

Environmental aspects of nuclear energy

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Environmental aspects of energy

Environmental aspects assesment

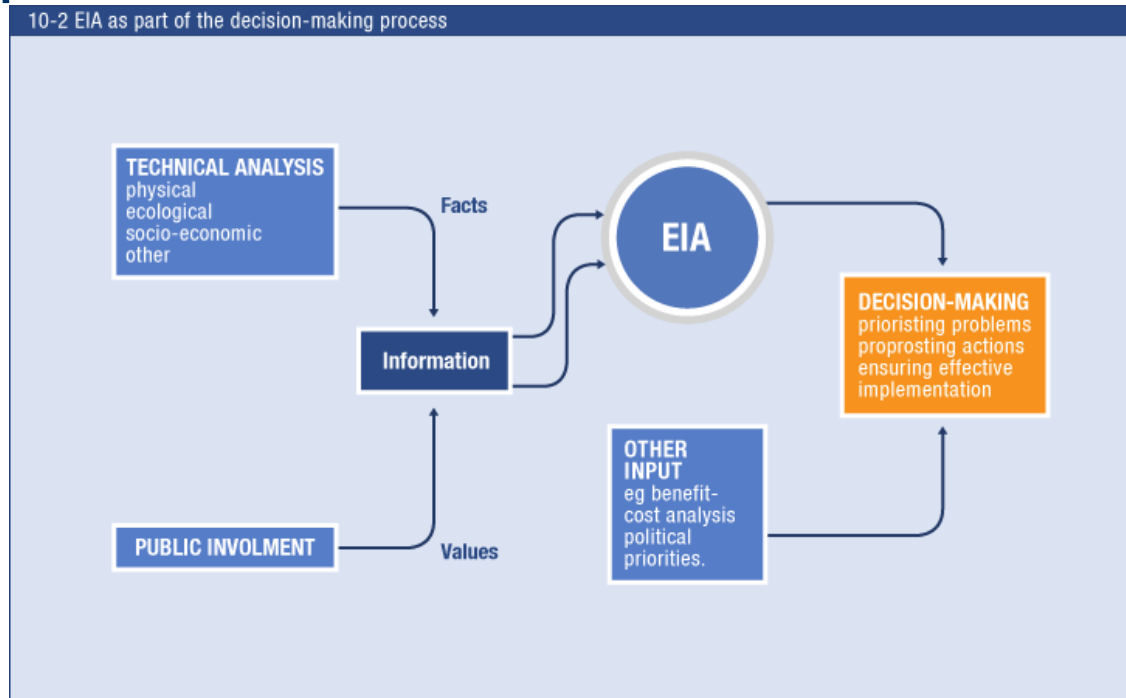
Over the next five minutes each of you write pros and cons of nuclear energy in terms of national energy security.

Environmental aspects assesment

Over the next five minutes each of you write pros and cons of nuclear energy in terms of purely subjective, personnal point of view.

Environmental aspects assessment

To bridge the conflict between state and industry interests and personal subjective perception of the problem serves the EIA.



Environmental aspects assesment

What is an *environmental aspect* ?

According to ČSN EN ISO 14001 definition:

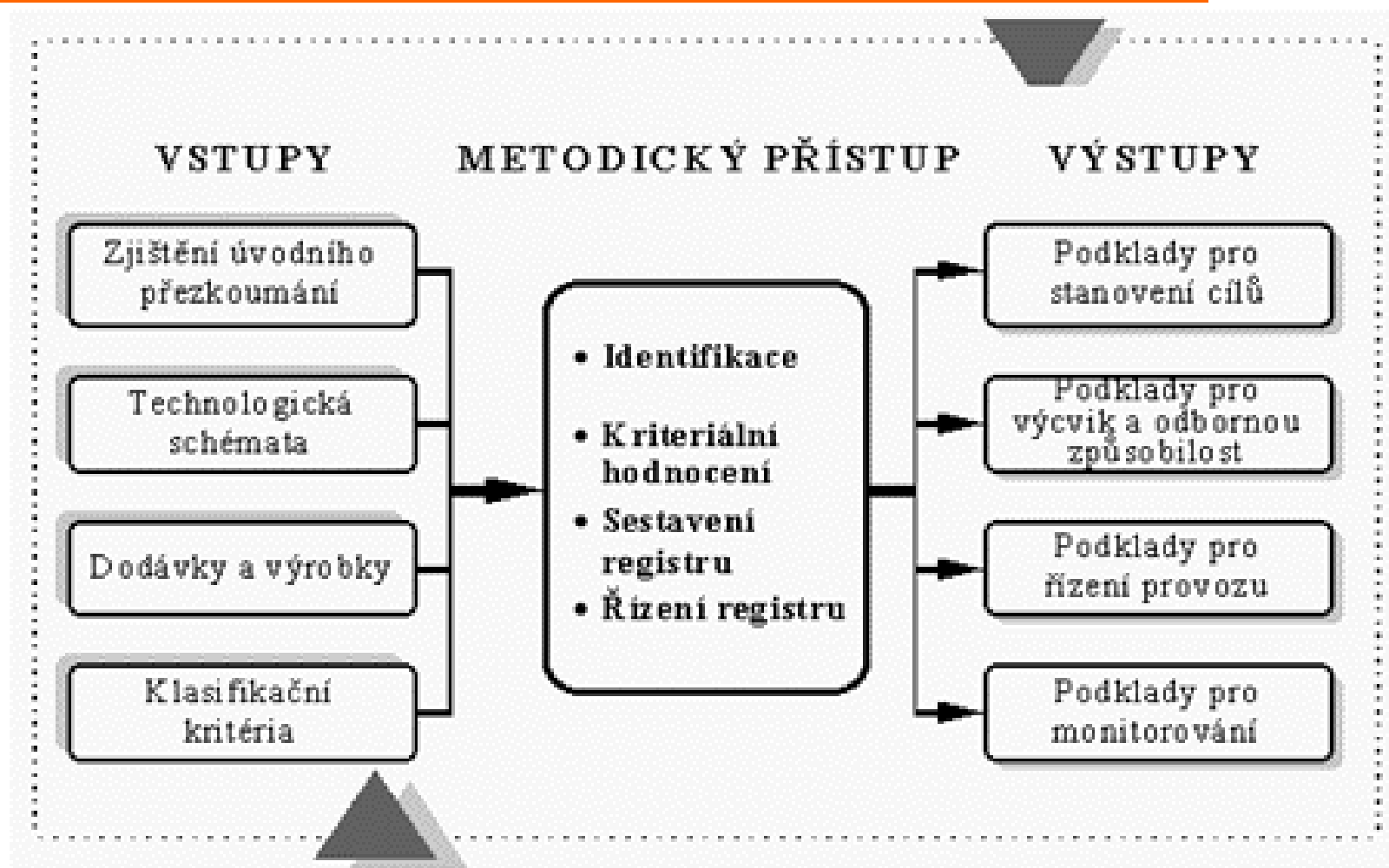
„The environmental aspect is an element of the activities, products or services that can interact with the environment.“

Environmental aspects assessment

ISO 14001 (voluntary norm of the International Organization for Standardization on environmental management, prestige of the company, the norm requires to have an **environmental policy and environmental risk assessment**)

EMAS (Environmental management and audit system developed by EC in 1993, it requires ISO 14001 and other requirements such as the involvement of employees, etc., EMAS is thus perceived as a **premium tool** for environmental management. As part of this process so called **Environmental review** takes place - own risk identification, preparation of environmental policy, determining environmental aspects, objectives, programs)

Environmental aspects assessment



Environmental aspects assesment

Tabulka registru aspektů a dopadů – část A – přímé

VEA – významný environmentální aspekt, NEA – nevýznamný environmentální aspekt, H- stav havarijní, B –běžný provoz, M – mimořádný stav S - součet

Poř. číslo	Místo vzniku (pracoviště, proces)	Činnost	Aspekt	Dopad	Provoz B/M/H	Významnost	L	D	P	S	Opatření, odpovědnost (měření, cíl atd.)
1	Ředitelství ZRS OK	administrativa	vznik sběrového papíru	čerpání přírodních zdrojů	B	NEA	1	1	1	3	optimalizace spotřeby papíru v administrativě
			spotřeba el. energie	čerpání přírodních zdrojů	B	NEA	1	1	1	3	nesvítit zbytečně, el. energii odebírat co nejrovnoměrněji
			spotřeba pitné vody	čerpání přírodních zdrojů	B	NEA	1	1	1	3	kontrolovat vypnutí kohoutků, neplýtvat pitnou vodou
			vznik odpadních splaškových vod	zátěž přírody v podobě odpadních vod	B	NEA	1	2	1	4	neznečišťovat splaškové vody závadnými látkami
			spotřeba zářivek	vznik nebezpečného odpadu	B	VEA	1	2	2	5	nesvítit zbytečně, zářivky opakovaně nezapínat a nevypínat EMS 1/2013
			spotřeba tonerů	vznik nebezpečného odpadu	B	VEA	1	2	2	5	maximální šetření při tisku dokumentů, zpětný odběr zajištěn smluvně
			vznik komunálního i ostatního odpadu	zátěž přírody v podobě ukládání odpadů	B	NEA	1	1	1	3	maximální množství obalů vrátet k recyklaci, třídit odpady

Environmental aspects assesment

Methodology for assessing the environmental aspects

Assessment of the EA is performed using following 4 criteria.

