Environment in the Czech Republic

For General Medicine

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Definition of the issue

Taking into account lessons in the first year of study

- Ecological issue of the nuclear energy
  - Nuclear incidents and its implication on population of Central Europe
    - Jaslovské Bohunice
    - Černobyl – was already discussed
    - Fukušima
    - another
  - Temelin and its implication on public health
- Issue of noise

Levels of accident

- 0 – difference
- 1 – anomaly
- 2 – accident
- 3 – serious accident
- 4 – accident with local consequences (without serious risk)
- 5 – accident with wider consequences (risk out of facilities)
- 6 – serious accident
- 7 – major accident

Designed accident

Designed accident is accident for which is facility designed to cope with

Jaslovské Bohunice 1 (Block A1)

Jaslovské Bohunice 2

Situation

- Two power plants, two designs
- A1 original Czechoslovak design, heavy water, cooled by CO_2
  - highly technically elaborated
  - for example enabled to change fuel during operation of reactor
  - demanding for operation
- V1 classic according to Soviet model (VVR) control rod elements, light water in primary circuit

Jaslovské Bohunice 3

Accidents

There were two accidents

1. 5. 1. 1976 Due to fault of gasket there was a leak of CO_2 from reactor. Accident was reduced by operators of refilling instrument, who used it to seal the leakage. Two workers were killed but not by the radioactivity, but by suffocating (they were below the reactor). Accident was level 3.
2. 22. 2. 1977 There was a rupture of silica gel sachet used to keep fuel core elements? (rods) dry. Not all particles of silica gel were removed before insertion into the reactor, where they swelled up by the heat and deformed the fuel core element. There was a de-hermetisation of fuel and reactor had to be closed down because of high contamination of primary circuit. Now is under liquidation. Accident was level 4.

Černobyl

Chernobyl I would like to remind you what we discussed in first year. Despite the fact that it was accident of level 7, implication on health of population of central Europe was relatively small.

Fukushima I 1.

Nuclear power plant at Japan on coastline.
Due to earthquake and following tsunami there was an over designed accident on 11.3.2011. Three reactors were on planned shut down and the other three were working. Tsunami did not damaged working reactors, they shut down as well. Mistake was out of power plant, were priorities were set wrong and power plant did not received fuel for generators. When they run out of fuel cooling of reactors stopped, they overheated by residual radiation, melted down and stopped be hermetic. Disaster affected surrounding of the power plant, adjacent areas were evacuated. Accident was of level 7.

Fukushima I 2.

Disaster Fukushima disaster became iconic for ecologist and opponents of nuclear power nevertheless? . . .

- Disaster was not caused by design of reactors, they were not even damaged, but it is necessary to blame organizers of rescue work after tsunami, who did not supply diesel for generators.
- If there was a tsunami which would flood reactors in central Europe, we would have different problems than leak of radiation from them.

Really big tsunami

Monitoring of influence of Temelin on (population) health

Areas for comparison

Rural areas

Surrounding of Temelin is compared with rural areas around Pisek and Ceske Budejovice.
It is additionally divided into nearer and more distant area (according to if power station is visible or not from that area).

Urban territories

The nearest bigger town, České Budějovice, is compared with Hradec Králové and Olomouc (mainly potential psychogenic influence)

Further division

Control and more distant exposed areas are further divided in districts.

Data and their processing

Origin of data

Czech Statistical Office

What is monitored – health

- Total mortality
- Mortality for cardiovascular diseases
- Mortality for malign tumor
- Total mortality in productive age
- Mortality for cardiovascular diseases in productive age
- Mortality for malign tumor in productive age
- So called „lost years“
- Occurence of spontaneous abortion
- Number of children with birth weigh under 2500 g

Indicators are standardized and processed separately for male and female. Beside that three year moving average to smooth random variations is calculated.

Standardized mortality ratio

or age-standardized mortality rate

Conversion of mortality of the real population to the mortality rate of the population at standard age composition.
The purpose is to eliminate the effect of age on mortality because older people die more often.

Simplified example:

If we build a large seniors' home in the city that will attract clients from the wider neighborhood, it will affect raw mortality, but the age-standardized mortality rate should change little, ideally not at all.

