kg].

Gy and Sv are units of different quantities. The gray (Gy) expresses the physical effect of radiation, i.e. the absorbed dose, whereas the sievert (Sv) expresses the biological effect of radiation on the human body. Although both units have the dimension $\text{J}\cdot\text{kg}^{-1}$, they cannot be interchanged with one another.

External exposure: exposure of the human body caused by a source of ionising radiation located outside the body.

Internal exposure: exposure of the human body resulting from internal contamination by radionuclides taken into the body by inhalation or by consuming food and water. The measure of internal exposure is the effective dose that an individual receives from a radionuclide while it remains in the body. It is expressed by the quantity **committed effective dose**. The **committed effective dose** depends on the intake, i.e. the activity of the radionuclide that has entered the body via the given pathway. Following the intake of a radionuclide, the body is not exposed uniformly. Certain organs and tissues preferentially accumulate a given radionuclide, such as the thyroid gland,

which concentrates radioactive iodine. Organs and tissues at greater risk of damage are referred to as **critical organs**.

Representative person: a member of the public representing a model group of natural persons who receive the highest exposure from the given source and via the given pathway.

Lifetime cumulative effective dose from ionising radiation – the sum of all effective doses that an individual receives over their lifetime from various radiation sources (natural background radiation, medical examinations, occupational exposure, and emergency exposure) and from various external and internal sources.

Lifetime radiation exposure – When estimating lifetime radiation exposure, a conservative scenario assuming a constant annual effective dose over a period of 70 years is used in some situations. The lifetime dose is then determined as 70 times the annual dose. This approach is used primarily when assessing the long-term exposure of a representative person and is based on an assumed lifespan of 70 years.

1.3 Characteristics of the dose–effect relationship for ionising radiation

The **linear no-threshold (LNT) model** is used to assess the relationship between the dose and the effects of ionising radiation. It is based on the assumption that the risk of stochastic effects is directly proportional to the dose and that there is no safe threshold. This approach is conservative and is used as a precautionary measure to protect the public.

Risk characterisation is based on the probability of occurrence of stochastic effects. The ICRP states that the risk of fatal cancer is approximately 5% per 1 Sv of effective dose received. Lower values are assumed for non-fatal cancers and heritable effects.

A conservative procedure for estimating risk according to the ICRP, published in ICRP Publication 103 (ICRP 103, 2009), may be used to assess the stochastic effects of ionising radiation. This publication specifies risk coefficients for estimating **health detriment from the stochastic effects of low-dose radiation**.

Based on cancer incidence data, the detriment-adjusted nominal risk coefficients for cancer are $5.5 \times 10^{-2} \text{ Sv}^{-1}$ for the whole population and $4.1 \times 10^{-2} \text{ Sv}^{-1}$ for adult workers.

The probability coefficients for heritable diseases, adjusted for detriment affecting the first two subsequent generations, are $0.2 \times 10^{-2} \text{ Sv}^{-1}$ for the whole population and $0.1 \times 10^{-2} \text{ Sv}^{-1}$ for adult workers.

The total detriment-adjusted nominal risk coefficient for stochastic effects from exposure to low-dose-rate radiation is $5.7 \times 10^{-2} \text{ Sv}^{-1}$.

Because small risks are difficult to detect in epidemiological studies, the dose-specific risk estimates in ICRP Publication 103 are based primarily on acute doses of 200 mSv and above.

However, many of the more challenging issues in radiation protection involve continuous or fractionated exposures with individual fractions of a few mSv or less. Experimental research tends to support the finding that fractionated or protracted doses are associated with a lower risk, suggesting that dose-specific estimates derived from high doses received during acute exposure should be **divided by the dose and dose-rate effectiveness factor (DDREF)** when applied to low continuous or fractionated doses.

The dose and dose-rate effectiveness factor is an estimated factor that generally characterises the usually lower biological effectiveness per unit dose of exposure at low doses and low dose rates compared with exposure at high doses and high dose rates.

A **DDREF value of 2** is generally consistent with data from animal studies. Despite all the uncertainties, the ICRP recommends that a DDREF value of 2 continue to be used for radiation protection purposes (ICRP 103, 2009).

This uncertainty is the main reason why it is generally impossible to determine solely on the basis of epidemiological evidence whether or not radiation exposure of the order of several tens of mSv or less increases the risk of cancer.

In calculating the lifetime risk of health detriment, the same calculation algorithm (DDREF = 1) was used as in report (Kotulán, 2010) to allow the results to be compared.

Table 2 Detriment-adjusted nominal risk coefficients [μSv^{-1}] for stochastic effects from exposure to low-dose-rate radiation (ICRP 103, 2009), (ICRP, 1991).

Exposed population	Cancer		Heritable effects		Total	
	ICRP 103	ICRP 60	ICRP 103	ICRP 60	ICRP 103	ICRP 60
Whole population	5.5	6.0	0.2	1.3	5.7	7.3
Adults	4.1	4.8	0.1	0.8	4.2	5.6

Although there is still no direct evidence that parental exposure to radiation leads to an increase in heritable diseases in their offspring, it has been convincingly demonstrated that radiation causes heritable effects in experimental animals (according to the ICRP).

The risk of heritable effects therefore continues to be included in the system of radiation protection.

In its 2012 report, UNSCEAR stated that epidemiological evidence of health effects at effective doses below 100 mSv is limited and uncertain, making any increase in health risk at this level of exposure difficult to demonstrate (UNSCEAR, 2012).

It also states, among other things, that the uncertainties surrounding low doses are so great that UNSCEAR “**does not recommend multiplying very low doses by large numbers of individuals to estimate numbers of radiation-induced health effects within a population exposed to incremental doses at levels equivalent to or lower than natural background levels.**”

At the effective doses typically received by the public in the vicinity of nuclear power plants, which are of the order of several μSv per year, the increase in the risk of **stochastic effects** is **entirely negligible** in statistical terms. Epidemiological studies of residents living near nuclear facilities have not confirmed an increased incidence of cancer when the plant is operating normally.

Under normal operation and at the exposure levels considered, deterministic effects are not expected because the doses remain well below the thresholds required for their occurrence. Risks are assessed using conservative models that deliberately overestimate potential radiation exposure to ensure an adequate level of protection for the public.

1.4 Principles and objectives of radiation protection

The main objective of radiation protection is to **protect people and future generations from the harmful effects of ionising radiation** by:

1. **Preventing deterministic effects** – i.e. protecting against doses so high that they would inevitably result in tissue damage (e.g. radiation burns or damage to the haematopoietic system).
2. **Limiting stochastic effects** – i.e. reducing the probability of cancer and heritable diseases to a level that is as low as reasonably achievable.
3. **Protecting the environment as well**, so that human health is not indirectly endangered.

The health objective of radiation protection is therefore to prevent deterministic effects and minimise the probability of stochastic effects. This is achieved through four principles: **justification, optimisation (ALARA), dose limitation, and security of source**.

Basic principles of radiation protection

Justification

- No use of ionising radiation may be introduced unless **its benefits outweigh the risks**.

Example: The operation of a nuclear power plant is acceptable from the perspective of radiation protection because radiation doses to workers and the public are consistently maintained well below the established limits and are further minimised in accordance with the ALARA principle. The lifetime cumulative dose from operation does not represent a significant increase in health risk compared with natural background radiation. The benefits of operating a nuclear power plant outweigh the potential risks, thereby satisfying the justification requirement.

Optimisation (ALARA – As Low As Reasonably Achievable)

- Radiation doses must be kept **as low as reasonably achievable**, taking into account technical capabilities and economic and societal factors.
- The objective is not merely to reduce the dose, but to achieve an **optimum balance between quality, cost, and protection**.

Dose limitation

- No one may be exposed to doses exceeding the **established limits**.
- These limits apply to radiation workers and the general public.
- Exception: patients undergoing examination or treatment are not subject to a dose limit because the dose is “justified by the therapeutic benefit”. Patients are not subject to dose limits, but **reference levels** are used as an optimisation tool.

Security of source

The aim is to ensure that ionising radiation sources or radionuclides do not fall into unauthorised hands and are not misused.

This mainly concerns:

- the control and record-keeping of radioactive substances and sources (e.g. in hospitals, laboratories, and industry),
- the physical protection of facilities where sources are stored or used,
- the prevention of the loss or theft of sources (“orphan sources” pose a major risk when they are no longer under control),
- security during the transport of radioactive materials.

This principle therefore concerns **security** rather than **safety**, but is an integral part of the overall radiation protection system.

The principles of radiation protection constitute general conditions for carrying out activities associated with the use of nuclear energy and activities within exposure situations. They are laid down in **Section 62 of the Atomic Energy Act**, which states: *“Any person carrying out an activity within a planned exposure situation shall limit the exposure of a natural person so that the total exposure caused by the combination of exposures arising from these activities is justified, optimised, and does not, in aggregate, exceed the exposure limits.”* (Česko, 2016).

1.5 Limits in radiation protection

The International Commission on Radiological Protection (ICRP) establishes recommended dose limits. These are implemented in the legislation of individual countries. Protection of the public in

the Czech Republic is enshrined in the Atomic Energy Act (Act No. 263/2016 Coll., as amended) and its implementing regulations, particularly Decree No. 422/2016 Coll., on Radiation Protection and Security of a Radionuclide Source (Česko, 2016), (Česko, 2016a).

An exposure limit is a quantitative indicator used to restrict the total exposure of a natural person arising from activities within planned exposure situations.

Exposure limits:

- **general limits for the public** – apply to exposure from all activities resulting in exposure, with the exception of the exposures referred to above, medical exposure, exposure of persons participating in interventions in the event of a radiation accident, and cases of exposure subject to special limits. These general limits apply to the average exposure in the critical group of the public from all exposure pathways and all activities,
- **limits for radiation workers** – apply to exposure incurred in direct connection with their work, i.e. by Category A or Category B workers,
- **limits for pupils and students** – apply to exposure knowingly and voluntarily incurred, after being informed of the associated risks, by persons undergoing specialised training for occupations involving sources of ionising radiation.

Basic general limits:

- **1 mSv per calendar year** for the sum of effective doses from external exposure and committed effective doses from internal exposure,
- **15 mSv per calendar year** for the equivalent dose to the lens of the eye,
- **50 mSv per calendar year** for the average equivalent dose to any 1 cm² of skin, irrespective of the size of the exposed area.

Basic limits for radiation workers:

- **20 mSv per calendar year** for the sum of effective doses from external exposure and committed effective doses from internal exposure, or a value approved by the State Office for Nuclear Safety pursuant to Section 63(4) of the Atomic Energy Act. However, the dose must not exceed **100 mSv** over five consecutive calendar years or **50 mSv** in any single calendar year,
- **100 mSv** over five consecutive calendar years for the equivalent dose to the lens of the eye, with a maximum of **50 mSv** in any single calendar year,
- **500 mSv** per calendar year for the average equivalent dose to any 1 cm² of skin, irrespective of the size of the exposed area.

The limits for radiation workers apply to occupational exposure, i.e. exposure incurred in direct connection with the work performed.

The limits for radiation workers apply to the sum of doses from all exposure pathways and all work activities performed by a radiation worker, whether for a single licensee, concurrently for several licensees authorised to handle sources of ionising radiation, or as an independent holder of an authorisation to handle sources of ionising radiation.

The limits for radiation workers are deemed not to be exceeded if the quantitative indicators expressed in measurable quantities (hereinafter referred to as “derived limits”) are not exceeded.

Derived limits for external exposure:

- **500 mSv** per calendar year for the **personal dose equivalent at a depth of 0.07 mm**,
- **20 mSv** per calendar year for the **personal dose equivalent at a depth of 3 mm**,
- **20 mSv** per calendar year for the **personal dose equivalent at a depth of 10 mm**.

Derived limits for internal exposure in a calendar year resulting from radionuclide intake:

- by ingestion:
 - the **value obtained by dividing 20 mSv by the ingestion dose coefficient h_{ing}** for the relevant radionuclide taken in by a radiation worker,
- by inhalation:
 - the **value obtained by dividing 20 mSv by the inhalation dose coefficient h_{inh}** for the relevant radionuclide taken in by a radiation worker.

