M501

Measurement of Hazardous Substances

TEACHING GUIDES

TEACHING GUIDE – DAY 1

INTRODUCTION TO PHYSIOLOGY & TOXICOLOGY

- **STUDENT LEARNING OUTCOMES:**

1. Understand and be aware of the features of the interacting systems of the human body.

2. Understand the routes of contaminant entry into the human body and their target organs and systems.

3. Understand the concept of dose response.

RISK ASSESSMENT

- **STUDENT LEARNING OUTCOMES:**

4. Understand the principles and processes of risk assessment in relation to hazardous substances.

5. Be able to apply the principles of risk assessment by the review of a workplace situation.

HYGIENE STANDARDS

- **STUDENT LEARNING OUTCOMES:**

6. Understand the principles of setting hygiene standards.

7. Understand the application and limitations of hygiene standards.

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
0-30 minutes	Course Opening	Welcome	Welcome participants to course	Overhead 1	
		Emergency Procedures	Indicate the Site Emergency Procedures to participants	Overhead 2	Understanding of Emergency Procedures
		Introductions	Introduce the lecturers and ask participants to introduce themselves and indicate their background in occupational hygiene	Overheads 3 & 4 (plus extra overheads if more than one lecturer)	
30-60 minutes	Course Overview	Course Aims	Indicate the course aims	Overhead 5	Active involvement
		Overall Learning Outcomes	Indicate the overall course learning outcomes	Overhead 6	
		What is Required to Complete course?	Indicate requirements	Overhead 7	
		What is Occupational Hygiene?	Discuss the IOHA definition of occupational hygiene and what it means	Overhead 8	
		Topics to be Covered	Discuss the topics to be covered in the course	Overhead 9	

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Course Overview (Cont'd)	Today's Learning Outcomes	Indicate the learning outcomes for Day 1	Overheads 10, 11 & 12	
		Assignment of Groups	Assign individuals to a work group. Ensure persons with some experience are distributed evenly amongst groups	Overhead 13	
60-120 minutes	Physiology & Toxicology	Human Body	Discuss the 12 interacting systems of the human body	Overheads 14 – 28	Active involvement Learning Outcome 1
		Routes of Entry	Discuss the routes of contaminant into the human body	Overheads 29 & 30	Learning Outcome 2
		Target Organs & Systems	Discuss the target organs and systems affected by exposure	Overheads 31 – 35	
		Dose Response	Discuss the dose response by the human body to toxic chemicals	Overheads 36– 49	Learning Outcome 3
120-150 minutes	Coffee Break				
150-240 minutes	Risk Assessment	Definitions	Introduce the concept of hazard, risk and exposure	Overheads 50 & 52	Active involvement Learning Outcome 4

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Risk Assessment (Cont'd)	Risk Assessment Process	Discuss how the process can be applied to many environments	Overhead 53	
			Discuss generic risk assessment process for hazardous substances	Overheads 54 & 55	
		Information	Introduce MSDS and discuss the importance of obtaining quality information	Overheads 56 – 60	
			Introduce concept of risk and safety phrases	Overheads 61 & 62	
			Discuss the GHS and present the GHS pictograms	Overheads 63– 66	
			Discuss other sources of information	Overheads 67 – 70	
			Discuss the concept of "Walkthrough Surveys" and the type of information they can produce	Overheads 71 – 73	
			Discuss generation of hazardous substances	Overhead 74	
		Assessment of Risk for Hazardous Substances	Discuss factors which influence the level of risk	Overheads 75 & 76	

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Risk Assessment (Cont'd)	Risk Analysis	Discuss the types of risk analysis possible and the differences between them	Overheads 77 – 80	
			Discuss the use of non monitoring approaches such as COSHH Essentials and the ILO Toolkit	Overheads 81 – 94	
			Discuss the potential risk assessment outcomes - Significant, or - Not significant	Overhead 95	
		Actions	Introduce the process for controlling significant risks	Overheads 96 & 97	
			Discuss the hierarchy of control	Overheads 98 – 108	
			Discuss other issues such as - Training - Ongoing workplace monitoring - Health surveillance - Emergency procedures and first aid	Overheads 109 & 110	
		Records	Indicate the importance of good records.	Overheads 111 - 113	

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Risk Assessment (Cont'd)	Management	Discuss the changes in health and safety legislation from prescriptive to risk based. Highlight the role of hygienists in this process	Overhead 114	
240-300 minutes	Lunch Break				
300-390 minutes	Case Study 1	Paint Manufacture (Super IH Paints)	Provide an overview of the paint manufacture and cleaning process using video and process description Indicate to students that they need to review the video and gather information and attempt to document a risk assessment Ask students to apply the processes in the manual and make a conclusion regarding risk to employees and actions to reduce the risk.	Overheads 115 - 117	Detailed critical review of paint manufacture Case Study Learning Outcome 5