Lost years

Index number calculating mean of years (of death persons) of life less than the age „which should be experienced by everyone“ (usually age of retirement).

e.g.

If age of retirement is 65, so:

- Person dying in 65th and more years of age is count as 0
- Person dying in 64th year of age is count as 1
- Person dying in 55th year of age is count as 10

etc.
The sum is divided by the number of deceased persons in the given year.

Data and their processing

What is monitored – sociodemographic characteristics of populatins in monitored localities

Existing differences in age atructure and gender representations, income, type of housing, and many smilar indicators can identify differences which were not caused by the power station but differences in these characteristics themselves.

Why data from Czech Statistical Office werw chosen

There is quarantee of the same method of data collection, which can elliminate artificial differences given by various probability of disease record in various locatoons. It happened for example at Hiroshima and Nagasaki, where impact of nuclear bombarding on population health was overestimated. The reason was that residents from these two towns were examined much more carefully than the rest of Japan population and part of detected differences aroused from this fact.

General knowledge

Leukemia

Bigger incidence od leukemia, mainly for children, was described close to nuclear power plants. The reason is not radiation, but accumulation of many people from distant localities and mutual attacks of viruses, which can cause not only banal diseases, but can be also oncogenic. This is not the case only for nuclear power stations, but they are usually more dangerous as we are talking about large scale building site, where very different professions of workers are taking turns (stand with laborers of rouugh construction up to operators of working power station) in big numbers.

What was found?

Better health around Temelín

It is not caused by positive unfluuence of nuclear power plant on human health, but it is likely to be socio-economic, such as employment, salary, economic power of numerous JETE staff to purchase goods and services in the neighborhood.

What was found?

Some negative trends in health indicators

These trends are based on comparison of years 2000 up 2016. They are comparable for exposed and control areas.

Curiosity

It was calculated, that if all inhabitands of Prague were drinking only untreated water from Vltava river for the whole year, only one of them would die because of long term effect of radioation in this water.
After warer company treatment it would be only one person per few years.
In reality majority of inhabitants of Prague are not drinking warer from eiver Vltava (even after water company treatment) and it was not the case even during Middle Ages (wells in areas of houses and usage of water from tributaries of Vltava).

Risks of radiation

The main argument of ecologists

In fact, there are also issues related to nuclear fuel mining and processing and storage.

Benefits

Permanent source

The nuclear power station is independent of weather and daytime.
This property lacks all uv ecological and uv alternative resources. Even hydroelectric power plants can rule out long-term drought or put us in front of the dilemma of whether to produce electricity or water for irrigation and water transport purposes.

Side effects

Spent fuel contains a number of critical elements for modern technologies, such as lanthanides, which are indispensable for LEDs that are essential for optoelectronics. At present, lanthanides are mined only in China. Existence of lanthanide in spent fuel is an important factor limiting China's demands for their price, human rights, etc.

Radiation – sorting and basic concepts

Depending on the type of particles

corpuscular it is a stream of particles of defined masses and speed

electromagnetic a stream of photons, described as electromagnetic radiation of a certain wavelength and intensity

Depending on the influence on matter

ionizing produces electrically charged particles in the irradiated mass – ions

non-ionizing electrically charged particles are not produced

Types of radiation

Types of ionizing radiation

Ionizing radiation types include radiation particle (at least common types, such as helium nucleus streams (α radiation), electrons (β radiation), positrons (*beta+* radiation), neutrons, protons, etc.) and electromagnetic radiation with a wavelength shorter than ultraviolet light.

Types of non-ionizing radiation

Non-ionizing radiation includes electromagnetic radiation of higher wavelength, and some types of less common particles (eg neutrino).

Non-ionizing radiation

Ultraviolet (UV) radiation

We distinguish UV-A (320 – 400 nm), UV-B (280 – 320 nm) and UV-C (below 280 nm). UV radiation can be considered inferior border (due to wavelength) of non-ionizing radiation, because at higher intensity is already influenced by O_3 creation in the air and free radicals in some materials. UV-C (which is only around us exceptionally) can be regarded as very weak ionizing.

