BASIC ENVIRONMENTAL FACTORS

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HYGIENE

Science and practice of maintenance and promotion of health in the individual and group

ALMA MATER of all branches of preventive medicine
• Hygiene as a branch of preventive medicine is one of the pillars of public health because prevention of disease and maintenance of health are the primary aims of medical science.

• Taking into account accumulating risk factors that originate from environment and food, the use of up-to-date methods of exposure analysis and environmental health risk assessment are essential for modern hygiene.

• Hygiene promotes healthy lifestyle which includes avoidance of major risk factors for diseases with the largest socio-medical importance.
ENVIRONMENTAL HYGIENE AND HEALTH

The first goal of hygiene is to provide satisfactory living conditions by, i.e. reduction of disease to a minimum level,

The second goal of hygiene is defensive; an attempt to set limits for biologically harmful changes in the environment

ENVIRONMENTAL HEALTH
PUBLIC HEALTH AUTHORITY of Slovak Republic, Regional Public Health Authorities – section of Environmental Health - Department of Living Environment Hygiene

36 regional public health authorities established in the Slovak Republic, according to the Act No. 355 Coll./2007 of Laws on protection, promotion and development of Public Health
Field description

• To determine acceptable limits of bionegative agents present in the environment - impact on human health

• To identify and promote the principles of healthy living, to provide specialized consultancy services to the public

• To determine land use principles

• In spatial planning to identify the specific areas, the definition and the use of protection zones

• Treatment of drinking water supplies, supplementation of the public with drinking water

• The operation of natural and artificial swimming pools
Field description

- To ensure hygienically satisfactory air quality and the indoor environment of buildings

- When considering proposals for the commissioning and operation of facilities for the human body care, recreational, social, sporting, cultural and accommodation facilities, for funeral services and ensuring the protection of non-smokers

- To assess health status of the population, health risks and to propose appropriate measures with a focus on disease prevention

- To perform public health surveillance and to ensure protection of public health during disasters and other emergency situations in the environment
LEGISLATION - EXAMPLES


- DIRECTIVE 2006/7/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 February 2006 concerning the management of bathing water quality

- Act 337/2004Coll. on protection of non-smokers

- COUNCIL DIRECTIVE 98/83/EC on the quality of water intended for human consumption amended in 2015 (Europe), Decree No 247/2017 laying down details of drinking water quality, control of drinking water quality, monitoring program and risk management at drinking water supply (Slovakia)

- Act 131/2010 Coll. on funeral

- DIRECTIVE 2008/50/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on ambient air quality and cleaner air for Europe (Europe) Act 137/2010 on air quality (Slovakia)
## Examples of Traditional vs. Modern Health Hazards

<table>
<thead>
<tr>
<th>Traditional Hazards</th>
<th>Modern Hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease Vectors</td>
<td>Tobacco Smoking</td>
</tr>
<tr>
<td>Infectious Agents</td>
<td>Alcohol</td>
</tr>
<tr>
<td>Housing and Shelter</td>
<td>Transport Hazards</td>
</tr>
<tr>
<td>Drinking-Water and Sanitation</td>
<td>Environmental Pollution</td>
</tr>
<tr>
<td>Indoor Air Pollution From Cooking</td>
<td>Outdoor Air Pollution</td>
</tr>
<tr>
<td>Dietary Deficiencies</td>
<td>Use of Chemicals</td>
</tr>
<tr>
<td>Reproduction</td>
<td>Workplace Hazards</td>
</tr>
<tr>
<td>Injury Hazards in Agriculture</td>
<td>Unbalanced Diet</td>
</tr>
</tbody>
</table>

Source: Yassi et al., 2001
Environmental hazards classification (the importance of hazards in individual environments)

<table>
<thead>
<tr>
<th>Agents</th>
<th>Home</th>
<th>Community</th>
<th>Workplace</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ionising radiation</td>
<td>++?</td>
<td>++?</td>
<td>+++</td>
</tr>
<tr>
<td>Non-ionizing radiation</td>
<td>+</td>
<td>++</td>
<td>++++</td>
</tr>
<tr>
<td>Noise</td>
<td>0</td>
<td>0</td>
<td>+++</td>
</tr>
<tr>
<td>Vibration</td>
<td>+</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Chemical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy metals</td>
<td>+++</td>
<td>++</td>
<td>++++</td>
</tr>
<tr>
<td>Pesticides</td>
<td>++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Solvents</td>
<td>+</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Chlorinated HC</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Polyaromatics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Biologic</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacteria</td>
<td>+++</td>
<td>++++</td>
<td>+++</td>
</tr>
<tr>
<td>Viruses</td>
<td>+</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>Fungi</td>
<td>++++</td>
<td>++++</td>
<td>+++</td>
</tr>
<tr>
<td>Allergens</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trauma</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>+++</td>
<td>++++</td>
<td>++++</td>
</tr>
<tr>
<td>Cumulative</td>
<td>+</td>
<td>0</td>
<td>+++</td>
</tr>
<tr>
<td><strong>Psychosocial</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal</td>
<td>+++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Family</td>
<td>+++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Co-workers</td>
<td></td>
<td></td>
<td>++++</td>
</tr>
</tbody>
</table>

Source: Brooks et al., 1995
2011 – Environmental Burden of Disease Working Group (6 European countries)

9 selected environmental hazards

Noise – the most important effect on population health

(together with passive smoking and air pollution (PM))
RISK ASSESSMENT
RISK MANAGEMENT

Characteristics

- **Risk** - the quantitative probability that a health effect will occur after an individual has been exposed to a specified “amount” of hazard

- **Risk assessment** - the process of quantifying the probability that exposure to hazardous materials will damage the health of individuals in a population

- **Health risk** - the probability of health impairment, disease or death of a man, as a result of risk factors (chemical, physical, biological) exposure in the environment

- **Ecological risk** - the probability of occurrence of unfavorable ecological effects, as a result of human exposure to single or more stress factors
Risk management - the process of weighing policy alternatives and selecting the appropriate regulatory action, takes into account the results of risk assessment, engineering data and social, economic and political factors.

Risk communication — the purposeful exchange of information about the existence, nature, form, severity or acceptability of risks among individuals, groups and institutions.

Environmental Protection Agency (EPA) define Seven cardinal rules of risk communication:

1. Accept and involve the public as a legitimate partner
2. Plan carefully and evaluate your efforts
3. Listen to the specific concerns of a public
4. Be honest, frank and open
5. Coordinate and collaborate with other credible sources
6. Meet the needs of the media
7. Speak clearly and with compassion
RISK PERCEPTION

Which of the following subjects you consider to be the most threatening to your existence?

- Antropogenic contaminants in food
- Natural toxic substances
- Unbalanced diet
- Alimentary infections
- Food additive substances
## RISK PERCEPTION

<table>
<thead>
<tr>
<th>CONSUMERS</th>
<th>SCIENTISTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Food additive substances</td>
<td>1. Unbalanced diet</td>
</tr>
<tr>
<td>2. Antropogenic contaminants in food</td>
<td>2. Alimentary infections</td>
</tr>
<tr>
<td>3. Unbalanced diet</td>
<td>3. Natural toxic substances</td>
</tr>
<tr>
<td>4. Natural toxic substances</td>
<td>4. Anthropogenic contaminants in food</td>
</tr>
<tr>
<td>5. Alimentary infections</td>
<td>5. Food additive substances</td>
</tr>
</tbody>
</table>
Chemical risk assessment and management in Slovakia

- Higher incidence of acute respiratory diseases and bone growth retardation in children in highly polluted areas
- Hearing loss in children in areas polluted with arsenic (near Nováky power plant)
- Fluorosis in workers and children living near the aluminium smelter Ziar nad Hronom
- Bladder cancer among workers exposed to PAH
- Congenital anomalies in Michalovce region near plant manufacturing PCB
- Higher concentrations of PCB in mother`s milk (Michalovce region and other)
- Methemoglobinaemia in infants due to high levels of nitrates in soil and water
- Higher levels of Pb and Cd in fruits, vegetables and potatoes near lead smeltery
- NO$_x$ emissions, SO$_2$, PCB in food chain, bad agricultural practice, toxic wastes
Methods for assessment of environmental factors

- Observation
- Field measurement
- Laboratory examination
Evaluation of hygienic situation

• comparison of the values with acceptable (reference) concentrations and applicable standards

• the importance of systematic monitoring and hazard assessment of chemicals before using them in practice

Maximum allowable concentration of pollutants (MAC) - the components of the environment (water, soil, air, food) - knowledge of acceptable daily intake (amount of limiting total daily dose of pollutants that can get into the body without the risk or consequences - health impairment

Threshold concentration of the substance - the maximal, still ineffective concentration or dose of pollutants
AIR

Atmosphere – a layer of gases, protects life on Earth by absorbing ultraviolet solar radiation, warming the surface through heat retention (greenhouse effect), and reducing temperature extremes between day and night
– height 500-1000 km upon Earth
• Layers – troposphere, stratosphere, ionosphere, exosphere

Troposphere
• 8-16 km
• the most important part
• 80 % of all air, life processes, weather

Stratosphere
• 10-80 km
• 25-30 km ozonosphere $O_3$ - acts as a protective filter that protects Earth's surface from the effects of harmful ultraviolet component of UV-B radiation
• ozone formed by the action of Sun radiation on oxygen molecules
• ozone layer and its disturbance by human activity
• mesosphere – part of stratosphere in the height 40-80 km

Ionosphere
• 500 km
• captures the primary cosmic radiation
• allows radio communication on the Earth

Exosphere
• over 500 km
• Comes into cosmic space
Physical characteristics

radiation, temperature, humidity, circulation, atmospheric pressure, atmospheric electricity

Effects of physical factors on man

- **Meteorotropism**
  - sensitivity to physical factors of air
- **Meteorotropic disease**
  (significantly worsen with changes)
  - pain in operational and amputation scars
  - headache, toothache, migraine
  - cardiovascular disorders
  - neurological disorders
  - mental disorders
  - acute glaucoma
  - allergies and respiratory system diseases
  - rheumatic pain
Meteorotropism

- **High atmospheric pressure** - good mood, increased self-confidence, overestimation of their own abilities,
- **Sudden drop in air pressure** - increased demand for breathing and heart activity
- **High humidity** - adverse effect on rheumatism, joint disease, bronchial asthma
- **Warm wind** - depression, headaches, migraine, increased number of accidents, violence and suicide
- **Light air anions** - a beneficial effect on hypertension, bronchial asthma, rheumatism, central and peripheral nervous system. Induce a feeling of freshness.
Physical characteristics

radiation, temperature, humidity, circulation, atmospheric pressure, atmospheric electricity

- radiation- electromagnetic
- - corpuscular

- temperature - thermal state of the atmosphere is a function of solar radiation, decreases with altitude, time, meteorological situation, ground floor layers are the warmest
To measure the air temperature ($t_a$) - spirit and mercury (or ternary) thermometers (mercury thermometers from April 3, 2009 may not be sold and replaced with thermometers with thermometric substance consisting of gallium, indium and tin), which have different accuracy and range. To measure the highest and lowest temperatures maximum, resp. minimum thermometers.

