M501 Module Syllabus

Measurement of Hazardous Substances (Including Risk Assessment)

Teaching Aims

This course aims to provide candidates with an outline to the general approach advocated for the assessment of the health risk(s) associated with exposure to hazardous substances and then focuses in 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.

It also covers principles of occupational hygiene on the basis of anticipation, recognition, evaluation, and control of hazards that can be encountered in the workplace.

Prior Knowledge and Understanding

Candidates who undertake this course are expected to be aware of the contents of the Control of Substances Hazardous to Health regulations (COSHH), HSE Guidance HSG173, Monitoring Strategies for Toxic Substances and HSE guidance General Methods for Sampling and Gravimetric Analysis of Respirable and Inhalable Dust.

This course would be suitable for technicians and technologists who conduct measurements and testing in workplaces.

Learning Outcomes

On completion of this module, candidates will demonstrate their knowledge and understanding of the following:

- 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

The syllabus is structured into seven sections:

		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 and other documentation. This list may not include the most up-to-date relevant publications from HSE and other sources and is intended as guidance only for candidates.

1 Risk Assessment (20%)

This section will provide suitable knowledge and training to ensure that the candidate can demonstrate their understanding of risk assessments and definitions used.

In order to achieve this the candidate must be able to demonstrate both their knowledge and understanding in the following:

1.0.1 To be able to define a hazard in terms of chemical safety and be able to define risk in terms of chemical safety

1.0.2 The Risk Assessment Process and information gathering:

To be aware of various sources of information available and be able to make judgements about the significance of a hazard from toxicological properties, physiochemical properties, and other data

1.0.3 Assessing risk:

- To understand the relationship between risk, hazard, and exposure
- To be able to make judgements about likely risk based upon the possible health effects, physiochemical properties, and use of a hazardous material
- To be able to make judgements about probable risk based upon measurement data

1.0.4 To be able to use risk assessments to decide on appropriate actions to protect worker health

1.0.5 To be able to record risk assessment information in a useful form and understand why it is important to record risk assessment information

1.0.6 Understand the role of risk assessment in occupational health and safety management

2 Air Sampling Theory and Practice (20%)

This section will provide suitable knowledge and training to ensure that the candidate is able to devise a range of appropriate sampling strategies and provide sufficient useful data on which to base decisions regarding health risks and exposure control measures.

In order to achieve this the candidate must be able to demonstrate their knowledge and understanding in the following:

2.0.1 Workplace Sampling Strategies:

- Strategies - Understand what a sampling strategy is and its importance in gaining representative results and be aware of how the choice of a strategy may affect the measurement results
- Surveys - Understand the different types of surveys and be aware of how the results from various surveys can be used
- Routine monitoring - Understand the role of routine monitoring and be able to plan basic routine monitoring programmes
- Interpretation of results - To be able to interpret results, understand how monitoring strategy and survey type can affect results and be able to make judgements about the significance of measurement results.
- Basic statistical analysis - Be aware of how basic statistical tools can be used to help with the interpretation of measurement results
- Quality assurance - Understand the importance of quality assurance in surveys

2.0.2 Survey design:

- Non-sampling sampling approaches - To Be able to apply non-sampling approaches such as the ILO Chemical Control Toolkit or COSHH essentials and understand the uses and limitations of such approaches
- Survey design - To understand the effects of survey design on measurement results and be able to design basic surveys to produce representative measurements (what, who, where, when, etc)
- Sample numbers - Be able to calculate the appropriate number of samples required to produce representative measurements and understand the basis of statistically representative sampling
- Grab sampling - understand the use of and limitations of grab sampling
- Acute and chronic effects - To be able to design sampling strategies that are appropriate for different types of health effects
- 8 hour TWA and 15 minute STEL sampling - Understand the significance of TWA and STEL measurements, be able to adjust measurements for different sampling periods and be able to calculate TWA results from multiple measurements

2.0.3 Personal sampling:

- Understand the location of the breathing zone and its significance in personal sampling
- Effect of sample head location
- Understand the effect of sample head location on the sample collected
- Operator variability
- Understand the reasons for the differences in exposure measurement between operators
- Understand the effect of sample head location on the sample collected
- Understand the reasons for the differences in exposure measurement between operators

2.0.4 Area sampling:

- Understand the function and limitations of background measurements
- Understand the effect of particle size and physiochemical properties on contaminant spread
- Be aware of the techniques for assessing the quality of breathing air supplied for use in air-fed respirators and self-contained breathing apparatus

2.0.5 Surface and other measurements:

- Be aware of the techniques and uses of surface contamination measurements
- Be aware of the uses of in-situ XRF metal analysis
- Be aware of how settlement rates of particulates can affect their dispersion
- Understand the role of bulk sampling in determining the nature of a contaminant
- Understand the techniques for assessing skin exposure

2.0.6 Confined spaces:

- Identification and the nature of confined spaces hazards
- Be aware of where confined space hazards might exist
- Understand the nature of such hazards
- Be aware of the techniques for assessing and monitoring confined spaces

3 Air Sampling Equipment (20%)

This section will provide suitable knowledge and training to ensure that the candidate is able to choose the most appropriate air sampling equipment for the contaminant under investigation and be able to operate the equipment.