Sources of UV radiation

- objects heated to high temperature, eg electric arc, Sun.
- different types of lamps (vacuum tubes etc), LED (for near UVA)

Effects of UV radiation

- bactericidal effects
- produces provitamin D from cholesterol contained in blood
- a positive effect on some skin infections as well as some noninfectious skin diseases (eg psoriasis)
- irritation of the skin to inflammation and necrosis (consequence – pigmentation according to the phototype)
- skin cancer - melanoma + carcinomas
- damage to the conjunctiva and the retina

The provitamin D production is sufficient daily for about 1 hour in lightweight clothing especially in southern countries early in the morning or late afternoon, higher exposure does not bring any other positive effect.

Comment

Epidemiologists do not recommend relying on bactericidal and virucidal effects of germicidal fluorescent lamps and take them as a complementary measure. Any grain dust creates a shadow in which the survival time of bacteria and other microbes is many times longer than in the surrounding area (and the survival time may be longer than running time germicidal lamps, a time when people are not in the workplace). That is why it should this irradiation can only be used after perfect cleaning.

Visible light

- It has a wavelength range of approximately 400–760 nm.
- Visual sensitivity receptors to light at the shortwave end of the spectrum is very steeply declining, on long-wave is a gradual decline.
- The people in the dark were able to detect radiation with a wavelength exceeding 1000 nm.
- The source may be heated objects (continuous spectrum, characterized by Kelvins) as well as lamps and LED (line spectrum, deforms color perception).

Visible light

Significance 1

- Visible light participates in vision.
- Illumination is measured in luxuries (the intensity of light falling on the illuminated area)
- The hygienic standards take into account:
  - visual complexity of the activity being performed
  - glare, or alternating light and darkness (especially if workers have to move from one place to another)
  - some work has to be done for several tens of minutes of dark adaptation
  - special standards for working with lasers

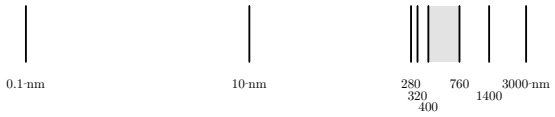
Visible light

Significance 2

- For fluorescent lamps, lamps and LEDs, there is a stroboscopic effect
- The color of light is important for mental well-being, a colorful interior design for the use of light, the shape of the window also contributes to the intensity of natural lighting
- Intense visible light causes photodermatitis on the skin and can also contribute to conjunctivitis (so-called „snow blindness“ in the long term stay without protection in the snow-covered landscape; but UV radiation is part of it).
- Together with IR, it is involved in the generation of sunburn (see below).

Infrared radiation

Again, we recognize the IR-A (760 – 1400 nm), IR-B (1400 – 3000 nm) and IR-C (above 3000 nm)
Caution: Location is symmetrical about visible light. It is, then sorted by wavelength as follows: UVC – UVB – UVA – visible light – IRA – IRB – IRC.
Its source is heated objects, IR-A and IR-B are a component of the sun's radiation, which is on the Earth's surface, IR LEDs are often in home electronics controls



Infrared radiation

Effect on health

- At high intensities, the thermal effect can cause acute burns
- Blurred eye lens. It was mainly for workers exposed radiation from furnaces or hot material *glass cataract*.
- Sunburn occurs due to total overheating of the organism by visible and IR radiation. It also shares air temperature, relative humidity and flow air, that is, the so-called thermal complex. There is a total overheating organisms, accompanied by nausea and vomiting.
- The sunstroke is caused mainly by the overheating of the head, while the longwave component IR-B can penetrate through the surface structures and irritate the brain packaging. Symptoms are similar to sunburn, but more nauseous and strong in the foreground headaches.

Infrared radiation

Effect on health

- Both (sunburn and sunstroke) can cause epileptic or epileptiform convulsions in the individual with disposition. Preventing both:
  - avoiding an open space in the sun
  - sufficient drinking regime,
  - wearing headgear is a prevention of sunstroke
  - children with epilepsy, kidney disease, diabetes, illneses of cardiovascular system, diabetics, etc. should be monitored separately!
- Chronic effects of IR radiation: The possible influences of extremely long exposures of still the same places on the skin were discussed, however the risk of tumors etc. is very low.