**Six extreme thermometer** is used to measure the highest and lowest temperatures at the same time for a period of time.

**Thermistor thermometers** - semiconductors change electrical resistance due to temperature, which changes are measured with microamperemeter with temperature scale. For the continuous recording of changes in temperature **thermographs** are used.

**Vernon-Jokl globe thermometer** is used to measure the resulting temperature of the globe thermometer ($tg$) - characterizes the common qualitative effect of convection and radiant heat in man.
Physical characteristics

- humidity
- **atmospheric pressure** – normal – 101.32 kPa; with increasing altitude decreases exponentially, Mountain (altitude) sickness
- movement of air - air **velocity** occurs due to the tendency of air pressure to compensate for variations in different places of the earth, which are caused by diversity of temperature, occurs in the horizontal (wind) or vertical direction
- **Atmospheric electricity** - transportation of air ions forming either ionization or electric discharges

*Air pressure measurement*

To measure air pressure **manometers**, **aneroids** and **barographs** are commonly used.
• Air velocity

- occurs when compensating the changes in air pressure on different places in the Earth - the influence of different temperatures in vertical and horizontal direction

- wind - air movement in the horizontal direction
  - factor of thermal properties
  - the cause of meteorological changes
# Beaufort Scale of Wind Power

<table>
<thead>
<tr>
<th>Number and Description Features</th>
<th>Air Speed (km / h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 calm</td>
<td>0–2</td>
</tr>
<tr>
<td>1 light air</td>
<td>2–5</td>
</tr>
<tr>
<td>2 light breeze</td>
<td>6–11</td>
</tr>
<tr>
<td>3 gentle breeze</td>
<td>12–19</td>
</tr>
<tr>
<td>4 moderate breeze</td>
<td>20–29</td>
</tr>
<tr>
<td>5 fresh breeze</td>
<td>30–39</td>
</tr>
<tr>
<td>6 strong breeze</td>
<td>40–50</td>
</tr>
<tr>
<td>7 near gale</td>
<td>51–61</td>
</tr>
<tr>
<td>8 gale</td>
<td>62–74</td>
</tr>
<tr>
<td>9 strong gale</td>
<td>75–87</td>
</tr>
<tr>
<td>10 storm</td>
<td>88–101</td>
</tr>
<tr>
<td>11 violent storm</td>
<td>102–117</td>
</tr>
<tr>
<td>12 hurricane</td>
<td>above 118</td>
</tr>
</tbody>
</table>
Chemical characteristics

<table>
<thead>
<tr>
<th>Chemical component</th>
<th>Volume (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>78.08</td>
</tr>
<tr>
<td>Oxygen</td>
<td>20.95</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>0.03-0.04</td>
</tr>
<tr>
<td>Noble gases (He, Ne, Ar, Kr, Xe)</td>
<td>0.9</td>
</tr>
</tbody>
</table>

- Trace gases - greenhouse gases - water vapor, carbon dioxide, methane, nitrous oxide, and ozone.

- Natural substances - in tiny amounts in an unfiltered air sample, including dust, pollen and spores, sea spray, volcanic ash, and meteoroids.

- Industrial pollutants - chlorine (elementary or in compounds), fluorine compounds, elemental mercury, and sulfur compounds such as sulfur dioxide (SO₂), CO.
Chemical characteristics

- **Ozone** – in the troposphere is normally not present, occurs when there is an electrical discharge in the storms, anthropogenic activity, inhaled in high concentrations damages the respiratory system, irritates the mucous membranes of the upper respiratory tract.

Carbon dioxide
- breathing of higher animals, fire, fermentation green plants consuming him during photosynthesis
- higher concentration in the closed spaces, air pollution indicator, is heavier than the air, accumulates in the ground
- sensory disturbances, headache, vomitus, heat balance of the atmosphere,
- absorbs infrared radiation emitted by the Earth`s surface, causes greenhouse effect (increasing the ground temperature of the atmosphere with melting of polar ice and rising sea levels)
Chemical assessment of the air

• *Physical-chemical methods*
  - atomic absorption spectroscopy
  - ultraviolet photometry
  - gas chromatography
  - mass spectroscopy

• *Electrochemical methods*
  - potentiometry
  - polarography
  - conductometry
Climate change (WHO 2012)

- In the 20th century global temperature raised by approximately 0.75° C
- Malnutrition, diarrheal disease, malaria and dengue
- Natural catastrophes
- Some vectors of diseases change their natural habitat
- More and more arable land is changed to deserts
Biological characteristics

- Pathogenic microorganisms - *Staphylococcus pyogenes aureus*, *S. albus*, *Streptococcus haemolyticus*, *S. viridans*, *Clostridium tetani*, *Mycobacterium tuberculosis*, etc., can survive in the air for different amounts of time

- Saprophytic microorganisms - moulds, yeasts, actinomycetas, sarcinas (*S. lutea*) and other cocci and sporulative and non-sporulative sticks

- Biological pollutants - allergens, asthma, allergic diseases

Microbiological assessment of the air

- Sedimentation method
- Filtration method and method of membrane filters
- Aeroscopic method
MICROBIOLOGICAL EXAMINATION OF THE AIR

In facilities where there are high demands for clean air (medical devices, pharmaceuticals and others). Increased content of microorganisms in the air is one of the indicators of poor quality.

The methods by which we can monitor microorganisms in the air, microorganisms are actively aspired or the property to sediment is used.
Microbiological examination of the air

Sedimentation method

\[ M = \frac{a \cdot 100}{\pi \cdot r^2} \cdot 100 \]

- \( M \) - Number of microorganisms (M) (microbial units, colony-forming units (CFU)) in 1 m³
- \( a \) - Number of grown colonies
- \( r \) - Radius of Petri dish (cm)

On the open Petri dish with blood agar sediment microorganisms from the air. After exposure samples are cultivated at 37 °C for 24 to 48 hours. The outcome depends on several factors (temperature, humidity, velocity, size of suspended particles). To the area 100 cm² in five minutes sediment microorganisms of 10 liters of air. Number of microorganisms (M) (microbial units, colony-forming units (CFU)) in 1 m³ is calculated using the formula.

Filtration method
Method of membrane filters
Aeroscopic method
MICROBIOLOGICAL EXAMINATION OF THE AIR

Aeroscopic (impaction) method

Aeroscopes are apparatuses, through which holes the air is aspired and directed to Petri dish with blood agar. Apparatuses aspire particles of size 1 to 20 μm and more, corresponding to particle size breathing by man.

When taking air samples we put the open Petri dish with a soil under sterile conditions to Air Sampler. Turn on the device draws a certain period of time defined by the amount of air. Sample cultivate at 37 °C for 24 to 48 hours, the number of grown colonies counted to 1 m³ of the air.

Aeroscope RCS Plus based on the principle of centrifugal force.
Limit values of microbiological and biological indicators of indoor air quality

Total number of microorganisms < 500 CFU/m3
Moulds < 500 CFU/m3
Pathogenic microorganisms < 1 CFU/m3
Legionellas < 1 CFU/m3

Source: Vyhláška MZ SR č. 210/2016 Z.z., ktorou sa mení a dopĺňa vyhláška Ministerstva zdravotníctva Slovenskej republiky č. 259/2008 Z. z. o podrobnostiach o požiadavkách na vnútorné prostredie budov a o minimálnych požiadavkách na byty nižšieho štandardu a na ubytovacie zariadenia

www.slovlex.sk
The highest permissible concentrations of dust particles and microbiological factors in clean spaces of the health-care facility

<table>
<thead>
<tr>
<th>Grade</th>
<th>The highest permissible concentrations</th>
<th>Classification of spaces according cleanliness requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dust particles/m³</td>
<td>Non-pathogenic microorganisms</td>
</tr>
<tr>
<td></td>
<td>&lt; 0.5μm</td>
<td>&lt; 5μm</td>
</tr>
<tr>
<td>M 3.5</td>
<td>3 530</td>
<td>0</td>
</tr>
<tr>
<td>M 4.5</td>
<td>35 300</td>
<td>247</td>
</tr>
<tr>
<td>M 5.5</td>
<td>353 000</td>
<td>2 470</td>
</tr>
<tr>
<td>M 6.5</td>
<td>3 530 000</td>
<td>24 700</td>
</tr>
</tbody>
</table>

**Superaseptic operating theatre** for transplantation, neurosurgical, osteal and burn surgeries, intraocular surgeries, heart surgeries, aseptic ICU after transplantation, aseptic box for patients with radiation syndrome and burn unit.

**Surroundings of operating tables in superaseptic operating theatre**, operating theatre for aseptic and septic performances, spaces for manipulation with sterile health-care tools

**Background of cleanliness grades M 3.5 and M 4.5**: aseptic and septic operating theatre including operating theatre for laparoscopic and arthroscopic procedures, delivery and section room, clean part and storeroom for aseptic medical devices in central sterilisation department, ward in the department of anaesthesiology and intensive medicine, ICU of patients with serious immunity weakening and pathological newborns, consulting room of angiography using intravascular catheters and probes

**Operating theatre background M5.5**: Surgical room, neonatal unit, nuclear medicine applications, consulting room for endoscopy, room for small and superficial surgical procedures

Comments:
The cleanliness grade is appointed by common logarithm of the highest permissible number of dust particles (size from 0.5 μm in 1 m³ of the air)
The numbers of particles have been measured out of operation at first 15-20 minutes after activity
### Microclimate and acoustic requirements on out-patients and hospital wards

<table>
<thead>
<tr>
<th>Room</th>
<th>Temperature [°C]</th>
<th>Relative Humidity [%]</th>
<th>Number of air exchanges /h</th>
<th>Pressure</th>
<th>Noise level $L_{Aeq}$ [dB (A)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic rooms:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consulting room</td>
<td>22 – 24</td>
<td>30 – 70</td>
<td>5</td>
<td>overpressure</td>
<td>40</td>
</tr>
<tr>
<td>Doctor’s Office</td>
<td>20 – 22</td>
<td>30 – 70</td>
<td>5</td>
<td>overpressure</td>
<td>40</td>
</tr>
<tr>
<td>Patient’s room</td>
<td>20 – 24</td>
<td>30 – 70</td>
<td>5</td>
<td>underpressure</td>
<td>35 day 25 night</td>
</tr>
<tr>
<td>Waiting rooms</td>
<td>18 – 20</td>
<td>30 – 70</td>
<td>3</td>
<td>underpressure</td>
<td>50</td>
</tr>
<tr>
<td>Supplementary rooms:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storeroom</td>
<td>10 – 17</td>
<td>30 – 70</td>
<td>10</td>
<td>underpressure</td>
<td>50</td>
</tr>
<tr>
<td>Offices for employess</td>
<td>20 – 22</td>
<td>30 – 70</td>
<td>5</td>
<td>underpressure</td>
<td>40</td>
</tr>
<tr>
<td>Wardrobe and accessories</td>
<td>20 – 22</td>
<td>30 – 70</td>
<td>10</td>
<td>underpressure</td>
<td>50</td>
</tr>
</tbody>
</table>
AIR POLLUTION

Major sources of air pollutants
- industry – metallurgical, chemical, building materials
- energetics – heating plants, power plants, boilers
- transport – road traffic
- agriculture (agrochemicals)