The Atomic Energy Act, i.e. Act No. 263/2016 Coll., introduced a requirement to establish **dose constraints (DCs)**.

A dose constraint is an upper bound on prospective individual doses established for the purposes of optimising radiation protection for the relevant source in a planned exposure situation.

When establishing dose constraints for a radiation practice or a source of ionising radiation, the following must be taken into account:

- previous experience with similar activities and sources of ionising radiation, so that the level of radiation protection is not lower than that already achieved,
- the effects of other activities and sources of ionising radiation, so that there is no risk of the exposure limits being exceeded.

For the relevant source, this constitutes the upper bound for optimisation. The upper dose constraint may be compared to an annual investigation level (it is not a limit!). If the dose constraint is exceeded, the reason for the exceedance is investigated, since an exceedance is not expected under normal circumstances.

Dose constraints are established:

- for radiation workers – by the licensee,
- for the public – by the regulatory body.
-

Any person carrying out activities within a planned exposure situation is required, for the purposes of optimising public exposure, to comply with the dose constraint of **0.25 mSv/year** for the representative person.

Pursuant to Section 82(1) of Act No. 263/2016 Coll., the Atomic Energy Act, as amended by Act No. 83/2025 Coll., a dose constraint of 0.25 mSv per calendar year for the representative person is used in the optimisation of radiation protection of the public. In the case of a nuclear power facility, this dose constraint applies collectively to all nuclear facilities within the relevant nuclear facility siting area. At the same time, a value of 0.20 mSv per year is established for discharges of radioactive substances to the atmosphere and 0.05 mSv per year for discharges to surface water (Česko, 2025).

At the same time, the following applies to a nuclear power facility:

- **0.20 mSv/year** for discharges to the atmosphere,
- **0.05 mSv/year** for discharges to surface water.

Authorisations for the discharge of radioactive substances during normal operation are issued to operators by the State Office for Nuclear Safety (SONS). Models of radionuclide dispersion in the environment and models for calculating doses to humans are used to determine the effective dose equivalent for residents living closest to a nuclear power plant. SONS has established **authorised limits** for both nuclear power plants in the Czech Republic. For the Temelín NPP (ETE1,2), these are:

- **10 µSv/year** for gaseous discharges,
- **4 µSv/year** for liquid discharges.

1.6 Individual components of radiation exposure of the public

Since the formation of the Earth, its environment, including all living organisms, has been exposed to ionising radiation from both outer space and radioactive material contained in the Earth's crust and core. Radioactivity is an integral part of the Earth and has always existed. Naturally occurring radioactive materials are present in the Earth's crust, in the floors and walls of our homes, schools, and offices, and in the food we eat and the water we drink. Radioactive gases are present in the air we breathe. Our own bodies – muscles, bones, and tissues – contain naturally occurring radioactive elements.

The **effective dose** from external exposure and the **committed effective dose** from internal contamination received by a person are used to assess the extent of the overall effects.

The total effective dose from external exposure and the committed effective dose from internal contamination will collectively be referred to as **total radiation exposure** (or radiological exposure).

Depending on the location of the source of ionising radiation, two categories are distinguished:

- radiation exposure from external exposure,
- radiation exposure from internal contamination (internal exposure).

Depending on the origin of the source of ionising radiation, a further distinction is made between:

- radiation exposure from natural sources of ionising radiation,
- radiation exposure from artificial sources of ionising radiation.

Table 3 Main natural sources of radiation exposure of the public.

Exposure source	Radiation exposure		
	Internal exposure		External exposure
	inhalation/ingestion	Inhalation of Rn	
Natural radionuclides (terrestrial radionuclides)	Internal exposure to terrestrial radionuclides (excluding Rn)	Internal exposure to radon ^{222}Rn and its decay products	External exposure to terrestrial radionuclides
		Internal exposure to radon ^{220}Rn and its decay products	
Cosmic radiation and cosmogenic radionuclides	Internal exposure to cosmogenic radionuclides	Internal exposure to cosmogenic radionuclides	Cosmic radiation

1.6.1 Radiation exposure from natural sources of ionising radiation

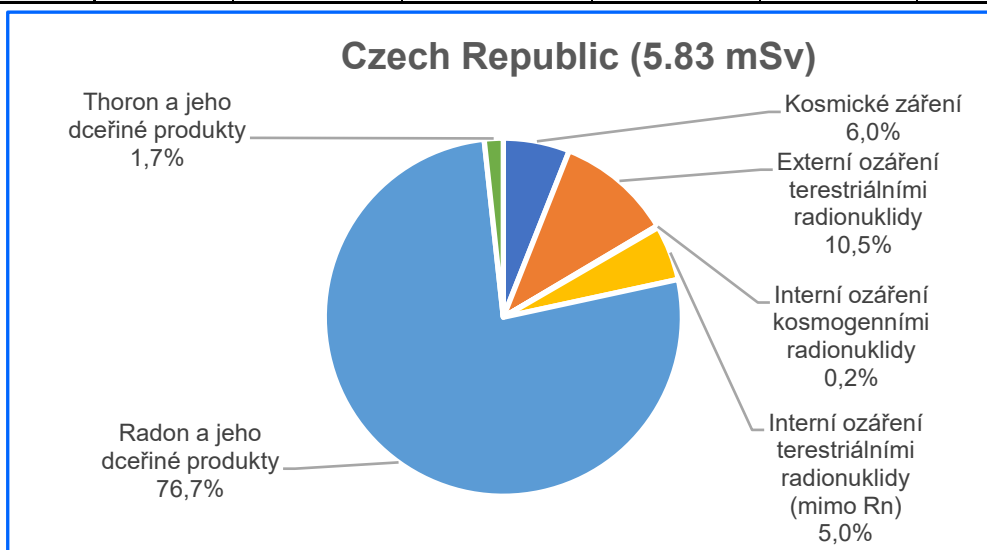
The dose from cosmic radiation depends primarily on altitude, so low-lying countries, such as the Netherlands, Denmark, and the Baltic States, are less affected than Turkey, Switzerland, or Austria. The average effective dose from cosmic radiation is estimated at 0.34 mSv/year for the EU and **0.38 mSv/year** worldwide. For European countries, it ranges from 0.31 mSv/year in Denmark, Estonia, Finland, Ireland, Latvia, the Netherlands, and Sweden to 0.41 mSv/year in Switzerland and 0.42 mSv/year in Turkey. **For the Czech Republic, it is estimated at 0.35 mSv/year.** The effective dose from external exposure to terrestrial radionuclides is estimated at **0.61 mSv/year** (Cinelli, 2019). The average annual effective dose per capita from natural background radiation therefore totals approximately **1 mSv per year** (0.96 mSv), which corresponds to an ambient dose equivalent rate of approximately **115 nSv/h**.

In the case of exposure from natural radionuclides, the greatest radiation exposure is caused by internal contamination with **radon** and its decay products. In the following sections of this document, the term “radon” will be used for the isotope ^{222}Rn , which is the most significant in this context. The term “thoron” denotes the isotope ^{220}Rn .

Doses from radon and its decay products are the main contributors to exposure in European countries, accounting for approximately 60% of the total dose of 3.2 mSv/year in Europe, compared with approximately 50% of the average worldwide total dose of 2.4 mSv/year. The estimated effective dose from internal contamination with radon and its decay products in the Czech Republic is **4.47 mSv/year**. In Europe, the estimated total radiation exposure from natural sources ranges from 1.48 mSv/year in the Netherlands to **5.83 mSv/year** in the Czech Republic and 6.16 mSv/year in Finland (Cinelli, 2019).

Table 4 Estimated average annual effective dose [mSv] per capita from natural background radiation in selected countries (Cinelli, 2019).

Country	Average annual effective dose [mSv] per capita from natural background radiation						
	External exposure		inhalation/ingestion		Inhalation of Rn		Total
	Cosmic radiation	External exposure to terrestrial radionuclides	Internal exposure to cosmogenic radionuclides	Internal exposure to terrestrial radionuclides (excluding Rn)	Radon ²²² Rn and its decay products	Radon ²²⁰ Rn and its decay products	
Czech Republic	0.35	0.61	0.01	0.29	4.47	0.1	5.83
USA	0.33	0.2	0.01	0.29	2.18	0.1	3.11
EU	0.34	0.5	0.01	0.29	1.96	0.1	3.20
World	0.38	0.48	0.01	0.29	1.15	0.1	2.41



Thoron a jeho dceřinné produkty	Thoron and its decay products
Kosmické záření	Cosmic radiation
Externí ozáření terestriálními radionuklidy	External exposure to terrestrial radionuclides
Interní ozáření kosmogenními radionuklidy	Internal exposure to cosmogenic radionuclides

Interní ozáření terestriálními radionuklidy (mimo Rn)	Internal exposure to terrestrial radionuclides (excl. Rn)
Radon a jeho dceřinné produkty	Radon and its decay products

Fig. 1 Percentage contribution of the weighted annual average effective dose [%] from the various natural radiation sources to the total effective dose in the Czech Republic¹ (Podzimek, 2024).

The tables and figure above show that radon and its decay products account for the predominant proportion of radiation exposure from natural sources in the Czech Republic.

1.6.2 Radiation exposure from natural sources in the Temelín area of interest

- **External exposure**

The primary source comprises data from the Monitoring of the Radiation Situation in the Czech Republic (**MonRaS**), performed mainly through the nationwide **Radiation Monitoring Network** – the Early Warning Network and the integral measurement network.

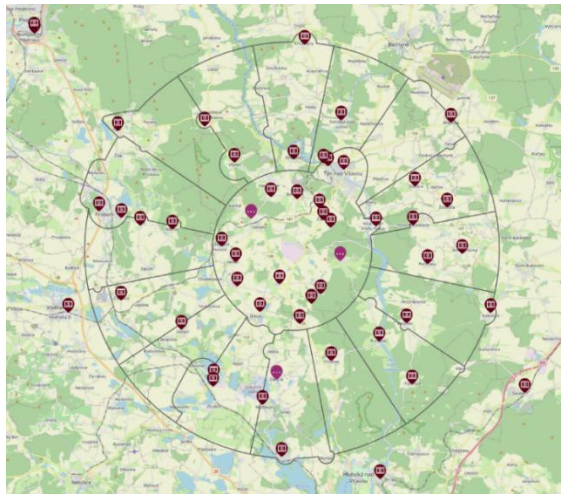


Fig. 2 Location of MonRaS measurement points in the vicinity of the Temelín NPP.

Table 5 Average quarterly ambient dose equivalent rate values in [nSv/h] measured by the local integral measurement network (TLDs) in the vicinity of the Temelín NPP and in the Czech Republic in 2025 (SÚJB, 2026b).

Measuring site	1st quarter	2nd quarter	3rd quarter	4th quarter
Dívčice	132	127	131	138
Hluboká nad Vltavou	114	121	130	124

¹This is a weighted average of the values for the individual settlements, weighted by the population of each settlement.

Litoradlice	117	119	123	128
Mydlovary	128	120	132	129
Olešník	120	124	131	125
Protivín	150	149	157	157
Radonice	116	120	120	126
Ševětín	156	157	156	167
Temelín	117	119	124	125
Týn nad Vltavou	133	129	132	138
Vodňany	135	140	142	143

Czech Republic				
Brno	115	115	118	124
Brno b	132	135	140	135
České Budějovice	128	132	125	138
České Budějovice b	159	154	161	156
Hradec Králové	100	93	92	99
Hradec Králové b	101	100	97	102
Jihlava	116	122	127	130
Jihlava b	162	162	168	163
Karlovy Vary	131	136	139	136
Czech Republic				
Measuring site	1st quarter	2nd quarter	3rd quarter	4th quarter
Karlovy Vary b	82	76	78	81
Liberec	169	171	168	179
Liberec b	155	156	157	167

Olomouc	88	88	90	94
Olomouc b	107	104	110	109
Ostrava – Syllabova	93	100	90	109
Ostrava – Syllabova b	157	158	161	160
Pardubice	99	101	93	106
Plzeň	108	107	106	110
Plzeň b	121	123	123	128
Prague 1 – SONS	108	106	100	105
Prague 1 – SONS b	117	119*	–	125
Prague 4 – SÚRO	112	114	108	114
Prague 4 – SÚRO b	126	121	120	126
Ústí nad Labem – Habrovice	79	77	80	81
Ústí nad Labem – Habrovice b	137	122	121	136
Zlín	97	102	109	104
Zlín b	85	94	94	97

Table 5 presents the results of monitoring in the vicinity of the Temelín NPP, conducted by SONS, as reported in the SONS Annual Report for 2025 (SÚJB, 2026b).

