Exposure assessment, industrial hygiene, and environmental management

- As Environmental Health (5) on 7 Nov. 2013
- Key Concepts
  - Assessment of env. exposure -> Identify hazards -> understand the effect of hazards on health -> control the hazards -> monitor
  - Industrial hygiene: anticipation, recognition, evaluation, control of workplace hazards
    - using air sampling, biomonitoring
    - hierarchical control: eg. substitution - ventilation - personal protection
  - Exposure science = new field: tools of industrial hygiene -> general environment, leading to environmental management

Exposure assessment

- Start from industrial hygiene (exposure at workplace)
- Know the hazard of exposures
  < Quantify hazardous exposures
  - eg. CO = asphyxiant (stop breathing)
    < How much CO exposure can be tolerated or dangerous? / How to measure, where and when they occur? -> We can understand biological effect of CO exposure completely
  - In turn, we can identify acceptable level, set standard, monitor environments to be safe

Four profession's paradigms of industrial hygiene

- Anticipation: Proactive estimation of health and safety concerns (commonly or potentially) related with a given occupational or environmental setting
- Recognition: Identification of potential and actual hazards in a workplace
- Evaluation: Visual or instrumental monitoring of a site, measuring exposures
- Control: Reduction of risk to health and safety through administrative or engineering measures

Anticipation ~ pre-preliminary assessment

- Traditional two focus areas: safety and health
- Safety hazards -> Needs safety engineering
  - Insufficient emergency egress (exit)
  - Slippery surfaces / risks of trips and falls
  - Chemical storage posing fire/explosion risk
  - Moving machinery
  - Unguarded catwalks
- Health hazards
  - Physical hazards: high noise levels, elevated temperatures and humidity, radiation, repetitive motion, ...
  - Chemical hazards
    - Acute: high level chlorine gas -> disability, death
    - Chronic: low level solvent exposure -> neurological damage / benzene -> bone marrow dysfunction, aplastic anemia / uranium -> lung cancer, ...
- New focus: environmental hazards (chlorine tank ruptures -> endangered safety, plume of organic wastes -> polluted drinking water, smokestack -> tree damage, ecological damage (reduced O2 in water), land deterioration by heavy metals

Recognition

- After anticipation of potential hazard -> Recognition of actual hazard
- By a site visit or walk-through (visual inspection of the facility)
  - both qualitative and quantitative info about occupational and environmental hazard
  - review job category, number of workers in each, job description, health/safety program
  - identify hazardous physical/chemical/biological exposures and mechanical/psychological factors
  - find subpopulations with different hazard levels

Evaluation

- Where to sample?
  - area sampling: at a part of workplace
  - personal sampling: vicinity of individual workers
  - biological sampling: bodies of individual workers
- How to sample?
  - "representative of population" vs "worst case"
- Instruments
  - Direct reading instruments: eg. digital thermometer, hygrometer, noise monitor, Geiger counter, GC-on-a-tip for organic vapors, ...
  - Sample collection instruments: collect air sample on absorbing media (active vs passive sampling) -> measuring at laboratory
  - Biological monitoring: human hair, saliva, blood or urine are common to be used for exposure (nails for long-term exposure)

Control

- Control = Primary prevention
- Approaches to modify workplaces (in Japanese, 作業環境管理)
  - Substitution: replacing hazardous material / process with a less hazardous one (eg. replace benzene by toluene)
  - Isolation: limiting access to the hazardous process (eg. place metal cage around moving parts to reduce the likelihood of clothes catching on the parts)
  - Ventilation: eg. introduction of fresh air, local exhaust ventilation, cool air
- Use protective devices
  - Fail-safe instruments: using two-buttons for operation
  - Personal protective equipments: gloves, safety glasses, ...
  - Administrative strategies: rotating workers to limit aggregation, ... (in Japanese, 作業管理)

Exposure science

- Quantifying the contaminant exposures in daily activities
  - Magnitude, frequency and duration of exposure (exposure profile): the difference of peak and mean concentrations is important
  - Acute/chronic/subchronic exposures
  - Route and pathways of exposure: inhalation? ingestion? dermal?
  - Various methods
    - imputing or modeling (indirect exposure assessment, exposure scenarios, job-exposure matrix)
    - measuring environmental exposures (eg. environmental monitor NO2, PM)
    - measuring personal exposures (eg. air monitor during work: see photo above, source: http://www.cameco.com/uranium_101/mining-milling/more-topics/safety/)
    - aggregate and cumulative exposure assessment (cf. TDI / ADI)
    - measuring biomarkers (contaminants or its metabolic products in human body)
- Evaluating factors that influence exposures
- Exploring new measuring method: ingestion and skin absorptions are challenges. duplicate diet study, dietary diaries, and FFQ for ingestion, wearing skin patch for dermal exposure
- Exposure assessment ~ quantification of exposures in both occupational and environmental settings