

## M502 Module Syllabus

### Thermal Environment

#### Teaching Aims

This course aims to provide candidates with a sound understanding of the effects of the thermal environment on people, and the means of assessing and controlling the risks associated with thermal stress.

#### Prior Knowledge and Understanding

There are no prerequisites required for this qualification, however, 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 have a basic understanding of the following:

- Identify sources of thermal stress within the working environment
- Understand the nature of thermal strain on the body
- Make an assessment of the thermal environment through appropriate measurement and other means
- Evaluate the possible risks from exposure to thermal stress
- Suggest appropriate control approaches for the thermal environment

#### Content

The syllabus is structured into ten sections:

		<b>Time Allocation</b>
<b>1</b>	<b>The Thermal Spectrum</b>	<b>5%</b>
<b>2</b>	<b>Principles</b>	<b>10%</b>
<b>3</b>	<b>Effects of Temperature Extremes</b>	<b>10%</b>
<b>4</b>	<b>Thermal Comfort</b>	<b>5%</b>
<b>5</b>	<b>Evaluation of Hot Environments</b>	<b>15%</b>

<b>6</b>	<b>Control of Hot Environments</b>	<b>15%</b>
<b>7</b>	<b>Thermal Surveys</b>	<b>10%</b>
<b>8</b>	<b>Evaluation of Cold Environments</b>	<b>10%</b>
<b>9</b>	<b>Control of Cold Environments</b>	<b>15%</b>
<b>10</b>	<b>Approaches to Risk Assessment</b>	<b>5%</b>

**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 for candidates only.

**1 The Thermal Spectrum (5%)**

This section will provide candidates with suitable knowledge and training to ensure that the candidate can demonstrate their understanding in the following:

- 1.0.1 Extreme Temperatures: Examples of work environments where extreme temperatures can be found.
- 1.0.2 Moderate Temperatures: How work in moderate thermal environments can present a risk.

**2 Principles (10%)**

This section will provide candidates with suitable knowledge and training to ensure that the candidate can demonstrate their understanding in the following:

- 2.0.1 Definition of heat stress
- 2.0.2 Definition of heat strain
- 2.0.3 Homeostasis:
  - Understand the principles of homeostasis
  - Be aware of typical core, muscle, and skin temperatures and how they vary with environmental and other conditions
- 2.0.4 Thermal Regulation including Feedback and Control Mechanisms:
  - Thermoregulation through a feedback system
  - The role of the hypothalamus
  - Thermoreceptors
  - Control actions such as shivering, vasomotor etc.
- 2.0.5 Physiological Responses to Hot Environment:
  - Vasodilation

- Sweating
- Electrolyte changes
- Dehydration
- Heart rate
- Respiration rate
- Other effects

2.0.6 Physiological Responses to Cold Environments:

- Vasoconstriction
- Shivering
- Piloerection
- Cold diuresis
- Respiration
- Heart rate
- Dehydration
- Psychological
- Other responses

2.0.7 Heat Production and Heat Exchanges with the Surroundings:

- External heat sources
- Internal heat sources
- Basic thermodynamics

2.0.8 The Heat Balance Equation - Definitions of Terms:

- The heat balance equation
- Definition of terms

2.0.9 Metabolic Heat Production and Efficiency:

- Metabolic heat production
- Typical values of metabolic heat production for different tasks
- Work

2.0.10 Sensible Heat Exchanges:

- Convection
- Radiation
- Conduction

2.0.11 Latent Heat Loss:

- Evaporative heat loss

2.0.12 Acclimatisation:

- Physiological mechanisms

### **3 Effects of Temperature Extremes (10%)**

This section will provide candidates with suitable knowledge and training to ensure that the candidate can demonstrate their understanding in the following:

#### **3.0.1 Effects of Excessive Heat Strain – Hot Environments:**

- Syncope
- Salt balance
- Dehydration
- Cramps
- Hyperpyrexia
- Prickly heat
- Heat stroke

#### **3.0.2 Effects of Excessive Heat Strain – Cold Environments:**

- Frostbite
- Trench foot
- Hypothermia

#### **3.0.3 Predisposing Factors:**

- Age
- General health
- Weight and physical fitness
- Hydration state
- Acclimatisation
- Alcohol
- Drugs
- Diet
- Fatigue

### **4 Thermal Comfort (5%)**

This section will provide candidates with suitable knowledge and training to ensure that the candidate can demonstrate their understanding in the following:

#### **4.0.1 Thermal Comfort:**

- What is thermal comfort?
- Why thermal comfort can be important

#### **4.0.2 Scales for Subjective Evaluation of Comfort:**

- Bedford
- ASHRAE

#### **4.0.3 Actual Ideal Indoor Environments:**

- Temperature, humidity, and air movement

#### **4.0.4 An Introduction to the Work of Fanger:**

- Predicted Percentage Dissatisfied (PPD)
- Predicted Mean Vote (PMV)
- ISO 7730

## **5 Evaluation of Hot Environments (15%)**

This section will provide candidates with suitable knowledge and training to ensure that the candidate can demonstrate their understanding in the following:

### 5.0.1 The Use of Heat Stress Indices:

- Definition of terms and environments where indices can be applied
- Effective and Corrected Effective Temperature, WBGT, Heat Stress Index, Required Sweat Rate

### 5.0.2 Effect of Heat Stress:

- Physiological measurements as predictors of heat strain

### 5.0.3 Effective and Corrective Effective Temperatures:

- Application of Basic Effective Temperature (BET) and Corrective Effective Temperature (CET)