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Case Study 1 (Cont'd)		Advise students they have 60 minutes to complete this task	Overhead 118	
		Group Discussion	Review the outcomes of the individual groups' findings regarding Case Study 1		
390-420 minutes	Coffee Break				
420-510 minutes	Hygiene Standards	Introduction	Discus the background and need for hygiene standards	Overheads 119 - 122	Active involvement Learning Outcomes 6 & 7
		ACGIH – TLVs	Discuss the ACGIH TLVs and their documentation	Overheads 123 – 136	
		Units of Measure & Conversions	Discuss units commonly used and process for conversion	Overheads 137 - 139	
		Definitions & Notations	Discuss the ACGIH Definitions & Notations	Overheads 140 - 144	
		Applications	Discuss the application of the standards including extended work shifts	Overheads 145 – 151	

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Hygiene Standards (Cont'd)	Limitations	Discuss the limitations of hygiene standards	Overhead 152	
		Other Standards	Discuss and be aware of other hygiene standards	Overheads 153 – 159	
	Learning Outcomes	Review of today's Learning Outcomes	Review and discuss	Overheads 160 - 162	Agreement that learning outcomes for today have been achieved

TEACHING GUIDE – DAY 2

REVIEW OF OVERNIGHT QUESTIONS

- **STUDENT LEARNING OUTCOMES:**

1. Receive guidance in understanding the reasons for any incorrect answers to the overnight questions from Day 1.

AIR SAMPLING THEORY & PRACTICE

- **STUDENT LEARNING OUTCOMES:**

2. Understand the principles of sampling for airborne contaminants and be able to use those principles to devise a suitable sampling strategy.

CONFINED SPACES

- **STUDENT LEARNING OUTCOMES:**

3. Be familiar with the requirements for monitoring in confined spaces and understand some of the issues that need to be considered during this process.

BIOLOGICAL MONITORING

- **STUDENT LEARNING OUTCOMES:**

4. Understand the principles of biological monitoring and their appropriate application.

SAMPLE ANALYSIS

- **STUDENT LEARNING OUTCOMES:**

5. Be familiar with the various methods that are used to analyse the various contaminants found in the workplace.

QUALITY ASSURANCE

- **STUDENT LEARNING OUTCOMES:**

6. Understand the requirements to ensure the quality of laboratory analysis.

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
0-30 minutes	Learning Outcomes	Learning outcomes for today	Discuss	Overheads 3 - 5	Active involvement
	Overnight Questions	Student Guidance	Discuss answers to questions and provide guidance where required	Answer sheet	Satisfactory understanding and successful completion of questions Learning Outcome 1
30-120 minutes	Introduction	Overview	Discuss topics to be covered during the day	Overhead 6 & 7	
	Air Sampling Theory & Practice	Workplace Sampling Strategies	Indicate the topics to be covered in discussion	Overhead 8 & 9	Active involvement Learning Outcome 2
		Sampling Strategies	Discuss the primary and other possible objectives of a sampling strategy. Indicate the need for clear objectives before commencing an exercise.	Overheads 10 & 11	
			Indicate those issues that the BOHS suggests considering	Overhead 12	
			Indicate the factors that need to be considered when designing a monitoring strategy	Overheads 13 & 14	

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Air Sampling Theory & Practice (Cont'd)	Surveys	Indicate the four types of surveys that are commonly used	Overhead 15	
			Discuss the format of an initial appraisal and the information that can be obtained	Overheads 16 & 17	
			Discuss when a basic survey would be undertaken and its possible objectives	Overheads 18 & 19	
			Indicate what needs to be understood before proceeding	Overhead 20	
			Indicate those other factors which may influence the decision process	Overhead 21	
			Discuss the format of a detailed survey and the requirements for a satisfactory outcome.	Overhead 22 & 23	
			Discuss when a routine survey would be undertaken	Overhead 24	
		Routine Monitoring	Discuss the reasons for routine monitoring the issues that need to be considered and the frequency of surveys	Overheads 25 & 26	

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Air Sampling Theory & Practice (Cont'd)	Statistical Based Monitoring	Discuss the principles of statistical monitoring and how it can be applied	Overheads 27 – 32	
		Basic Statistical Analysis	Indicate how statistical analysis can assist in decision-making. Indicate the limitations and discuss the various formulae and other statistical measures	Overheads 33 - 47	
		Quality Assurance	Indicate the need to adopt QA procedures in both sampling and analysis. Discuss how a self audit of practices and procedures can be useful	Overhead 48	
		Survey Design	Introduce the topics relating to survey design that will be discussed	Overhead 49	
		Non Sampling Approaches	Discuss the basis of control banding. Use the example for chemicals by inhalation to demonstrate the different bands. Indicate systems currently in place or under development Discuss limitations	Overheads 50 - 53	