In order to achieve this the candidate will be able to demonstrate their knowledge and understanding in the following:

3.0.1 Sampling pumps:

- Common types of pumps - Be aware of the different types of sampling pump and their use
- Fixed volume hand pumps for indicator tubes - Understand the correct use of fixed volume hand pumps
- Mechanism of operation - Be aware of the basic operating systems for sampling pumps
- Intrinsic safety of sampling equipment - Be aware of the need for intrinsically safe sampling pumps in certain environments

3.0.2 Sampling Heads and Filters:

- Particulates - Understand the techniques for sampling of common particulates
- and the use of size fractionation techniques for respirable dusts
- Sampling heads - Be aware of the different types of sampling heads and their uses and understand the effect of the filter head on the sample collected
- Filters - Be aware of the different types of filters, understand the use of filters for trapping particulates and be aware of the use of chemically treated filters for sampling for reactive materials
- Gases and vapours - Understand the use of whole air sampling, the use of solvation for trapping gases and vapours, the use of chemical derivatisation for sampling for reactive materials and understand the use of adsorption
- Types of adsorbents and absorbents - understand the basic principles of adsorption, the difference between adsorbents and absorbents and be aware of the common types of adsorbents and their uses
- Colorimetric tubes - be aware of the operating principle of colorimetric tubes, understand the correct use of colorimetric tubes and be aware of the limitations of colorimetric tubes
- Mixed exposure to solid/liquid/aerosol/gases - Be aware of the techniques available for mixed phase sampling
- Sampling trains - Understand how the different components of a sampling system connect together to form the sampling train and how the sampling train is attached to the worker
- Collection efficiency - Be aware of the collection efficiency of common sampling devices
- Sample stability - Be aware of how minimise sample loss between sampling and analysis
- Diffusive (“passive”) samplers - Understand the basic operating principle of a diffusive sampler, be aware of the different types of diffusive sampler and the relative advantages and disadvantages of diffusive samplers

3.0.3 Direct reading instruments:

- Portable, fixed-site or personal devices - Be aware of the operating principles of common direct reading instruments and understand the nature of the information provided by such instruments
- Intrinsic safety of instruments - Be aware of the need for the use of intrinsically safety instruments in some environments

- Real-time analysis - Be aware of the uses of real-time measurements for training and other purposes
- Uses - Understand the appropriate use of direct reading instruments and their limitations
- Instruments for particulates - Be aware of the common types of instruments available for direct reading measurements of particulate concentrations
- Instruments for gases and vapours - Be aware of the common types of instruments available for direct reading measurements of gas and vapour concentrations

3.0.4 Calibration of air sampling equipment:

- Flow rate and primary standards - Understand what primary standards are and how they are used in flow rate calibration
- Secondary standards - Understand what secondary standards are and how they are used in flow rate calibration
- Known concentrations and standard atmosphere generalisation - Be able to use standard atmospheres to calibrate direct reading equipment
- Known concentrations and primary and secondary standards - Understand the difference between primary and secondary standards

4 Sample Analysis (5%)

This section will provide suitable knowledge and training to ensure that the candidate has an understanding of different types of sample analysis methods and techniques, is able to choose the most appropriate analytical technique for a given sampling medium and contaminant and understands quality of analysis.

In order to achieve this the candidate will be able to demonstrate their knowledge and understanding in the following:

4.0.1 Trace level analytical methods:

- Basic techniques and applications - Know the analytical techniques used for common hazardous substances
- Detection limits, sensitivity, chemical interferences - Understand how detection limits and sensitivity of such techniques will affect the sample volume required and understand how chemical interferences may bias results
- Sources of methods - Be aware of the sources of standard sampling and analysis methods such as the NIOSH NMAM and HSE MDHS methods

4.0.2 Gravimetric Analysis:

- Weight variation - Understand the common causes of weight variation and how they can be minimised
- Instrument sensitivity - Understand the level of sensitivity of the technique and how this may affect the sample size required
- Cost of analysis - Be aware of the relative cost of using this technique
- Specificity - Understand what this type of information for this type of measurement provides

4.0.3 Microscopy:

Fibre identification of asbestos - be aware of the technique used for the measurement of asbestos fibre concentrations

4.0.4 Quality assurance of analysis:

- Internal quality control - Understand the importance of internal quality control in analysis
- External quality assessment - Be aware of the function of external quality assessment schemes in improving reliability of laboratory measurements

5 Hygiene Standards (10%)

This section will provide suitable knowledge and training to ensure that the candidate is able to correctly interpret relevant information. In addition, the candidate will also be able to decide when quantitative measurements are required, understand the evidence on which standards are set and be able to interpret results in the light of this background.