In 2025, the average quarterly ambient dose equivalent rate values (ADER) in the vicinity of the Temelín NPP ranged from **114 to 167 nSv/h**. The lowest value was measured at **Hluboká nad Vltavou** in the first quarter (114 nSv/h), and the highest at **Ševětín** in the fourth quarter (167 nSv/h). For comparison, values ranging from **76 nSv/h** (Karlovy Vary b) to **179 nSv/h** (Liberec) were recorded across the territorial integral measurement network in the Czech Republic (SÚJB, 2026b).

The results obtained to date show that the measured values exhibit certain fluctuations caused primarily by the location, seasonal effects, changes in weather, etc. The values measured at the point of interest fall within the stated range of values for the Czech Republic as a whole.

No exceedances of monitoring levels were recorded during 2025. The measurement results obtained from the Early Warning Network (EWN) and the territorial network of thermoluminescent dosimeters (TLDs) in 2025 were comparable, as in previous years.

The average ambient dose equivalent rate at the Temelín measuring site in 2025 was **121.3 nSv/h**. Assuming continuous residence at the location, this value corresponds to an annual ambient dose equivalent of approximately **1.06 mSv**. Since, for photon radiation under external exposure conditions, the ambient dose equivalent may be considered approximately equal to the effective dose for the purposes of an indicative assessment, the measured dose rate corresponds to an effective dose of approximately **1.06 mSv per year**.

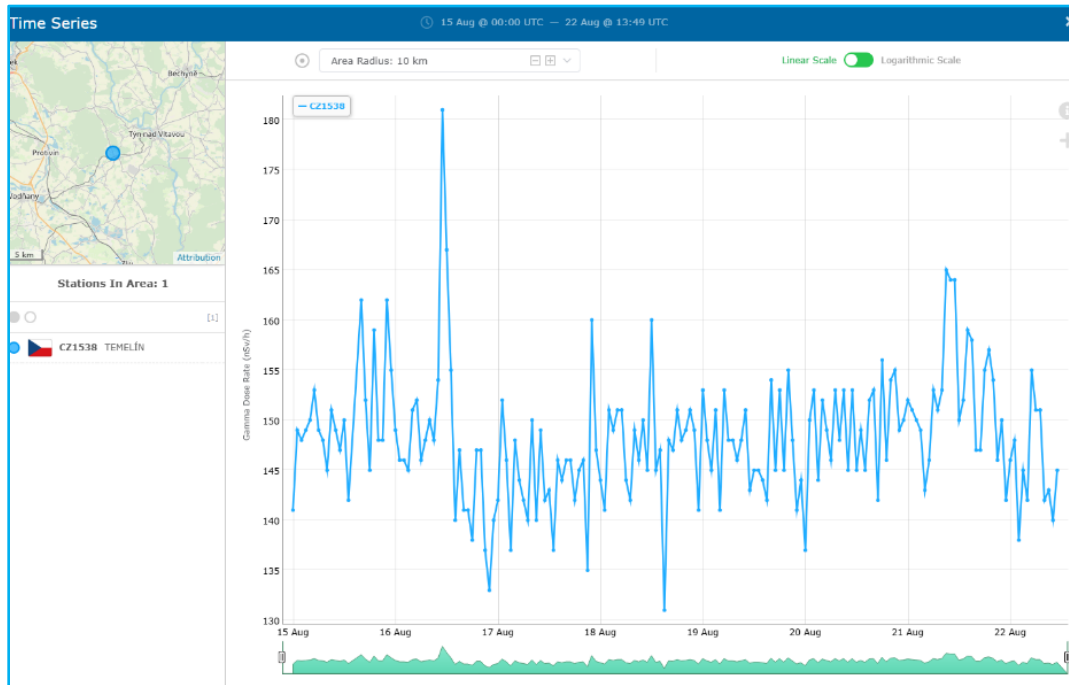


Fig. 3 Photon dose equivalent rate (PDER) at the Temelín site according to the European EURDEP database for the period 15–22 August 2025.

Fig. 3 shows the time course of the ambient dose equivalent rate $H(10)$ measured by an automatic monitoring station at the Temelín site. The data were obtained from the EURDEP database (European Radiological Data Exchange Platform) and processed as a time series of values in units of $\text{nSv} \cdot \text{h}^{-1}$ for the monitored period in 2025. The selected period is considered to be representative for assessing the radiation situation at the site because it includes normal operating conditions and captures seasonal changes in the natural radiation background. The observed fluctuations in dose-rate values correspond mainly to natural changes in the radiation background, particularly the effects of meteorological conditions and the variable presence of natural radionuclides in the environment.

- **internal contamination**

The Temelín site is located in an area with a medium radon index, which expresses the radon potential of the geological bedrock. However, the actual exposure of residents to radon primarily depends on the radon concentration in the indoor air of buildings and therefore cannot be determined directly from the radon index. According to national data on public exposure, inhalation of

radon (^{222}Rn), thoron (^{220}Rn), and their decay products results in an average annual effective dose of approximately **4.57 mSv**. The contribution from inhalation and ingestion of other natural terrestrial radionuclides is approximately 0.3 mSv per capita per year.

The total annual **radiation exposure from natural sources** at the Temelín site can be estimated at **5.93 mSv per year**, which is also consistent with the estimated value for the Czech Republic as a whole (**5.83 mSv**) (Cinelli, 2019).

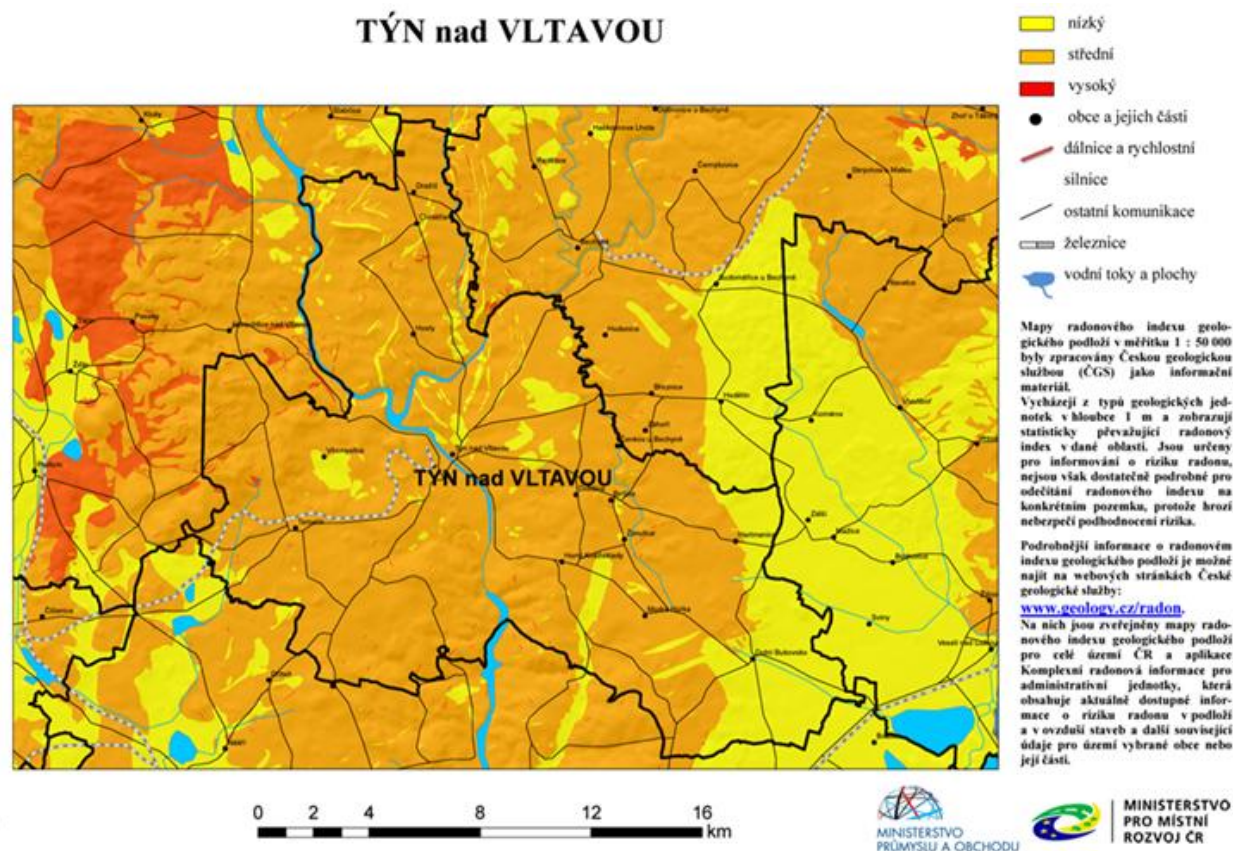


Fig. 4 Radon index in the Týn nad Vltavou area (ČGS, mapy.geology.cz/radon/, 2023).

TÝN nad VLTAVOU	TÝN nad VLTAVOU
Nízký	Low
Střední	Medium
Vysoký	High
Obce a jejich části	Municipalities and their parts
Dálnice a rychlostní silnice	Motorways and expressways
Ostatní komunikace	Other roads

Železnice	Railways
Vodní toky a plochy	Watercourses and bodies of water
Mapy radonového indexu geologického podloží v měřítku 1 : 50 000 byly zpracovány Českou geologickou službou (ČGS) jako informační materiál.	Radon index maps of the geological bedrock at a scale of 1 : 50,000 were prepared by the Czech Geological Survey (CGS) for information purposes.
Vycházejí z typu geologických jednotek v hloubce 1 m a zobrazují statisticky převažující radonový index v dané oblasti. Jsou určeny pro informování o riziku radonu, nejsou však dostatečně podrobné pro odečítání radonového indexu na konkrétním pozemku, protože hrozí nebezpečí podhodnocení rizika.	They are based on the type of geological units at a depth of 1 m and show the statistically prevailing radon index in the relevant area. They are intended to provide information on radon risk but are not sufficiently detailed to determine the radon index for a specific plot of land, as this could result in the risk being underestimated.
Podrobnější informace o radonovém indexu geologického podloží je možné najít na webových stránkách České geologické služby: www.geology.cz/radon	More detailed information on the radon index of the geological bedrock is available on the website of the Czech Geological Survey: www.geology.cz/radon
Na nich jsou zveřejněny mapy radonového indexu geologického podloží pro celé území ČR a aplikace Komplexní radonová informace pro administrativní jednotky, která obsahuje aktuálně dostupné informace o riziku radonu v podloží a v ovzduší staveb a další související údaje pro území vybrané obce nebo její části.	The website provides radon index maps of the geological bedrock for the entire Czech Republic and the Comprehensive Radon Information for Administrative Units application, which contains currently available information on radon risk in the bedrock and indoor air of buildings, together with other related data for the territory of a selected municipality or part thereof.

1.6.3 Radiation exposure from artificial sources of ionising radiation

- **external exposure**

Radiation exposure from artificial sources of ionising radiation primarily includes exposure from the following areas:

- **medical examinations** – diagnostic procedures such as X-rays, CT scans, or nuclear medicine,

- **operation of nuclear power and research reactors** – such as Dukovany, Temelín, and the research reactors at Řež and Prague,
- **mineral extraction and remediation of uranium sites,**
- **other industrial sources (food irradiation and sterilisation),**
- **fallout from nuclear accidents and atmospheric nuclear tests.**

In the first decade of the twenty-first century, the annual effective dose per capita worldwide from medical exposure was **0.62 mSv**, predominantly as a result of diagnostic X-ray examinations. Diagnostic nuclear medicine examinations accounted for only 5%. The situation in the Czech Republic is described in the 2021 SONS publication Assessment of Medical Exposure (Petrová, 2021).