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Air Sampling Theory & Practice (Cont'd)	Sample Numbers	Indicate that the number of samples required is dependent on a number of factors	Overhead 54	
			Discuss the various approaches that have evolved over the years	Overheads 55 – 60	
			Indicate what the real world options are and the "point of diminishing returns", ie extra samples	Overheads 61 – 63	
		Sampling Patterns	Indicate the type of patterns possible and when each would be applicable	Overheads 64 – 66	
			Discuss the constant variability in an exposure profile		
		Sampling for Acute or Chronic Effects	Indicate the relationship between toxicology and sampling time. Give examples	Overhead 67 & 68	

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Air Sampling Theory & Practice (Cont'd)	Practicalities of Sampling	Highlight what can be reasonably done by one person. Indicate that it is better to have good quality data that leads to an outcome rather than numerous samples that don't	Overheads 69 & 70	
		Personal Sampling	Discuss the benefits of personal sampling and the location of the breathing zone	Overheads 71 - 74	
		Operator Variability	Discuss those factors which can influence operator variability	Overhead 75	
		Area Sampling	Discuss the uses and limitations of area sampling	Overhead 76 - 78	
		Particle Size	Discuss the role of particle size in sampling	Overhead 79	
		Breathing Air Quality	Indicate the requirements for monitoring breathing air	Overhead 80	
		Surface & Other Measurements	Indicate topics to be discussed	Overhead 81	

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Air Sampling Theory & Practice (Cont'd)	Surface Contamination Measurements	Discuss the role of surface contamination sampling. Indicate the methods available for this process	Overheads 82 & 83	
		In-situ XRF Metal Analysis	Indicate the uses of portable XRF analysers	Overheads 84	
		Bulk Sampling	Discuss the role of bulk sample analysis	Overhead 85	
		Skin Exposure	Indicate the importance of dermal exposure with some compounds	Overhead 86	
			Discuss the methods of dermal evaluation	Overhead 87	
			Discuss RISKOFDERM	Overheads 88 - 90	
120–150 minutes	Coffee Break				
150-240 minutes		Confined Spaces	Discuss the hazards associated with confined spaces and the issues of monitoring within such areas	Overheads 91 – 96	Active involvement Learning Outcome 3

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Case Study 2		Using the overheads and notes at the bottom of each overhead, lead the group in discussion as to how incorrect conclusions can be inferred if all data isn't available. Highlight the need for extreme caution when monitoring in confined spaces	Overheads 97 – 110	Active participation in discussion
240-30 minutes	Lunch Break				
300-390 minutes	Case Study 3	Designing a Sampling Strategy	Using the materials provided, the participants should break into groups and complete the required tasks		
			Provide an overview of the process	Overheads 111 - 116	
			Individual groups should present their findings		Successful completion of the tasks and an understanding of how to develop an appropriate monitoring strategy for the situation concerned
					Learning Outcome 2

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
390-420 minutes	Coffee Break				
420-510 minutes	Biological Monitoring	Introduction	Discuss the reasons for undertaking biological monitoring	Overheads 117 - 120	Active involvement. Learning Outcome 4
		Direct Biological Monitoring and Biological Effect monitoring	Discuss the differences between direct and effect monitoring	Overheads 121 - 126	
		Biological Half Life and Collection Time	Discuss how biological half life affects sample collection time	Overheads 127 - 130	
		Common Industry Exposures	Discuss some of the common industry exposure	Overhead 131 - 133	
		Sources of Biological Standards and how they are applied	Discuss the ACGIH & HSE standards and their application	Overheads 134 - 140	
		Confidentiality	Discuss the importance of confidentiality	Over head 141	
	Sample Analysis	The laboratory	Discuss the relationship with the laboratory for analytical needs. Discuss topics to be covered	Overheads 142 - 145	Active involvement. Learning Outcome 5

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Sample Analysis (Cont'd)	Spectroscopy	Discuss the spectroscopic techniques	Overheads 146 - 161	
		Chromatography	Discuss the use of chromatography	Overheads 162 - 164	
		X –Ray Diffraction & X-Ray Fluorescence	Discuss the use of X-Ray diffraction and X-Ray fluorescence	Overhead 165 & 166	
		Mass Spectrometry	Discuss the use of mass spectrometry	Overhead 167	
		Detection Limits	Discuss using example	Overhead 168	
		Methods	Discuss sources of Analytical methods	Overhead 169 & 170	
		Filters	Discuss the selection of filters for occupational hygiene sampling	Overhead 171 - 176	
		Laboratory Balances	Discuss the use and calibration of laboratory balances	Overhead 177 & 178	
		Microscopy	Discuss the use of microscopy for fibre identification and counting	Overheads 179 - 181	