Radiation with higher wavelengths

- Microwaves and waves used in telecommunications have effects primarily on heat (heating of microwave dishes).
- Talk about negative health effects
  - the risk of some maligne brain tumors
  - heating and bleeding of brain tissue during intensive exposure
- Beneficial effects:
  - the most considerate cooking what is possible
  - availability of rapid help for accidents and illness
- Higher incidence of tumors around the HV and VHV lines was explained electrostatic ion concentration, unrelated to microwaves

Comment

Bleeding and warming of the brain was observed in the rats with which the cell phone was attached to the head. Human has a brain away from the device, and the flow of blood (draining heat) is much higher in his brain.

Ionizing radiation

These include:

- electromagnetic radiation with a wavelength shorter than UV-C,
  - RTG radiation
  - γ radiation
  - cosmic rays
- α radiation (nuclei of helium atoms)
- β radiation (stream of electrons, or like $\beta+$, a stream of positrons)
- neutron radiation

Some particulate radiation does not ionize, eg neutrino, which pass freely without interaction with the mass of the whole planet, others are high exotic.

Pervasiveness of radiation

To to cause harm the radiation must:

- Penetrate into living tissue
- At least partially interact with matter and pass on it to its energy (or part thereof)

Penetration of Radiation – Types

Little penetrating radiation

The most famous radiation of this type is α.
Any solid matter, even a sheet of paper, and dead cells on the surface of skin will stop it. It has effect only under specific circumstances.

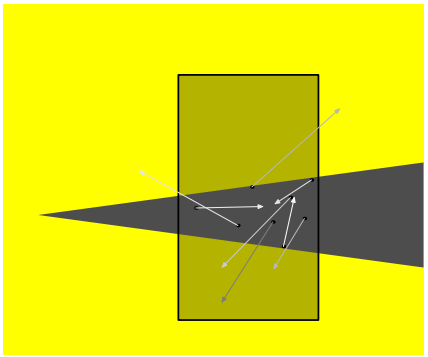
Highly penetrating radiation

Extrem is neutrino.
It passes through matter without interacting with it - it does not hurt.

Penetration „between“

It is these radiation that give their energy to the living mass and are the source of risk. They are also a source of secondary photons (Compton's phenomenon) even better trapped in the tissue.

Compton effect



In the irradiated material secondary photons are formed at random locations a with random (but always lower than photons irradiating material) energy

Comment

Compton's phenomenon also threatens workers who are outside the main beam ionizing radiation, eg escorting a dishonest patient to an X-ray device. Due to distraction of this exposure to many people, accompanying children and mentally disabled patients receiving X-ray images either family members or department staff, (except for pregnant women).
Ionization of the air may also lead to inhalation of the ions. For this reason, they are X-rays and similar devices equipped with strong ventilation.

Sources of ionizing radiation

Natural sources of ionizing radiation

- Sun and other similar astronomical objects
- Secondary radiation from Van Allen belts
- Exotic space objects (γ flashes, etc.)
- Radioisotopes
  - Isotopes of heavy elements at the end of the periodic system (and other radioisotopes with extra long half-life) – remains explosion of the supernova before the solar system
  - Isotopes continuously occurring in high atmospheric layers by influence radiation from space, eg ^{14}C, ^{40}K.

Sources of ionizing radiation

Artificial sources of ionizing radiation

- Artificially Concentrated Natural Radioisotopes
- Artificially created radioisotopes
- RTG device
- Other technical devices, particle accelerators,
- γ-lasery

Characteristics of radioisotopes

Half-life

is the time at which half the atoms of the respective radioisotope fall apart.

Activity

comes from the half-life atoms of the relevant isotope and their amount contained in the observed material. It expresses itself with the Becquerel unit [Bq], which is one decay behind second. However, the most common work is with *specific activity* that refers to weight, or of the volume (ie Bq.kg^{-1}, Bq.l^{-1} (in case some liquids) or Bq.m^{-3} (for some gases, including air)).

