Course Specification

Course Title	**Thermal Environment**
Code	**W502**
Level	**Intermediate**
Pre-requisites	**None**
Course Material	**Course manual available from OHTA Training.org**
Coordinating Editor	**Brian Davies & Ross Di Corleto**
Approval Date	**June 2017**
Review Date	**March 2019**

Aims

This course aims to:
Provide the student 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.

Learning outcomes

On completing this course successfully the student will be able to:

- 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 likely risk from exposure to thermal stress.
- Suggest appropriate control approaches for the thermal environment.

Course format

Normally run as a 5 day taught course [minimum 45 hours including practical/demonstration sessions, lectures, tutorials, guided reading, overnight questions and examination].

There will be a 40 short answer question 'open book' examination with an allowed time of 120 minutes.

Content

Topic	Title	Time allocation
1	The Thermal Spectrum	5%
2	Principles	10%
3	Effects of Temperature Extremes	10%
4	Thermal Comfort	5%
5	Evaluation of Hot Environments	15%
6	Control of Hot Environments	15%
7	Thermal Surveys	10%
8	Evaluation of Cold Environments	10%
9	Control of Cold Environments	15%
10	Approaches to Risk Assessment	5%

Note: Reference is made to standards and good practice documentation. This may not be the most up-to-date relevant publications and is intended as guidance for candidates only.

Detailed Course Content

1 The Thermal Spectrum (5%)

1.1 Extreme Temperatures

1.1.1 Examples of work environments where extreme temperatures can be found.

1.2 Moderate Temperatures

1.2.1 How work in moderate thermal environments can present a risk.

2 Principles (10%)

2.1 Heat Stress

2.1.1 Define heat stress

2.2 Heat strain

2.2.1 Define heat strain

2.3 Homeostasis

2.3.1 Understand the principles of homeostasis

2.3.2 Be aware of typical core, muscle and skin temperatures and how they vary with environmental and other conditions

2.4 Thermal Regulation including Feedback and Control Mechanisms

2.4.1 Thermoregulation through a feedback system

2.4.2 The role of the hypothalamus

2.4.3 Thermoreceptors

2.4.4 Control actions such as shivering, vasomotor etc.

2.5 Physiological Responses to Hot Environment

2.5.1 Vasodilation

2.5.2 Sweating

2.5.3 Electrolyte changes

2.5.4 Dehydration

2.5.5 Heart rate

2.5.6 Respiration rate

2.5.7 Other effects

2.6 Physiological Responses to Cold Environments

2.6.1 Vasoconstriction

2.6.2 Shivering

2.6.3 Piloerection

2.6.4 Cold diuresis

2.6.5 Respiration

2.6.6 Heart rate

2.6.7 Dehydration

2.6.8 Psychological

2.6.9 Other

2.7 Heat Production and Heat Exchanges with the Surroundings

2.7.1 External heat sources
2.7.2 Internal heat sources
2.7.3 Basic thermodynamics

2.8 The Heat Balance Equation - Definitions of Terms

2.8.1 The heat balance equation
2.8.2 Definition of terms

2.9 Metabolic Heat Production and Efficiency

2.9.1 Metabolic heat production
2.9.2 Typical values of metabolic heat production for different tasks
2.9.3 Work

2.10 Sensible Heat Exchanges

2.10.1 Convection
2.10.2 Radiation
2.10.3 Conduction

2.11 Latent Heat Loss

2.11.1 Evaporative heat loss

2.12 Acclimatisation

2.12.1 Physiological mechanisms

3 Effects of Temperature Extremes (10%)

3.1 Effects of Excessive Heat Strain – Hot Environments

3.1.1 Syncope
3.1.2 Salt balance
3.1.3 Dehydration
3.1.4 Cramps
3.1.5 Hyperpyrexia
3.1.6 Prickly heat
3.1.7 Heat stroke

3.2 Effects of Excessive Heat Strain – Cold Environments

3.2.1 Frostbite
3.2.2 Trenchfoot
3.2.3 Hypothermia

3.3 Predisposing Factors

3.3.1 Age
3.1.2 General health
3.3.3 Weight and physical fitness
3.3.4 Hydration state
3.3.5 Acclimatisation
3.3.6 Alcohol
3.3.7 Drugs
3.3.8 Diet
3.3.9 Fatigue