Criteria:

- compliance with the limits and mandatory requirements
- frequency impact
- impact associated with the effects on the environment (size, persistence, scale)
- impact on society (its economy and image)

Environmental aspects assesment

Klasifikace (K)		1 bod	2 body	3 body
kritérium č.	váha kritéria (V)	problém není nebo je malý	existuje problém	existuje zásadní problém
1.	3	limity a zákony jsou plněny nebo limity a zákony nejsou stanoveny	limity a zákony nejsou občas plněny nebo jejich plnění je na hranici limitu	limity a zákony nejsou plněny nebo jsou často překračovány
2.	2	výskyt dopadu je minimální a/nebo dopadu lze zabránit	výskyt dopadu je častý a/nebo dopadu lze částečně zabránit	výskyt dopadu je vysoký a/nebo dopadu nelze zabránit
3.	2	dopad se dá odstranit a/nebo ovlivnění ŽP je minimální a není trvalé a/nebo ovlivnění ŽP je v lokálním měřítku	dopad se dá částečně odstranit a/nebo ovlivnění ŽP je velké ale není trvalé a/nebo ovlivnění ŽP je v regionálním měřítku	dopad se nedá odstranit a/nebo ovlivnění ŽP je trvalé a/nebo ovlivnění ŽP je v globálním měřítku
4.	1	EA nemá vliv na společnost (neohrožuje ani nezatěžuje její ekonomiku) a/nebo není příčinou stížností a/nebo dopad EA není viditelný	EA má vliv na společnost (zatěžuje její ekonomiku) a/nebo ojedinele je příčinou stížností a/nebo dopad je viditelný	EA má významný vliv na společnost (významně zatěžuje její ekonomiku) a/nebo v minulosti byly stížnosti a/nebo v lokalitě má společnost špatné jméno

Environmental aspects assesment

Important EA	Over value less equals or higher then 15 (and all rated 3 in criterium 1)
Not important EA	Over value less than 15

EIA (Environmetal Impact Assessment, all projects that could have a negative impact on public health, flora, fauna, ecosystems, soil, air, but also on cultural heritage, natural resources or assets, are within the scope of the assesment according to the law - a list of projects is given in Annex Law)

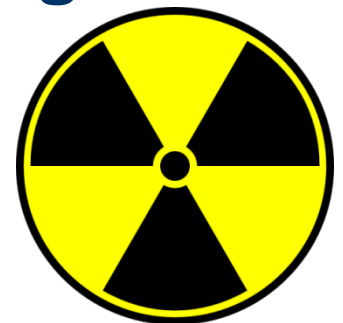
Environmental aspects assessment

The process is:

- announcement to the authorities (Region, ME)
- official publication/announcement by the competent authorities
- 20-day deadline for comments
- screening procedure
- documentation
- preparing the report (90 days)
- Comments (30 days)
- the final opinion as a professional basis for related procedures (eg. land, construction) valid for 5 years and with the possibility of extension

Nuclear energy in general

- **production of fissile materials**
- production of electricity in nuclear power plants
- release of nuclear energy from the atomic nucleus
- chain fission in nuclear fuel
- accompanying phenomenon - **ionizing radiation**



Production of fissile materials

Mining in the open pit mines:

- extraction in open pit mines very similar to coal production
- generally the least impact on the environment with respect to other methods of mining
- extraction of nuclear fuel is just as harmful as other methods of mining
- intervention in the landscape depends on the amount of ore and yield (percentage of) nuclear fuel

Rössing, Namibia



Brown coal production – chateau Jezeří



Uranium production – Rožná



Production of fissile materials

Chemical processing of mined ore (Mydlovary MAPE, 20 km from ETE):

- leaching with sodium bicarbonate (higher content of carbonates) or sulfuric acid (reduced content of carbonates)
- ratio of sulfuric acid up to 560 g of 94% acid per one liter of the leached material
- processed 16.7 mil. tonnes of ore, formation of tailing ponds with a total area of 300 ha - 36 mil. tonnes of sludge
- heavy metals and radioactive substances



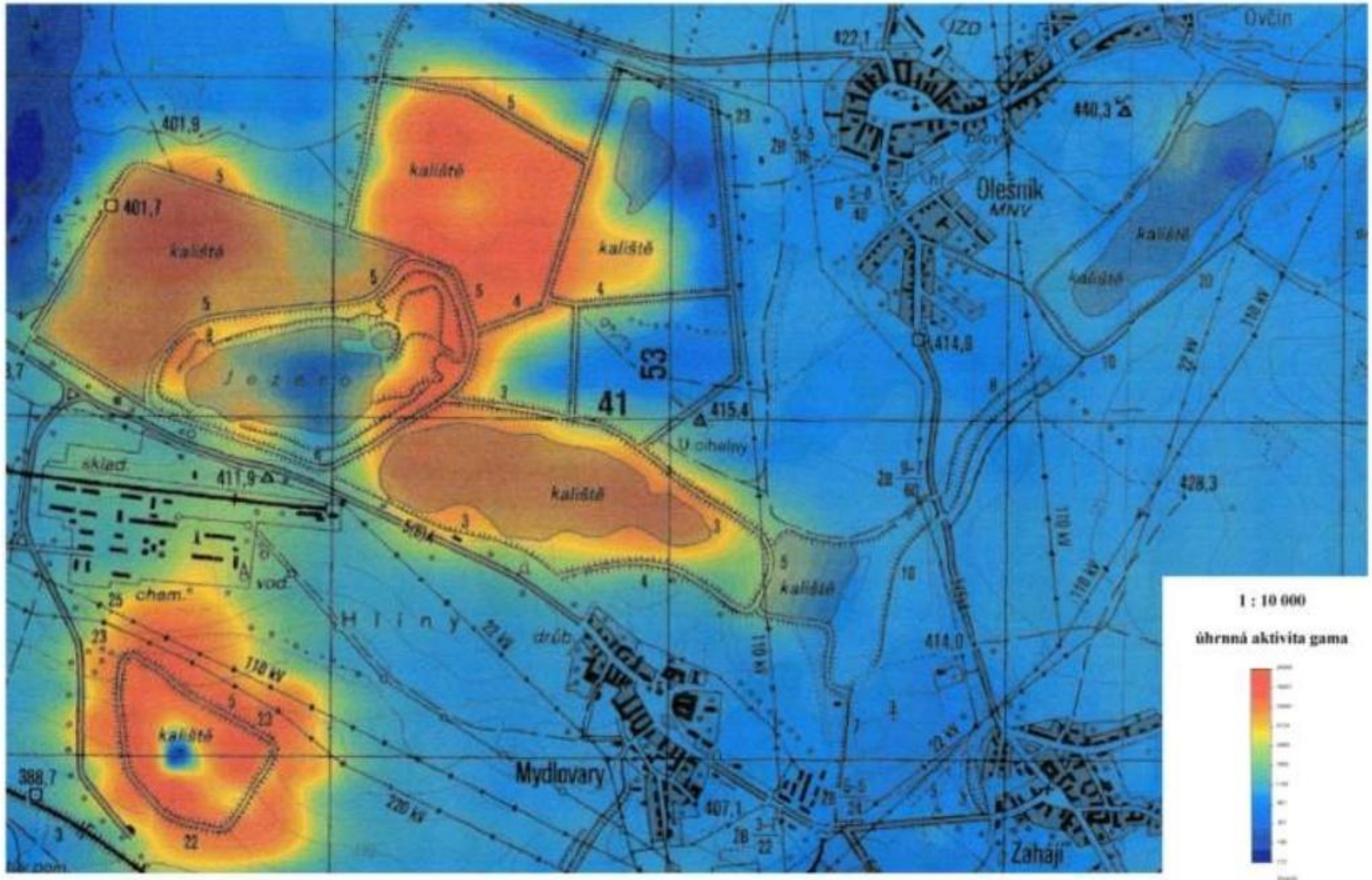


Production of fissile materials



Radiokontaminace půd a sedimentů:

Uran, alfa zářiče, radon apod.