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Quality Assurance	Laboratory Systems & Procedures	Discuss the requirements of quality assurance for a laboratory	Overheads 182 - 187	Learning Outcome 6
	Learning Outcomes	Review of Learning Outcomes	Discuss what topics have been covered today	Overheads 188 - 190	Agreement that learning outcomes have been achieved

TEACHING GUIDE – DAY 3

REVIEW OF OVERNIGHT QUESTIONS

- **STUDENT LEARNING OUTCOMES:**

1. Receive guidance in understanding the reasons for any incorrect answers to the overnight questions from Day 2.

DUST, FUMES & FIBRES

- **STUDENT LEARNING OUTCOMES:**

2. Understand the types of sampling pumps and capture devices used for dust, fume and fibre monitoring.

3. Understand the principles of workplace monitoring for dust, fumes and fibres including calibration of equipment and calculation of results.

4. Review direct reading instrumentation and discuss limitations.

5. Indicate common sources of error in sampling for dust and fumes.

***Note**: It would be useful to have examples of the various pieces of monitoring equipment available (where possible) so that they can be shown to students during discussions.*

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
0-30 minutes	Learning Outcomes	Learning outcomes for session	Discuss	Overheads 2 & 3	Active involvement
	Overnight Questions	Student guidance	Discuss answers to questions and provide guidance where required	Answer sheet	Satisfactory understanding and successful completion of questions Learning Outcome 1
30-120 minutes	Dust, Fumes & Fibres	Introduction	Discuss the difference between dust, fumes & fibres	Overheads 4 – 7	Active involvement
		Sampling Pumps	Discuss requirements of a sampling pump	Overheads 8 - 10	Active involvement Learning Outcome 2
			Indicate the most common operating system and discuss advantages and disadvantages of each	Overheads 11 & 12	
			Discuss issues such as maintenance, battery charge and internal flowmeters	Overhead 13	

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Dust, Fumes & Fibres (Cont'd)	Capture Devices	Deposition Curves – discuss the various size fractions and why they are important	Overheads 14 – 17	Active involvement Learning Outcome 2
		Sampling Heads	Discuss sampling heads for Inhalable dust, Respirable dust Thoracic dust, Special sampling heads	Overheads 18 – 38	Active involvement Learning Outcome 2
120-150 minutes	Coffee Break				
150-240 minutes		Sampling Trains	Indicate how the various components are linked together to make a sampling train. Discuss how to take a sample, including the location of sampler, data collection, etc	Overheads 39 – 46	Active involvement Learning Outcome 3
		Calibration of Equipment	Indicate what primary an secondary standards are and provide examples Discuss issues that need to be addressed when calibrating sampling trains	Overheads 47 – 55 Overhead 56	

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Dust, Fumes & Fibres (Cont'd)		Demonstrate the calibration process to the group		
			Discuss calibration schedules	Overheads 57 – 59	
		Calculation of Results	Discuss how to calculate dust and fume results	Overheads 60 - 66	
		Direct Reading Instruments	Discuss how direct reading instruments can be used. Indicate possible limitations	Overheads 67 – 69	Active involvement Learning Outcome 4
			Discuss emerging technology (ie PDM) which may overcome these problems	Overhead 70	
			Discuss the "Tyndall Effect" and how this can be useful	Overheads 71 & 72	
		Selection Guide	Indicate selection guide		Active involvement
		Most Common Sources of Error	Discuss common sources of error	Overheads 73 - 83	Active involvement Learning Outcome 5
240-300 minutes	Lunch Break				

TEACHING GUIDE – DAY 3

DUST PRACTICAL

STUDENT LEARNING OUTCOMES:

6. Develop the basic skills required to undertake dust sampling in the workplace, such as:

   - correct method selection
   - appropriate equipment selection and use
   - correct calibration procedures

7. Describe and demonstrate the correct procedure for calibrating sampling equipment for dust monitoring to the relevant standard using electronic and soap film flowmeters.

8. Participate in exercises to ensure students understand the correct calculation of results and interpretation of data.

TASK GROUPS:

1. Students should be allocated to one of four (4) groups. If some members of the class have a higher skill level than others then these students should not dominate in numbers within any group.

2. All students are expected to complete all the exercises within the allocated time, including the preparation of a short report on the findings of the exercise.