4 Thermal Comfort (5%)

4.1 Thermal Comfort

4.1.1 What is thermal comfort?
4.1.2 Why thermal comfort can be important

4.2 Scales for Subjective Evaluation of Comfort

4.2.1 Bedford
4.2.2 ASHRAE

4.3 Actual Ideal Indoor Environments

4.3.1 Temperature, humidity and air movement

4.4 An Introduction to the Work of Fanger

4.4.1 Predicted Percentage Dissatisfied (PPD)
4.4.2 Predicted Mean Vote (PMV)
4.4.3 ISO 7730

5 Evaluation of Hot Environments (15%)

5.1 The Use of Heat Stress Indices

5.1.1 Definition of terms and environments where indices can be applied

5.1.2 Effective and Corrected Effective Temperature, WBGT, Heat Stress Index,Required Sweat Rate

5.2 Effect of Heat Stress

5.2.1 Physiological measurements as predictors of heat strain

5.3 Effective and Corrective Effective Temperatures

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

5.4 Heat Stress Index

5.4.1 Application of the Heat Stress Index

5.5 Required Sweat Rate (PHS)

5.5.1 Application of the Required Sweat Rate

5.6 WBGT

5.6.1 Application

5.6.2 ISO 7243

5.6.3 Threshold Limit Values of ACGIH

6 Control of Hot Environments (15%)

6.1 Personal Factors Mitigating Against 'Hot' Work

6.1.1 Obesity

6.1.2 Medication

6.1.3 Age

6.1.4 State of acclimatisation

6.2 A Simple Introduction to Control by Engineering and Organisational Measures

6.2.1 Control strategies

6.2.2 Engineering controls

6.2.3 Management controls

6.2.4 Personal protective clothing

6.2.5 Refuges

6.3 Hot Surfaces

6.3.1 Exposure to hot surfaces

7 Thermal Surveys (10%)

7.1 Measurement Equipment

7.1.1 Air temperature

7.1.2 Radiant temperature

7.1.3 Humidity

7.1.4 Air movement

7.1.5 Integrating meters

7.1.6 Personal monitoring

7.2 Surveys

7.2.1 Strategies

7.3 Assessment of the Degree of Risk

7.3.1 Use of measurement data.

8 Evaluation of Cold Environments (10%)

8.1 Assessment Indices

8.1.1 Wind chill index

8.1.2 Equivalent chilling temperature

8.1.3 IREQ

8.1.4 ACGIH TLV Standards

9 Control of Cold Environments (15%)

9.1 Personal Factors

9.1.1 Heart and lung conditions

9.1.2 Circulatory problems

9.2 Engineering Controls

9.2.1 Wind barriers

9.2.2 Refuges

9.3 Management Controls

9.3.1 Monitoring

9.3.2 Work – rest regimes/warming regimes

9.4 Clothing
- 9.4.1 Clothing insulation and clo values
- 9.4.2 Wind proofing
- 9.4.3 Water proofing
- 9.4.4 Gloves
- 9.4.5 Heated clothing

10 Approaches to Risk Assessment (5%)

10.1 AIOH Tiered Approach
- 10.1.1 Overview and application
- 10.1.2 Advantages and disadvantages

10.2 SA DoMR Code of Practice for an Occupational Health Programme on Thermal Stress
- 10.2.1 Overview and application
- 10.2.2 Advantages and disadvantages