The population dose from medical exposure in the Czech Republic was updated for 2019, taking account of the current frequency of individual examinations, and amounts to **1.16 mSv** per capita. The average annual effective dose per capita from nuclear medicine in the Czech Republic can be estimated at approximately **0.1 mSv**, while the average annual effective dose from medical applications is estimated at approximately **1.3 mSv**.

The assessment of **radiation exposure from industrial applications** in the Czech Republic is regularly reported in the SONS annual reports (SÚJB, 2026b). The **2025 Annual Report** states:

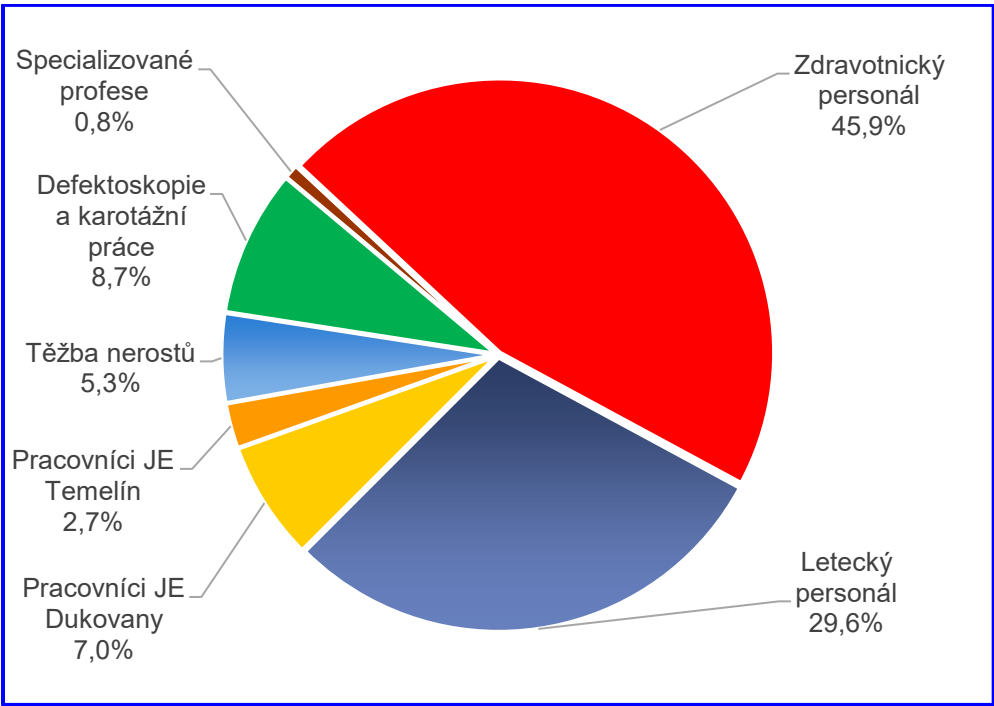
A total of 19,584 workers were monitored by dosimetry services in 2025. The decrease in the number of monitored radiation workers compared with 2024 (21,581 workers) is due to dosimetry services having ceased reporting the doses of Category B radiation workers monitored using personal dosimeters with a three-month evaluation period. Reporting the doses of these workers had not previously been mandatory either; nevertheless, until 2024 these doses were reported and entered, together with the doses of Category A radiation workers, in the Central Register of Occupational Exposure (CRPO) maintained by SONS. Effective doses:

- At the Dukovany NPP, 3,027 radiation workers were monitored, comprising 1,155 ČEZ, a. s., employees and 1,872 contractor employees. The total annual collective effective dose was **972.31 mSv** (including all doses exceeding 0.001 mSv), of which **154.94 mSv** was received by ČEZ, a. s., employees and **817.37 mSv** by contractor employees. The highest annual individual effective dose was **5.06 mSv** for a ČEZ, a. s., employee and **8.14 mSv** for a contractor employee.
- At the Temelín NPP, 2,545 radiation workers were monitored, comprising 969 ČEZ, a. s., employees and 1,576 contractor employees. The total annual collective effective dose was **195.19 mSv** (including all doses exceeding 0.001 mSv), of which **57.26 mSv** was received by ČEZ, a. s., employees and **137.93 mSv** by contractor employees. The highest annual individual effective dose was **1.49 mSv** for a ČEZ, a. s., employee and **2.71 mSv** for a contractor employee.
- At DIAMO, s. p., workplaces where activities associated with the extraction of radioactive minerals are carried out, a total of 835 radiation workers were monitored. Of these, 574 were Category B workers and 261 were Category A workers. The annual collective

effective dose of Category A workers was **0.5 Sv**, the average annual individual effective dose was **1.9 mSv**, and the highest annual individual effective dose was **11.57 mSv**.

- 864 workers were monitored in other industrial applications, with an average annual individual effective dose of **0.69 mSv**; occupations monitored by SONS over the long term include industrial radiography (**0.52 mSv**) and well logging (**0.31 mSv**).
- At healthcare workplaces using sources of ionising radiation, doses were evaluated for 10,326 workers, more than 70% of whom had an annual individual effective dose below the recording level (0.1 mSv); the average annual individual effective dose of the remaining workers was **1.53 mSv**, while the average annual individual effective dose of physicians performing interventional procedures was **2.40 mSv**.
- Workers in specialised occupations, such as servicing and inspecting sources of ionising radiation, numbering 4,870 in total, received an average annual individual effective dose of **0.23 mSv**.
- In 2025, the total annual collective effective dose was evaluated at **8.08 Sv** and the average individual effective dose per monitored worker at **0.36 mSv**.

To date, the most significant occupational group whose doses are routinely evaluated in this field has comprised **aircrew on board aircraft flying at altitudes above 8 km**. In aviation, 2,026 workers were monitored in 2024 (the latest data available; there were 1,119 in 2021, 1,486 in 2022, and 1,613 in 2024). The maximum effective dose received by a worker in this occupational group ranged from **0.55 to 2.56 mSv/year** (the maximum dose in 2023 was **2.53 mSv/year**). No person with a dose exceeding 6 mSv/year was reported to the Central Register of Occupational Exposure.



Specializované profese	Specialized professions
------------------------	-------------------------

Zdravotnický personal	Healthcare staff
Defektoskopie a karotážní práce	Flaw detection and logging
Těžba nerostů	Minerals mining
Pracovníci JE Temelín	Temelín NPP staff
Pracovníci JE Dukovany	Dukovany NPP staff
Letecký personal	Aviation staff

Fig. 5 Approximate contributions of the individual monitored groups to the collective dose in 2020 (according to the latest available data) (Podzimek, 2024).

Compared with the total collective dose to patients from medical exposure, the contribution from industrial applications (including nuclear power plant operation and aviation) is **less than 1‰ (one thousandth)**.

- **Internal exposure**

Large quantities of artificial radionuclides were discharged into the environment during the era of atmospheric nuclear testing. Significant quantities of radioactive material also entered the environment during the nuclear reactor accidents at Chernobyl and Fukushima.

Low activity levels of ^{137}Cs , which entered the environment primarily following the Chernobyl accident and atmospheric nuclear weapons testing, are still measurable in monitored environmental and food-chain items and in the human body; the measured ^{137}Cs activity levels now remain almost unchanged. In 2025, as in several preceding years, the ^{137}Cs content of many samples was below the detection limit.

Very low activity levels of ^{90}Sr , ^{239}Pu , and ^{240}Pu in the air and of ^{90}Sr in milk and mixed diet samples are also measurable during certain periods; these originate primarily from nuclear weapons testing.

In 2025, no significant activity levels of artificial radionuclides were detected in the air in the Czech Republic; the measured values (^{137}Cs and ^{131}I) did not differ from their long-term averages or from the usual levels of artificial radionuclides in the environment.

No unusual activity levels of artificial radionuclides were detected in other European countries either.

1.6.4 Radiation exposure from artificial sources in the Temelín area of interest

The Temelín NPP report entitled “Results of Monitoring of Discharges and the Radiation Situation in the Vicinity of the Temelín Nuclear Power Plant in 2025” evaluates the monitoring of

atmospheric discharges and the percentage of the authorised limit used, as calculated using the RDETE software, which takes account of the actual meteorological situation at the Temelín NPP site in 2025 and the relevant radionuclide intake pathways. (SÚJB, 2026b)

The sum of the effective dose from external exposure and the committed effective dose from internal exposure calculated in this manner was highest for children aged 0–5 years in the municipality of Litoradlice (3–5 km east of the NPP), amounting to **0.025 µSv**; this constituted **0.25%** of the annual authorised limit of **10 µSv**.

¹⁴C discharges accounted for the largest proportion (**78.27%**) of total atmospheric discharges. Balance measurements of radionuclide activity in liquid discharges from the Temelín NPP confirm that the annual authorised limit of 4 µSv for liquid discharges was not exceeded in 2025. When calculating the percentage of the annual authorised limit used for discharges to watercourses, the RDETE software enables the actual hydrological situation and the relevant exposure pathways to be taken into account.

The calculated sum of the effective dose from external exposure and the committed effective dose from internal exposure was highest for children aged 0–5 years in the populated area of **Dvůr Ůjezd**, 5–7 km north of the discharge point, amounting to **0.995 µSv**; this constituted **24.88%** of the authorised limit of 4 µSv. ³H discharges accounted for **99.48%** of total liquid discharges (SÚJB, 2026b).

Table 6 Overview of monitored environmental and food-chain items in the vicinity of the Temelín NPP in 2024 (data provided by SONS and SÚRO) (SÚJB, 2026b).

¹³⁷ Cs				
Monitored item	Unit	Highest value	Total number of measurements	>MSA
aerosols ¹⁾	Bq/m ³	<3.8·10 ⁻⁶	52	0
fallout	Bq/m ²	<0.358	24	0
soil	Bq/kg	33.7	4	4
soil – in situ	Bq/m ²	679.9	24	24
sediments	Bq/kg	10.2	2	2
drinking water	Bq/l	<0.170	4	0
surface water	Bq/l	<0.012	22	0
groundwater – boreholes	Bq/l	<0.018	31	0
raw cow's milk	Bq/l	<0.153	26	0
forest fruits	Bq/kg	2.056	1	1

fruit	Bq/kg	<0.082	1	0
agricultural crops	Bq/kg	<0.090	4	0
fish	Bq/kg	<0.079	2	0
⁹⁰Sr				
Monitored item	Unit	Highest value	Total number of measurements	>MSA
aerosols ²⁾	Bq/m ³	<1.932·10 ⁻⁷	1	0
surface water – water-courses	Bq/l	11.6·10 ⁻³	4	0
raw cow's milk ³⁾	Bq/l	<0.061	1	0
soil ⁴⁾	Bq/kg	<3.151	1	0
³H				
Monitored item	Unit	Highest value	Total number of measurements	>MSA
rainwater	Bq/l	<2.9	12	0
surface water – water-courses	Bq/l	122.1	40	15
surface water – reservoirs	Bq/l	<2.9	4	0
drinking water	Bq/l	<2	18	0
groundwater – boreholes	Bq/l	<2	6	0
¹³¹I				
Monitored item	Unit	Highest value	Total number of measurements	>MSA
gaseous iodine	Bq/m ³	< 0.345·10 ⁻³	52	0

Notes:

- Activity concentration, surface activity, and specific activity of radionuclides in environmental compartments and food chains (including in situ measurements) – sampling and

measurements by the Temelín NPP Environmental Radiation Monitoring Laboratory – results taken from the Temelín NPP report (SÚJB, 2026b).

- MSA refers to the minimum significant activity.

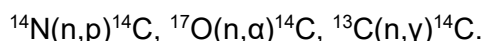
- 1) Composite measurements are performed on samples from 8 sampling sites. If the investigation level is exceeded, the individual samples are measured separately.
- 2) The composite annual sample consists of half of all aerosol filters from all sites.
- 3) A pooled annual sample from all fortnightly samples.
- 4) A composite sample from 4 sampling sites, from the 0–5 cm layer.