EQUIPMENT LIST:

- Sampling pumps (capable of operating between 1.7 – 2.5 L/min)
- Battery charger for sampling pumps
- Screwdriver to suit pump flow adjustment
- Pump instruction manual
- Miniature cyclone(s) for respirable dust

- Sample collection head(s) for inhalable dust (with appropriate calibration connection devices)
- Tubing for connection of sampling train
- Cutting knife/box cutter/side cutter for tubing
- Soap film flowmeter
- Soap film solution and suitable dish
- Electronic flowmeter and charger
- Instruction manual for electronic flowmeter
- Selection of membrane filters (eg PVC, mixed cellulose ester, polycarbonate, etc)
- Flat faced tweezers
- Covered dishes for filters (eg Petrie dishes)
- Permanent marking pen
- Static eliminator
- Portable microbalance (if available)
- Narrow beam light source (eg high powered narrow beam torch and spare battery)
- Direct reading instrument, eg Dust Trak (if available)
- Stopwatch
- Electric sander and abrasive sanding paper
- Particle board for dust source
- Disposable coveralls, glasses and respirator (if required)
- Plastic drop sheet
- Belts for use by students wearing sampling train
- Tissues
- Calculator
- Power board (with circuit breaker) for use with chargers (if required)

Notes: *a) The selection of sampling heads for respirable and inhalable dust should reflect local statutory requirements. For international classes a selection of different types of devices should be provided.*

b) If it is at all possible the practical exercises should be run in a suitable workplace. However, as such arrangements are difficult to organise, the exercises have been designed so that they can be run in a hotel or convention centre.

c) If a direct reading instrument is not available students should focus on the use of the dust lamp, ensuring that each individual observes the "Tyndall effect". Discussion with this group should highlight how such simple devices can be used to assist in the design of a suitable monitoring strategy. A copy of MDHS 82 should be provided to each student.

d) If a portable (or suitable) microbalance is not available, students should be shown the principles of filter equilibration, static elimination, etc and then asked a series of questions about filter selection (from the notes) for various contaminants.

CLASS EXERCISES:

Each group will be allocated one of the following four tasks. These are:

a) Measurement of respirable dust including calibration of the sample train with an electronic flowmeter.

b) Measurement of inhalable dust including calibration of the sample train with a soap film flowmeter.

c) Evaluation of a dust cloud using a dust lamp and a direct reading instrument (if available).

d) Selection and weighing of filters.

At the completion of the allotted time for each exercise (25 minutes) each group should move to the next task. This process is repeated until all groups have completed each task.

At the completion of all tasks each group will be given monitoring data for respirable and inhalable dust. Information on the toxicological properties of the substance being measured will also be provided. The local statutory exposure standards for the substance should also be provided. For an international audience it may be appropriate to use the ACGIH TLV® listed values for the substance concerned, as presented in the student exercise.

Students will use the above data to:

a) Calculate the appropriate worker exposures.

b) Assess the risk of adverse health effects arising from exposure to the substance.

c) Prepare a report on the monitoring exercise in an appropriate format.

A suggested timeline for the practical exercises is provided below.

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
300-315 minutes	Introduction	Outline of Exercise	Provide overview of practical	Overhead 84 - 86	Learning outcomes
		Content of Practical • Respirable dust • Inhalable dust • Dust lamp/direct reading instrumentation • Filters	Go through what is required in each exercise	Overheads 87 - 90	
315-340 minutes	Practical Exercises	Tasks	Allocate a group to each exercise and commence overview and assist with practical tips	Exercise requirements and equipment resource desk. Lecture notes, standard methods for respirable and inhalable dust, MDHS 82 (dust lamp)	Active involvement / Learning outcomes 6 & 7
340-365 minutes	Practical Exercises	Rotate tasks	Rotate groups to the next exercise	As above	As above
365-390 minutes	Practical Exercises	Rotate tasks	Rotate groups to next exercise	As above	As above
390-420 minutes	Coffee Break				

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
420-445 minutes	Practical Exercises	Rotate tasks	Rotate groups to final exercise	As above	As above
		Overview	Discuss what is required	Overheads 91 & 92	
445-490 minutes	Calculation, Interpretation & Presentation of Results	Calculate results	Each group to calculate employee exposures from raw data	Raw exposure data	Successful completion of calculation exercise / Learning outcome 8
		Interpret results	Each group to interpret exposures of workers	Provide sufficient information on substance(s) as to toxicological properties and exposure standards	Demonstrate understanding of toxicological data in exposure assessment / Learning outcome 8
		Preparation of report	Each group to prepare a suitable report based on the calculated exposures and interpretation of data		Active involvement
490-510 minutes	Group Discussion	Review the key points of the practical	Focus on what were the key learnings of the exercise		Active listening
		Review the learning outcomes for today	Review and discuss	Overhead 93	
510 minutes	Close				

KEY POINTS FROM PART B:

1. Reference to the MSDS indicates wood dust to give rise to respiratory irritation and congestion. Skin and eye irritation an issue. Potential for lung fibrosis.

