

**The British Occupational Hygiene Society**  
Faculty of Occupational Hygiene

**MODULE SYLLABUS**

**M201 - THERMAL ENVIRONMENT AND  
NON-IONISING RADIATION (Including LIGHTING)**

**AIM:** To provide an introduction to the hazards and related risks to health or well-being associated with the thermal environment and NIR (including lighting).

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

- describe the hazard and risk presented by the thermal environment and NIR (including Lighting);
- be able to make simple measurements to support an assessment of the above physical agents;
- indicate the need for and identify control approaches for the above physical agents.

**CONTENT:**

	<b>TOPIC</b>	<b>TIME ALLOCATION</b>
1.	<b>THE THERMAL ENVIRONMENT</b>	<b>45%</b>
2.	<b>NON-IONISING RADIATION INCLUDING LIGHTING</b>	<b>50%</b>
3.	<b>RELEVANT LEGISLATION</b>	<b>5%</b>

**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.

## 1. THE THERMAL ENVIRONMENT (45%)

### 1.1 Thermoregulation

Acceptable range of 'core' temperature.  
 Skin temperatures.  
 Simple approach to homeostasis and thermal regulation including feedback and control mechanisms.  
 Heat production and heat exchanges with the surroundings.  
 The heat balance equation- definitions of terms.  
 Metabolic heat production and efficiency.  
 Convective, radiative and conductive heat exchanges.  
 Evaporative heat loss.  
 Acclimatisation.

### 1.2 Effects of Temperature Extremes

Effects of excessive heat exposure - syncope, salt balance, dehydration, cramps, hyperpyrexia, prickly heat, heat stroke.  
 Effects of extreme cold - frostbite, trenchfoot, hypothermia.

### 1.3 Thermal Comfort

The Bedford and ASHRAE scales for subjective evaluation of comfort.  
 Actual ideal indoor environments including temperature, humidity and air movement.  
 An introduction to the work of Fanger.  
 Predicted Percentage Dissatisfied (PPD) and Predicted Mean Vote (PMV). BS EN ISO 7730:2005.

### 1.4 Prediction of Thermal Stress

Heat stress indices- definition of terms and environments where these are applied - Effective and Corrected Effective Temperature, WBGT, Heat Stress Index, Predicted 4- Hour Sweat Rate.  
 Effect of heat stress on the heart rate. Overall stress.  
 WBGT and its application in BS EN 27243:1994 (2) and the Threshold Limit Values of ACGIH (3).

### 1.5 Control of Thermal Stress

Personal factors mitigating against 'hot' work eg. obesity, medication, age, state of acclimatisation.  
 A simple introduction to control by engineering and organisational measures.  
 Personal protective clothing. Refuges.

### 1.6 Thermal Surveys

Equipment for measuring air temperature, radiant temperature, humidity, air movement.  
 Simple use of smoke in assessing air movement.  
 Carrying out the survey. Using the results to assess the degree of risk.

### 1.7 Cold Stress

Wind Chill Index. Equivalent Chilling Temperature. ACGIH TLV Standards. (3)  
 Clothing insulation and clo values.

Need for appropriate protection, eg. for cold wet conditions, the need for an impervious outer layer.

Control measures other than clothing, eg. work/rest regimes.

Special suits for particular conditions. Refuges.

Throughout this part of the course the student should be made aware of practical situations where these risks occur, eg. operating furnaces, removing asbestos insulation from live steam pipes, fish gutting, cold stores.

## **PRACTICAL**

The student should have an opportunity to use simple equipment such as Kata thermometers, Globe thermometers and whirling hygrometers.

## **RECOMMENDED DOCUMENTATION**

BOHS Technical Guide No 12 'The Thermal Environment' (Second Edition)

## **Educational Objectives**

On completion of this part of the course the student should have a basic understanding of thermoregulation, understand the effect of ambient temperatures on workers (and others), and be able to carry out simple measurements and recognise potentially hazardous situations.

## **2. NON-IONISING RADIATION including LIGHTING (50%)**

### **2.1 Electromagnetic Spectrum**

E.M. Spectrum.

Ionising and non-ionising radiation.

### **2.2 Ultra Violet (UV) Radiation**

Spectrum from 10nm to 400nm.

Effects of exposure to UV radiation - erythema, skin cancer (including melanoma), photokeratitis, conjunctivitis.

Standards: ACGIH TLV Curve for the prevention of erythema and photokeratitis.

Sources of exposure: sunlight, uv lamps, welding arcs.