Comment

If work (including medical workplaces) with radioisotopes and short half-life (hours) contaminated objects are stored at the workplace for the prescribed time (days, storage places are called „dump chamber") and then disposed of as common or bio-waste. Urine and faeces of patients who received an injection such radioisotopes are drawn from the special WCs through the loop they are in the waste stream is so slow that the isotopes are enough to die out and then go into normal cameling.
In the case of long-lived radioisotopes, waste must be stored separately and weighed into special repositories. This would also apply to the urine and faeces of the patients were (eg in an accident) contaminated by such isotopes.

The impacts of particles (but also of sufficient energy photons) can be measured by different types sensors. Very well known is the *Geiger-Müller's computer* whose sensor is formed by tube filled by highly dilute gas whose conductivity with passage of particle the ionizing radiation changes for a moment, which follows the electronic circuits convert „classically" into a characteristic click in the headphones or the loudspeaker, the more modern, then calculate the particle passage and relate it to the time axis. In principle, similar gauges can not detect very bad penetrating particles (especially α) because they can not fly through the wall of tube.

Measurement of ionizing radiation

Dosimetry 1

Film dosimeters

Equipment of radiological and RTG workers worn on chest. This is a piece of special photographic film in the box visible light. Parts of the film are still covered metal plates. After exposure (weeks to months, if not for example accident), the film is evoked and the blackness of the photographic emulsion evaluated. That darkening of areas covered by different shading materials can be estimated the penetrating radiation, to which the worker was exposed, and from this data the batch equivalent for the deep tissues.

Measurement of ionizing radiation

Dosimetry 2

Thermoluminescent Dosimeters

For example, it can be placed in the ring and monitored by hand exposure.

Dosimetry on α particles

The plastic disc, after the etching, shows the effects of the α particles.

Important:

Dosimeters do not blame their wearer for a continuously received dose!

Radiation measurement units

Radiation delivers energy to the irradiated matter. We call this energy **dose** and we express it with the unit Gray [Gy] (represents one joule passed kilogram irradiated mass).

Dose Calculation

The dosage can be relatively easily calculated for homogeneous bodies of regular geometric shapes. One does not answer. For modeling used to calculate the doses you get from different types of radiation in different irradiation modes are used specially puppets made of plastic, imitating the properties of human tissues, enabling to put into the individual parts of the body a measuring technique called a phantom.

Earlier unit – rentgen

Definition

A dose that creates a 1 Coulomb charge in m^3 of air.

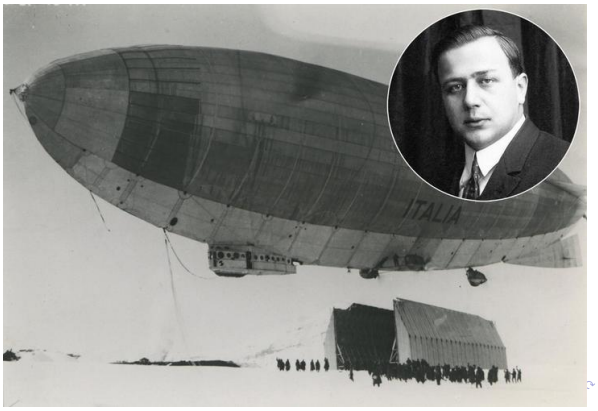
Advantages and Disadvantages

- The disadvantage is that it is exactly defined for air, for other materials there are recalculations that are not too precise
- An easy measurement based on the discharging of an electroscope from which the charge is charged by the ions contained in the ambient air.

An illustrative example of the ease of dose measurement in rentgen

After the disaster of the airship „Italia“ in the northeast of Spitsbergen a larger part of the crew stayed on the ice with a broken cabin and other debris. Among them was Czech radiophysicist František Běhounek, who, in the conditions of an improvised ice-skating camp, organised a laboratory in which he measured the intensity of cosmic rays. His results were the only scientific result of the expedition.

Italia on Svalbard



Biological effect

Individual types of radiation have different biological effects. Therefore, for evaluation irradiating live objects uses the bf batch equivalent whose unit is Sievert [Sv], which is Gy multiplied by the qualitative factor of the relevant type radiation. Because in healthcare we most often encounter x-rays γradiation having a qualitative factor of 1, therefore, are a dose equivalent numerically identical, sometimes they are confused. To predict the effect, it is still necessary to take into account the different sensitivity of the irradiated weaving.
There are two types of effects: *stochastic* and *nonstochastic*.