Production of fissile materials



Production of fissile materials

Underground mine in Straz pod Ralskem

- 1966-1970 first attempts introducing methods of chemical leaching
- until the early 90s leaching fields with a total area of 7 km²
- during the entire period of the chemical extraction of underground injected more than 4 mil. tons of sulfuric acid

Production of fissile materials

Underground mine in Straz pod Ralskem

- contamination has spread to an area covering about 27 km²
- affected 370 mil. m³ of groundwater
- currently the contamination in an amount of 4.9 mil. t of solutes
- beginning of restoration

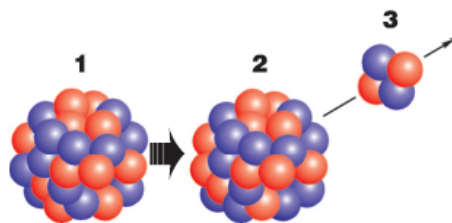
Restoration – Stráž pod Ralskem (DIAMO)

- restate geological environment to the state that will ensure exploitation of drinking water in the region
- dispose of wells and surface facilities
- incorporate the surface of extracted fields in ecosystems with regard to regional systems of ecological stability
- several stages of redevelopment, estimated cost of 40 billion CZK

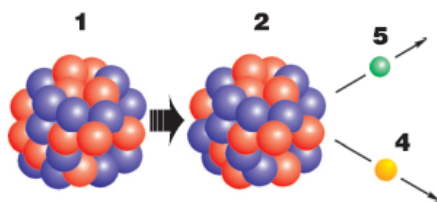
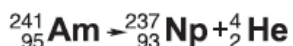
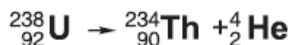
Radioactivity

- radioactivity (or radioactive decay) is the spontaneous transformation of nuclei unstable nuclides other cores
- at the same time it generates ionizing radiation
- natural or artificial radioactivity
- transmutation
- decay of nuclei by decay series and the established principles

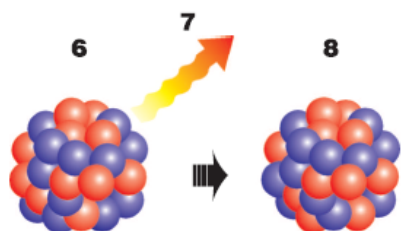
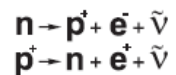
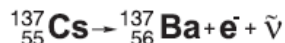
Radioactivity



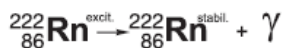
PŘEMĚNA ALFA



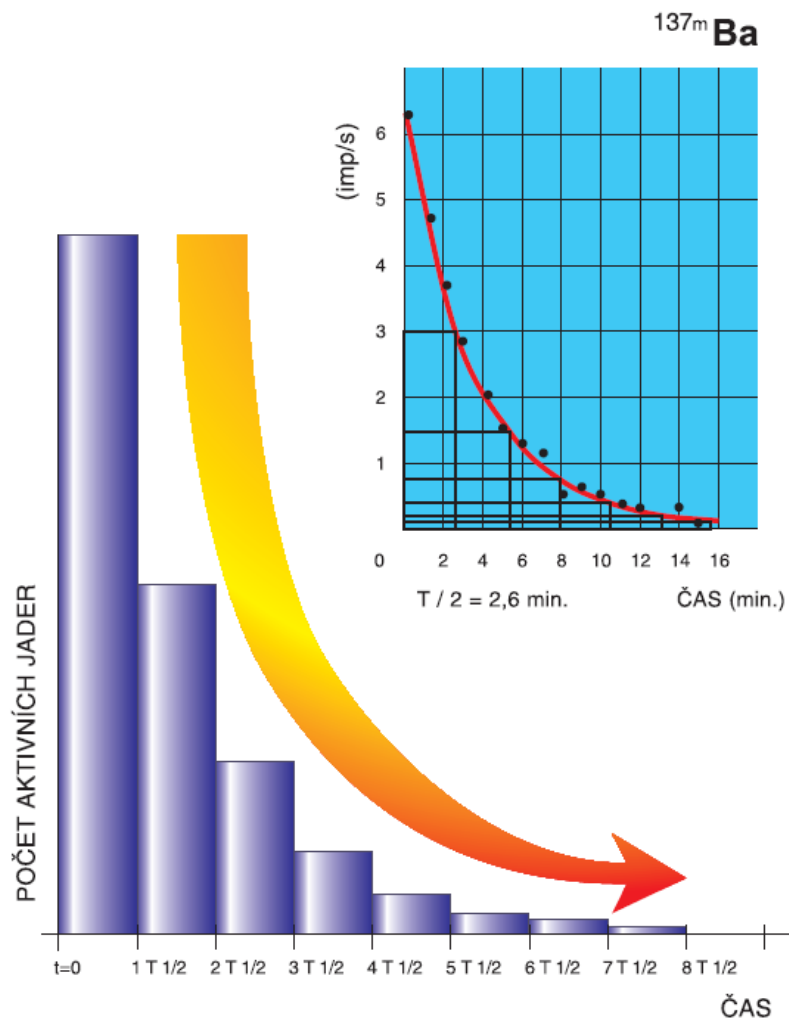
PŘEMĚNA BETA



PŘEMĚNA GAMA



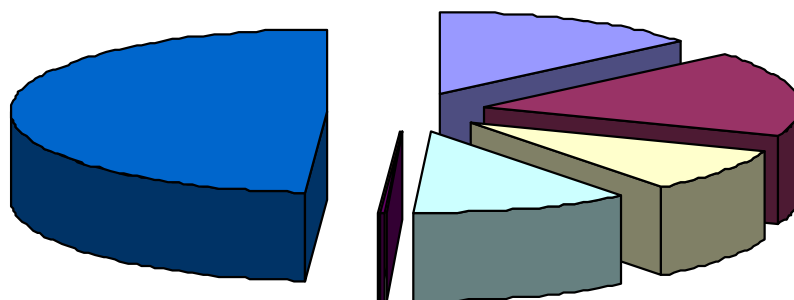
- | | | |
|---------------------|---------------------------------|-----------------------------|
| 1. MATEŘSKÉ JÁDRO | 4. ELEKTRON (β^-) | 7. γ ZÁŘENÍ (fotony) |
| 2. DCEŘINÉ JÁDRO | 5. ANTINEUTRINO ($\bar{\nu}$) | 8. STABILIZOVANÉ JÁDRO |
| 3. α ČÁSTICE | 6. EXCITOVANÉ JÁDRO | |