Risk for outdoor occupations, eg. farmers, road-menders etc. Internal factory risks, eg. UV polymer curing systems, printing ink curing, welding etc. Associated risks from ozone and oxides of nitrogen.

Control of exposure: avoidance, skin covering, UV absorbing eye protection.

### **2.3 Visible Region and Lighting**

Spectrum from 400nm to 780nm. Colours and relative sensitivity of the eye.

Photochemical damage to the eye in the blue region.

Wavelength and colour, polarised and un-polarised light, reflection and refraction.

The inverse square law.

Units and Definitions: SI unit of luminous intensity (candela), luminous flux (lumen), illuminance (lux).

Disability glare, discomfort glare, glare index, illuminance ratios, reflectance, colour rendering, daylight and daylight factor.

Light levels for particular tasks including display screen use. Accommodation. Adaptation. Visual acuity. Colour and sensitivity.

Visual fatigue. Stroboscopic effects. Effects of age and malfunction.

Measurements of illuminance, assessment of glare, suitability for tasks, avoidance of fatigue.

#### **2.4 Infra-Red (I.R.) Radiation**

Spectrum from 780nm to 1000nm.

Possible sources of risk - hot objects, Infra-red lamps, Infra-red lasers.

Infra-red absorption characteristics of the eye and cataract formation.

Protective measures eg. use of green IR absorbing glass to view hot objects, or with new technology the use of TV cameras.

#### **2.5 Radio Frequency Spectrum**

Division of the spectrum into microwave (1mm to 1m), Very High Frequency (VHF - 1m to 10m), High Frequency (HF - 10m to 100m), Medium Frequency (MF - 100m to 1km), and Low Frequency/Extremely Low Frequency (LF/ELF).

Frequency and wavelength.

Differences between 'near-field' and 'far-field' conditions.

Hazards, measurement and standards of EF and EMF fields.

Thermal effects of absorption of radio frequency energy and a mention of possible field effects.

Standards for Protection: ACGIH TLV(3) and WHO Criteria. NRPB Investigation levels, volume 15

Occurrence of risk: microwave ovens/plastic welders, radar systems, radio transmitters (high power broadcast and base stations, hand held personal), induction furnaces. High frequency/microwave medical treatment systems.

High frequency drying ovens eg. wood glue curing.

Measurements: Testing microwave ovens for leakage BSEN60335-2-90 (5)

Protection by shielding and exclusion zones etc.

### **RECOMMENDED DOCUMENTATION**

WHO Environmental Health Criteria Series No's 14 (UV), 16 (Radio frequency and microwaves), 23 (Lasers and Optical radiation), 35 (ELF fields). HSE HSG38 (1998) "Lighting at Work". CIBSE Code for Lighting 2004. HHSC Handbook No.7 (1991), "Lighting for Occupational Hygienists". ACGIH Threshold limit Values (UV and IR) (3)

### **Educational Objectives**

After completing this section the student should be able to:

- a. Recognise risks associated with exposure to electromagnetic energy from the UV-C region to the ELF region of the spectrum.
- b. Obtain information on standards and indicate possible exposure control methods.
- c. Identify significant lighting problems, eg. glare.
- d. Carry out simple tests on microwave ovens.

### **3. RELEVANT LEGISLATION (5%)**

General requirements of the Health and Safety at Work Act 1974

Workplace Health, Safety and Welfare Regs.1992

Management of Health and Safety at Work Regs. 1999.

The Health and Safety (Miscellaneous Amendments) Regulations 2002

### **Educational Objectives**

The student should acquire a knowledge of the main UK Legislation addressing physical agents.

## References

- (1) BS EN ISO 7730:2005 Ergonomics of the thermal environment. Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD Indices and local thermal comfort criteria.
- (2) BSEN 27243:1994 Hot Environments. Estimation of the Heat Stress on Working Men Based on the WBGT-Index.
- (3) ACGIH Threshold Limit Values for Chemical Substances and Physical Agents and Biological Indices.
- (4) NRPB Investigation Levels. Documents of the NRPB Including Board Statement on Restriction on Human Exposure to Static and Time Varying Electric and Magnetic Fields and Radiation. Vol 15 (No 2 advice on Limited Exposure to Electromagnetic Fields (0-300GHz) and No 3 Review of the Scientific Evidence for Limiting Exposure to Electromagnetic Fields (0-300GHz).
- (5) BSEN 60335-2-90:1998. Specification for Safety of Household and Similar Electrical Appliances, Particular Requirements, Commercial Microwave Ovens.