Non-stochastic effects

They have a threshold and dose (or dose batch respectively equivalent), the magnitude of these effects increases with a dose.

- Irradiation sickness (1st to 3rd grade)
- Local tissue necrosis („X-ray ulcers“)
- Cataract
- Gonad damage

Radiation sickness

First stage : bone marrow and organs producing immunocompetent cells. Deaths occur for secondary infections, anemia, etc. Light forms are possible survive under antibiotic protection, with blood transfusions, a special diet etc. This form of radiation sickness is artificially created in patients with leukemia.
The second and third degree of irradiation illness have a fatal prognosis.

Second stage is characterized the disintegration of digestive tract mucosa with subsequent conditions similar to severe cholera, dysentery, and the like. In general, patients die in a days after irradiation.

Third stage is characterized by a disruption of the nervous activity, states of confusion to loss of consciousness. Death occurs within hours, at high radiation levels in minutes.

Stochastic effects

They occur at random, their intensity is not dose-dependent; on the dose depends the probability that effects will occur.

- Tumors in irradiated and their offspring (practically take into account the next two generations)
- Inborn developmental defects in offspring irradiated (again in more generations).
- Practical manifestation may be a fertility disorder

The upper limit of the stochastic effects is given by the onset non-stochastic effects. Below this limit experimentally proved linear dose dependence (dose equivalent) and its consequences. Lower limit is due to the natural radioactivity of the environment.

Hormesis

It means increasing vitality after small doses of radiation (the same for some harmful chemicals).
It has been demonstrated in bacteria, unicellular eukaryotes, plants and some lower animals. In the higher animals it was not proven, although it was searched for attempts today are unacceptable for ethical reasons (the 40s and 50s of the 20th century).

Linear Model

So far, it is generally accepted, it allows estimation of health damage even when uneven exposure of the population.

Radiation load of population

The sources of radiation load vary according to the living conditions of the population. For our population (that part that does not have a professional exposure to ionizing radiation) approximately one third of the yearly dose equivalent is valid is made from radon, another third is divided by radiation from the environment (radioisotopes in building materials, air, soil, etc.) and radioisotopes from ours of the organism itself (including the mentioned C^{14}), the remaining then cosmic radiation and artificial resources.

Comment

We are trying to reduce the burden of population by means of investigative methods methods with ionizing radiation by other imaging methods, possibly substitution x-rays by ionizing radiation (it is significantly lower load).
We protect the surroundings of the workplace (barite plasters and concrete - containing barium sulphate, lead sheets, leaded aprons and leaded glass windows to guard the walls during construction work - all breaks should be broken, so that there is no room for direct exposure).

Comment

An overwhelming majority of professionals will enter lower dose than the limit for unprofessional population, the majority of the rest will not reach the limit for professionals. This is overcome practically only in accidents,
If the dosimetry approaches the limit, the worker is transferred by the end of the year to work without radiation load. The same is done with the workers who get pregnant.

Radon

Resources

Radioisotopes in uranium ore. For release, they must be scattered in porous or crystalline rock.

Character

Radon isotopes have a half-life decay from several hours to several days. They fall apart with α disintegration of which are the isotopes with a very short half-life, and subsequently again with alpha decay isotope more stable. From the radon atom, then, when it begins to disintegrate, they come out two particles α.

Danger

In particular, incidence in the inhaled air, such radon is an inert gas, does not catch up filters. It causes lung cancer.

Radon – Risks for the population

Drains of radon from the subsoil

Very important if they go inside the buildings. There is the highest known concentrations of radon.

Buzz from building material

Only some types of uranium ore-contaminated sludge.

Water, gas

Only in case of contamination of underground sources.

Measurement

The air activity in $Bq.m^{-3}$ is measured because Rn has several isotopes of different activity and its chemical content does not characterize the hazard.

Radon – risk reduction

- Building isolation (from the ground)
- Radon wells
- Monitoring Rn in building materials
- Monitoring Rn in groundwater
- Greater natural gas batch goes to industrial boilers a heating plant, not in households

A condition of risk reduction is its proper detection.