Monitoring in the vicinity of the Temelín NPP has shown that there are no significant differences between radionuclide concentrations in the individual environmental items monitored in the vicinity of nuclear power plants and those in the rest of the country, with the exception of ^3H concentrations in watercourses affected by NPP discharges.

1.7 Characteristics of risks from NPP operation

1.7.1 Risk from atmospheric discharges from the NPP

Atmospheric discharges are the main pathway by which trace amounts of radionuclides may enter the environment. These are primarily noble gases (krypton and xenon), iodine isotopes, and tritium. Radionuclides are dispersed through the atmosphere, may be deposited on vegetation, and, to a lesser extent, enter the food chain. ^{14}C discharges account for the largest proportion of total atmospheric discharges from the NPP. It is produced mainly in the reactor coolant and structural materials through nuclear reactions:



It may enter the environment **through gaseous and liquid discharges**. It is most commonly in the form of carbon dioxide or methane. Once discharged to the atmosphere, ^{14}C is rapidly incorporated **into the global carbon cycle** (plants → food chain → humans). Because of its half-life (5,730 years), it accumulates in the environment over the long term, but its concentrations are very low.

The effective dose to the public from ^{14}C discharges from a single nuclear power plant is several $\mu\text{Sv}/\text{year}$ – and is therefore **negligible** compared with natural background radiation.

Public exposure occurs primarily through inhalation and the consumption of locally produced food. Monitoring data from Czech nuclear power plants show that effective doses to the public from these pathways do not exceed a few hundredths of μSv per year. This is much less than 1% of the limit established for the public.

Atmospheric dispersion models that take account of meteorological conditions, stack heights, and discharge rates are used to model the dispersion of radionuclides in the atmosphere. Calculations are performed for conservative scenarios to ensure safety even under adverse conditions.

The following may be discharged to the atmosphere in particular:

- **radioactive noble gases (argon, krypton, xenon), ^{14}C ,**
- **^{131}I (with a short half-life and significance for the thyroid gland),**
- **tritium (in the form of water vapour).**

Exposure pathways:

- **inhalation** – breathing air containing radionuclides,
- **ingestion** – the food chain (deposition of radionuclides on plants → milk, vegetables).

Dispersion models show that even in the nearest municipalities, the dose to the public is well below the limit of 1 mSv/year, typically <0.005 mSv.

Safety measures:

- filtration systems, fuel assembly integrity, suitability of the materials used, optimisation of chemical regimes, and minimisation of inter-circuit leaks,
- real-time monitoring of discharges,
- mandatory reporting to SONS.

1.7.2 Risk from discharges to watercourses from the NPP

Discharges to watercourses primarily contain tritium and trace amounts of activation and corrosion products, such as ^{60}Co or ^{54}Mn . These radionuclides may enter surface waters and subsequently drinking water sources or food chains (fish and irrigated crops).

However, public exposure via this pathway is very low – typically of the order of a few μSv per year. It is, however, higher than exposure from atmospheric discharges. Tritium behaves similarly to water in the body and is therefore readily excreted, while its radiological effect is relatively low. The monitoring of radioactivity in watercourses forms part of mandatory monitoring programmes, which confirm long-term stable values well below the limits.

At Czech nuclear power plants, discharges to watercourses are strictly regulated and subject to authorisation. Monitoring results show that this pathway does not pose a health risk even to the most highly exposed population groups.

Discharges to water contain primarily:

- **tritium** (the most common radionuclide, with low biological effectiveness),
- **corrosion products** (^{60}Co , ^{54}Mn , ^{59}Fe),
- **trace amounts of actinides.**

Exposure pathways:

- **drinking water,**
- **fish from watercourses,**
- **recreational activities (swimming, fishing).**

Measures:

- monitoring of radioactivity in surface waters, fuel assembly integrity, suitability of the materials used, optimisation of chemical regimes, minimisation of inter-circuit leaks and, for discharges to water, controlled discharge following sufficient dilution,
- establishment of discharge limits,
- immediate reporting if reference values are exceeded.

Measured concentrations are usually well below the detection limit. Calculations of effective doses indicate values of the order of a few $\mu\text{Sv}/\text{year}$ even under conservative scenarios.

The **health risk** is therefore considered **negligible**, particularly in comparison with other factors affecting public health (e.g. air quality and lifestyle).

1.8 Risk of radiation exposure from operation of SMR ETE

A project for the siting of a small modular reactor (SMR) with an installed electrical capacity of up to 500 MW_e, designated **SMR ETE**, is currently being prepared at the ETE site.

As part of the preparation of the SMR ETE project and in accordance with the applicable legislation, a study of the radiological effects of normal operation of SMR ETE was prepared (Abmerit – nuclear and space, 2026).

The calculation of the radiological consequences of normal operation of SMR ETE was performed using the ESTE Annual Impacts software, which makes it possible to identify representative persons for different exposure pathways, determines individual effective doses and 50-year (adults) or 70-year (children) committed individual effective doses, determines doses to the average inhabitant, and calculates collective doses from them.

The software calculates the effects of discharges to the atmosphere and to watercourses; in the case of discharges to the atmosphere, it makes it possible to enter a discharge and calculate the dispersion of radionuclides from different points at the site (ventilation stacks or cooling towers). The methodological procedures and algorithms used by the software take account of all potential exposure pathways and a large number of radionuclides in a potential discharge. The methodology and calculation model are described in greater detail in the study of the radiological effects of normal operation of SMR ETE.

The report analyses the results using 3 scenarios for exposure from atmospheric discharges and 3 scenarios for exposure from discharges to watercourses.

The original 2025 report was revised in 2026 to take account of changes resulting from the amendment to Decree No. 422/2016 Coll., which was published in the Collection of Laws and

International Treaties on 29 January 2026 as No. 13/2026 Coll., with the following effective date: 1 February 2026 (SUJB, 2026a).

Based on meteorological data from 2018 to 2024, an analysis of wind direction at the selected SMR ETE site and an analysis of the flow rate of the Vltava River were performed. Weather conditions did not change significantly during the selected period. Based on the meteorological data, 2018, 2023, and 2024 were selected as representative years: **2018** was considered a **dry year** with a lower flow rate in the Vltava River at Kořensko, while **2023** was selected as an **average year** corresponding to the long-term annual average at the Kořensko profile. The year **2024** was selected as a **wet year**.

The study (Abmerit – nuclear and space, 2026) identified inhabited locations in the vicinity of SMR ETE where the highest effective dose values for the representative person were found. In terms of atmospheric discharges, three locations were identified in this way – **Kočín, Litoradlice, and Zvěrkovice**. In terms of liquid discharges, this was the location of **Neznašov, including Újezd and the Pašovice cottage area**. The effective doses determined for bounding discharges from SMR ETE to the atmosphere and hydrosphere are presented in Table 7 and Table 8.

The following quantities were determined for the individual locations of interest:

Discharges to the atmosphere

- committed effective dose (50 or 70 years) from inhalation for the (given) age category (sum over all nuclides) [Sv],
- committed effective dose (50 or 70 years) from ingestion for the (given) age category (sum over all nuclides) [Sv],
- effective dose from external exposure from deposition (sum over all nuclides) [Sv],
- effective dose from external exposure from the cloud (sum over all nuclides) [Sv].

ATMOSPHERE: Total effective dose and committed effective dose via all considered pathways [Sv].

Discharges to the hydrosphere

- committed effective dose (50 or 70 years) from ingestion (sum over all nuclides) [Sv],
- drinking water, committed effective dose (50 or 70 years) from ingestion for the (given) age category (sum over all nuclides) [Sv],
- irrigation, watering of animals, and fish, committed effective dose (50 or 70 years) from ingestion for the (given) age category (sum over all nuclides) [Sv],
- effective dose from external exposure during swimming [Sv],
- effective dose from external exposure during boating [Sv],
- effective dose from external exposure during time spent on the riverbank [Sv].
- HYDROSPHERE: Total effective dose and committed effective dose via all considered pathways for the (given) age category [Sv].

ATMOSPHERE + HYDROSPHERE: Total effective dose and committed effective dose via all considered pathways for the (given) age category [Sv]:

Study (Abmerit – nuclear and space, 2026) identified two age groups of the population as those for which the maximum annual effective dose values from atmospheric discharges apply, namely the 6–15 years and 16+ years age groups. For hydrospheric discharges, the age groups of interest were identified as the foetus and children aged 0–5 years, for whom the maximum annual doses from discharges to the hydrosphere apply.

Table 7 Summary results, effective dose including the committed dose to the representative person as a result of bounding discharges from SMR ETE – atmosphere.

Radiological effect of discharges to the atmosphere			
Year	2018	2023	2024
Height of ventilation stack [m]	56	56	56
Location	Kočín	Zvěrkovice	Zvěrkovice
Age group	6–15 years (16+ years)	6–15 years (16+ years)	6–15 years (16+ years)
Total annual effective dose and committed effective dose via all considered pathways [Sv/year]	1.4E-07 (1.3E-07)	1.78E-07 (1.73E-07)	1.57E-07 (1.52E-07)

Cells shaded in gray indicate the maximum calculated values of the effective dose.

Table 8 Summary results, dose including the committed effective dose to the representative person as a result of bounding discharges from SMR ETE – hydrosphere.

Radiological effect of discharges to the hydrosphere			
Year	2018 (dry)	2023 (average)	2024 (wet)
Location	Újezd location and Pašovice cottage area		
Age group	Foetus (0–5 years)	Foetus (0–5 years)	Foetus (0–5 years)
Total annual effective dose and committed effective dose via all considered pathways [Sv/year]	2.80E-07 (2.05E-07)	1.48E-07 (1.09E-07)	1.31E-07 (9.60E-08)

Cells shaded in gray indicate the maximum calculated values of the effective dose.

The results are presented for a reference ventilation stack height of 56 m and the meteorological conditions in the selected representative years 2018, 2023, and 2024. According to the study, meteorological conditions influence the identification of the representative person, particularly with respect to direction.

In the process of identifying the primary radionuclides, the primary and secondary radionuclides contributing most to the annual effective doses of the representative person were determined.

Primary and secondary radionuclides contributing to the annual effective dose of the representative person from SMR ETE (atmosphere) are presented in Table 9. All radionuclides that contribute at least 2% to the annual effective dose are considered primary radionuclides.

Table 9 Primary and secondary radionuclides contributing to the annual effective dose of the representative person from SMR ETE (atmosphere).

Height of ventilation stack [m]	56
Primary radionuclides contributing to the annual effective dose	^{41}Ar (58.09%), ^{14}C (21.13%), ^3H (7.92%), ^{138}Xe (3.86%), ^{88}Kr (2.27%), ^{85}Kr (2.06%)
Secondary radionuclides contributing to the annual effective dose	^{135}Xe , $^{135\text{m}}\text{Xe}$, $^{131}\text{I}_{\text{gas}}$, ^{87}Kr , $^{131}\text{I}_{\text{aer}}$, $^{85\text{m}}\text{Kr}$, ^{133}Xe , $^{133\text{m}}\text{Xe}$, ^{60}Co

A **key factor for discharges** to the hydrosphere is the **water flow rate** of the Vltava River (Kořensko). For the selected representative dry year 2018 (24.4 m³/s), the annual effective dose values for the representative person are almost double those for 2023 (an average year in terms of flow rate, 47.4 m³/s) and more than double those for the wet year 2024 (with a flow rate of 63.3 m³/s).

The principal exposure pathways for the representative persons are contributions from:

- committed doses from the **ingestion of drinking water** (56.8%),
- committed doses from the **ingestion of food** (irrigation, watering of animals, and fish consumption) (43.2%).

From SMR ETE discharges, tritium accounts for approximately 99.9% of the total annual effective dose from the hydrosphere.

Table 10 Primary and secondary radionuclides contributing to the annual effective dose of the representative person from SMR ETE (hydrosphere).

Primary radionuclide contributing to the annual effective dose	^3H (99.92%)
Secondary radionuclide contributing to the annual effective dose	^{134}Cs (0.05%) ^{137}Cs (0.03%)

The annual effective dose values for the representative person from SMR ETE hydrospheric discharges are at the level of **0.1 $\mu\text{Sv/year}$** for average years.