In order to achieve this the candidate will be able to demonstrate their knowledge and understanding in the following:

5.0.1 Principles of calculation / setting of standards:

- Be aware of how hygiene standards are set

5.0.2 Standards used in other countries:

- Be aware of commonly used international hygiene standards

5.0.3 Application of standards:

- Understand how exposure measurements relate to hygiene standards
- Understand how hygiene standards are used to protect worker health

5.0.4 Definitions, terminology, units:

- Understand the terminology commonly used in association with standards
- Understand the relationship between ppm and mg m3 for gases and vapours

5.0.5 'Sk' 'Sen' notations:

- Understand the meaning of the skin notation
- Understand the meaning of the sensitiser notation

5.0.6 Problems:

- Be aware of situations that may require different interpretation of standards

5.0.7 Limitations:

- Be aware of the limitations of exposure standards in the light of this background

6 Biological Monitoring (10%)

This section will provide suitable knowledge and training to ensure that the candidate understands Biological Monitoring and other factors which need to be considered.

In order to achieve this the candidate will be able to demonstrate their knowledge and understanding in the following:

6.0.1 Biological monitoring - Be aware of common methods of biological monitoring

6.0.2 Biological effect monitoring - Understand the difference between biological monitoring and biological effect monitoring

6.0.3 Metabolites - Be aware of the role of measurement of metabolites in biological monitoring

6.0.4 Target organs - Be aware how the target organ may affect the choice of monitoring technique

6.0.5 Local action - Understand the difference between local and systemic actions

6.0.6 Biological half-life - Understand the significance of biological half-life in biological monitoring

6.0.7 Sample timing - Be aware of how to plan the timing of biological sampling

6.0.8 Biological standards - Be aware of the sources of biological standards and understand how they are applied

6.0.9 Confidentiality - Be aware of the need of confidentiality when dealing with biological sampling data

7 Calculation, Interpretation and Presentation of Results (10%)

This section will provide suitable knowledge and training to ensure that the candidate is 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.

In order to achieve this the candidate will be able to demonstrate their knowledge and understanding in the following:

7.0.1 Numerical Evaluations:

- Time-weighted average airborne concentration - Be able to calculate TWA values
- Standardised format - Be able to present calculations in a standardised format

7.0.2 Interpretation:

- Relevance of the calculated result - Understand the significance of exposure measurements
- Overall accuracy - Be aware of the elements that effect the overall accuracy of measurements

7.0.3 Presentation of Results:

- Relevant information - Be able to organise and present data in a relevant format
- Interpretation of data - Be able to provide useful and appropriate interpretation of data
- Recommendations - Be able to make relevant and appropriate recommendations based upon exposure measurements

Suggested References and Further Reading

(1) BOHS Technical Guide No 15 Direct Reading Instruments
(2) ILO Chemical Control Toolkit
(3) The Occupational Environment – Its Evaluation and Control (the "White Book") published by AIHA Press
(4) Air Sampling Instruments for the evaluation of atmospheric contaminants published by ACGIH
(5) Occupational Hygiene, Edited by Harrington and Gardiner, Published by Blackwell Science

Course Length

This course will require at least **45** hours of study time, of which at least **37** hours will be taught (teaching and practical assessments) and **8** hours will be independent (in the candidates' own time).

Examinations and Assessment

Candidates are required to pass all of the following parts (A and B below) to be awarded this qualification.

A Practical Assessment

The practical assessment will be conducted by the Tutor during relevant parts of the course for all candidates. This is to ensure that every candidate can demonstrate their individual ability and correct method.

The studies are designed to assess the basic skill and knowledge of each of the candidates in the techniques of personal sampling for the assessment of personal exposure.

The exercises will involve:

- The setting up and calibration of sampling pumps for vapour sampling with charcoal tubes
- The flow calibration will be conducted using basic equipment such as a soap bubble meter and stopwatch rather than more sophisticated equipment now used by experienced staff in the field
- The set up and use of both a cyclone sampler for respirable dust and an open faced sampler for inhalable dust. This will include the weighing of filters, preferably GFA, before and after a sampling sequence to demonstrate that all candidates have the requisite manipulative skills needed for this procedure
- The correct positioning of sampling equipment on the wearer

B Written Examination

This is an open-book examination comprising of **40** (**160** marks) **short-answer** questions to be answered in **2** hours. Each question is worth **4** marks.

Questions may also include multiple answers and some questions may require calculations.

The examination covers **all** sections of the syllabus and is overseen by an invigilator.

The pass mark for this examination is **50 %**

Certification

Candidates who pass all the parts (A and B) within 12 months will be awarded the: '**M501- Measurement of Hazardous Substances (Including Risk Assessment)'**