The British Occupational Hygiene Society
Faculty of Occupational Hygiene

MODULE SYLLABUS

M102 - MEASUREMENT OF HAZARDOUS SUBSTANCES (Including Risk Assessment)

AIM: To outline the general approach advocated for the assessment of the health risk(s) associated with exposure to hazardous substances and then focuses in some detail on the role and application of atmospheric monitoring. It addresses the theory of sampling, practical sampling and analytical considerations and the calculation and presentation of results. Numerical calculations are included to ensure that the underlying principles are understood.

On successful completion of this module the student should be able to:

- describe the general approach to health risk assessment, including the role of atmospheric monitoring;
- select appropriate equipment to measure specific airborne contaminants and devise a suitable sampling strategy;
- present the results in a form useful for health risk assessment purposes to enable management to comply with relevant legislation.

CONTENT:

	TOPIC	TIME ALLOCATION
1.	RISK ASSESSMENT	20%
2.	AIR SAMPLING THEORY AND PRACTICE	20%
3.	AIR SAMPLING EQUIPMENT	20%
4.	SAMPLE ANALYSIS	5%
5.	HYGIENE STANDARDS	15%
6.	BIOLOGICAL MONITORING	10%
7.	CALCULATION, INTERPRETATION AND PRESENTATION OF RESULTS	10%

Note: Reference is made in this syllabus to HSE guidance or other documentation. This may not be the most up-to-date relevant publications from HSE/other sources and is intended as guidance for candidates only.

RELEVANT DOCUMENTATION

i. The Control of Substances Hazardous to Health Regulations 2002 (as amended) ACOP and Guidance(Fifth Edition)
ii. HSE Guidance HSG97 (2004) A Step by Step Guide to COSHH Assessment.
iii. HSE Guidance HSG193 (2003) COSHH Essentials Easy Steps to Control Chemicals
iv. The Chemicals (Hazards Information and Packaging for Supply) Regulations 2002
v. HSE Guidance Note Environmental Hygiene EH40 Workplace Exposure Limits (issued annually) and other EH's in the series.
vi. HSE Guidance HSG173 (1997) Monitoring Strategies for Toxic Substances
vii. HSE Guidance Note MDHS 14/3 (2000) General Methods for Sampling and Gravimetric Analysis of Respirable and Inhalable Dust
viii. HSE Guidance HSG167 (1997) Biological Monitoring in the Workplace
ix. BSEN 689:1996 Workplace atmospheres – Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategies, ISBN 0 580 25420 8
x. Guidance on laboratory techniques in occupational medicine – available from the Biological Monitoring Section, HSL, Buxton
xi. HSE Guidance HSG248 Asbestos The analysts Guide for sampling analysis and clearance procedures

Note: The above is not exhaustive and other standard occupational hygiene texts should also be referred to.

1. RISK ASSESSMENT (20%)

1.1 Definition of 'hazard' and 'risk'

1.2 The Risk Assessment Process

Gather information.
Assess the health risk(s).
Specify any action required, eg additional control measures.
Record the risk assessment - and establish tracking procedures.
Review the risk assessment.
The first two steps are outlined in some detail below:

Gather information

Nature of the process / operation, eg continuous or batch, indoor or outdoor. The hazardous substances used or produced (chemical, biological), including intermediates (substances inventory). NB. the problem of trade names, mixtures.
The form of the substances identified and how released/where present in the workplace.
An understanding of the effect(s) of the hazardous substances on the body, including general sources of information, eg HSE EH Series. The Chemical (Hazard Information and Packaging For Supply) Regulations 2002, computer databases, journals, trade literature.

The types of job carried out, eg operating, maintenance, laboratory, office / persons exposed (task inventory) - and in particular the elements of the jobs for which higher exposures might occur, including when and why.

Work / shift pattern.

Recommended operating practices and precautionary measures, eg engineering control, personal protective equipment.

Foreseeable mishaps / emergencies.

Existing exposure data - and the role / likely need for additional data (available monitoring method/limitations?).

Past experience, eg occupational health complaints, incidents, ill-health, compensation cases

Assess the health risk(s)

Develop an assessment plan, dividing areas / activities into manageable units for assessment purposes. Use a generic approach (eg. group similar processes) where appropriate.

From observation, questioning and (where necessary/appropriate) atmospheric/ biological monitoring (eg exposure), make an assessment of the health risk(s).

Consider the need for additional control measures, routine monitoring, instruction and training and health surveillance

The role of COSHH Essentials in the assessment and control of health risks

2. AIR SAMPLING THEORY AND PRACTICE (20%)

2.1 Workplace Sampling Strategies

HSE Guidance HSG 173 Monitoring Strategies for Toxic Substances. Basic and detailed surveys.
Routine monitoring; representative versus worst case.
Arithmetic and geometric means and their application in the interpretation of results.
Basic statistical analysis of results to indicate confidence limits. Limitations of statistical analysis. Quality Assurance of sampling and analysis process.

2.2 Survey Design

Evaluating risk without the need for sampling eg. COSHH Essentials.
Principles of survey design, including the preliminary survey. Effective and efficient sampling strategies.
Optimum number of samples. Grab samples.
Sampling in relation to acute and chronic effects.
8 hour TWA and 15 minute STEL sampling.

2.3 Personal sampling

Breathing zone, left/right lapel variations, non-invasive.
Operator variability.

2.4 Area Sampling

For general or background measurements, to show spread of contaminant; entry to a confined space; for breathing air quality.

2.5 Surface and Other Measurements

Non-airborne sampling of the work environment by surface wipe tests, lift-off tape, in-situ XRF metal analysis, etc. Settlement of contaminants.
Bulk sampling.