Radioactivity

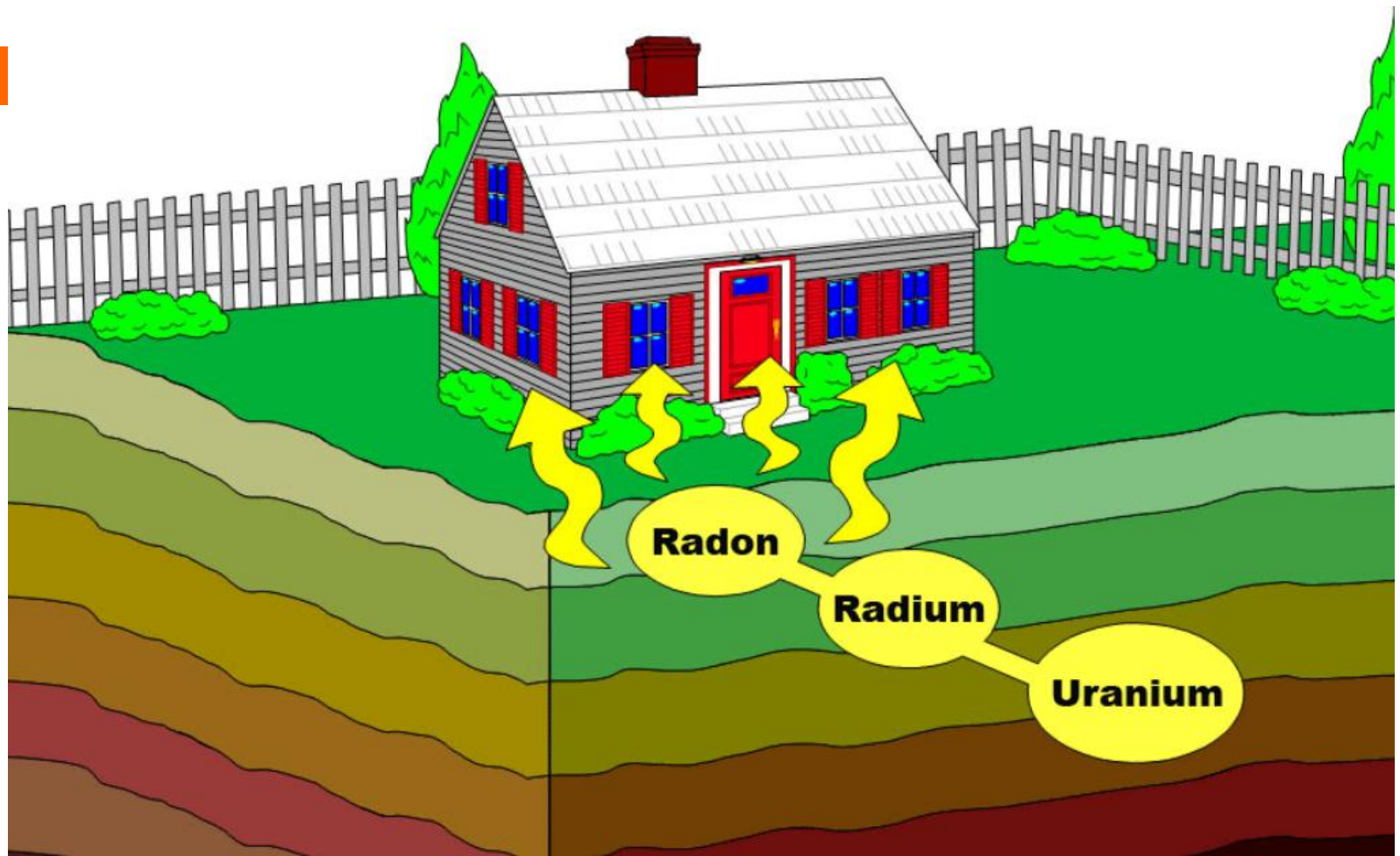
- **cosmogenic radionuclides:** tritium ^3H (half-life 12,5 years), carbon ^{14}C (half-life 5730 years)
- **Primary radionuclides :** potassium ^{40}K (half-life $1,26 \times 10^9$ years), thorium ^{232}Th (half-life $1,4 \times 10^{10}$ years), uranium ^{238}U (half-life $4,5 \times 10^9$ years), ^{235}U (7×10^8 years)
- **Secondary radionuclides:** radionuclides of decay series – thorium, uranium, aktinouranium, neptunim

Sources of radiation



- Kosmické záření - 14 %
- Záření z půdy a hornin - 17 %
- Přírodní radionuklidy v lidském těle - 9 %
- Lékařství - 11 %
- Spad z testů jad. zbraní - 0,3 %
- Jiné - 0,13 %
- Radon v domech - 49 %

Radon



Nuclear energy safety and environmental aspects

- the use of nuclear energy is regulated by law
- Nuclear safety is not a mere formality, it is an enforceable requirement
- All effects are monitored and evaluated
- responsibility is transferred to the operator's license holder

Nuclear safety – deep protection

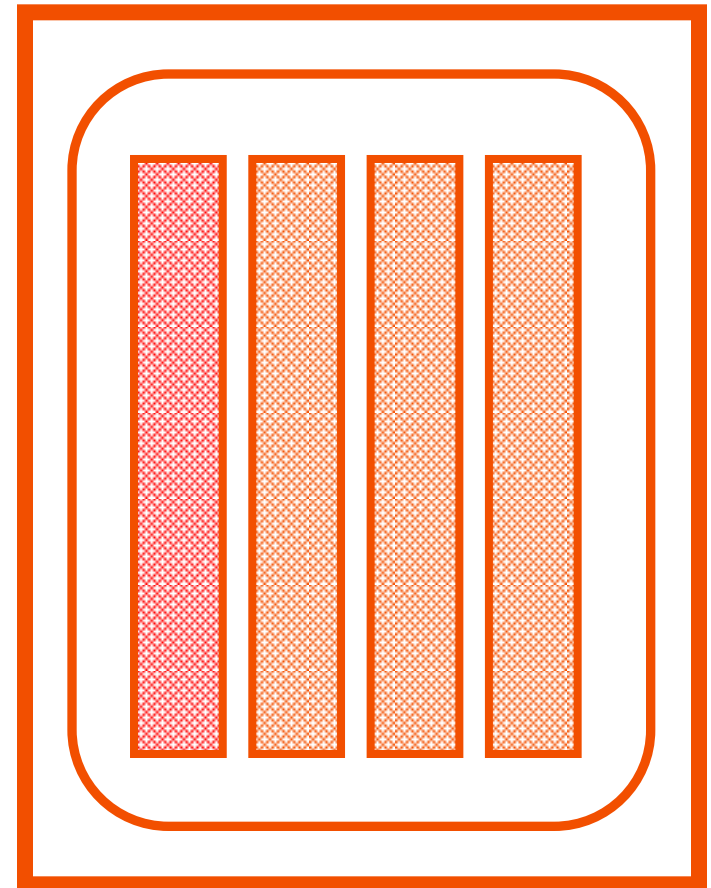
Deep protection = means to achieve the basic objective of safety

First barrier: **molecular matrix fuel** (almost all the fission products resulting from fission are captured in the matrix of the uranium tablets)

Second barrier: **hermetic fuel cladding** (an alloy of zirconium-niobium)

Third barrier: **the primary circuit pressure limit** (resistant to high pressure, temperature, radiation and radiation dynamic conditions of operation)

Fourth barrier: **hermetic borders of rooms - containment** (building design protection, resists airplane crash, blast wave, explosion, storm, extreme temperatures, extreme precipitation, etc.)



Operation of nuclear power plant

- nuclear fission
- necessary operating conditions
- waste production
- disposal of spent nuclear fuel

All the above can be part of the process or source of ionizing radiation.