   IARC classify wood dust as carcinogenic to humans and EU as possibly carcinogenic.

   If we are going to fully understand the carcinogenic potential we need more information as to how these differing classifications were derived.

2. Exposure standard is 1 mg/m^3 as inhalable dust. Respirable dust measurements are not useful as we don't have an appropriate exposure standard. No monitoring has been conducted for formaldehyde but this is most likely due to the fact it would be present as a reacted produce rather than "free formaldehyde". Some monitoring may still have been justified.

3. Dust-laden atmospheres above 60 mg/m^3 have the potential to explode. Peak readings were as high as 420 mg/m^3 so a major risk of explosion exists.

4. **Inhalable Dust Results**

   Sample for O Book is void as final flowrate varies from initial flowrate by greater than ±5%.

NAME	mg/m^3
A Black	10
S Mann	55
R Small	22
M Water	2.6
S Wiskey	1.5
O Book	void
F White	24
F White	78

   The two results for F White can be combined using the appropriate formula to provide a time weighted average result of 46 mg/m^3.

All personal exposures exceed the exposure standard of 1 mg/m^3. Remedial action to reduce exposures is required.

It is obvious that orbital sanding generates the majority of the dust. Controlling dust levels from this source would not only reduce the risk of an explosion but would also reduce the health risk. Control of dust from the lathe would be the next priority followed by belt sanding and other operations.

5. It is clear that the extraction system is overloaded and poorly designed. Directing the exhaust outside the building in an appropriate manner would reduce background exposures and general build-up on surfaces.

The introduction of regular cleaning of dust from around machines and the general area would assist.

TEACHING GUIDE – DAY 4

REVISION OF OVERNIGHT QUESTIONS

- **STUDENT LEARNING OUTCOMES:**

1. Receive guidance in understanding the reasons for any incorrect answers to the overnight questions from Day 3.

GAS & VAPOURS

- **STUDENT LEARNING OUTCOMES:**

2. Understand the types of sampling techniques used for gas and vapour sampling

3. Understand the principles of workplace monitoring for gases and vapours including calibration of equipment and calculation of results.

4. Review direct reading instrumentation and discuss limitations.

***Note**: It would be useful to have examples of the various pieces of monitoring equipment available (where possible) so that they can be shown to students during discussions.*

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
0-30 minutes	Learning Outcomes	Learning Outcomes for Session	Discuss	Overheads 1 & 2	Active involvement
	Overnight Questions	Student Guidance	Discuss answers to questions and provide guidance where required	Answer Sheet	Satisfactory understanding and successful completion of the questions Learning Outcome 1
30-120 minutes	Gases and Vapours	Introduction	Discuss the difference between a gas and a vapour and the different sampling formats	G & V Overheads 3 - 9	Active involvement Learning outcome 2
		Whole of Air or Grab Sampling	Discuss requirements for whole of air sampling	Overheads 10 - 14	
		Active Sampling	Discuss general active sampling and sampling train for gases and vapours	Overheads 15 - 20	
		Absorption	Discuss liquid absorption technique	Overheads 21 - 24	
		Adsorption	Discuss solid adsorption technique	Overheads 25 - 31	
		Thermal Desorption	Discuss thermal desorption technique	Overheads 32 - 34	

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Gases and Vapours (Cont'd)	Collection Efficiencies	Indicate how collection efficiencies of adsorption tubes can be affected	Overhead 35 & 36	
		Mixed Phase Sampling	Discuss how mixed phase sampling may be carried out	Overhead 37	
		Treated Filters	Discuss use of chemical impregnated filters for sampling	Overhead 38	
120-150 minutes	Coffee break				
150- 240 minutes	Gases and Vapours (Cont'd)	Diffusion or Passive Sampling	Discuss principles and how to carry out diffusion sampling	Overheads 39 - 46	
		Calculation of Results	Discuss how to calculate gas and vapour results	Overheads 47 & 48	
		Direct Reading Instruments	Discuss uses and advantages of direct reading instruments	Overheads 49 - 53	Active involvement Learning Outcome 3
			Discuss the limitations of direct reading instruments	Overheads 54 - 57	Active involvement Learning Outcome 4

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Gases and Vapours (Cont'd)		Discuss the types of direct reading instruments	Overheads 58 - 65	
			Discuss the requirements for maintenance and calibration	Overheads 66 - 69	Active involvement Learning Outcome 3
		Intrinsic Safety	Discuss requirements for the use of Intrinsically Safe gas detecting equipment	Overheads 70 - 75	Active involvement Learning Outcome 4
		Detector Tubes – Colorimetric Tubes	Discuss the use of direct reading colorimetric tubes	Overheads 76 - 79	Active involvement Learning Outcome 4
240-300 minutes	Lunch Break				

TEACHING GUIDE – DAY 4

GAS and VAPOUR PRACTICAL

STUDENT LEARNING OUTCOMES:

5. Develop the basic skills required to undertake gas and vapour sampling in the workplace using sorbent tubes, impingers, diffusion badges or direct reading colorimetric tubes, such as:

    - correct method selection
    - appropriate equipment selection and use
    - correct calibration procedures

6. Describe and demonstrate the correct procedure for calibrating sampling equipment for gas and vapour monitoring to the relevant standard using electronic and soap film flowmeters.