OUTDOOR AIR POLLUTION CONSIDERATIONS
- Climate
- Temperature
- Prevailing winds
- Seasonal changes
- Topography
- Prevailing winds
- Hills and valleys
- Dominant vegetation
- Cities and surfaces
The Role of Inversions

**An inversion** is an extremely stable layer of the atmosphere that forms over areas. Temperature inversions trap pollutants close to the ground. These inversions involve layers of hot air sitting above cooler air near ground level. When particles accumulate in the air layer, they are unable to rise into the atmosphere where winds will disperse them.
<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Number</th>
<th>Pollutant</th>
<th>Manifestation of the clinical finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1930</td>
<td>Meuse Valley, Belgium</td>
<td>Majority of the population</td>
<td>63 Sulphur and fluorine compounds</td>
<td>Mucous membranes of respiratory tract and eyes, circulatory system</td>
</tr>
<tr>
<td>1948</td>
<td>Donora, USA</td>
<td>6, 000</td>
<td>20 Sulphur compounds</td>
<td>Mucous membranes of respiratory tract and eyes, circulatory system</td>
</tr>
<tr>
<td>1952</td>
<td>London, UK (several times)</td>
<td>Majority of the population</td>
<td>4000 Sulphur oxides, smoke</td>
<td>Respiratory system, circulatory system</td>
</tr>
<tr>
<td></td>
<td>Los Angeles, USA</td>
<td>Majority of the population</td>
<td>- Photochemical smog</td>
<td>Respiratory system, eyes</td>
</tr>
<tr>
<td>1950</td>
<td>Posa Rica, Mexico</td>
<td>320</td>
<td>22 Sulphan</td>
<td>Respiratory system</td>
</tr>
<tr>
<td>1976</td>
<td>Seveso, Italy</td>
<td>The health status of citizens is being monitored</td>
<td>- Trichlorphenol, dioxin</td>
<td>Skin, gastrointestinal tract</td>
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<tr>
<td>1984</td>
<td>Bhopal, India</td>
<td>150, 000</td>
<td>1500 Methyl isocyanate, hydrogen cyanide</td>
<td>Eyes, respiratory system, CNS</td>
</tr>
<tr>
<td>Year</td>
<td>Location</td>
<td>Event</td>
<td>Health Status</td>
<td>Pollutants</td>
</tr>
<tr>
<td>------</td>
<td>--------------</td>
<td>------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>1984</td>
<td>Chemko, Strážske, Slovakia</td>
<td>The health status of citizens is being monitored</td>
<td>PCB, polychlorinated biphenyls</td>
<td>PCB poisoning damage to the skin, decreased immunity, neurological disorders, gastrointestinal disorders, endocrine cycle, menstrual cycle, reproductive anomalies, behavioral abnormalities, impaired intellect, carcinogenesis</td>
</tr>
<tr>
<td>1986</td>
<td>Chernobyl, USSR</td>
<td>Late effects (?)</td>
<td>Radioactive substances</td>
<td>Radiation sickness</td>
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<tr>
<td>1995</td>
<td>U.S. Steel, Košice, Slovakia</td>
<td>300 - 400</td>
<td>Carbon monoxide</td>
<td>CO Poisoning</td>
</tr>
<tr>
<td>2010</td>
<td>Ajka, Hungary</td>
<td>&gt;150</td>
<td>Red sludge - waste in the production of aluminum, fine dust containing arsenic into the atmosphere</td>
<td>Arsenic poisoning, teratogenic effects, oncological diseases</td>
</tr>
<tr>
<td>2011</td>
<td>Fukushima I, II, Okuma, Japan, tsunami</td>
<td>The health status of citizens is being monitored</td>
<td>-</td>
<td>Radioactive substances, $^{131}I$, $^{137}Cs$</td>
</tr>
</tbody>
</table>
AIR POLLUTION

state, in which we find in the atmosphere substances that does not belong there, depending on concentration - can damage living and death part of nature

• exhalates – pollutants in the air – gaseous, liquid and solid substances from natural or artif. sources, changes in atmospheric air content

SIZE MATTERS

- Coarse particles (2.5–10 micrometres) deposited in the upper respiratory tract and large airways

- Fine particles (< 2.5 micrometres) may reach terminal bronchioles and alveoli

PARTICULATE MATTER
AIR POLLUTION

Emissions (pollutants) - the amount of harmful substances eliminated by certain sources of air within a given time unit (kg / h, T / year)
Primary emissions - a group of substances eliminated directly from the sources of pollution
Secondary emissions - a group of substances generated in the atmosphere by reactions between two or more primary pollutants

Slovak Hydrometeorological Institute

Current air quality information

http://www.shmu.sk/en/?page=1&id=oko_imis
AIR POLLUTION

**Immission** - the actual content of the pollutants in the air, detected by air sampling, carried out at 1.5 to + 1.7 m above the ground (the breathing zone of a person), the values are given in mg/m³ air

Particulate – dust, ash, soot, chemical content - SiO₂, As, Pb, Sr, F, Cd and size < 5 μm, heavy metals, fibers – asbestos, synthetic fibers

Pollutant gases - sulfur dioxide (SO₂), nitrogen oxides (NOₓ - N₂O, NO₂, NO), carbon monoxide (CO – binding on Hb, carbonylHb), organic compounds - aldehydes, polycyclic aromatic hydrocarbons, volatile organic compounds, benzene, organic acids, smog

### Types of Air Pollution

Primary air pollutants: harmful chemicals that enter directly into the atmosphere.

Secondary air pollutants: harmful chemicals that form from other substances in the atmosphere.
### TRADITIONAL AIR POLLUTANTS

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Sources</th>
<th>Health Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate Matter</td>
<td>Automobile, bus and truck exhaust, fuel burning (wood stoves, fireplaces), industry, construction.</td>
<td>↑ infant respiratory mortality, ↓ lung function, ↓ lung growth, ↑ symptoms in asthmatics</td>
</tr>
<tr>
<td>Ozone</td>
<td>Produced when nitrogen oxides (vehicle emissions) and volatile organic compounds (VOC) chemically react under sunlight.</td>
<td>↓ lung growth, ↑ asthma exacerbations, ↑ all respiratory hospitalization, ↑ asthma hospitalization, ↑ asthma ED visit, ↑ school absence for respiratory illness</td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>Results from high temperature fuel combustion and atmospheric reactions.</td>
<td>↑ symptoms in asthmatics, ↓ lung growth</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>Formed when carbon-containing fuel is not burned completely, emitted by motor vehicles more than any other source.</td>
<td>↑ asthma hospitalization, ↑ clinic visits for lower respiratory tract disease, headache</td>
</tr>
<tr>
<td>Sulfur dioxide</td>
<td>Industrial sites such as smelters, paper mills, power plants and steel manufacturing plants are the main sources.</td>
<td>↑ asthma hospitalization, ↑ clinic visits for lower respiratory tract disease</td>
</tr>
</tbody>
</table>
Endemic in at least 25 countries

Sources
- Water (primary)
- Air
- Iatrogenic

In China
- From burning high-fluoride coal
- Affects over 10 million people:
  - dental and skeletal fluorosis
AIR POLLUTION

Smog – fog containing a high concentration of smoke fumes

- **reductive smog** – occurs in towns with smoke accumulation in bad weather conditions (smoke, sulfur oxides, gaseous wastes from coal)- London, inversion

- **oxidative** – occurs in sunny weather, accumulation in the exhaust gases of combustion engines (fotochem. mix) - Los Angeles, NO, VOCs, PAN – per oxyacetyl nitrate – secondary pollutant

London – industrial smog, 5 December 1952

Death tolls - 4,703 people died during the two weeks of the London smog

- death rate peaked on the 8th and 9th days at 900 deaths per day

Health effects – Pneumonia, Asthma, Respiratory, Cardiac Distress, Heart Failure
“Los Angeles” Smog

Los Angeles Smog: driven by the photochemistry of the volatile organic compounds (VOCs) and oxygenated nitrogen species ($\text{NO}_x$) contained in exhaust from combustion engines + sunlight. Photochemical smog is air saturated with ozone, VOCs and aerosol particles.
For limestone, the acidic water reacts with the calcium to form calcium sulfate:

\[
\text{CaCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + 2\text{H}^+ + \text{CO}_3^{2-}
\]

The calcium sulfate is soluble so it is easily washed away during the next rain storm.
AIR POLLUTION

The effects of air pollution on human beings and their environment:

• **direct** - direct harmful effect on the body
• **indirect (mediated)** - damaged by the environment (reduction of solar radiation due to reduced clarity of air, lack of vegetation, contaminated food, water, soil)

Depending on the quality and quantity of air pollution can occur:

• **acute damage** - when exposed to high concentrations of toxic substances for a short time, can cause irritation of conjunctivas associated with lacrimation, respiratory mucosa (coughing, asthma attack)
• **chronic damage** - if a man is long time exposed to low concentrations of pollutants (chronic damage of upper respiratory tract, allergies)
• **delayed effects on health** - carcinogenic, mutagenic, teratogenic (developmental anomalies)

The scope of health impairment:

• **local**
• **total** (after absorption, contamination and disruption of biochemical and immunological processes CNS)
AIR POLLUTION

Measures:

- **legislative** – legal standards determining health and technical measures
- **hygienic** – to determine maximum allowable concentrations of pollutants in the air and in protection zones around sources of pollution

WHO AIR QUALITY GUIDELINES

https://www.who.int/airpollution/guidelines/en/
Indoor air pollution

Indoor air quality is influenced by:

- Outdoor air pollution: vehicles and industrial plants
- Secondhand, thirdhand tobacco smoke
- Fuels used for heating and cooking
- Confined and poorly ventilated spaces
- Overcrowded homes and insufficient living space
- Customs, habits, traditions
- Level of economic development (industrialized, developing countries)

Global burden of disease due to indoor air pollution

- WHO assessed the contribution of a range of risk factors to the burden of disease – indoor air responsible for 2.7 % of the global burden of disease (WHO, 2004)
- Indoor air is important because people spend a substantial proportion of their time in buildings
ADVERSE HEALTH EFFECTS OF AIR POLLUTANTS

Acute:
- Irritation of the mucous membranes (eyes, nose, throat)
- Cough, wheeze, chest tightness
- Increased airway responsiveness to allergens
- Increased incidence of acute respiratory illness: "cold", pneumonia, otitis media
- Tracheobronchitis
- Exacerbation of asthma

Chronic:
- Impact of long-term exposure to lung growth
- Impairment of pulmonary functions
- Increased susceptibility to chronic obstructive lung diseases, including asthma
<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respirable particles</td>
<td>Tobacco smoke, stoves, aerosol sprays</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>Combustion equipment, stoves, gas heaters</td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>Gas cookers, cigarettes</td>
</tr>
<tr>
<td>Sulfur dioxide</td>
<td>Coal combustion</td>
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<tr>
<td>Carbon dioxide</td>
<td>Combustion, respiration</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>Particle board, carpet adhesives, insulation</td>
</tr>
<tr>
<td>Other organic vapors (benzene, toluene, etc.)</td>
<td>Solvents, adhesives, resin products, aerosol sprays</td>
</tr>
<tr>
<td>Ozone</td>
<td>Electric arcing, UV light sources</td>
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<tr>
<td>Radon and “daughters”</td>
<td>Building materials</td>
</tr>
<tr>
<td>Asbestos</td>
<td>Insulation, fireproofing</td>
</tr>
<tr>
<td>Mineral fibers</td>
<td>Appliances</td>
</tr>
</tbody>
</table>
CARBON MONOXIDE: THE "SILENT KILLER"
A COMMON CAUSE OF ACUTE AND LETHAL POISONING