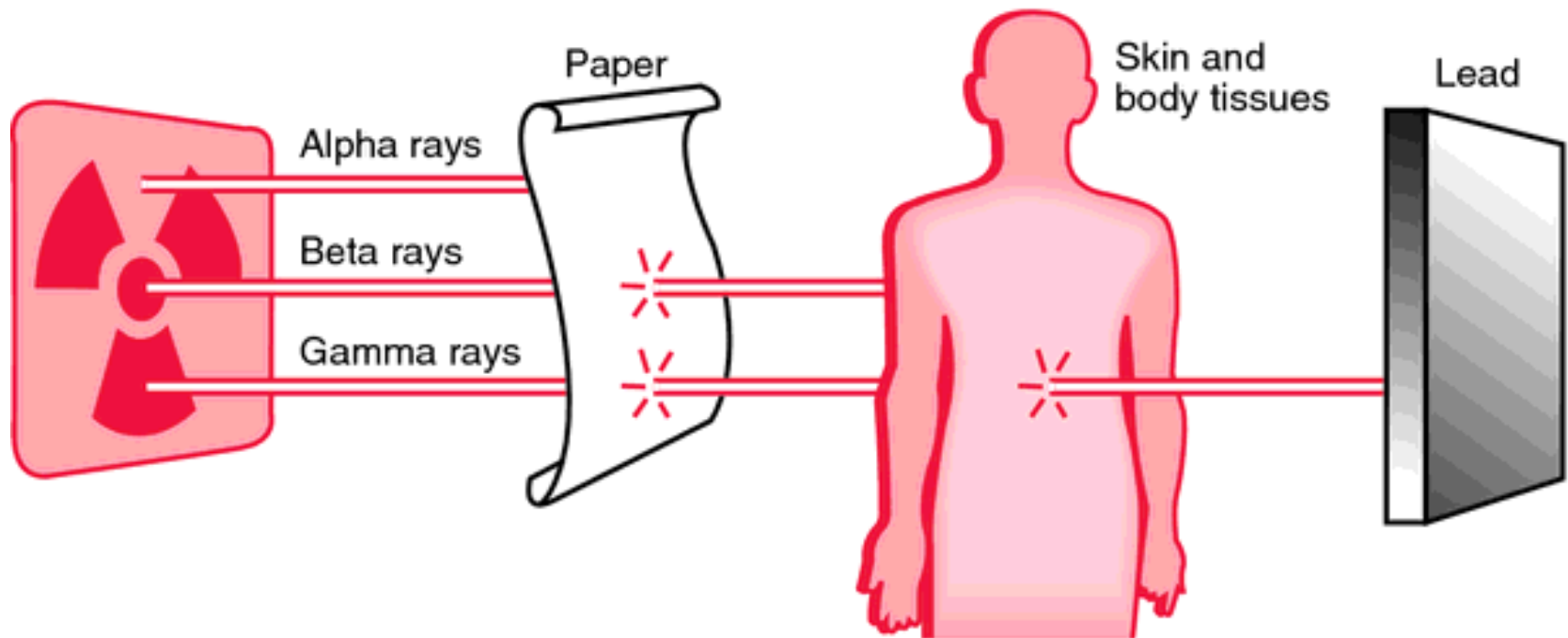
Protection against radiation

Distance - ionizing radiation intensity decreases with the square of the distance, ie. after 10 m it is 100 times lower, after 100 m it is 10000 times lower, after 1 km it is a million times lower.

Time - the shorter the exposure, the smaller the cumulative dose

Shielding - depending on the type of radiation: alpha radiation skin tones, clothing, paper; beta radiation, aluminum sheet; gamma rays concrete, a layer of water, soil; neutron radiation, water, polystyrene, paraffin.

Protection against radiation



Protection against radiation

Objective of the radiation protection

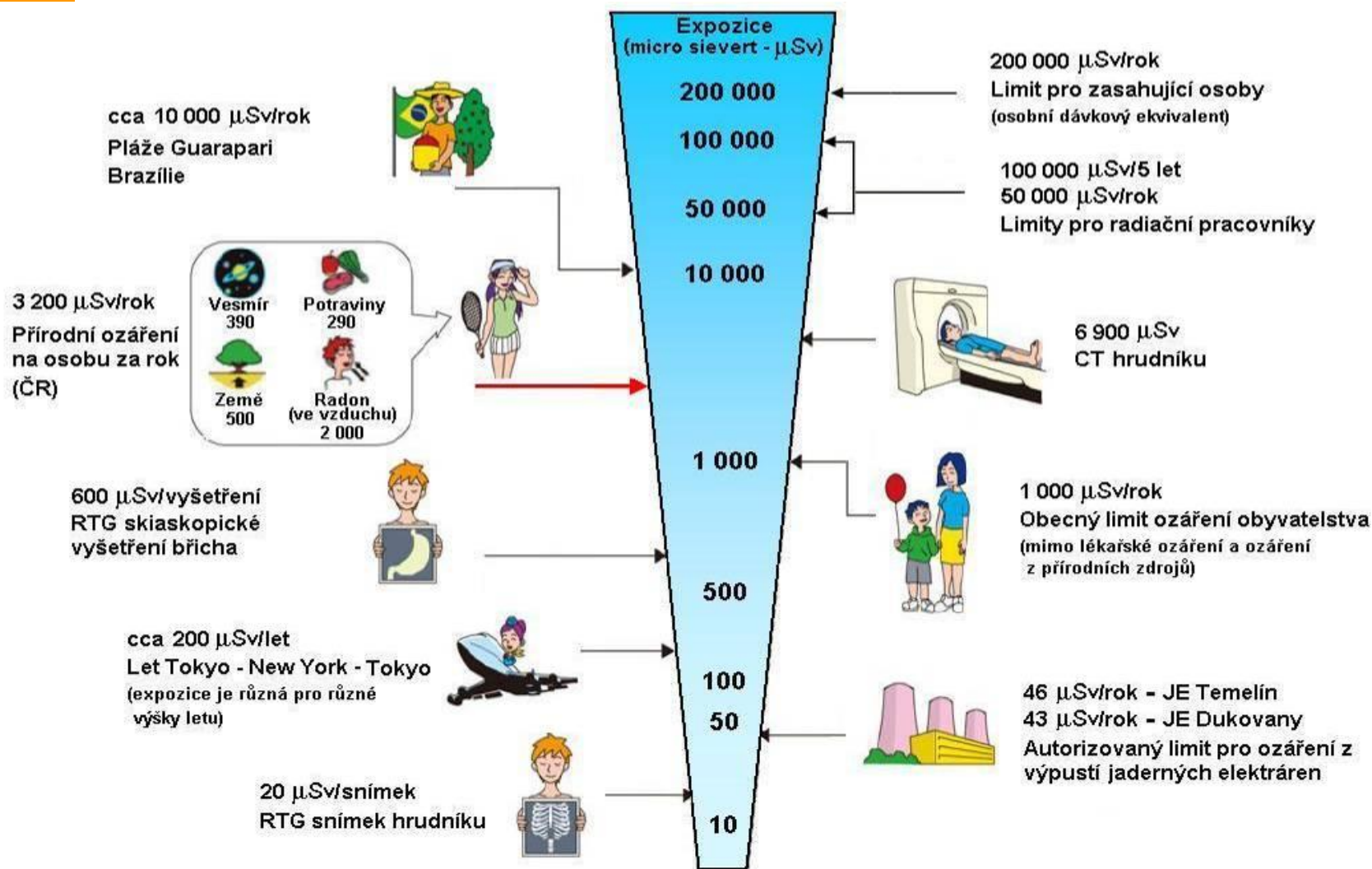
To ensure that during normal operation the radiation exposure inside the device and/or the release of radioactive materials into the environment is as low as reasonably achievable, taking into consideration economic and social factors and prescribed limits and ensure mitigate the extent of exposure to radiation accidents.