The contribution of the total annual effective dose and committed effective dose from all SMR ETE pathways considered is **approximately 4.2%** of the total annual effective dose and committed effective dose from all pathways considered when the contributions from ETE1,2 and New NPP ETE are included.

In terms of annual effective dose per 1 MW_e of installed capacity, the SMR ETE contribution is **approximately 47%** of the combined contribution from ETE1,2 and New NPP ETE per 1 MW_e, and is therefore approximately half as large.

Table 11 Identification of the representative person and the total dose to the representative person from all exposure pathways as a result of annual bounding discharges from SMR ETE in the individual scenarios analysed (Abmerit – nuclear and space, 2026).

Calendar year	2018	2023	2024
	“Dry year”	“Average year”	“Wet year”
Effect of atmospheric discharges			
Populated location with the highest effective dose [Sv] to the representative person			
Description of location	Cadastral areas of the municipalities of Dříteň and Temelín, “Kočin” location	Cadastral areas of the municipalities of Temelín and Týn nad Vltavou, “Zvěrkovice” location, “Zadní kohout”	Cadastral areas of the municipalities of Temelín and Týn nad Vltavou, “Zvěrkovice” and “Zadní kohout” locations
Effective dose	1.4E-07	1.8E-07	1.6E-07
Age group	16	16+ years	6–15 years, 16+ years
Effect of discharges to the Vltava River			
Populated location with the highest effective dose [Sv] to the representative person			
Description of location	Cadastral areas of the municipalities of Albrechtice and Chrášťany, the “Újezd” location and the “Pašovice” cottage area	Cadastral area of the municipality of Albrechtice, Chrášťany, “Újezd” location	Cadastral areas of the municipalities of Albrechtice and Chrášťany, “Újezd” location
Effective dose	2.8E-07	1.5E-07	1.3E-07
Age group	Children aged 0–5 years	0–5 years	0–5 years
Combined effect of atmospheric discharges and discharges to the Vltava River (resulting representative person)			
Populated location with the highest effective dose [Sv] to the representative person			
Description of location	Cadastral areas of the municipalities of Chrášťany and Všemyšlice, “Neznašov” location	Cadastral areas of the municipalities of Temelín and Týn nad Vltavou, “Zvěrkovice” and “Zadní kohout” locations	Cadastral areas of the municipalities of Temelín and Týn nad Vltavou, “Zvěrkovice” and “Zadní kohout” locations
Effective dose	3.0E-07	1.8E-07	1.6E-07
Age group	Foetus, children aged 0–5	16+ years	6–15 years, 16+ years

The following conclusions can be drawn from Table 11:

- The maximum effective dose, including committed effective dose, to the representative person as a result of bounding atmospheric discharges from SMR ETE is **1.8×10^{-7} Sv**, in the “Zvěrkovice” and “Zadní kohout” locations in the cadastral areas of the municipalities of Temelín and Týn nad Vltavou.
- The maximum effective dose, including committed effective dose, to the representative person as a result of bounding discharges from SMR ETE to the hydrosphere is **2.8×10^{-7} Sv**, in the “Újezd” location and the “Pašovice” cottage area in the cadastral areas of the municipalities of Albrechtice and Chrástany.
- The maximum effective dose, including committed effective dose, to the representative person as a result of bounding discharges from SMR ETE to the atmosphere and surface water was calculated at **3.0×10^{-7} Sv per year** (0.3 μ Sv/year). This value was determined for the “Neznašov” location in the cadastral area of the municipality of Všemyslice. Compared with the assumed annual effective dose from natural background radiation of **5.93 mSv**, the contribution from the bounding discharges represents approximately **0.005%** of this value.

For the three maximum effective dose and committed effective dose values specified above, a conservative model (annual rate $\cdot$ residence period) can be used to calculate the total radiation exposure for various periods of residence in the area of interest and subsequently the total health detriment (the product of the total radiation exposure and the detriment-adjusted nominal risk coefficient (5.7×10^{-2} Sv $^{-1}$) for stochastic effects from exposure to low-dose-rate radiation).

Based on the values presented in Tables 12 to 14, it can be concluded that the contribution of the source assessed to the radiation exposure of the public is low. The estimated health risk is low compared with the other components of public exposure, although the uncertainties associated with the model assessment used must be taken into account.

Table 12 Cumulative effect of atmospheric discharges from SMR ETE on the representative person.

Effect of atmospheric discharges from SMR ETE on the representative person			
Annual radiation exposure [Sv]	Residence period [years]	Radiation exposure over the residence period [Sv]	Total health detriment
1.8E-07	1	1.80E-07	1.03E-08
	5	9.00E-07	5.13E-08
	10	1.80E-06	1.03E-07
	20	3.60E-06	2.05E-07

	30	5.40E-06	3.08E-07
	50	9.00E-06	5.13E-07
	70	1.26E-05	7.18E-07

Table 13 Cumulative effect of discharges from SMR ETE to the hydrosphere on the representative person.

Effect of discharges from SMR ETE to the hydrosphere on the representative person			
Annual radiation exposure [Sv]	Residence period [years]	Radiation exposure over the residence period [Sv]	Total health detriment
2.8E-07	1	2.80E-07	1.60E-08
	5	1.40E-06	7.98E-08
	10	2.80E-06	1.60E-07
	20	5.60E-06	3.19E-07
	30	8.40E-06	4.79E-07
	50	1.40E-05	7.98E-07
	70	1.96E-05	1.12E-06

Table 14 Combined effect of discharges from SMR ETE to the atmosphere and hydrosphere on the representative person

Combined effect of discharges from SMR ETE to the atmosphere and hydrosphere on the representative person			
Annual radiation exposure [Sv]	Residence period [years]	Radiation exposure over the residence period [Sv]	Total health detriment
3.0E-07	1	3.00E-07	1.71E-08
	5	1.50E-06	8.55E-08
	10	3.00E-06	1.71E-07
	20	6.00E-06	3.42E-07
	30	9.00E-06	5.13E-07
	50	1.50E-05	8.55E-07
	70	2.10E-05	1.20E-06

1.9 Risk of radiation exposure from the operation of ETE1,2 and New NPP ETE

Two VVER-1000 V320 units with a total installed electrical capacity of $2 \times 1,125 \text{ MW}_e$ are currently in operation at the Temelín site. As part of the project for the siting of New NPP ETE at the Temelín site, two additional New NPP ETE units with an electrical capacity of up to $2 \times 1,700 \text{ MW}_e$ have long been planned at the site.

As part of the EIA Documentation for New NPP ETE, the effects of the two ETE1,2 units and New NPP ETE on the population and the environment were assessed. Under the original concept ($4 \times 1,000 \text{ MW}_e$), New NPP ETE constitutes an expansion of the power plant by the addition of new modern units.

The radiological effects of ETE1,2 and New NPP ETE are analysed in the report New Nuclear Power Plant at the Temelín site, including power evacuation to the Kočín substation, environmental impact assessment documentation (AMEC, 2010).

The calculation of the atmospheric radiological consequences of normal operation of ETE1,2 (two units) and New NPP ETE ($2 \times 1,700 \text{ MW}_e$) was performed using the NORMAL software, version 02, which was approved for use by Evaluation Commission No. 6 of the State Office for Nuclear Safety. The calculations of the radiological consequences of New NPP ETE and ETE1,2 were performed by dividing the surroundings of the ETE site into 16 directional and 20 distance zones. The software takes into account elevations, terrain roughness, and land surface types according to the actual situation at the Temelín site. Conservative assumptions (AMEC, 2010) were used to calculate and determine ground-level activity concentrations, deposition on the ground surface, and deposition rates.

In the environmental impact assessment documentation (AMEC, 2010), the radiological effects of discharges from ETE1,2 to the hydrosphere, expressed as annual effective doses and committed effective doses, were determined using the RDETE software. The software includes the dispersion of radioactive substances and their decay products in the aquatic environment, estimates of the effect of swimming in contaminated water, boating, time spent on sediment, time spent on irrigated soil, ingestion of drinking water, ingestion of fish living in contaminated water, ingestion of meat and milk from animals watered with contaminated water, and ingestion of agricultural products irrigated with contaminated water. The exposure pathways considered are evaluated for all age groups.

In the environmental impact assessment documentation (AMEC, 2010), annual effective doses are determined as the sum of the annual dose from the cloud, the annual dose from deposition in the given year, the committed effective dose from inhalation and ingestion, and committed effective doses from inhalation due to resuspension.

In the study of the radiological effects of atmospheric discharges from New NPP ETE and ETE1,2, annual effective doses to the population were determined, with the maximum annual dose calculated for the north-eastern direction. The study quantifies values given for this direction as the most unfavourable ones.

The values of the total effective dose and committed effective doses via all considered pathways for public exposure were calculated separately for New NPP ETE (2 units of 1,200/1,700 MW_e) and ETE1,2 (2 units). The calculated values of the total effective dose and committed effective doses via all considered pathways for the population are divided into 6 age categories:

- children aged 0–1 year, children aged 1–2 years, children aged 2–7 years, children aged 7–12 years, children aged 12–17 years, and adults.

Given the distances of the locations determined in the study of radiological effects of normal operation of SMR ETE on the **Kočín, Zvěrkovice, and Litoradlice** locations in terms of atmospheric discharges, the distances of interest are 2,333 m and 3,333 m from ETE1,2.

Following the publication of the amendment to Decree No. 422/2016 Coll. (SONS, 2026a), new annual effective dose and committed effective dose values from atmospheric discharges for the individual age groups of the population were determined in the report “Amentum DP29 – Revision of Study DP17B Taking into Account the Amendment to Decree No. 422/2016 Coll.” (Amentum Clean Energy s.r.o., 2026). The newly calculated annual effective dose values are lower than those determined under the original wording of the Decree. However, when assessing the cumulative effects of the contributions from ETE1,2 and New NPP ETE, the annual effective dose values used in the EIA Documentation for New NPP ETE at the Temelín site (AMEC, 2010) were retained for conservative reasons. These values were therefore not updated to reflect the amendment to Decree No. 422/2016 Coll. If the conversion factors resulting from the amendment to the Decree were applied to the annual effective dose values for ETE1,2 and New NPP ETE, the resulting values would be reduced by approximately 6%.

Table 15 Sum of annual effective doses and committed effective doses via all considered pathways for individual age categories resulting from one year of operation of ETE1,2 and New NPP ETE (2× 1,700 MW_e), from atmospheric discharges, at selected distances of interest.

Distance	Total annual effective dose and committed effective dose via all considered pathways					
	Children aged 0–1 years	Children aged 1–2 years	Children aged 2–7 years	Children aged 7–12 years	Children aged 12–17 years	Adults
[m]	[Sv/year]	[Sv/year]	[Sv/year]	[Sv/year]	[Sv/year]	[Sv/year]
2,333	1.00E-06	1.35E-06	1.11E-06	1.07E-06	1.03E-06	1.03E-06
3,333	6.31E-07	8.85E-07	7.10E-07	6.77E-07	6.48E-07	6.47E-07

According to the New NPP ETE project, the two new units are to be located north-west of the existing ETE1,2 site. This increases the distance between New NPP ETE and the village of Litoradlice to 4.3 km; however, a distance of 3.3 km continues to be conservatively assumed for the subsequent analysis.

The discharged radioactive wastewater from ETE1,2 is diluted with all non-radioactive wastewater from the ETE1,2 power plant, primarily cooling tower blowdown, after which the water is discharged to the receiving water body (the Vltava River, Kořensko profile). The average flow rate of the Vltava River at the profile of wastewater discharge from ETE1,2 and the planned New NPP ETE was considered in the EIA Documentation for New NPP ETE to be 50 m³/s.

The values in the following table were adjusted using proportional coefficients reflecting the increase in annual effective doses for the individual age groups resulting from Decree No. 13/2026 Coll., which amended Decree No. 422/2016 Coll. Since the annual effective dose values for ETE1,2 and New NPP ETE following the amendment by Decree No. 13/2026 Coll. are not directly available, the proportional coefficients for annual effective doses were derived from SMR ETE data based on the updated report Amentum DP29 – Revision of Study DP17B Taking into Account the Amendment to Decree No. 422/2016 Coll. (SUJB, 2026a). The annual effective dose and committed effective dose values from SMR liquid discharges are now higher than those obtained using the dose coefficients under the original wording of Decree No. 422/2016 Coll. A proportional increase factor was therefore also conservatively applied to the annual effective dose values for ETE1,2 and New NPP ETE.