Comment

The radon well is a pit with permeable walls. Radon flows into it because it is heavier than air and is continuously pumped out and dispersed into the outside air.
The level of radon in the soil decreases and then it stops penetrating into the nearby buildings.

Other preventable sources

Radiation from Van Allen's Belts

The dose equivalent increases with altitude and distance from the equator.

Chernobyl stains

Until now, a map of Chernobyl stains, with higher contamination isotopes Sr and Cs having a high affinity for organisms, has not been published.

Artificial sources

The main source is X-ray examination, prevention is a substitute for other types of examination and technical measures to ensure that the patient is irradiated as little as possible during the examination.

Radiophobia issue

To a large extent, it is due to sensory undetectability of radiation.
It is sometimes called deliberately for political reasons (Temelín). Sometimes they are rumors are induced by effects other than radiation (for example, toxicity manifestations uranium).
It often arises as a response to concealment and disinformation from offshore sources (Chernobyl).
Sometimes legitimate concerns, such as risk, are identified as „radiofobia" terrorist attack on a nuclear waste repository, again for political reasons.

Smog

Definition:
„smoke" + „fog" = „smog"

Smog Types

london = SO_2, carbon black, other reducing substances, water, salt, oxidation producing H_2SO_4
- Human-influenced resources: Coal burning
- natural resources: sea fog

losangelean = O_3 + nitrogen oxides
- human-affected sources: internal combustion engines
- natural resources: high intensity and long sun exposure UV radiation

London smog

A picture of the smog of London type

Los Angeles type of smog

Town in USA with the smog of LA type

Smog in the Czech Republic

Summer Smog

Summer smog in areas with high traffic load is close to the losangelean-type smog, which is predominantly oxidising chemicals.

Winter Smog

Winter smog, and especially in areas with a high coal production, and in the inversion period, is close to the London type, with the predominance of reducing chemicals.

Note

Both our smogs do not reach extreme values because we have no sea or desert.

Influence on health

During the smog peak, increased mortality was observed.
Other studies have shown that

- died of health stigmatized persons whose mortality decreased significantly after the end of the smog situation
- the statistical significance of a given increase is doubtful (justified by highly specialized mathematics, specialized in time series statistics)

However, this problem can be concluded by the original study, taking into account only raw mortality during smog situations, the risk of smog overstated.

Factors damaging health

Overview

- Physical
  - Noise and vibrations
  - Radiation
  - Others
- Chemical
  - From the point of view of one person
  - From the point of view of environment and its influence on health
- Biological
- Psychosocial

What is it noice?

Physical definition?

Vibration of air or other medium, which can be transmitted on earth apparatus of human? **sound**

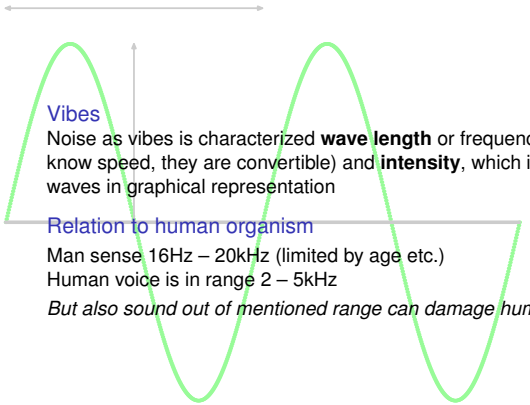
Origin

By vibration of solid bodies plus transmission on other media

Correction for subjectivity

Noise is sound, which is perceived negatively, it damages health? (the latter is not necessary 100% true)

Physical characteristic



Vibes

Noise as vibes is characterized **wave length** or frequency (if we know speed, they are convertible) and **intensity**, which is high of waves in graphical representation

Relation to human organism

Man sense 16Hz – 20kHz (limited by age etc.)
Human voice is in range 2 – 5kHz

But also sound out of mentioned range can damage human health.

Measuring intensity of noise

- Primarily it is issue of **pressure** of sound waves on objects.
- It is measured in decibels, but there are also? (not so common) units, which take into account various ear sensitivity for different wave lengths.
- We can measure actual **level of noise** (using sound level meter) or **weighted average** (using the sound level meter plus noise dosimeter) for which norms are designed.