- Colourless, odourless gas formed by incomplete burning of carbon-based fuels
- CO’s affinity for Hb is 240–270 times greater than oxygen
- Fetal Hb has higher affinity for CO
- CO causes a leftward shift of the oxyhaemoglobin (OHb) dissociation curve
- Intoxication results in tissue hypoxia
- Multiple organ systems are affected

CARBON MONOXIDE (CO): SOURCES

- Gas, kerosene, wood stoves and coal
- Fires, fireplaces, furnaces
- Leaking chimneys and vents
- Room and water heaters
- Vehicle exhaust in closed garage
- Tobacco smoke
- Any place where combustion is incomplete
PREVENTION OF EXPOSURE TO CO

- Keep fuel-burning appliances in good working condition
- Check heating systems, chimneys and vents regularly
- Never burn charcoal indoors
- Never leave a car running in a closed garage
- Consider CO detectors
ETS – Environmental tobacco smoke

Over 4,000 irritating chemical compounds in tobacco smoke, 100 – carcinogenic, including CO - binds hemoglobin and prevents oxygen transport in the body.

ETS causes over 600,000 deaths per year with more than a third of all people exposed to the harmful effects of smoke. It corresponds to 1% of the global burden of diseases worldwide \(\text{WHO, 2017}\).

Around the world, 40\% of children, 33\% of male non-smokers, and 35\% of female non-smokers were exposed to ETS in 2004.
Consequences of ETS

Physical Health

lung cancer, cardiovascular disease, respiratory impairment, asthma, fire-related injuries

Mental Health

depression (there is less data on mental health effects)

Children

over 700 million exposed to ETS, SIDS, middle ear infections, lung disease, obesity, metabolic syndrome, diabetes, cognitive functional impairment, leukemia

Fetus

spontaneous abortions, perinatal death, prenatal complications, premature birth, low birth weight, placental problems

New Tobacco Products—Not Regulated by FDA

- Hookahs/water pipes/nargile/shisha
- Cigars, cigarillos—flavored and unflavored
- Kreteks
- Bidis
- Non-combustible tobacco: snuff, snus
- Electronic cigarettes – ENDS – electronic nicotine delivery systems

The Three Major Public Health Questions About E-Cigarettes

- Are they an effective means of facilitating cigarette smoking cessation or reduction?
- Do they lead to adolescent smoking initiation (uptake)?
- What kind of adverse effects do they have, i.e nicotine dependence…others?
VOLATILE ORGANIC COMPOUNDS: HEALTH EFFECTS

Acute:
• Irritation of eyes and respiratory tract
• General: headache, dizziness, loss of coordination, nausea, visual disorders
• Allergic reactions, including asthma and rhinitis

Chronic:
• Damage to liver, kidney, blood system and central nervous system (CNS)
• Some may cause cancer in humans (formaldehyde)
FORMALDEHYDE: HEALTH EFFECTS

- Irritation of eyes, nose and throat
- Breathing difficulties
- Skin rash
- Asthma and other allergic reactions
- May be a sensitizer
- May cause cancer

Prevention:
- Reduce exposure
- Provide adequate ventilation
- Maintain moderate temperature and humidity levels
BIOLOGICAL POLLUTANTS

Biological pollutants are/were living organisms:
• Animal dander – cat, dog, cockroach, dust mites, moulds, infectious agents, pollen

Sources of biological agents:
• Water-damaged surfaces and materials
• Humidifiers and stagnant water
• Water vapour from cooking and showering
• Air conditioning systems
• Mattresses, upholstered furniture and carpets
• Dirt
INDOOR AIR QUALITY: BUILDING COMPONENTS - HVAC

The importance of:
- Materials in houses and schools:
- Asbestos, wood preservatives, paints and others
- Ventilation
- Heating
- Use (overuse) and location of electric appliances
- Air conditioning
SICK BUILDING SYNDROME

What is this syndrome?
• Discomfort not related to specific illness
• Effects appear to be linked to time spent inside the building
• Cause of symptoms is unknown
• Most complaints relieved soon after leaving the building

Symptoms:
- Headache
- Irritation of eyes, nose or throat
- Dry cough
- Dry or itchy skin
- Difficulty in concentrating
- Fatigue
- Sensitivity to odours

Solutions:
- Remove source of pollutant
- Increase ventilation
- Air cleaning: filters
- Education and communication

Building related illness: symptoms of identified illness attributed to airborne contaminants in the building
Approaches to reduce indoor air pollution

1. Eliminate or control the sources of pollution
   • Improved stoves
   • Clean fuels (kerosene, gas)
   • Venting stoves for cooking and heating
   • Regular maintenance of cooking, heating and cooling systems
   • Choose non-volatile, non-toxic building materials
   • Maintaining dry homes and schools

2. Ventilation – building design
   • Dilute and remove pollutants through ventilation with outdoor air

3. Air cleaning – NOT air fresheners!
   • Air filters and ionizers may remove some airborne particles
   • Gas adsorbing material is used to remove gaseous contaminants
Hygienic assessment of the air in indoor environment

Physical properties

Microclimatic comfort
Thermal and humidity microclimate
Dry air temperature \((t_a)\), operative temperature \((t_o)\),
temperature of the globe thermometer \((t_g)\), relative
humidity of the air \((\phi)\) and air velocity \((v_a)\)

Measurement of air humidity

*Humidity* is given by the content of water vapor in a given volume of air.

*Absolute humidity* is the amount of water vapor in grams in 1 m\(^3\) of air (the partial pressure of water vapor in air) \((\text{Pa})\). *Relative humidity* is the ratio of maximum and absolute humidity (maximum water vapor saturation of air at a certain temperature), we express it as a percentage.
Assmann aspiration psychrometer - the principle of evaporation, a system of two mercury thermometers protected against radiation by metallic pads. The degree of evaporation of water from the fabric of moist thermometer and the temperature against dry thermometer drops by.

Aspirator provides constant airflow around the thermometers. One of the thermometers indicates dry temperature, the other is covered with a moist cloth ("stocking") and indicates moist temperature. The difference in temperature on both thermometers (psychrometric difference) can determine the relative humidity in tables. At 100% relative humidity, evaporation of stockings cannot be possible and the temperature on both thermometers is the same.

Measurement procedure: Stocking of thermometer moistened with distilled water, stretch clockwork aspirator. After stable levels of mercury in thermometers subtract both dry and wet data of temperature and relative humidity subtract from the table to determine the relative humidity.

Air humidity values falling within the zone of thermal comfort range from 30-60%. Very dry air dries out mucous membranes and increases their susceptibility to infections. Humid air makes it difficult for thermoregulatory evaporation mechanism.
Table to determine relative humidity of the air

<table>
<thead>
<tr>
<th>Dry temperature T (°C)</th>
<th>Difference dry and wet temperature T – T (°C)</th>
<th>Dry temperature T (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
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<tr>
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</tbody>
</table>
Measuring direction and velocity of air flow

Smaller flow of indoor air is measured by katathermometer (thermal anemometer) - cooling rate principle. A spirit thermometer, the capillary tube is extended at both ends and has a bearing temperature of 38 °C and 35 °C. Each katathermometer has marked factor (F), which indicates the amount of heat released from the reservoir area 1 cm² at cooling from 38 °C to 35 °C.

Measuring procedure: heat the katathermometer in the water bath to about 40 °C to get spirit ascended to the upper reservoir. Dry katathermometer and issue an air flow of about 1.5 m above the ground. With stopwatch we measure time drop of alcohol from 38 °C to 35 °C (shown on the thermometer). If kata-factor divided by the time in seconds, we get refrigeration value (kata-value) H.

\[ H = \frac{F}{s} \]
Refrigeration value - complex influence of temperature and velocity on organism, optimal values - 5 – 10. Higher values – feeling of cold, lower values – feeling of warm. After enumeration of the temperature difference between the mean value of katathermometer (36.5 °C) and ambient temperature (36.5 - ambient temperature = Q) air velocity can be calculated. Air velocity in m/s corresponding to the value of H/Q are shown in the tables. Air velocity accurately calculated according to the formula for speeds less than 1 m/s (1), or the formula for speeds greater than 1 m/s (2).

H – refrigeration valuea (F/T)
F – factor of katathermometer
T – kata - time (s)

In confined spaces, the optimum temperatures by air velocity should not exceed 0.2 m/ s. If there are increased requirements for microbial air quality (aseptic operation, eg. operating rooms) flow higher (up to 0.5 m / s). Direction of air flow - ventilation or air-conditioning facilities. Overpressure in the operating room will prevent air infiltration from adjacent less clean areas. Ensuring air flow from the top down will prevent the pollution of the floor space. Underpressure - to prevent penetration of pollutants into neighbouring spaces.
<table>
<thead>
<tr>
<th>H/Q</th>
<th>Rýchlosť (m.s⁻¹)</th>
<th>H/Q</th>
<th>Rýchlosť (m.s⁻¹)</th>
</tr>
</thead>
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<tr>
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<tr>
<td>0,63</td>
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<td>0,64</td>
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<td>7,30</td>
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<td>1,22</td>
<td>1,45</td>
<td>7,89</td>
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<td>1,27</td>
<td>1,50</td>
<td>8,50</td>
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<td>0,67</td>
<td>1,32</td>
<td>1,55</td>
<td>9,13</td>
</tr>
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<td>0,68</td>
<td>1,37</td>
<td>1,60</td>
<td>9,78</td>
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<td>0,69</td>
<td>1,42</td>
<td>1,65</td>
<td>10,50</td>
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<td>0,70</td>
<td>1,47</td>
<td>1,70</td>
<td>11,20</td>
</tr>
<tr>
<td>0,71</td>
<td>1,52</td>
<td>1,75</td>
<td>11,90</td>
</tr>
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<td>0,72</td>
<td>1,58</td>
<td>1,80</td>
<td>12,60</td>
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<td>0,73</td>
<td>1,63</td>
<td>1,85</td>
<td>13,40</td>
</tr>
<tr>
<td>0,74</td>
<td>1,68</td>
<td>1,90</td>
<td>14,2</td>
</tr>
<tr>
<td>0,75</td>
<td>1,74</td>
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<td>15,00</td>
</tr>
<tr>
<td>0,76</td>
<td>1,80</td>
<td>2,00</td>
<td>15,80</td>
</tr>
</tbody>
</table>
All microclimatic factors affect person in complexity, so they are examined together.

Complex effects of temperature, humidity and air velocity to the body expresses the **effective temperature**. This is the value that at the same combination of temperature, humidity and velocity causes that the majority of people feel the same heat.