### 5.0.4 Heat Stress Index:

- Application of the Heat Stress Index

### 5.0.5 Required Sweat Rate (PHS):

- Application of the Required Sweat Rate

### 5.0.6 WBGT:

- Application
- ISO 7243
- Threshold Limit Values of ACGIH

## **6 Control of Hot Environments (15%)**

This section will provide candidates with suitable knowledge and training to ensure that the candidate can demonstrate their understanding in the following:

### 6.0.1 Personal Factors Mitigating Against 'Hot' Work:

- Obesity
- Medication
- Age
- State of acclimatisation

### 6.0.2 A Simple Introduction to Control by Engineering and Organisational Measures:

- Control strategies
- Engineering controls
- Management controls
- Personal protective clothing
- Refuges

6.0.3 Hot Surfaces:

- Exposure to hot surfaces

**7 Thermal Surveys (10%)**

This section will provide candidates with suitable knowledge and training to ensure that the candidate can demonstrate their understanding in the following:

7.0.1 Measurement Equipment:

- Air temperature
- Radiant temperature
- Humidity
- Air movement
- Integrating meters
- Personal monitoring

7.0.2 Surveys:

- Strategies

7.0.3 Assessment of the Degree of Risk:

- Use of measurement data

**8 Evaluation of Cold Environments (10%)**

This section will provide candidates with suitable knowledge and training to ensure that the candidate can demonstrate their understanding by way of examination in the following:

8.0.1 Assessment Indices:

- Wind chill index
- Equivalent chilling temperature
- IREQ
- ACGIH TLV Standards

**9 Control of Cold Environments (15%)**

This section will provide candidates with suitable knowledge and training to ensure that the candidate can demonstrate their understanding in the following:

- 9.0.1 Personal Factors:
- Heart and lung conditions
  - Circulatory problems
- 9.0.2 Engineering Controls:
- Wind barriers
  - Refuges
- 9.0.3 Management Controls:
- Monitoring
  - Work – rest regimes/warming regimes
- 9.0.4 Clothing:
- Clothing insulation and CLO values
  - Wind proofing
  - Water proofing
  - Gloves
  - Heated clothing

## **10 Approaches to Risk Assessment (5%)**

This section will provide candidates with suitable knowledge and training to ensure that the candidate can demonstrate their understanding in the following:

- 10.0.1 AIOH Tiered Approach:
- Overview and application
  - Advantages and disadvantages
- 10.0.2 SA DoMR Code of Practice for an Occupational Health Programme on Thermal Stress:
- Overview and application
  - Advantages and disadvantages
- 10.0.3 ACGIH Thermal Stress TLVs:
- Overview and application
  - Advantages and disadvantages
- 10.0.4 Quantitative vs Qualitative Approaches
- Quantitative vs Qualitative approaches
- 10.0.5 Physiological Assessments:
- Physiological Assessments

## **Suggested References and Further Reading**

- (1) Human Thermal Environments: The Effects of Hot, Moderate, and Cold Environments on Human Health, Comfort, and Performance
- (2) A guide to managing heat stress: Developed for use in the Australian environment
- (3) Guideline for Compilation of a Mandatory Code of Practice for an Occupational Health Programme (Occupational Hygiene and Medical Surveillance) on Thermal Stress
- (4) ISO 7243: 1989 Hot environments – Estimation of heat stress on a worker, based on the WBGT – Index (Wet Bulb Globe Temperature)
- (5) BS 7915:1998 Ergonomics of the thermal environment – Guide to design and evaluation of working practices in cold indoor environments
- (6) ISO 11079:2007 Ergonomics of the thermal environment - Determination and interpretation of cold stress when using required clothing insulation (IREQ) and local cooling effects (IREQ)
- (7) 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
- (8) ISO 10551:1995 Ergonomics of the thermal environment – assessment of the influence of the thermal environment using subjective judgment scales
- (9) ISO 12894:2001 Ergonomics of the thermal environment – Medical supervision of individuals exposed to extreme hot or cold environments
- (10) ISO 7933:2004 ISO 7933:2004 Ergonomics of the thermal environment – Analytical determination and interpretation of heat stress using calculation of the predicted heat strain
- (11) BS 7963:2000 Ergonomics of the thermal environment – Guide to the assessment of heat strain in workers wearing personal protective equipment
- (12) ISO 7726: 1998 Ergonomics of the thermal environment – Instruments for measuring physical quantities
- (13) BS EN 14058 Protective clothing garments for protection against cool environments
- (14) ISO 15265:2004 Ergonomics of the thermal environment – Risk assessment strategy for the prevention of stress and discomfort in thermal working conditions
- (15) BS EN 511: 2006 Protective Gloves Against Cold
- (16) ISO 13732-3:2006 Ergonomics of the thermal environment – Methods for the assessment of human responses to contact with surfaces - Part 3: Cold Surfaces
- (17) ISO 11399:1995 Ergonomics of the thermal environment – Principles and application of relevant international standards
- (18) ISO 9920:2007 Ergonomics of the thermal environment – Estimation of the thermal insulation and water vapor resistance of a clothing ensemble
- (19) ISO 13732:1:2006 Ergonomics of the Thermal Environment: Methods for assessment of human response to contact with surfaces: Part 1: Hot Surfaces

## **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 the relevant parts of the course for all candidates. This is to ensure that each candidate can demonstrate their individual ability and correct method.

The studies are designed to assess the basic skill and knowledge of each candidate in the techniques in making measurements of conditions for the purpose of assessing the thermal environment.

The exercises will involve:

- The setting up and reading of a static wet and dry bulb thermometer and calculation of humidity etc.
- The set up and use of a whirling hygrometer and a globe thermometer to evaluate a WBGT value.

Full details of the practical requirements and individual candidate reporting can be found in the Practical Evaluation Report which is available from [www.bohs.org](http://www.bohs.org)

## **B Written Examination**

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

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: '**M502 - Thermal Environment**'