The principle of ALARA

Observe the rules and seek new and better ways of performing work

Already applied in the design

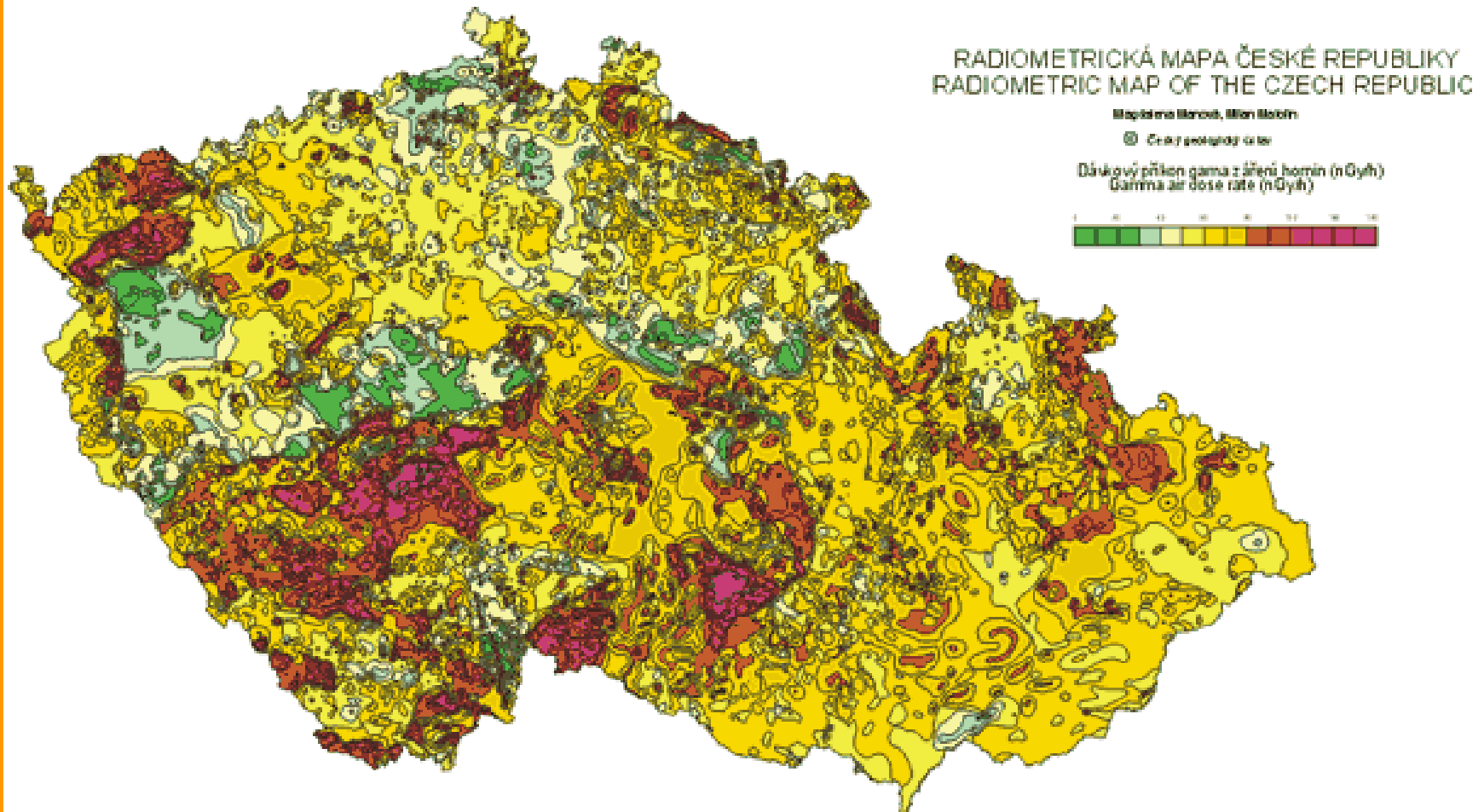
Příklady expozic ionizujícímu záření včetně limitů platných v ČR



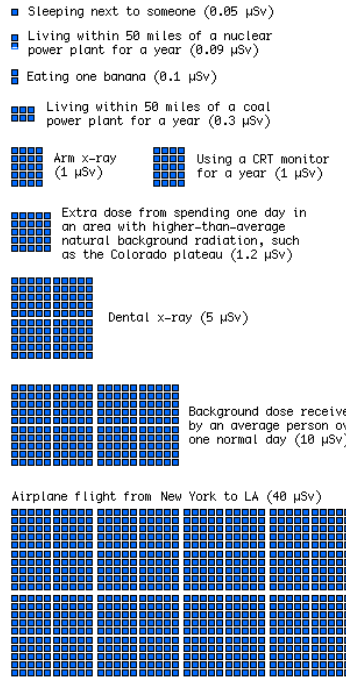
Průměrný dávkový příkon z přírodního pozadí v ČR: $0,14 \mu\text{Sv}/\text{h} = 1226,4 \mu\text{Sv}/\text{rok}$

Czech Republic
Iran (Ramsar)
India (Kerala)
Brazil (Guarapari)

- cca 3 mSv/year
- up to 400 mSv/year
- up to 17 mSv/year
- up to 175 mSv/year

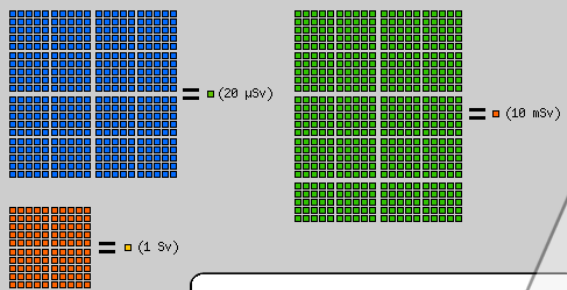


Protection



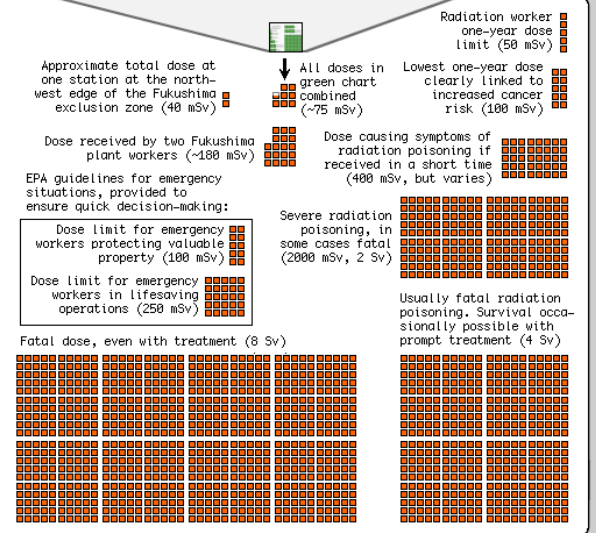
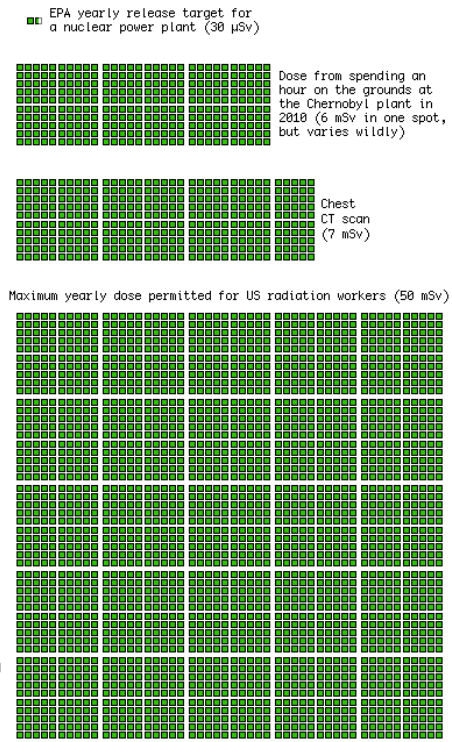
■ Using a cell phone (0 μ Sv)—a cell phone's transmitter does not produce ionizing radiation* and does not cause cancer.
* Unless it's a banana phone.

■ = (0.05 μ Sv)



Ten minutes next to the Chernobyl reactor core after explosion and meltdown (50 Sv)