**Equivalent effective temperature** is the temperature of the air flow speed in $\leq 0.2 \text{ ms}^{-1}$ and the relative humidity $R = 100\%$, that evokes in humans the same thermal feeling as the environment with the temperature $t$ (° C), velocity (ms$^{-1}$) and the relative humidity $R$ (％).
Optimal and acceptable conditions of microclimate for warm and cold period of the year

<table>
<thead>
<tr>
<th>Class</th>
<th>Operative temperature $t_0$ [°C]</th>
<th>Acceptable air velocity $v_a$ [m.s$^{-1}$]</th>
<th>Acceptable humidity [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>optimal</td>
<td>acceptable</td>
<td></td>
</tr>
<tr>
<td>Warm period of the year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>25 – 28</td>
<td>20 – 29</td>
<td>≤ 0,2</td>
</tr>
<tr>
<td>1a</td>
<td>23 – 27</td>
<td>20 – 28</td>
<td>≤ 0,25</td>
</tr>
<tr>
<td>1b</td>
<td>22 – 25</td>
<td>19 – 27</td>
<td>≤ 0,3</td>
</tr>
<tr>
<td>1c</td>
<td>20 – 24</td>
<td>17 – 26</td>
<td>≤ 0,3</td>
</tr>
<tr>
<td>Cold period of the year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>22 – 26</td>
<td>20 – 27</td>
<td>≤ 0,2</td>
</tr>
<tr>
<td>1a</td>
<td>20 – 24</td>
<td>18 – 26</td>
<td>≤ 0,2</td>
</tr>
<tr>
<td>1b</td>
<td>18 – 21</td>
<td>15 – 24</td>
<td>≤ 0,25</td>
</tr>
<tr>
<td>1c</td>
<td>15 – 20</td>
<td>12 – 22</td>
<td>≤ 0,3</td>
</tr>
</tbody>
</table>
Total amount of water in the human body is about 60 %

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>body fluids</td>
<td>97 – 99 %</td>
</tr>
<tr>
<td>tissues</td>
<td>80 %</td>
</tr>
<tr>
<td>bones</td>
<td>22 %</td>
</tr>
<tr>
<td>teeth</td>
<td>10 %</td>
</tr>
</tbody>
</table>
### DAILY WATER INTAKE

<table>
<thead>
<tr>
<th>Source</th>
<th>Quantity</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>700 ml</td>
<td>35 %</td>
</tr>
<tr>
<td>Water from oxidation</td>
<td>300 ml</td>
<td>15 %</td>
</tr>
<tr>
<td>Liquids</td>
<td>1000 – 1500 ml</td>
<td>50 %</td>
</tr>
</tbody>
</table>

**Total consumption 2000 - 2500 ml**

### DAILY WATER EXPENDITURE

<table>
<thead>
<tr>
<th>Source</th>
<th>Quantity</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin</td>
<td>500 ml</td>
<td>25 %</td>
</tr>
<tr>
<td>Lungs</td>
<td>400 ml</td>
<td>20 %</td>
</tr>
<tr>
<td>Urine</td>
<td>1000 – 1500 ml</td>
<td>50 %</td>
</tr>
<tr>
<td>Stool</td>
<td>100 ml</td>
<td>5 %</td>
</tr>
</tbody>
</table>

**Total expenditure 2000 - 2500 ml**
WATER CYCLE

Water - \( \frac{3}{4} \) of Earth’s surface. 97% - water from seas and oceans, 3% - the fresh water, 2% in the form of iceberg and 1% in lakes and rivers

Solar radiation – water from rivers and oceans evaporates and enters the atmosphere. There is condensation and the creation of clouds. By the action of the Earth's gravity water falls back to the Earth's surface in the form of precipitation (snow, hail, rain). Rainwater will become part of the surface water of rivers and lakes, or soaks into the ground and form groundwater. Groundwater is the source for surface water courses (streams, rivers), lakes and water flows out into the oceans and seas. Evaporation of precipitation and the water cycle (hydrological cycle) continues.

1.1 billion of people (1/6 world population) has no access to drinking water
NEEDS AND EXPLOITATION OF WATER

MUNICIPAL
1. drinking and food preparation
2. for personal hygiene activities including bathing and laundering
3. for residential and commercial heating and air conditioning
4. for urban irrigation and street cleaning
5. for amenity purposes such as public fountains and ornamental ponds
6. for recreational venues including swimming and wading pools, water parks, and hot tubs and spas
7. for residential and commercial fire protection
8. for water transport and carriage
9. for the removal and cleaning of waste (municipal sewage, wastewater treatment plants)

INDUSTRIAL
10. in the food, paper, chemical, metalworking, oil and mining industry
11. to produce electricity and thermal energy (hydropower)
12. to cool the nuclear fuel and energy production (cooling towers)

AGRICULTURAL
13. in plant and animal management (supply farms and cooperatives, irrigation? feeding the animals)
14. in agricultural production (primary production of milk, alpine dairy, forestry)
15. like the natural environment for fish and aquatic animals, forest and field game
Health risks from water

1. The risk of transmission of pathogenic germs and diseases caused by bacteria, viruses, protozoa and parasitic worms

- **Bacterial infections** - intestinal infections: typhoid and paratyphoid (Salmonella), bacillary dysentery (Shigella), cholera (Vibrio), acute gastroenteritis (E. coli, Campylobacter, Yersinia enterocolitica, Cryptosporidium), brucellosis, tularemia, anthrax, tuberculosis, legionellosis

- **Viral infections** - hepatitis A, poliomyelitis, inclusion conjunctivitis, acute gastroenteritis (Coxsackie, Echoviruses, Rotaviruses, Enteroviruses, Adenoviruses)

- **Protozoal infections**: amoebic dysentery (Entamoeba histolytica), giardiasis (Lamblia intestinalis) balantidiasis (Balantidium coli). Fatal meningoencephalitis Naegleria fowleri (nose, along n. olfactorius directly into the brain when swimming in pools) and among helmintosis larvae agent-schistosomiasis bilharzia (through the skin while swimming in surface waters of the subtropical and tropical regions)
Protozoal infections: Animal and bird schistosomes are widespread also in mild climate including Europe. Cercarial dermatitis known as Swimmer’s itch, a short-term immune reaction occurring in the skin of humans that have been infected by schistosomatidae. Symptoms - itchy, raised papules, commonly occur within hours of infection and do not generally last more than a week.

Humans usually become infected with avian schistosomes after swimming in lakes or other bodies of slow-moving fresh water. Snails shed cercariae most intensely in the morning and on sunny days, and exposure to water in these conditions may therefore increase risk. Duration of swimming is positively correlated with increased risk of infection and shallow inshore waters—snail habitat—undoubtedly harbour higher densities of cercariae than open waters offshore.
Health risks from water

2. The risk of toxic action of chemical substances - nitrates, fluorides, radioactive and trace elements as well as toxic substances that enter the environment in relation to human activities, industrial and agricultural production (solid and liquid waste, air pollutants), water treatment

- Higher concentrations of nitrates in drinking water can cause in artificially infants methemoglobinemia, in adults formation of nitrosamines with potential carcinogenic effects.

- Higher concentrations of fluoride in drinking water cause fluorosis. The lighter forms (staining of dental enamel) can also occur with long-term consumption of water with only slightly higher fluoride content than specified limit.

**FLUORIDE (FI) - FLUOROSIS**

From natural erosion, discharge from fertilizer and aluminium factories, or added to drinking water

Bone disease, mottled teeth – elevated fluoride

WHO guideline: 1.5 mg/l
Health risks from water

3. **The risk of disturbance of the biological value of potable water** – shortage or excess of mineral substances and trace elements, breach of balance (fluorine, iodine, sodium). F – caries, I – endemic goiter, excess of sodium + Cd – systolic blood pressure increase

**Hardness** consists of carbonates and sulphates of calcium and magnesium, according to the results of epidemiological studies is indirectly linked with the incidence of cardiovascular diseases (harder water = less of these diseases)
REMEDIATION–WATER TREATMENT PLANTS

Coagulation

Sedimentation

Filtration

Disinfection

Storage
Drinking water quality standards

- health based targets based on an evaluation of health concerns
- system assessment to determinate whether the drinking water supply as a whole can deliver water that meets the health based targets
- operational monitoring in the process of drinking water supply
- management plans documenting the system assessment and monitoring plans and describing actions to be taken in normal operation
- a system of independent surveillance that verifies that the above are operating properly

Drinking water water is physically flawless that even with continuous drinking does not cause disease or health disorder presence of microorganisms and organisms or substances affecting consumer health acute, chronic or late action (mutagenic, carcinogenic, teratogenic, allergenic), its properties do not prevent drinking

Public supply from a water supply a public water supply system or from a water source that supplies more than 50.

Individual supply from one water supply for less than 50 persons

Limit the value of the indicator of drinking water quality, exceeding it water loses satisfactory quality in the indicator, which has been exceeded, only after aproval of public health body

Maximum limit excludes the use of excess water as drinking; is intended for substances with a threshold exposure
WATER SUPPLY

WATER SOURCE
Groundwater – the best source (well)
Source – good quality A1, after treatment (river, lake)

PROTECTIVE ZONE
I. grade
II. grade
III. grade
DRINKING WATER QUALITY ASSESSMENT

- for hygienic assessment we note its location and the possible pollution sources
- source has to be located to exclude the possibility of direct microbiological and chemical contamination
- into sterile glass bottles
- principles of aseptic work
- sample processed by in the shortest time (up to 6 hours, at latest to 24 hours after collection)

COUNCIL DIRECTIVE 98/83/EC

‘water intended for human consumption’ shall mean:
(a) all water either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes, regardless of its origin and whether it is supplied from a distribution network, from a tanker, or in bottles or containers;
(b) all water used in any food-production undertaking for the manufacture, processing, preservation or marketing of products
## Requirements on Microbiological Properties on Drinking Water

Decree No 247/2017 laying down details of drinking water quality, control of drinking water quality, monitoring program and risk management at drinking water supply

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Public supply</th>
<th>Individual supply</th>
<th>Bottled drinking water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum limit</td>
<td>Limit</td>
<td>Maximum limit</td>
</tr>
<tr>
<td><em>Escherichia coli</em> <em>EC</em></td>
<td>0 / 100 ml</td>
<td>0 / 10 ml</td>
<td>0 / 250</td>
</tr>
<tr>
<td>Coliform bacteria <em>KB</em></td>
<td>0 / 100 ml</td>
<td>0 / 10 ml</td>
<td>0 / 250</td>
</tr>
<tr>
<td>Enterococcus - EK</td>
<td>0 / 100 ml</td>
<td>0 / 10 ml</td>
<td>0 / 250</td>
</tr>
<tr>
<td>Colony count at 36 °C - KM36</td>
<td>50 / 1 ml</td>
<td>100 / 1 ml</td>
<td>20 / 1 ml</td>
</tr>
<tr>
<td>Colony count at 22 °C - KM22</td>
<td>200 / 1 ml</td>
<td>500 / 1 ml</td>
<td>100 / 1 ml</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa PA</em></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DRINKING WATER  STN EN ISO 19458

LABORATORY EXAMINATION

* Source assessment (location, construction security, outline)
* Sample taking (aseptic work principles)
  - Sample of chlorinated water (0.1 ml 3% solution sodium tiosulfate Na₂S₂O₃)

PHYSICAL EXAMINATION (immediately)

* Temperature 8 – 12°C (MH)
* Colour colourless, max. 20 mg Pt /1 l
* Odour (20°C, 60°C, druh) intensity max. 2 balls
* Turbidity max. 5 ZF (formasin units)
* Transparency min. 30 cm (MH)
* Sediment (after 2 hrs, amount, quality, colour)

*Ph – 6.5-8.5 
Drinking water without sediment
INDICATORS OF FECAL CONTAMINATION

Coliform bacteria (Enterobacteriaceae) – E.coli
• G- non-sporeforming sticks (Endo, lactose media 37°C)
• Termotolerant coliform bacteria are able to grow and to fermentate lactose at 43°C
• Coli – titer
• Coli index
• The lowest amount of water with positive finding
  • 1. Ø CFU / 100 (10) ml
  • 2. Ø CFU / 100 (100) ml
• Fecal streptococci, Enterococci – G+, termoresistant, resistant against chemical, physical conditions
• Ø CFU / 100 (10) ml
• Clostridium perfringens)
• Colony count at 36 °C
• Colony count at 22 °C
• Pseudomonas aeruginosa
1. COLONY COUNT AT 36 °C ASSESSMENT

Procedure:
- Into sterile Petriho dish 1 ml of water sample
- Pour 20 ml MPA – media
- Mix, let harden
- Incubation 36°C / 48 hod.