Table 16 Annual effective dose and committed effective dose via all considered pathways from the use of water affected by discharges to the hydrosphere from ETE1,2 and New NPP ETE.

Age group [years]	Total annual effective dose and committed effective dose via all considered pathways from operational discharges to the hydrosphere from the two ETE1,2 units (2 × 1,000 MW _e) [Sv/year]	Total annual effective dose and committed effective dose via all considered pathways from design values of discharges to the hydrosphere from the two New NPP ETE units (2 × 1,700 MW _e) [Sv/year]	Sum of the total annual effective dose and committed effective doses via all considered pathways from discharges to the hydrosphere from ETE1,2 (2 × 1,000 MW _e) and New NPP ETE (2 × 1,700 MW _e) [Sv/year]
0–1	1.03E-06	2.71E-06	3.74E-06
1–2	8.17E-07	2.24E-06	3.05E-06
2–7	9.30E-07	2.49E-06	3.42E-06
7–12	5.71E-07	1.59E-06	2.16E-06
12–17	4.66E-07	1.38E-06	1.85E-06
Adults	6.03E-07	1.84E-06	2.45E-06

1.10 Risk of radiation exposure from loaded packages in the SNFS following its expansion

At the Temelín site, preparations are also under way to expand the capacity of the spent nuclear fuel storage facility (SNFS) from 96 to 152 packages.

As part of the preparation of the EIA Documentation for the SNFS expansion, the radiation exposure from gamma radiation and neutrons from loaded packages in the SNFS after expansion was assessed (Podzimek, červen 2024).

The maximum expected dose equivalent rates at a distance of 2 m from the outer shell of the OS ŠKODA 1000/19 package, adopted for the model calculation, are presented in Table 11.

Table 17 Maximum dose equivalent rates at a distance of 2 m from the outer shell of the OS ŠKODA 1000/19 package, adopted for the model calculation.

	Neutrons	Gamma radiation	Total
	[μSv/h]	[μSv/h]	[μSv/h]
2 m from the central part of the outer shell	61.4	33.0	94.4

For the conservative target scenario, the ambient dose equivalent rate (ADER) in open space, taking account of shielding provided by the building, was determined for 38 packages located in the first row along the wall of the storage facility. The effect on the immediate vicinity and the nearest permanently inhabited area, Kočín, part of the municipality of Temelín, located approximately 1,600 m from the SNFS, was evaluated. The results are presented in Table 18.

Table 18 Ambient dose equivalent rates in open space, taking account of shielding provided by the SNFS building, for 38 packages – conservative target scenario.

	ADER [Sv/h] at 2 m	Number of packages	Ambient dose equivalent rate in open space, taking into account building shielding [nSv/h]				
			Distance from package [m]				
			2	7	100	1,000	1,600
gamma radiation	3.30E-05	38	1.96E+04	1.60E+03	7.84E+00	7.84E-02	3.06E-02
neutrons	6.14E-05	38	2.30E+04	1.87E+03	9.19E+00	9.19E-02	3.59E-02

gamma radiation + neutrons	9.44E-05	38	4.26E+04	3.47E+03	1.70E+01	1.70E-01	6.65E-02
Contribution from neutrons to the total ADER	65.0%		54.0%	54.0%	54.0%	54.0%	54.0%

The following conclusions can be drawn from the table:

- Under the conservative target scenario, in which the maximum number of 38 packages in the first row was considered, the contribution to the existing radiation exposure at the nearest settlement, i.e. the municipality of Temelín (Kočín part), represented by the **annual ambient dose equivalent** caused by the SNFS after expansion, is **5.83×10^{-7} Sv (0.583 μ Sv)**, which only constitutes a small fraction of the radiation exposure from natural background, which at this location is approximately **5.65 mSv** per year (Podzimek, červen 2024).
- At the same time, assuming year-round residence in Kočín, the expected annual ambient dose equivalent of **583 nSv** caused by the expanded SNFS corresponds to **0.058%** of the annual effective dose limit for the public.

As at 31 December 2025, the SNFS contained 48 CASTOR 1000/19 packages holding 912 fuel assemblies, 5 ŠKODA 1000/19 packages holding 95 fuel assemblies, and 22 ŠKODA 1000/19M packages holding 418 fuel assemblies.

1.11 Risk of radiation exposure from the operation of SMR ETE, ETE1,2, the SNFS, and New NPP ETE

In the analysis of the combined effect of ETE1,2, the ETE SNFS following its planned future expansion, and the proposed New NPP ETE and SMR ETE projects, an **area of interest** for atmospheric discharges was defined that includes **Kočín, Zvěrkovice, and Litoradlice**. The effect of the ETE SNFS is characterised by ambient dose equivalent rates in open space according to report (Podzimek, červen 2024).

The cumulative assessment is performed for the New NPP ETE 2× 1,700 MW_e bounding case, whose overall consequences exceed those of the 2× 1,200 MW_e power output option. For data on effective doses from ETE1,2 and New NPP ETE, the value for distances of 2,333 m and 3,333 m was conservatively adopted for atmospheric discharges. For the hydrosphere, the **Neznašov location, including the Újezd location and the Pašovice cottage area**, was selected.

Representative data on the maximum annual effective doses from atmospheric discharges from ETE1,2 and New NPP ETE were determined in the **north-east direction**. Hydrospheric discharges from all assessed power plants are routed to the **Vltava River – Kořensko profile**. Within the selected area of interest for atmospheric discharges, the municipality of **Kočín is situated south-south-west of ETE1,2, Litoradlice is situated east-south-east of ETE1,2, and Zvěrkovice is situated north-east of ETE1,2**. Given the locations of the municipalities, the actual

contributions to annual effective doses from ETE1,2 and New NPP ETE in these locations will be lower (and, for Zvěrkovice, the same at most) than the data conservatively selected for the north-east direction in the EIA Documentation for New NPP ETE (AMEC, 2010).

The study of the radiological effects of SMR ETE considered three conditions: a **dry, average, and wet year** (Abmerit – nuclear and space, 2026).

In determining the effect of individual power plants, different age categories of representative persons were selected, corresponding to the legislation in force at the time and the legislation currently in force. Therefore, when comparing the values, the overlap of the given age groups was considered, and the highest value of the annual effective dose from ETE1,2 and New NPP ETE discharges was conservatively selected. The contribution from SMR ETE and the combined contribution from ETE1,2 and New NPP ETE were then determined. For the purposes of assessing the cumulative effect of SMR ETE, the sum of the annual effective dose values from ETE1,2 and New NPP ETE is regarded as the background contribution to public exposure.

The contributions of the **annual effective dose and committed effective dose** via all considered pathways **from atmospheric discharges from SMR ETE are significantly lower than those from ETE1,2 + New NPP ETE** in all the scenarios analysed. For the considered SMR ETE ventilation stack height of 56 m, the maximum share of the annual effective dose to the representative person from atmospheric discharges from ETE site is 18% at most.

In terms of the annual effective dose contribution from atmospheric discharges per 1 MW_e of installed capacity, the contribution from SMR ETE is approximately 73% of that from ETE1,2 and New NPP ETE.

The contribution of **annual effective dose from discharges to the hydrosphere** from SMR ETE is approximately twelve times lower than the combined contribution from ETE1,2 and New NPP ETE. In the study of the radiological effects of normal operation of SMR ETE, annual effective dose values were determined for the dry year 2018, the average year 2023, and the wet year 2024. For ETE1,2 and New NPP ETE, however, values were only determined for an average year with a Vltava River flow rate of 50 m³/s. The cumulative annual effective dose was therefore only determined for the average year 2023.

Table 19 Comparison of annual effective doses from hydrospheric discharges from SMR ETE and ETE1,2 + New NPP ETE.

Discharges to the hydrosphere	SMR ETE	ETE1,2 + New NPP ETE
Calculated average annual flow rate of the Vltava River – Kořensko [m ³ /s]	47.4	50
Age group [years]	0–5, foetus	0–1
Total annual effective dose and committed effective dose via all considered pathways [Sv/year]	1.48E-07 (1.09E-07)	3.74E-06

The total annual effective doses and committed effective doses via all considered pathways from exposure due to SMR ETE hydrospheric discharges do not exceed 5% of the contribution from hydrospheric discharges from the ETE site, consisting of ETE1,2 and New NPP ETE.

To determine the cumulative maximum annual effective doses to the representative person, the maximum public exposure values from the individual power plants were summed. In reality, these values will be lower (for Zvěrkovice, at most the same), because the maximum radiological effect of ETE1,2 and New NPP ETE is determined for the north-east direction (Zvěrkovice). The Kočín (S–SW) and Litoradlice (E–SE) locations, at which the highest doses from SMR atmospheric discharges occur, lie in different directions. In reality, the doses in Zvěrkovice will also be lower, because a conservative distance from ETE1,2 was also considered for the planned New NPP ETE, which will be located farther away.

Table 20 Cumulative maximum annual effective doses to the representative person from ETE1,2, New NPP ETE, and SMR ETE.

Scenario	Location and age group of representative persons	Maximum cumulative annual effective dose (ETE1,2, New NPP ETE, SMR ETE) [Sv/year]
Exposure scenarios for atmospheric discharges		
Scenario 2a, ventilation stack 56 m, dry year 2018	Kočín, children aged 0–5 years	1.47E-06
Scenario 4a, ventilation stack 56 m, average year 2023	Zvěrkovice, children ages 0–5 years	1.05E-06
Scenario 6a, ventilation stack 56 m, wet year 2024	Zvěrkovice, children ages 0–5 years	1.03E-06
Exposure scenarios for hydrospheric discharges		
Scenario 1 h, average year 2023	Újezd location and Pašovice cottage area, foetus/children aged 0–5 years	3.89E-06

In terms of **atmospheric discharges**, the **maximum cumulative annual effective dose, including the committed effective dose**, to the representative person in the vicinity of the ETE site, will be **1.47 $\mu\text{Sv/year}$** at most, with an SMR ETE ventilation stack height of 56 m. When the contribution of the ambient dose equivalent rate resulting from radiation from the expanded SNFS is included, the maximum value at the Kočín location will be **2.05 $\mu\text{Sv/year}$** .

In terms of the cumulative doses to the representative person from **hydrospheric discharges**, the maximum annual cumulative effective dose to the representative person, including the committed effective dose, is **3.89 $\mu\text{Sv/year}$** , assuming the average flow rate in the Vltava River in the Újezd location and the Pašovice cottage area.

Given the location of the representative person, there will be no contribution from the SNFS.

The following input data will be used to calculate the total radiation exposure and total health detriment:

- The maximum effective dose, including committed effective dose, to the representative person resulting from **bounding atmospheric discharges from ETE1,2, New NPP ETE, and SMR ETE is $1.47 \times 10^{-6} \text{ Sv/year}$** at the Kočín location. At the Kočín location, the ambient dose equivalent rate from the SNFS will also contribute and may reach up to **$5.81 \times 10^{-7} \text{ Sv/year}$** following its expansion. The total radiation exposure at the Kočín location from the cumulative effects of all nuclear facilities at the Temelín site could therefore reach up to **$2.05 \times 10^{-6} \text{ Sv/year}$** .
- The maximum effective dose, including committed effective dose, to the representative person resulting from **bounding discharges from ETE1,2, New NPP ETE, and SMR ETE to the hydrosphere is $3.89 \times 10^{-6} \text{ Sv/year}$** at the Újezd location and the Pašovice cottage area.
- At the **Pašovice** location, the annual contribution to the effective dose and committed effective dose from **ETE1,2 atmospheric discharges is $1.25 \times 10^{-7} \text{ Sv/year}$** (AMEC, 2010).
- At the **Pašovice** location, the annual contribution to the effective dose and committed effective dose from **New NPP ETE atmospheric discharges is $2.95 \times 10^{-7} \text{ Sv/year}$** (AMEC, 2010).
- At the **Pašovice** location, the annual contribution to the effective dose and committed effective dose from SMR ETE atmospheric discharges is **$1.6 \times 10^{-8} \text{ Sv/year}$**
- The maximum effective dose, including committed effective dose, to the representative person resulting from **bounding discharges from ETE1,2, New NPP ETE, and SMR ETE to the hydrosphere and atmosphere is $4.33 \times 10^{-6} \text{ Sv/year}$** .