Examples of intensity

dropping water 10 dB
human voice 40 – 50 dB
limit of working environment 85 dB
school gym 90 – 100 dB
techno music 110 dB
aircraft motors 130 dB
pain threshold 150 dB

Types according to duration

- stable
- variable
- puls

Why we distinguish

Protection of inner ear by reflective tension MUSCULUS STAPEDIUS, MUSCULUS TENSOR TYMPANI

it works if noise is stable not with fast changes

it fails with pulse noise changeable with rapid leaps

Consequence of failure: high energy reach the inner ear and damage sense cells

Impact

Physiological

- background (it was proved, that 0 leads to stress)
- informational, communication

Harmful

- Annoying, disturbing (moderate intensity, more depends on character of activity) disrupting communication
- Harm mediated by ear apparatus - various psychosomatic and neurotic damage
- Damage of ear apparatus (acute - acute trauma, damage of middle ear plus eardrum; chronical - damage of sense cells)
- Damage of other tissues (using very high intensity)

Damage of hearing

- On the edge of damage, in some cases it can be harmful: higher intensity wave prevent interception of following waves of lower intensity? (it is matter of fractions of seconds)
  - It can cover warning acoustic signals.
  - Exploitation – lossy data compression sound formats, e.g. mp3
- Deafening – shift of sound threshold for tens of minutes or hours?
- Acoustic trauma – physical resilience of ear was exceeded? (mainly middle ear)
- Chronical irreversible damage of hearing - long-lasting impact of high intensities (months or years, very high inter-individual differences): target tissue is sense epithelium in the inner ear

Overall impact on nerve system

It can cause

mental stress (generally)

neurotic manifestations mainly sleep disorder, feeling of tension, and failure of concentration

neurosis varied neurotic and somatic symptomatology

It can make worse, provoke crises

psychosis make course generally worse

epilepsy it can cause acute seizure

Relations to injuries

Injuries

Of ear apparatus – cause directly
Others – it increases risk of injury by various mechanisms, starting with lowering of ability to concentrate up to masking of alarm signals and blocking ability to notice them? (loss of hearing)

Relationship to psychosomatic illnesses

Cardiovascular illnesses

It mainly make worse hypertension and ischemic heart disease and mediating further

Gastrointestinal diseases

Mainly contributes to development of stomach and duodenum ulcer, but also other chronical diseases of GIT

Diabetes mellitus

It makes worse development of both types of diabetes, it changes insulin demand in both directions

Psoriasis

It makes worse psoriasis and other systemic diseases

It makes worse development of all serious chronical diseases

Influence on fetus development

Damage of fetus

- It is born with lower birth weight (risk)
- It can cause premature delivery (risk)
- Hearing can be damaged already from the prenatal period (mainly inner ear).

Hygienic limits (in Czech)

Working environment

Basic level

75 dB

Correction according to length of exposure

Up to 20 dB

Correction according to psychological demands of work

-40 up to + 10 dB

Correction according to protective equipment

- Safety limit can be increased according to ability of protective equipment to lower the noise.
- Effects of protective equipment can be partly added up.
- It is necessary to protect not only ear canal, but also temporal bone or even whole skull with high intensities of noise.

Hygienic limits

Environment

According to characteristic of environment

ZBasic limits are determined according to characteristic of housing development – environment (for example residential zone, industrial or shopping area, holiday resort etc.)

Adjustment according to day time

Adjustment towards lower levels is done during night.

Source of problems and controversy

Music, mainly during night

Anti-noise (acoustic) arrangements 1

Technical

- To reduce production of noise by source, remove the source or transfer it
- To reduce conduction of noise from source into environment

Organizational

(minly industrial sphere)

- Make exposition to noise shorter
- Prevent unnecessary exposition

Anti-noise (acoustic) arrangements 2

Individual

Protection of ear canal: cotton wool, special cotton, special ear plugs

Protection of ear: various type of shell protectors, similar protection can partly provide also earpiece

Protection of head: anti-noise helmets

Vibration

- Similar to noise problems
- Main health problem is vasoneurosis, including the fact, that it has tendency to re-occur
- Protection is in principle similar to noise protection (against vibration)
- Protection mainly hands (anti-vibration gloves), regime of work

Thank you for your attention!