7. Participate in exercises to ensure students understand the correct calculation of results and interpretation of data.

TASK GROUPS:

1. Students should be allocated to one of four (4) groups. If some members of the class have a higher skill level than others then these students should not dominate in numbers within any group.

2. All students are expected to complete all the exercises within the allocated time, including the preparation of a short report on the findings of the exercise.

EQUIPMENT LIST:

- Low volume sampling pumps
- Charger for sampling pumps
- Pump instruction manual

- Selection of different types of sorbent tubes eg charcoal, tenax, silica gel etc
- Sealing caps
- Sorbent tube holders
- Tubing for connection of sampling train
- Tubing for connection to calibration devices
- Screwdriver
- Cutting knife/box cutter/side cutter to cut tubing
- Soap film flowmeter
- Soap film solution and suitable dish
- Electronic flowmeter and charger
- Instruction manual for electronic flowmeter
- Selection of diffusion badges
- Stopwatch
- Selection of direct reading colorimetric tubes
- Colorimetric tube sampling pump
- Source of organic vapours eg Perfume, nail polish remover
- Belts for use by students wearing sampling train
- Masking tape
- Calculator
- Direct Reading Instrument (gas or vapour)
- Instruction manual for instrument
- Gas or vapour to demonstrate instrument

Note: *If it is at all possible the practical exercises should be run in a suitable workplace. However, as such arrangements are difficult to organise, the exercises have been designed so that they can be run in a hotel or convention centre.*

CLASS EXERCISES:

Each group will be allocated one of the following four tasks. These are:

a) Sampling of gases and vapours by solid adsorption techniques (sorbent tube) vapours including calibration of the sampling train with an electronic flowmeter.

b) Familiarisation with a direct reading instrument for either gases or vapours.

c) Sampling of gases and vapours with colorimetric tubes and a direct reading instrument (if available).

d) Sampling of organic vapours with a diffusion badge

At the completion of the allotted time for each exercise (25 minutes) each group should move to the next task. This process is repeated until all groups have completed each task.

At the completion of all tasks each group will be given monitoring data for an organic vapour. Information on the toxicological properties of the substance being measured will also be provided. The local statutory exposure standards for the substance should also be provided. For an international audience it may be appropriate to use the ACGIH TLV® listed values for the substance concerned, as presented in the student exercise.

Students will use the above data to:

a) Calculate the appropriate worker exposures.

b) Assess the risk of adverse health effects arising from exposure to the substance.

c) Prepare a report on the monitoring exercise in an appropriate format.

A suggested timeline for the practical exercises is provided below.

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
300-315 minutes	Introduction	Outline of Exercise	Provide overview of practical	Overheads 80 & 81	Learning outcomes
		Content of Practical • Sorbent tube sampling • Direct reading instrumentation • Diffusion badge sampling • Measurements with Colorimetric tubes	Go through what is required in each exercise	Overheads 82 - 85	
315-340 minutes	Practical Exercises	Tasks	Allocate a group to each exercise and commence overview and assist with practical tips	Exercise requirements and equipment resource desk. Lecture notes, standard methods for sampling by solid adsorption, liquid absorption, direct reading colorimetric tubes and diffusion sampling.	Active involvement / Learning outcomes 5 & 6
340-365 minutes	Practical Exercises	Rotate tasks	Rotate groups to the next exercise	As above	As above
365-390 minutes	Practical Exercises	Rotate tasks	Rotate groups to next exercise	As above	As above

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
390-420 minutes	Coffee Break				
420-445 minutes	Practical Exercises	Rotate tasks	Rotate groups to final exercise	As above	As above
		Overview	Discuss what is required	Overhead 86	
445-490 minutes	Calculation, Interpretation & Presentation of Results	Calculate results	Each group to calculate employee exposures from raw data	Raw exposure data	Successful completion of calculation exercise / Learning outcome 7
		Interpret results	Each group to interpret exposures of workers	Provide sufficient information on substance(s) as to toxicological properties and exposure standards	Demonstrate understanding of toxicological data in exposure assessment / Learning outcome 7
		Preparation of report	Each group to prepare a suitable report based on the calculated exposures and interpretation of data		Active involvement
490-510 minutes	Group Discussion	Review the exercises	Focus on what were the key learnings of the exercise		Active listening and discussion
		Review today's learning outcomes	Review and discuss	Overhead 87	
510 minutes	Close				