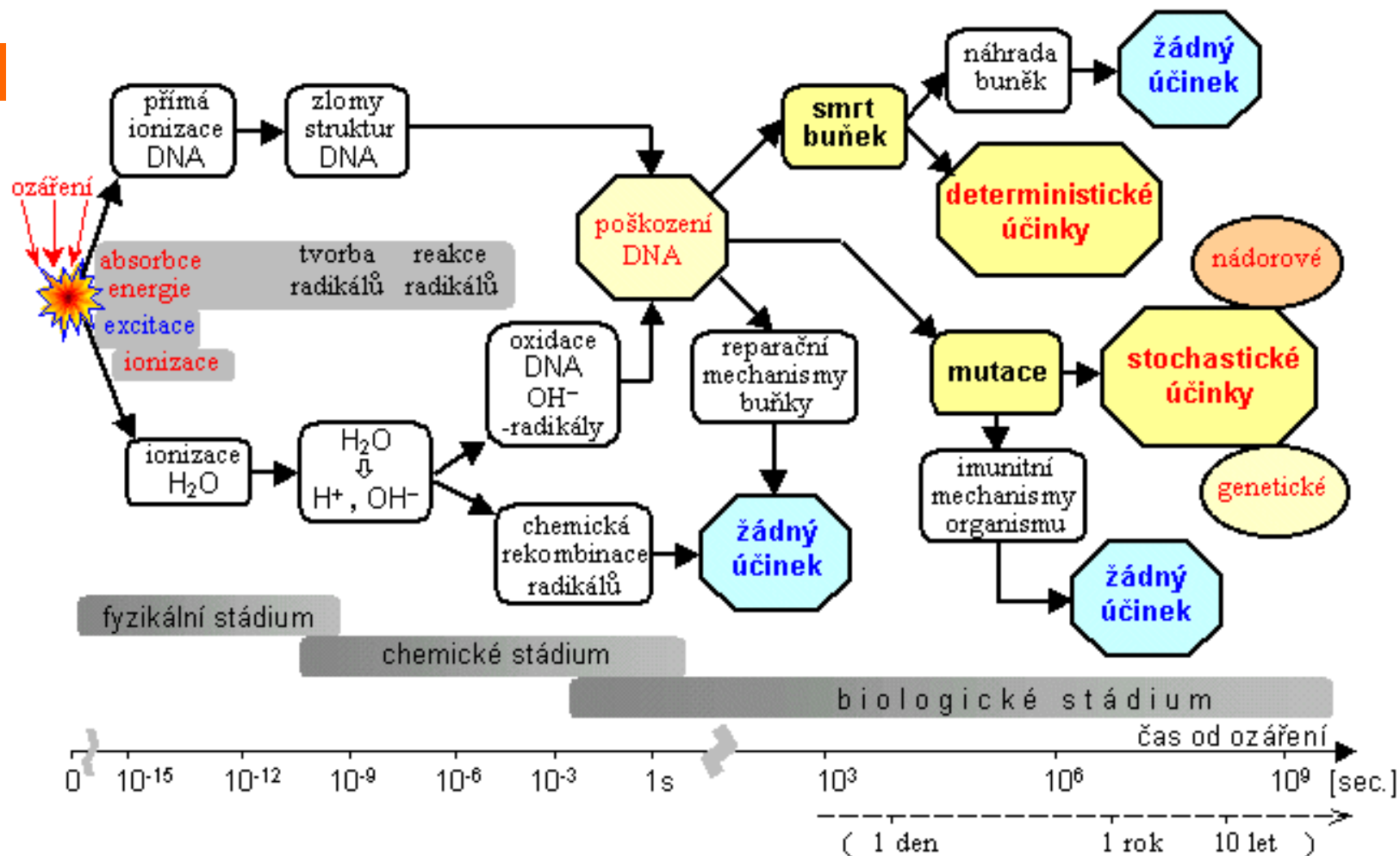
Sources:
<http://www.nrc.gov/reading-rm/doc-collections/cfr/part020/>
<http://www.nema.ne.gov/technological/dose-limits.html>
http://www.deq.idaho.gov/inl_oversight/radiation/dose_calculator.cfm
http://www.deq.idaho.gov/inl_oversight/radiation/radiation_guide.cfm
<http://mitnse.com/>
http://www.bnl.gov/bnlweb/DOE/03SEB/Chapter_8.pdf
http://deis-01a.nsl.gov/deis/rpt/briefs/rev1_fmnl.pdf
<http://people.reed.edu/~emchanis/radiation.html>
<http://en.wikipedia.org/wiki/Severt>
<http://blog.vornaskotti.com/2010/07/15/into-the-zone-chernobyl-prigat/>
<http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/tritium-radiation-fs.html>
http://www.next.gov.jp/component/a_menu/other/detail/_icsFiles/afieldfile/2011/03/18/1303727_1716.pdf
<http://radiology.rsna.org/content/248/1/254>



Porovnání ra

Type of Radiation (dose in mSv) [†]	Equivalent Period of Natural Background Radiation [‡]	Estimated Lifetime Risk of dying from cancer that results from a single exposure [§]
Airport Security x-ray scanner ²³ (~0.0001mSv)	less than one hour	Almost 0 (less than 1 in 100,000,000)
7 hour airplane flight ⁹ (~0.03 mSv)	a few days	Almost 0 (1 in 1,000,000 – 100,000)
Chest x-ray ⁶ (~0.1 mSv)	~ one week	Almost 0 (1 in 1,000,000 – 100,000)
Mammogram ²⁷ (~0.4 mSv)	a few months (~2 months)	1 in 100,000 to 10,000
CT of chest ²⁷ (~7 mSv)	a few years (~2.3 years)	1 in 10,000 to 1,000
Fluoroscopy: colon (barium enema) ²⁷ (~8 mSv)	a few years (~2.7 years)	1 in 10,000 to 1,000
CT of heart (angiography) ²⁷ (~16 mSv)	a few years (~5.3 years)	1 in 10,000 to 1,000
PET scan, whole body ⁵ (~14 mSv)	a few years (~4.6 years)	1 in 10,000 to 1,000
Fluoroscopy: kidneys, ureters and bladder ⁵ (~15mSv)	a few years (~5 years)	1 in 10,000 to 1,000
Whole-body CT scan ⁵ (~22.5 mSv)	several years (~7.5 years)	1 in 1,000
Nuclear Medicine: Cardiac stress-rest test (thallium) ²⁷ (~40.7mSv)	many years (~13.6 years)	~2 in 1,000
Transjugular intrahepatic portosystemic shunt placement ²⁷ (~70mSv)	many years (~23.3 years)	1 in 100 – 1,000
Lifetime risk of cancer death NOT caused by radiation ^{§§}		1 in 5

Chemical effects of radiation



Effects on human organism

Stochastic (random) - few cells damaged, subliminal dose or repeated small doses.

- we can only calculate the probability of injury, no injury may in fact occur.
- can be detected only by observing a large number of people. Risk of small doses? Scientists still do not match, they can not confirm nor deny it for there is not a sample of people who are not exposed to any radiation at all. No control sample.
- It is known that there is a "protective effect" radiation (hormesis) - in places with higher radioactivity there is less incidence of cancer (cells repair any damage).

Effects on human organism

Non-stochastic effects (deterministic) - after a large dose of radiation, many cells, appear in a short time.

Examples:

local dermatitis

Lenticular opacities

birth defects

fertility

Acute radiation sickness

Protection against outer sources

Protection against earthquake

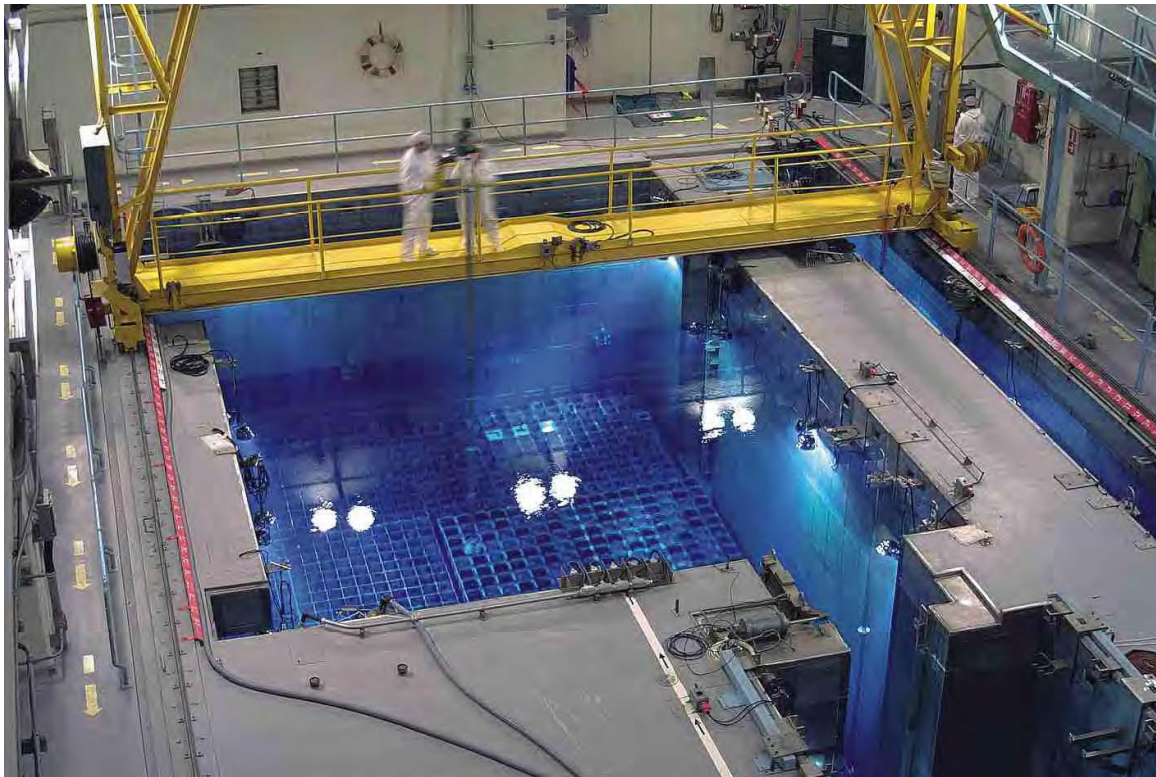
Protection from flood and adverse meteorological phenomena