Educational Objectives

The student should be able to devise an appropriate sampling strategy to provide sufficient useful data on which to base decisions regarding health risks and exposure control measures.

3. AIR SAMPLING EQUIPMENT (20%)

3.1 Sampling Pumps

Common types of pump: high flow (10-100 lpm), medium flow (1-8 lpm), low flow (1-1000 ml/m). Fixed volume hand pumps for indicator tubes.
Mechanism of operation: peristaltic, rotary vane or diaphragm principle. Intrinsic safety of sampling equipment.

3.2 Capture Devices

For particulates: Variety of sampling heads: open face, 4mm hole, seven hole head, cowl, cassette, cyclone, inhalable dust sampler. Different types of filter and their uses, mechanical strength, collection efficiency, resistance to flow, electrical resistance, weight stability and compatibility with subsequent analysis.
For gases and vapours: Different types of adsorbent and absorbent: charcoal, porous polymer, silica gel, a liquid medium or a specific chemical reagent held on a support medium (colorimetric tubes). Mixed exposure to solid/liquid/aerosol/gases. Sampling trains.

Collection efficiency of sampling medium (adsorbent or absorbent), stability during sampling, storage, transport and effect of humidity. Sample tubes and bubblers.Wearer acceptability, fragility, collection efficiency, compatibility with subsequent analysis. Use of diffusive (“passive”) samplers: construction, geometry, sampling rate, diffusion coefficient, temperature, humidity, air velocity effects. Advantages of passive samplers, worker acceptability. Disadvantages of interpretation of result, limits of sensitivity.

3.3 Direct Reading Instruments

Portable, fixed-site or personal devices.
Intrinsic safety of instruments.
Real-time analysis, identify specific parts of process, pin-point source of leaks.
For particulates: Instruments using principle of light scattering, β absorption and piezoelectric effect.

For gases and vapours: Instruments using principle of chemiluminescence, absorption of specific wavelength of electromagnetic radiation or paper tape impregnated with specific chemical.

3.4 Calibration of Air Sampling Equipment

Flow Rate. Calibration of flow rates of sampling pumps in sampling train using soap bubble (primary standard) or rotameter (secondary standard).

Known Concentrations. Standard atmosphere generation, both dust and vapour, for direct-reading instruments: vapour saturation devices, motor-driven syringes, permeation tubes.
Primary and secondary standards.

Educational Objectives

The student should be able to choose the most appropriate air sampling equipment for the contaminant under investigation and be able to operate the equipment.

4. SAMPLE ANALYSIS (5%)

4.1 Trace Level Analytical Methods.

Principles, applications, detection limits, sensitivity, chemical interferences, level of skill required, speed of analysis and approximate equipment costs of the following analytical techniques GLC, HPLC, AAS, XRF, XRD, and IR.
HSE published Methods for the Determination of Hazardous Substances (MDHS) as a source of information and reference.

4.2 Gravimetric Analysis

Reasons for weight variation, instrument sensitivity, cost of analysis, specificity. MDHS 14/3.

4.3 Microscopy

Brief description of the use of optical microscope to identify fibres - asbestos.

4.4 Quality Assurance of Analysis

Internal quality control and external quality assessment.
Role of the National Accreditation Service (UKAS) and the relevance of the HSE external quality assessment scheme Workplace Analysis Scheme for Proficiency (WASP).

Educational Objectives

The student should be able to choose the most appropriate analytical technique for a given sampling medium and contaminant.

5. HYGIENE STANDARDS (15%)

HSE EH40 Occupational Exposure Limits, WELs.
Other limits including those for lead in air and asbestos.
Awareness of proposals for change to Occupational Exposure Limits
EU Indicative Occupational Exposure Limit Values, EU binding OELV.
Standards used in other countries (eg Germany, USA).
Application of standards.
Personal exposure, time weighting, definitions, terminology, units, ‘Sk’, ‘Sen’ notations.
Problems, mixed exposure, action for non-published standards, derivation of limits, criteria document summaries, individual susceptibility.
Limitations of Hygiene Standards: relate to personal exposure, single substance and set time period assuming 8 hour day.
Relevance of mixed exposures, different exposure patterns and non-airborne exposures.

Educational Objectives

The student should be able to correctly interpret relevant information and in addition the student should be able to decide when quantitative measurements are required; he/she should understand the evidence on which standards are set and interpret results in the light of this background.

6. BIOLOGICAL MONITORING (10%)

Personal absorption assessed by biological monitoring or biological effect monitoring.
Consideration of absorbed substance metabolites.
Include target organs and local action, total body burden, biological half-life and timing of taking samples
Biological standards (UK, US, German)
Factors affecting absorption and the need for confidentiality of results. Regulation 11 of COSHH. Health Surveillance

7. CALCULATION, INTERPRETATION AND PRESENTATION OF RESULTS (10%)

Numerical Evaluations
Calculations of the appropriate time-weighted average airborne concentration from the sampling information and the analysis result; examples from Guidance HSG 173 and EH40. Standardised format

Interpretation
Interpretation of the relevance of the calculated airborne concentration either against an accepted hygiene standard or against other relevant data; consider the overall accuracy of the sampling and analysis procedures.

Presentation of Results
Reporting of results in a form useful for occupational hygiene purposes.
Relating measured concentrations to workplace conditions, working practices, protection strategies, special circumstances.
Description of scientific methods used for sampling and analysis. Detailed description of work being carried out at the time of sampling.

Educational Objectives

The student should be able to derive an airborne concentration and to interpret its significance with regard to health, also to indicate the accuracy of measurement and present all results suitable for occupational hygiene purposes including the need for remedial action.