Assessment:
Public water supply: v 1 ml max. 20 colonies
Individual water supply: v 1 ml max. 100 colonies (ML)

2. COLONY COUNT AT 22 °C ASSESSMENT

Incubation 22°C / 72 hrs

Procedure:
- The same as before

Assessment:
Public water supply: in 1 ml max. 200 colonies
Individual water supply: in 1 ml max. 500 colonies
3. DETE MINATION OF POSSIBLE NUMBER OF COLIFORM BACTERIA ON LACTOSE MEDIA (MUCHA METHOD)

Procedure:
- to 7 tubes with lactose broth water inoculated:
  - 5 x 10 ml
  - 1 x 1 ml
  - 1 x 0.1 ml
- cultivation 37°C / 24 hrs

Assessment:
Amount of coliforms according the table and the number of tubes with gas and turbidity
<table>
<thead>
<tr>
<th>10 ml</th>
<th>1 ml</th>
<th>0,1 ml</th>
<th>Possible number of bacteria subfamily Escherichiae in 100 ml water</th>
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<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2, 0</td>
</tr>
<tr>
<td>0</td>
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<td>0</td>
<td>1</td>
<td>1</td>
<td>4, 0</td>
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<td>2, 2</td>
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<td>1</td>
<td>4, 4</td>
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<td>7, 5</td>
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<td>1</td>
<td>0</td>
<td>7, 6</td>
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<tr>
<td>2</td>
<td>1</td>
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<td>96, 0</td>
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<td>0</td>
<td>240, 0</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1</td>
<td>&gt; 240, 0</td>
</tr>
</tbody>
</table>
Biological examination of drinking water

- for drinking water from groundwater simple microscopic examination is enough
- microscopic examination of abioseston – in percentage of microscope cover, limit 10 %
- results of seston - quality of water source, and water treatment efficacy

Chemical examination of drinking water

**Ammonia** - biochemical decomposition of organic nitrogenous compounds. Their presence in groundwater indicates fresh fecal pollution and may adversely affect the sensory quality of drinking water, high indicator value.
Limit - 0.5 mg/l.

**Nitrites** - formed by oxidation of ammonia, high indicator value, precursors of carcinogenic N-nitrosamines and have a close relationship to the development of methemoglobinemia in artificially fed infants. ML is 0.5 mg/l.

**Nitrates** - have little value indicator, their higher levels in groundwater can be a sign of old fecal contamination. They have a relationship to foodborne infant methemoglobinemia. ML for drinking water is 50 mg/l, the recommended amount is below 15 mg.

**Chlorides** – low indicator value. ML for drinking water is 100 mg/l.
Chemical examination of drinking water

From organic substances fenols and petroleum products are important, humine substances, detergents. The organic substances may be oxidized with strong oxidizing agents (permanganate, dichromate, etc.). Amount of oxygen, the equivalent consumption of oxidizing agent, is known as Oxidization or chemical oxygen consumption by permanganate. Limit for drinking water is 3.0 mg/l.

Anorganic substances – metal compounds, toxic (compounds of Cd, Hg, Pb, etc.)
- compounds of calcium, magnesium, iodine, fluorine

For quick estimation of common parameters, automatic apparatuses on the principle of photocolorimetry

DR/700 colorimeter Hach
SURFACE WATER

➢ from the hygienic point of view can be described as a soft, often contaminated chemically and microbiologically inadequate supply without treatment

Indicators:

1. **Indicators of oxygen regimen** - dissolved oxygen, oxygen saturation, biochemical oxygen demand after 5 days (BOD5), Oxidizing, free hydrogen sulfide level saprobity and saprobic index.
2. **Indicators of basic chemical composition** – chlorides, sulphates, calcium, magnesium, dissolved and suspended solids in the water
3. **Special indicators** - ammonia, nitrate, pH, iron, manganese, phenols, cyanides, oils, temperature, odor and color
4. **Indicators of microbial contamination** - bacteria of the family Enterobacteriaceae

Categories of surface water

- Category A1 - include water requiring simple physical treatment and disinfection, respectively. rapid filtration and disinfection.
- Category A2 we include water requiring physico-chemical treatment and disinfection (eg coagulation, flocculation, filtration, chlorine disinfection, and prechlorination decanting)
- Category A3 requires intensive physical-chemical treatment and disinfection (eg coagulation, flocculation, filtration, activated carbon adsorption, disinfection by chlorine or ozone, chlorination to break-point and decanting)
REPORT ON WATER EXAMINATION

Place of collection: Date:

Physical examination (sensoric):
Colour
Turbidity
Odour

Mikrobiological examination:
Coliform bacteria CFU/1ml, CFU/100 ml – Mucha method
Colony count pri 22°C CFU/1ml
Colony count 36n°C CFU/1ml

Chemical examination:
Active chlorine (Cl₂) mg/l
Ph (pH) mg/l
Ammonium ions (NH₄⁺) mg/l
Nitrites (NO₂⁻) mg/l
Nitrates (NO₃⁻) mg/l
Chlorides (Cl⁻) mg/l
Chemical consumption of O₂ (KMnO₄) mg/l

Evaluation:

Examined by:
### CHEMICAL EXAMINATION OF WATER SOURCES

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Tap water mg / l</th>
<th>Well mg / l</th>
<th>Danube mg / l</th>
<th>Štrkovec mg / l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active chlorine (Cl₂)</td>
<td>0.3</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Reaction (pH)</td>
<td>7.5</td>
<td>7.0</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Ammonium ions (NH₄)</td>
<td>neg.</td>
<td>neg.</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Nitrites (NO₂⁻)</td>
<td>neg.</td>
<td>neg.</td>
<td>0.10</td>
<td>0.20</td>
</tr>
<tr>
<td>Nitrates (NO₃⁻)</td>
<td>0.53</td>
<td>0.87</td>
<td>12.86</td>
<td>15.46</td>
</tr>
<tr>
<td>Chlorides (Cl⁻)</td>
<td>15</td>
<td>15</td>
<td>80</td>
<td>120</td>
</tr>
<tr>
<td>Chemical consumption of O₂ by potassium permanganate ChSK₉⁻Mn</td>
<td>0.95</td>
<td>1.03</td>
<td>3.04</td>
<td>6.25</td>
</tr>
</tbody>
</table>
BATHING AND RECREATIONAL WATER

Positives of swimming

Bathing, swimming is a very positive activity
- Conditioning of the body
- Supporting immunity
- Muscles activation
- Training, rehabilitation
- Practicing and promoting the development of cardiovascular and respiratory systems
- Massage the entire body surface
- Elimination of stress, positive emotional tuning
- Maintaining an appropriate body weight

Risks of swimming

- Health risks
- Transmission of infectious diseases, transmission of germs by direct contact, droplet infection at high accumulation of people in swimming pools
- Water - transmission medium of inflammatory diseases of skin and mucous membranes, diarrhea, inflammatory diseases of urinary and genital tract
- Infectious dose needed - the recirculation and high movement of people - unlikely
- Chemicals, accidents
- Injuries
Principles that should not be forgotten!

**In the natural pools**
- do not walk into unknown stagnant or running water
- do not enter the water which acts repugnant to us
- **do not bath in waters with high concentration of aquatic birds**
- do not bath in places with dead birds
- do not enter the water with cyanobacteria and algae
- **do not enter the water with water blossom on the surface**
- do not allow children to play on the banks with accumulation of water mashed flower
- to comply with all instructions and warnings in the area of water surface
- to shower thoroughly after each bath

**In the artificial pools**
- to shower before entering the pool
- prohibited from entering the water to persons suffering from communicable disease
- to use the toilet
- in suspected lack of cleanliness, disinfection or water replacement better not to enter the pool
- thoroughly shower after each use of the pool
ILLUMINATION

Daily – lateral, upper, combined secondary
Artificial
Combined

Illuminance (intensity of illumination- E) – proportion of lumen size and area unit - lux (lx)

Uniformity of daylight - the ratio of the minimal and the average values of daylight factor (Dmin: Dmean)
DAILY ILLUMINATION

- allows vision

- effect on the endocrine system - specialized part of the retina photoreceptor mediates the transfer of information to the hypothalamus, where it enters the pineal gland, which regulates the secretion of melatonin

- best for work performance and permanent stay of humans

- lack of daylight

- SAD - seasonal affective disorder - set of symptoms reminds hibernation phenomena animal-increased sleepiness, decreased work performance, weight gain, decreased sexual activity, restriction of social contacts, discomfort

Types of daylight:

- lateral
- top
- combined
- secondary

At daylight we consider:

- level of daily illumination
  (daylight factor)
- uniformity of daylight
- light distribution and direction
- occurrence of phenomena which distort vision
  well-being, especially glare
DAILY ILLUMINATION

- Assessed according STN 730580 Daily illumination of buildings
- Evaluation is performed in uniformly cloudy sky, calculation or measurement
- **Daylight factor (D)** – the ratio of illumination at a given point of the plane to the current illumination outside comparative unshaded plane defined by the brightness distribution of the sky as the exclusion of direct sunlight.

\[ D = \frac{\text{daylight illuminance at point within a room}}{\text{simultaneous illuminance on a horizontal plane outside the building}} \times 100\% \]

from a completely unobstructed sky (excl. sunlight)

3 components: sky, internal reflected, external reflected

If sky component is 0, the room is not good for permanent stay
The impact of new buildings - equivalent angle shield ($\varepsilon_e$)

Permissible value 30 degrees
PROTOCOL ON ENVIRONMENTAL ASSESSMENT

Measured object

Date

ILLUMINATION

Parameters of daily illumination assessment

- activity class:
- type of illumination:
- daylight factor:
- coefficient of glazing:

Evaluation:

ACOUSTIC COMFORT

- equivalent noise level A dB
- maximal noise level A dB

Evaluation:

OVERALL ASSESSMENT:
COMBINED ILLUMINATION

- daylight and artificial light
- assessed separately
- cannot substitute daylight
- ratio 1:1
- important is the source of artificial daylight
<table>
<thead>
<tr>
<th>Class of visual activity</th>
<th>Characteristics of visual activity</th>
<th>Examples of visual activities</th>
<th>Value of daylight factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Extremely accurate</td>
<td>The most precise visual activity with a limited possibility to use enlargement, with a requirement to eliminate errors in resolution, the hardest control</td>
<td>3.5</td>
</tr>
<tr>
<td>II</td>
<td>Very accurate</td>
<td>Very precise activities in production and control, very accurate drawing, hand engraving with very small detail, very fine artwork</td>
<td>2.5</td>
</tr>
<tr>
<td>III</td>
<td>Accurate</td>
<td>Precision manufacturing and inspection, drafting, technical drawing, difficult laboratory work, challenging tests, fine stitching, embroidery</td>
<td>2</td>
</tr>
<tr>
<td>IV</td>
<td>Moderately accurate</td>
<td>Moderately precision manufacturing and inspection, reading, writing, routine laboratory work, tests, treatments, operating machinery, rougher sewing, knitting, cooking</td>
<td>1.5</td>
</tr>
<tr>
<td>V</td>
<td>Inaccurate</td>
<td>Rougher works, manipulation with objects and material, food consumption and serving, relaxing activities, basic and recreational physical education</td>
<td>1</td>
</tr>
<tr>
<td>VI</td>
<td>Very inaccurate</td>
<td>Keeping cleanliness, showering and washing, changing clothes, walking in communications accessible to the public</td>
<td>0.5</td>
</tr>
<tr>
<td>VII</td>
<td>Total orientation</td>
<td>Walking, material transport, storage coarse material, overall supervision</td>
<td>0.25</td>
</tr>
</tbody>
</table>
# Standard values of daylight factor in school areas

<table>
<thead>
<tr>
<th>Name of room, type of activity</th>
<th>Daylight factor values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lateral $D_{min}$ (%)</td>
</tr>
<tr>
<td>Classrooms, workshops, reading rooms, kitchens (0.85 m from the floor)</td>
<td>1.5</td>
</tr>
<tr>
<td>Auditory, gymnasium, swimming pool (at floor level)</td>
<td>1.5</td>
</tr>
<tr>
<td>Features, drawer, fine piece of work, electronics, physician office (0.85 m from the floor)</td>
<td>2.5</td>
</tr>
<tr>
<td>Canteens, clubhouse, recreational facilities (0.85 m from the floor)</td>
<td>1.0</td>
</tr>
<tr>
<td>Corridors, stairs, hall, toilets, showers (floor level)</td>
<td>0.5</td>
</tr>
</tbody>
</table>
## Coefficient of glazing – recommended values

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Very fine work workplace</td>
<td>1 : 3</td>
</tr>
<tr>
<td>Operating theaters,</td>
<td>1 : 4 - 1 : 5</td>
</tr>
<tr>
<td>Hospital rooms</td>
<td>1 : 6 - 1 : 8</td>
</tr>
<tr>
<td>Classrooms</td>
<td>1 : 4 - 1 : 7</td>
</tr>
<tr>
<td>Rooms</td>
<td>1 : 8 - 1 : 10</td>
</tr>
<tr>
<td>Auxiliary rooms</td>
<td>max. 1 : 15</td>
</tr>
</tbody>
</table>

## REQUIREMENTS FOR ARTIFICIAL ILLUMINATION

<table>
<thead>
<tr>
<th>Category</th>
<th>Detail ( D/d )</th>
<th>Room</th>
<th>Illumination E ( lx )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>&gt; 3300</td>
<td>oper. theatres, spec. outpatients and labs</td>
<td>20 000 - 2000</td>
</tr>
<tr>
<td>B</td>
<td>3300 - 500</td>
<td>drawing rooms, examination rooms</td>
<td>2 000 - 200</td>
</tr>
<tr>
<td>C</td>
<td>&lt; 500</td>
<td>workplaces</td>
<td>200 - 20</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>relaxation, resting rooms, living rooms</td>
<td>500 - 20</td>
</tr>
</tbody>
</table>
NOISE

- **NOISE** - unwanted, unpleasant, annoying sound that may adversely affect the health and well-being of individuals or population

- **NOISE EXPOSURE ASSESSMENT** - important because of enormous increase of acoustic energy in the environment, auditory and non-auditory effects, as a stressor activating mechanisms of stress reactions in the organism
Lehmann’s noise classification according to effects on human organism
Sound exposure

Disturbance of intended activities

Stress indicators

Biological risk factors

Cardiovascular diseases

Noise Exposure (Sound Level)

Direct pathway

Hearing loss

Sleep disturbance

Indirect pathway

Disturbance of intended activities

Cognitive and emotional response

Annoyance

Stress Indicators

Physiological stress reactions (homeostasis)

Autonomic nervous system (sympathetic nerve)

Endocrine system (pituitary gland, adrenal gland)

Risk Factors

Blood pressure
Cardiac output

Blood lipids
Blood glucose

Blood viscosity
Blood clotting factors

Manifest Disorders

Cardiovascular Diseases

Hypertension
Arteriosclerosis
Ischaemic heart diseases
Stroke

Source: Babisch (2002)
# GRADATION OF NOISE EFFECTS ON HUMAN HEALTH

*(Jansen, 1998)*

## H (Healthy state):
- complete well-being, comfort, high quality of life
  - $L_{eq} = 30\, \text{dB/A IN}$
  - $L_{max} = 45\, \text{dB/A IN}$

## IHD (Increasing health disturbances):

<table>
<thead>
<tr>
<th></th>
<th>Slight disturbances, negative influence on creative work</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$L_{eq} = 50, \text{dB/A OUT}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Threshold of annoyance, vegetative reactions during sleep, communication disturbances, short time</th>
</tr>
</thead>
</table>
| 2 | $L_{eq} = 55\, \text{dB/A OUT}$
    | $L_{max} = 55\, \text{dB/A IN}$
    | $L_{eq} = 55\, \text{dB/A IN}$                                                  |

<table>
<thead>
<tr>
<th></th>
<th>Serious annoyance, awakening reactions</th>
</tr>
</thead>
</table>
| 3 | $L_{eq} = 65\, \text{dB/A OUT}$
    | $L_{max} = 60\, \text{dB/A IN}$                                                  |

## D (Diseases):
- Jeopardy
- Hearing loss
- Extraaural overstrain
  - $L_{eq} \geq 75\, \text{dB/A OUT}$
  - $L_{eq} = 85\, \text{dB/A IN}$
  - $L_{max} = 99\, \text{dB/A IN}$
## Night Noise Levels – Sleep Disturbance

<table>
<thead>
<tr>
<th>Average night noise level over a year $L_{\text{night, outside}}$</th>
<th>Health effects observed in the population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 30 dB</td>
<td>Although individual sensitivities and circumstances may differ, it appears that up to this level no substantial biological effects are observed.</td>
</tr>
<tr>
<td>30 to 40 dB</td>
<td>Number of effects on sleep are observed from the range: body movements, awakening, self-reported sleep disturbance, arousals.</td>
</tr>
<tr>
<td>40 to 55 dB</td>
<td>Adverse health effects are observed among the exposed population. Many people have to adapt their lives to cope with the noise at night.</td>
</tr>
<tr>
<td>Above 55 dB</td>
<td>The situation is considered increasingly dangerous for public health. People are highly annoyed and sleep-disturbed. The risk for adverse health effects (e.g. cardiovascular disease) increases.</td>
</tr>
</tbody>
</table>
## Acceptable noise levels (Decree of the MH SR No. 549/2007 Coll.)

<table>
<thead>
<tr>
<th>Area category</th>
<th>Land and water transport</th>
<th>Railways $L_{\text{Aeq,p}}$</th>
<th>Aircraft transport $L_{\text{Aeq,p}}$</th>
<th>Aircraft transport $L_{\text{ASmax,p}}$</th>
<th>Other transp. $L_{\text{Aeq,p}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Area with special protection against noise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>45</td>
<td>45</td>
<td>50</td>
<td>-</td>
<td>45</td>
</tr>
<tr>
<td>E</td>
<td>45</td>
<td>45</td>
<td>50</td>
<td>-</td>
<td>45</td>
</tr>
<tr>
<td>N</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>II Residential areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>50</td>
<td>50</td>
<td>55</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>E</td>
<td>50</td>
<td>50</td>
<td>55</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>N</td>
<td>45</td>
<td>45</td>
<td>45</td>
<td>65</td>
<td>45</td>
</tr>
<tr>
<td>III Residential areas near highways, roads and local communications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>E</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td>N</td>
<td>50</td>
<td>55</td>
<td>50</td>
<td>75</td>
<td>45</td>
</tr>
<tr>
<td>IV Non-residential areas, production zones, industrial parks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>-</td>
<td>70</td>
</tr>
<tr>
<td>E</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>-</td>
<td>70</td>
</tr>
<tr>
<td>N</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>95</td>
<td>70</td>
</tr>
</tbody>
</table>
Specific effect (kinetic energy)

- Hearing thresholds shift
  - temporary
  - permanent
  - acutrauma
  - barotrauma
  - chronic hearing impairment

Non specific effect (through CNS)

- Information
  - Acute response
    - orientation
    - startle
    - defense
- General
  - Chronic changes
    - nervous system
    - cardiovascular apparatus
    - Neurohumoral system

The effect of noise on human
ANNOYANCE

- psychic status, that arise from an unintended perception of influences or at subordination to circumstances with the negative attitude of an individual, they disturb his privacy, interfere with performed activities or they influence the rest. Feeling of antipathy, irritability and in some cases psychosomatic disorders

- a common judgemental response to noise regardless to its level. It has its base in the unpleasant nature of some sounds, in the activities that are disturbed or disrupted by noise, in the physiological reactions to noise, and in the responses to the meaning or messages carried by the noise

- together with noise sensitivity, the level of noise annoyance is often used as an important indicator of noise exposure in relation to non-auditory health effects (especially concerning cardiovascular system)

- The level of annoyance is assessed by a questionnaire, in which respondents subjectively describe on various scales the extent of noise annoyance. Fields et al. (1997, 2001) - suggested the standard five grade scale.
According to WHO more than 1 million healthy life years (DALY) are lost annually because of environmental noise exposure in European A-member states

Basner et al., 2014

Link on other noise publications

Filova et al., 2020 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6981737/

Argalasova-Sobotova et al., 2013
http://www.noiseandhealth.org/article.asp?issn=1463-1741;year=2013;volume=15;issue=62;spage=22;epage=31;aulast=Argal%E1%9Aov%E1%2DSobotov%E1

Sobotova et al., 2010
131 Agglomerations:
103,715,627 Inhabitants (21% of EU-27 population)

$L_{DEN} \geq 55$ dB(A): 54%
$L_{DEN} \geq 65$ dB(A): 15%
$L_{Night} \geq 50$ dB(A): 39%
$L_{Night} \geq 55$ dB(A): 18%


EU-27: 503,492,041 people

Status: June 2011
NOISE MEASUREMENT

Sound pressure level. - (L) - a measure of the air vibrations that make up sound. Because the human ear can detect a wide range of sound pressure levels (from 20 μPa to 200 Pa), they are measured on a logarithmic scale with units of decibels (dB) to indicate the loudness of a sound.