Table 21 Effect of atmospheric discharges from the operation of SMR ETE, ETE1,2, the SNFS, and New NPP ETE on the representative person.

Effect of atmospheric discharges from the operation of SMR ETE, ETE1,2, the SNFS, and New NPP ETE on the representative person at the Kočín location			
Annual radiation exposure [Sv/year]	Residence period [years]	Radiation exposure over the residence period [Sv]	Total health detriment
2.05E-06	1	2.05E-06	1.17E-07
	5	1.03E-05	5.84E-07
	10	2.05E-05	1.17E-06
	20	4.10E-05	2.34E-06
	30	6.15E-05	3.51E-06
	50	1.03E-04	5.84E-06
	70	1.44E-04	8.18E-06

Table 22 Effect of hydrospheric discharges from the operation of SMR ETE, ETE1,2, the SNFS, and New NPP ETE on the representative person.

Effect of hydrospheric discharges from the operation of SMR ETE, ETE1,2, the SNFS, and New NPP ETE on the representative person at the Pašovice location			
Annual radiation exposure [Sv/year]	Residence period [years]	Radiation exposure over the residence period [Sv]	Total health detriment
3.89E-06	1	3.89E-06	2.22E-07
	5	1.95E-05	1.11E-06
	10	3.89E-05	2.22E-06
	20	7.78E-05	4.43E-06
	30	1.17E-04	6.65E-06
	50	1.95E-04	1.11E-05
	70	2.72E-04	1.55E-05

Table 23 Combined effect of discharges to the atmosphere and hydrosphere from the operation of SMR ETE, ETE1,2, the SNFS, and New NPP ETE on the representative person.

Combined effect of discharges from the operation of SMR ETE, ETE1,2, the SNFS, and New NPP ETE to the atmosphere and hydrosphere on the representative person at the Pašovice location			
Annual radiation exposure [Sv]	Residence period [years]	Radiation exposure over the residence period [Sv]	Total health detriment
4.33E-06	1	4.33E-06	2.47E-07
	5	2.17E-05	1.23E-06
	10	4.33E-05	2.47E-06
	20	8.66E-05	4.94E-06
	30	1.30E-04	7.40E-06
	50	2.17E-04	1.23E-05
	70	3.03E-04	1.73E-05

These annual effective dose values, both individually and in aggregate, are significantly lower than the dose constraint established in Section 82 of the Atomic Energy Act (Act No. 263/2016 Coll., as amended), which is 250 μSv per year for the representative person. In the case of nuclear power facilities, this value applies collectively to all nuclear facilities within the relevant nuclear facility siting area, with a value of 200 μSv per year established for atmospheric discharges and 50 μSv per year for discharges to surface water. The maximum calculated annual effective dose of 0.3 μSv per year corresponds to approximately 0.12% of the overall dose constraint of 250 μSv per year. In the assessment of atmospheric discharges, this value represents approximately 0.15% of the relevant dose constraint of 200 μSv per year.

Exposure from the spent nuclear fuel storage facility is assessed separately and is not included in the assessment against the dose constraint for discharges.

Radiation exposure over the residence period, and consequently the risk of health detriment, were determined very conservatively because:

- the highest dose identified for an age category was assumed to apply throughout the entire period, irrespective of the representative person's actual age and changes in age over time,

- the directional effects of the combined atmospheric discharges from ETE1,2 and New NPP ETE were not taken into account, and the maximum value identified at a given distance was used,
- the SNFS was assumed to be filled to its maximum capacity, i.e. with 38 packages in the outermost row, which would not be the case throughout the calculation period.
- The total detriment-adjusted nominal risk coefficient of $5.7 \times 10^{-2} \text{ Sv}^{-1}$ is a population average covering all age groups, including children. The value for adults, $4.2 \times 10^{-2} \text{ Sv}^{-1}$, is lower because, for the same dose, the lifetime risk of stochastic effects is lower in the adult population.
- In calculating the lifetime risk of health detriment, the same calculation algorithm (DDREF = 1) was used as in the report (Kotulán, 2010) to allow the results to be compared.
- Fractionated or protracted doses are, however, associated with a lower risk, suggesting that dose-specific estimates derived from high doses received during acute exposure should be divided by the dose and dose-rate effectiveness factor (DDREF) when applied to low continuous or fractionated doses.
- The dose and dose-rate effectiveness factor is an estimated factor that generally characterises the usually lower biological effectiveness per unit dose of exposure at low doses and low dose rates compared with exposure at high doses and high dose rates.
- A DDREF value of 2 is generally consistent with data from animal studies and, despite all the uncertainties, the ICRP recommends that DDREF = 2 continue to be used for radiation protection purposes (ICRP 103, 2009).
- If a DDREF value of 2 is used, the total health detriment will be half as high.

The **health risk** is considered **entirely negligible**, particularly in comparison with other factors affecting public health (e.g. air quality and lifestyle).

1.12 Risk of radiation exposure from the operation of ETE1,2, New NPP ETE, and SMR ETE in border areas

For the cumulative effect on Austria, the representative person was determined at the **Rottal location** in the 6–15 years age category.

The maximum annual effective dose from discharges from SMR ETE, ETE1,2, and New NPP ETE for this representative person will not exceed **50 nSv**. The contribution of SMR ETE to this value is less than 10%.

For the cumulative effect on Germany, the representative person was determined at the **Schnellenzipf location** in the 6–15 years age category.

The maximum annual effective dose from discharges from SMR ETE, ETE1,2, and New NPP ETE for this representative person will not exceed **65 nSv**. The contribution of SMR ETE to this value is less than 5%.

The annual effective doses for Germany are higher due to the doses from ETE1,2 and New NPP ETE, which are determined on the basis of older weather data, when the wind direction and meteorological effect on Germany were more significant. (Amentum Clean Energy s.r.o, 2026)

Due to the distance, the SNFS does not contribute to the exposure of the person at this location.

Table 24 Risk of radiation exposure from the operation of ETE1,2, New NPP ETE, and SMR ETE in border areas of Austria.

Risk of radiation exposure from the operation of ETE1,2, New NPP ETE, and SMR ETE in the border areas of Austria			
Annual radiation exposure [Sv/year]	Residence period [years]	Radiation exposure over the residence period [Sv]	Total health detriment
5.00E-08	1	5.00E-08	2.85E-09
	5	2.50E-07	1.43E-08
	10	5.00E-07	2.85E-08
	20	1.00E-06	5.70E-08
	30	1.50E-06	8.55E-08
	50	2.50E-06	1.43E-07
	70	3.50E-06	2.00E-07

The **health risk** is considered **entirely negligible**, particularly in comparison with other factors affecting public health (e.g. air quality and lifestyle).

Table 25 Risk of radiation exposure from the operation of ETE1,2, New NPP ETE, and SMR ETE in border areas of Germany

Risk of radiation exposure from the operation of ETE1,2, New NPP ETE, and SMR ETE in border areas of Germany			
Annual radiation exposure [Sv/year]	Residence period [years]	Radiation exposure over the residence period [Sv]	Total health detriment
6.50E-08	1	6.50E-08	3.71E-09
	5	3.25E-07	1.85E-08
	10	6.50E-07	3.71E-08
	20	1.30E-06	7.41E-08

	30	1.95E-06	1.11E-07
	50	3.25E-06	1.85E-07
	70	4.55E-06	2.59E-07

The **health risk** is considered **entirely negligible**, particularly in comparison with other factors affecting public health (e.g. air quality and lifestyle).

1.13 Conclusion

As part of the assessment of the planned exposure situation during normal operation of SMR ETE, the maximum annual effective doses to the representative person resulting from atmospheric and liquid discharges of radioactive substances were determined. At the same time, the dominant exposure pathways and the radionuclides making the largest contributions to the total annual effective dose were identified. This assessment is limited to the radiological effects of normal operation of the facility and does not include potential exposure during radiation emergencies, emergency preparedness, or the assessment of non-radiological effects on the environment and public health. These areas are addressed separately in the relevant sections of the documentation and in the subsequent safety analyses.

Following the analysis for SMR ETE, the radiological effect of SMR ETE was compared with the effect of ETE1,2 and New NPP ETE. Based on the comparison, it was shown that the annual effective doses from atmospheric bounding discharges from SMR ETE are **significantly lower** in general than the total annual effective doses from ETE1,2 and New NPP ETE. The assessment of the radiological effects of SMR ETE from discharges to the hydrosphere determined the main exposure pathways to be the committed effective dose from ingestion of food and drinking water. For discharges to the hydrosphere, the annual effective doses represented approximately **4%** of the total contribution from the ETE site.

The annual effective dose values for the representative person from SMR ETE hydrospheric discharges are at the level of **0.1 µSv/year** for average years.

The contributions of both atmospheric discharges and hydrospheric discharges from SMR ETE to public exposure are no more than approximately **0.30 µSv/year**.

The conservatively determined cumulative contributions from atmospheric discharges from ETE1,2, New NPP ETE, and SMR ETE reach maximum values of approximately **1.47 µSv/year**. SMR ETE accounts for no more than **18%** of these doses. When the contribution of the ambient dose equivalent rate resulting from radiation from the expanded SNFS is included, the maximum value is **2.05 µSv/year**.

The conservatively determined cumulative contributions from discharges to the hydrosphere from ETE1,2, New NPP ETE, and SMR ETE reach maximum values of approximately **3.89 µSv/year** in an average year.

The maximum effective dose, including committed effective dose, to the representative person resulting from **bounding discharges from ETE1,2, New NPP ETE, and SMR ETE to the hydrosphere and atmosphere is 4.33×10^{-6} Sv/year.**

The maximum value occurs at the Pašovice location and is attributable primarily to discharges to the hydrosphere from New NPP ETE and ETE1,2.

These cumulative **contributions are safely below the dose constraints established by the Atomic Energy Act** for discharges to the hydrosphere (**50 μ Sv/year**) and atmosphere (**200 μ Sv/year**), which apply collectively to all nuclear facilities at the Temelín site.

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1.15 List of abbreviations

Abbreviation	Meaning
ADER	ambient dose equivalent rate values
ALARA	As Low As Reasonably Achievable
CRPO	Central Register of Occupational Exposure
CT	Computed tomography
CGS	Czech Geological Survey
CR	Czech Republic
DDREF	Dose and dose-rate effectiveness factor
DNA	Deoxyribonucleic acid
DC	Dose constraint
EIA	Environmental impact assessment
ESTE	Temelín Environmental System
ETE	Nuclear facility comprising the two existing VVER-1000 units (ETE1,2) and the planned third and fourth units (New NPP ETE)
ETE1,2	Temelín Nuclear Power Plant (in-service units 1 and 2)
EURDEP	European Radiological Data Exchange Platform
ICRP	International Commission on Radiological Protection
NPP	Nuclear power plant
NF	Nuclear facility
LNT	Linear no-threshold model
MonRaS	Radiation Monitoring Network
New NPP ETE	New Nuclear Power Plant at the Temelín site
NORMAL	NORMAL calculation software for assessing radionuclide dispersion and determining radiological effects
MSA	Minimum significant activity
OS	Package
DER	Dose equivalent rate
PES	Planned exposure situation
PDER	Photon dose equivalent rate
RDETE	Software for calculating the dispersion of radioactive substances and their decay products in the aquatic environment
X-ray	X-radiation

Abbreviation	Meaning
SI	International System of Units (Système international d'unités)
SMR	Small modular reactor
SMR ETE	New SMR Power Plant at the Temelín site
SNFS	Spent nuclear fuel storage facility
EWN	Early Warning Network
SONS	State Office for Nuclear Safety
SÚRO	National Radiation Protection Institute
TLD	Thermoluminescent dosimeters
UNEP	United Nations Environment Programme
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
VK	Ventilation stack

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