Protection against pressure waves from explosions

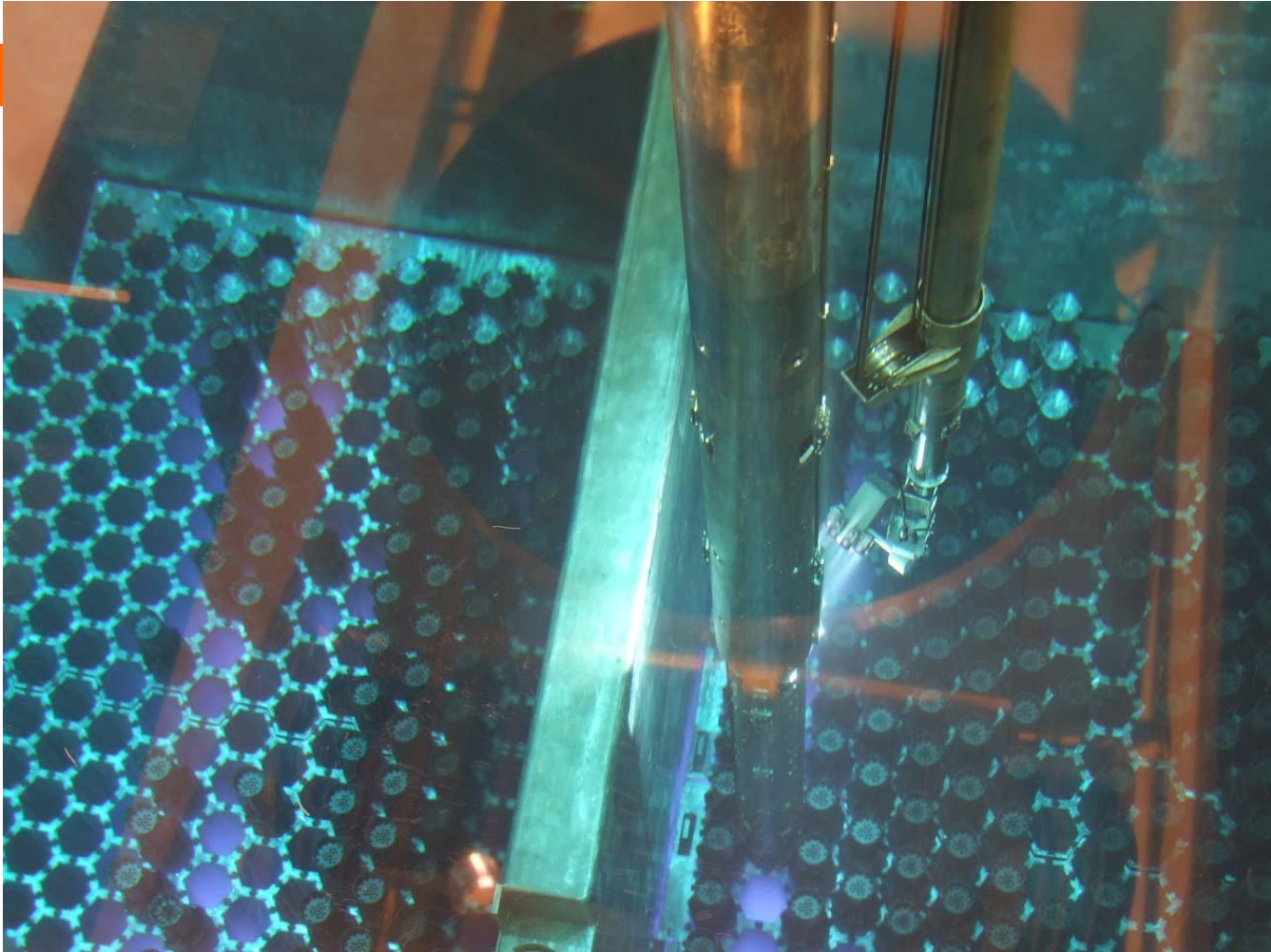
Protection against the effects caused by the fall of the aircraft

Protection against the influence of third parties

Storage



Storage



Storage



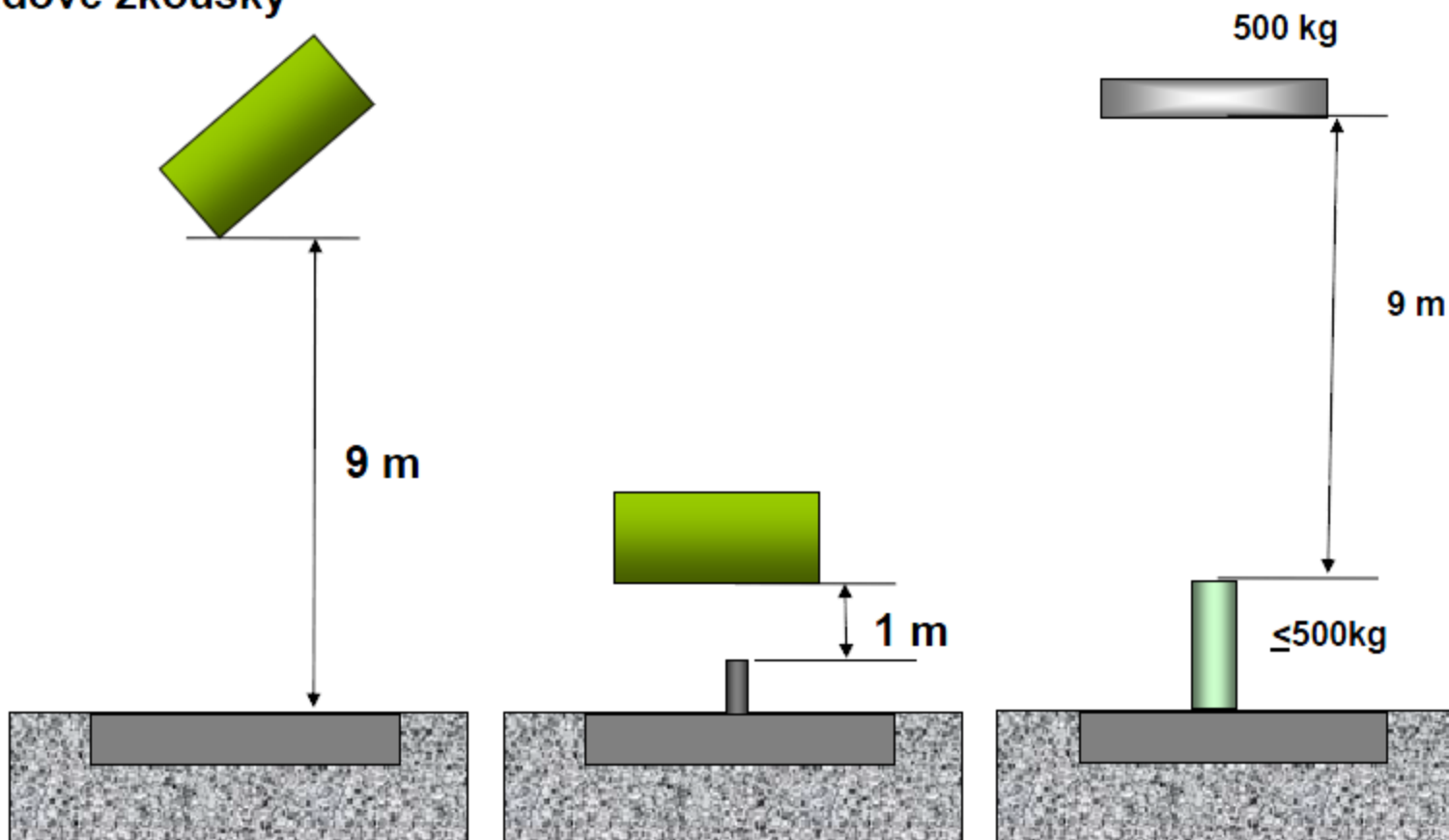
Storage



Storage

Zkoušky prokazující schopnost přestát podmínky nehody při přepravě

- Pádové zkoušky



Storage

Zkoušky prokazující schopnost přestát podmínky nehody při přepravě

- Požár
- Ponoření