Sound level. The human ear is not equally sensitive to sounds at different frequencies. To account for the perceived loudness of a sound, a spectral sensitivity factor is used to weight the sound pressure level at different frequencies (A-filter). These A-weighted sound pressure levels are expressed in units of dB(A).

Equivalent sound levels. When sound levels fluctuate in time, which is often the case for occupational noise, the equivalent sound level is determined over a specific time period. In this guide, the A-weighted sound level is averaged over a period of time (T) and is designated by LAeq,T. A common exposure period, T, in occupational studies and regulations is 8 h, and the parameter is designated by the symbol, LAeq,8h.

Hand held noise analyzer Brüel & Kjaer type 2250


Strategic noise map
http://www.laermkarten.de/bratislava/
Sources of environmental noise in SLOVAKIA

- In Slovakia, the rapid development in traffic density connected with the economic transformation since 1990 has brought new problems in relation to environmental noise, particularly road traffic noise.
- Road transport – the major source, gradually growing trend, increase in 40% in larger cities.
- Railway transport – lack of up-to-date technical level and insufficient maintenance of railways located in the vicinity of residential homes.
- Air transport – Eastern part of Bratislava and adjacent villages, military airport at Malacky region.
- HVAC
- Neighborhood noise, entertainment facilities, large production facilities, large shopping centres.
HEALTH RISKS FROM SOIL

- pathogenic microorganisms contamination
- chemical toxic substances contamination

Pathogenic microorganisms, that enter the soil mainly through animal waste, can be divided into several groups:
- Microorganisms of intestinal infectious diseases, bacteria of the family Enterobacteriaceae, including S. typhi abdominalis and other types of Salmonella, Sh. dysenteriae and others
- very dangerous spores of highly virulent anaerobic pathogens that survive in soil for several years, for example, microorganisms that cause botulism and wound infections (clostridia and vibrios, eg. Cl. tetani, Cl. welchii, V. septiquae, B. anthracis)
- Mycobacterium tuberculosis may occur in the soil near the man with the open form of tuberculosis, if such a person does not behave in accordance with the principles of hygiene,
- leptospiras of icteric and anicteric diseases (L. icterohaemorrhagiae, L. bataviae, L. grippotyphosa, L. sejroe, L. australis and others),
- zoopathogenic microorganisms (mainly pasteurelas - P. avicida, P. suilla, P. bovicida and others)
Geohelmints

*Ascaris lumbricoides, Trichuris trichiura, Oxyuris vermicularis*

Larvae of geohelmints enters the soil through faeces, in the soil surpass a certain part of their developmental cycle and contaminated vegetables or penetrate the skin back into the human body.

Eggs of parasites (*Toxocara canis*) are getting into the soil and sand by droppings of infected animals (eg dogs, cats), directly or through small animals on children's shoes, surface water, or contaminated dust.

Prevention

Sandpits (*belong to the basic equipment of playgrounds*) must meet certain health requirements:

The operator is obliged at least once in every two weeks to dig, rake, field and transport it, to exchange sand at the beginning of the season and, if necessary, during the season.

The soil and sand of playing surfaces **shall not contain more than 10 CFU** (colony forming units) of fecal coliforms and enterococci in **1 g of soil**, no occurrence of salmonella and developmental stages of the parasites.
Health risks from sandpits (parasitary, bacterial)

Toxocarosis – etiol. agens: toxocara canis, cati
Source of infection: cats (cca half of cats infected), dogs (cca 18%)
Eggs – resistant in the environment

Toxoplasmosis
Host (Toxoplazma gondii) – cat
Oocysts in faeces of cats – can survive long time (2 – 3 weeks)

Giardiosis
Etiolog. Agens - protozoa
(Lamblia intestinalis)
Source: cats

Shigelosis
Etiol. agens – bacteria Shigella dysenteriae
 Transmission – dirty hands, contaminated objects

Salmonelosis
Etiolog. agens – Salmonella enteritidis
Children are mostly vulnerable – immature immunity
Health risk from sandpits (risks from mechanical impairment)

Injuries from needles and broken glass

Risk
Injection syringes with blood residues

Possible infections
✓ Viral hepatitis
✓ HIV

Amount of risk
✓ HIV – injuries with inj. syringe, small risk of infection – virus sensitive to environment
✓ Hepatitis virus B – more than 100 x infectious than HIV, can infect several weeks drying blood
✓ Hepatitis virus C – most important, mostly to chronicity
Preventive measures

**Sandpits**
Regular check-ups, prohibition animals to enter, collection of syringes and wastes

**Animals**
Regular deworming (5 x year) and vaccination (rabies, etc.)

**Children**
Vaccination, basic hygienic customs

**After syringe injury**
✓ wound treated (disinfection)
✓ vaccination on hepatitis type A and B
✓ regular serological examination
✓ health status assessment for 6 months
HEALTH RISKS FROM SOIL
Chemical toxic substances contamination

In particular, the negative interference of agriculture, industry and transport, as well as the municipal sector bring to the soil substances with different chemical and biological properties.

With organic fertilizers can get into the soil heavy metals. At higher concentrations operate some heavy metals (eg cadmium, copper, lead, zinc) negatively especially on soil microorganisms and some other organisms.

The same is for pesticides, substances used to protect plants and agricultural crops from pests and diseases.
In crop production - occupational exposure, the residues (residues) of pesticides in the environment (air, water, soil) that can pass into the foods of plant and animal origin and through the food chain to humans.
MEASURES AGAINST SOIL POLLUTION

To prevent soil contamination could be by measures:
- planning,
- technical,
- technological,
- legislative,
- hygienic.

Waste (places and equipment for the collection of solid and liquid wastes, their disposal and utilization) must meet the requirements not to burden the land from biological, chemical and physical point of view. The aim is not to reduce self-cleaning capacity of the soil.

In dealing with specific hazardous waste the pollution of soil layers should be avoided (building and technical measures).
Burying people or dead animals - the appropriate locations. Currently in rendering plants, without soil contamination.
When irrigation - soil not biologic overload and water.
Degraded land must recultivate.
HYGIENIC PROBLEMS OF SOLID WASTE

Important ecological and hygienic problem.

Categorization of solid waste is determined with respect to the requirements of environmental protection and health and can be divided according to different criteria. Municipal solid waste (household waste, institutional waste from shops, factories), construction waste and demolition waste, discarded materials, sludge from waste water purification plants, mud, clinical waste waste from river ports agricultural waste

The basic components of municipal solid waste are paper, cardboard, plastics, food residues, metals, glass, wood, rubber, textile and others. The proportion of plastics in municipal waste is increasing due to changes in the structure of packages.
Hygienic importance of solid waste may endanger human: directly - contact with human waste indirectly - through the management of contaminated air, soil, water, via the food chain, transfer vectors-insects and rodents.

The health risks of solid waste depend on ways of dealing with them from their collection, transport and final disposal.

Management of hazardous waste requires special treatment due to its properties, particular toxicity, infectivity, irritability, explosiveness, flammability, chemical properties, carcinogenic, teratogenic, mutagenic properties or may be dangerous to human health and the environment.

Disposal of solid waste include problems: medical, technical, aesthetic and economic
Health problems of solid waste

- the incidence of infectious germs and parasitic diseases of humans and animals
- presence of toxic substances in the solid waste from various plants, industry, agriculture
- dust
- poisoning of the environment by unpleasant smell of ammonia, indole, skatole, fatty acids, etc., resulting from the decomposition of organic matter microorganisms.

Prevention:
Removal of municipal waste should be conducted at least twice a week.
Regular cleaning and disinfection of waste containers.
Most waste is dumped in landfills or composted. In both ways is disposed by biotermic mineralization processes.
Unorganized (wild) landfill waste and hazardous waste landfills threaten the health of people and the environment

Health impairment of population living close to risk landfills:
- reproductive failure and neonatal defects,
- cancer in certain anatomical locations,
- immune disorders
- renal disease,
- disturbances of liver function,
- disease of the lungs and respiratory system,
- neurotoxic manifestations.

Significant relationship to congenital defects:
- between pesticides and musculoskeletal system
- between metals and nervous system defects,
- plastics and chromosomal anomalies (20% to 46%).
Prevention

Solid waste disposal is to take place on managed landfills - their operation is organized according to the hygienic requirements: location of suitable landfill:
- its enclosure,
- spreading out regular waste
- layering with ground

Incineration - another way of disposal of solid waste. Many advantages for the environment: soil and water. It also brings a number of problems: the need for sorting the garbage, measures against air pollution. Combustion of waste generated from various organic materials, especially plastics, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, dioxins and dibenzofurans. These substances are characterized by high stability, and therefore the need for high temperatures of 1300 °C for elimination. Emissions of these substances may at lower temperature re-unite to toxic substances.
**Industrial waste**
Industrial waste is stored in plants or in the vicinity. May not bionegatively affect the environment. Pollution threatens the land, and therefore the possible pollution of ground and surface waters, e.g. sewage when it rains.

**Agricultural waste**
Agricultural waste includes waste from livestock and factory farms. These include chicken manure and pig feces, in their disposal thermal processes are used. Population in the vicinity of such equipment is exposed to unpleasant odors. Other health risks are dead animals to be disposed in veterinary remediation facilities. The main epidemiological risks are addressed already in the process of disposal by thermal treatment and disinfection. The only shortcoming is the smell spread around.

**Toxic and radioactive waste**
For the storage special regulations apply.
Waste from health-care facilities

Non-risk health care waste – same kinds of materials as urban domestic waste

Risk (hazardous) health care waste

“Sharp waste”; syringe needles, scalpels, other sharp medical instruments and contaminated broken glass

Infectious waste - blood and blood products, items contaminated with blood, serum or plasma, cultures and stocks of infectious agents from diagnostic and research laboratories, wastes from highly infectious patients.

Anatomical waste - human tissues, biopsies and autopsies.

Chemical waste - solvents, reagents, film developers, mercury from old thermometers, batteries.

Pharmaceutical waste

Radioactive waste

Pressurized containers - cylinders containing gases or aerosols, when accidentally punctured or incinerated could explode.
The disposal of solid waste from health-care facilities

The first priority is to dispose of sharps. This waste must be collected and processed in such a way as to eliminate any risk of accidental injury and prevent its retrieval by drug addicts.

**Incineration** in a collective installation is the most reliable method for destroying hazardous health care waste.

Waste must be **collected** as safely as possible; hazardous health care waste must be **disinfected** at the site of production. **On-site disinfection** of hazardous health care waste for small producers and pre-incineration waste processing.

**Landfilling** of untreated waste is an acceptable short-term method of disposal when the economic and social conditions of a country are such that no other solution is possible.