- ***Charcoal Tube***

Name	Task	S Time	Initial Final (mL/min)	mins	L	µg Styrene	mg/m³ Styrene	ppm Styrene
B Bartlett	Lay up	0730–1530 = 480	147 / 143 = 145	480	69.6	3480	50	12
J Smith	C gun	0735–1525 = 470	97 / 101 = 99	470	46.53	12,100	260	61
J Smith	C gun	0830–0900 = 30	125 / 129 = 127	30	3.81	1,580	415	98
R Clift	C gun asst	0740–1500 = 440	139 / 135 = 137	440	60.28	905	15	4
I Kerr	Sanding	0730–1520 = 470	(100 / 120 = 110)	470	Void*	530	Void*	Void*
A Blakey	G'coating	0800-1500 = 420	90 / 90 = 90	420	37.8	7,560	200	47

- ***Organic Vapour Monitor Diffusion Badge***

Name	Task	Sample Time (24hr Clock)	µg Styrene	mg/m³ Styrene	ppm Styrene	Time mins
M Watt	Hand lay up	0745 – 1515	695	55	13	450
J Wilson	Chopper gun	0800 – 1500	3530	300	70	420
M Howie	Gelcoating	0750 – 1520	2330	185	43	450
Area	Chopper area	0730 – 1530	200	15	4	480
Area	Finishing area	0740 – 1540	110	8	2	480

Where

Calculation Constants A = 34.6 mg/m³ B = 8.12 ppm
Recovery Coefficient (r) 0.97
Temperature 25°C

$mg/m^3 = \mu g \times A / r \times mins$
$ppm = \mu g \times B / r \times mins$

* Sample void due to final flowrate differing from initial flowrate by greater than 10%

TEACHING GUIDE – DAY 5

PRESENTATION OF RESULTS

- **STUDENT LEARNING OUTCOMES:**

1. Understand how to organise data into a useful format.

2. Understand how to communicate the outcome of an exposure assessment to the various stakeholders.

PRACTICAL ASSIGNMENT

- **STUDENT LEARNING OUTCOMES:**

3. Be familiar with the format and content requirements in a report by completion of formal report on the dust practical.

CASE STUDIES 4 & 5

- **STUDENT LEARNING OUTCOMES:**

4. Develop the skills of data interpretation.

5. Develop familiarity with the processes involved in numerical evaluations.

6. Apply the lessons of the previous four days' lectures to a real scenario.

Notes: *Case Studies 4 & 5 are true situations with Case Study 4 having been performed by an inexperienced hygienist and Case Study 5 by a person of many years experience in the petroleum industry.*

Case Study 4 is designed as a lead into Case Study 5 and thus should be completed relatively quickly so students can focus on the more detailed Case Study 5.

A total of 80 minutes is allocated for the two case studies plus 10 minutes to discuss the answers to the questions.

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
0-30 minutes	Learning Outcomes	Today's learning outcomes	Review	Overhead 2 & 3	Active involvement
	Overnight Questions	Review answers to overnight questions	Review		Active involvement
30–120 minutes	Presentation of Results	Importance of reporting data in an appropriate format	Indicate reasons why it is important to report data appropriately	Overheads 4 & 5	Active involvement Learning Outcomes 1 & 2
		Identification of stakeholders	List possible stakeholders	Overhead 6	
		Types of report • Laboratory • Typical • Visual	Discuss uses of each report type. Discuss how each stakeholder requires different information.	Overheads 7 - 12	
		Using data to drive improvement	Discuss how data can be used to bring about improvement	Overheads 13 & 14	
	Practical Assignment	Practical report	Provide overview of task	Overheads 15 & 16	Learning Outcome 3
120-150 minutes	Coffee Break				
150-230 minutes	Case Studies 4 & 5	Outline of case studies	Provide overview of scenarios and go through what is required	Overheads 17 - 22	Active involvement

Time	Topic	Contents	Learning Processes	Learning Resources	Assessment & Learning Outcomes
	Case Studies 4 & 5 (Cont'd)		Case studies	Guidance where required	Successful completion of numerical calculations and interpretation of data Learning Outcomes 4, 5 & 6
230-240 minutes	Case Studies 4 & 5	Group discussion	Go through the answers to the questions and address any student concerns	Copies of answers to questions for students	Active involvement
	Learning Outcomes	Today's learning outcomes	Review and discuss	Overhead 22 & 23	Agreement that outcomes have been achieved
240-300 minutes	Lunch Break				