10.3 ACGIH Thermal Stress TLVs
- 10.3.1 Overview and application
- 10.3.2 Advantages and disadvantages

10.4 Quantitative vs Qualitative Approaches
- 10.4.1 Quantitative vs Qualitative approaches

10.5 *Physiological Assessments*
- 10.5.1 Physiological Assessments

Learning and teaching activities

Scheduled contact hours: (Note these timings are indicative only)	Lectures	16
	Seminars	4
	Practical Sessions	4
	Tutorials	8
	Examinations (including mock examination)	5
	Other Scheduled Time	
Guided independent study *Note: include in guided independent study; preparation for scheduled sessions, follow up work, wider reading or practice, revision*	Independent coursework	8
	Independent laboratory work	
	other non-scheduled time	
Total hours		45

Assessment details:

Methods of Assessment	Practical Assessment	Open Book Examination
Grading Mode	Formative	Summative
Weighting %	NR	100
Pass Mark	NR	Set by Examination Board
Outline Details	**All candidates must participate in the practical studies and demonstrate the required skills.** The studies should be designed by the course tutor(s) to test the basic skill and knowledge of each of the candidates in the techniques in making measurements of conditions for the purpose of assessing the thermal environment. The exercises must, therefore, 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 the individual candidate reporting forms etc. are available in document BOHS. JB.2 Practical Evaluation Report which is available from www.bohs.org and www.ohtatraining.org	40 short answer questions to be answered in 120 minutes. The questions require candidates to write short answers which will require no more than the box provided but may include multiple answers. Some questions may require calculations. Students can only refer to the W502 student manual during the examination.

Is the student required to pass ALL elements of assessment in order to pass the course? Yes

Indicative course materials and reading:

ISBN Number	Author	Date	Title	Publisher
			W502 Thermal Environment Student Manual. **Downloadable for free from www.ohtatraining.org**	OHTA
	K.C.Parsons	2014	Human Thermal Environments: The Effects of Hot, Moderate, and Cold Environments on Human Health, Comfort, and Performance, Third Edition, Taylor and Francis,	Taylor and Francis
		2013	A guide to managing heat stress: Developed for use in the Ausztralian environment.	**Australian Institute of Occupational Hygienists**

		2015	**Guideline for Compilation of a Mandatory Code of Practice for an Occupational Health Programme (Occupational Hygiene and Medical Surveillance) on Thermal Stress**	**Department of Mineral Resources, Republic of South Africa**
		1989	ISO 7243: 1989 Hot environments – Estimation of heat stress on a working man, based on the WBGT – Index (Wet Bulb Globe Temperature)	
		1998	BS 7915:1998 Ergonomics of the thermal environment – Guide to design and evaluation of working practices in cold indoor environments	
		2007	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)	
		2005	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**	
		1995	ISO 10551:1995 Ergonomics of the thermal environment – assessment of the influence of the thermal environment using subjective judgment scales	
		2001	ISO 12894:2001 Ergonomics of the thermal environment – Medical supervision of individuals exposed to extreme hot or cold environments	
		2004	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**	
		2000	BS 7963:2000 Ergonomics of the thermal environment – Guide to the assessment of heat strain in workers wearing personal protective equipment	
		1998	ISO 7726: 1998Ergonomics of the thermal environment – Instruments for measuring physical quantities	
		2004	BS EN 14058 Protective clothing garments for protection against cool environments	
		2004	ISO 15265:2004 Ergonomics of the thermal environment – Risk assessment strategy for the prevention of stress and discomfort in thermal working conditions	
		2006	BS EN 511: 2006 Protective Gloves Against Cold	

		2006	ISO 13732-3:2006 Ergonomics of the thermal environment – Methods for the assessment of human responses to contact with surfaces - Part 3: Cold Surfaces	
		1995	ISO 11399:1995 Ergonomics of the thermal environment – Principles and application of relevant international standards	
		2007	ISO 9920:2007 Ergonomics of the thermal environment – Estimation of the thermal insulation and water vapor resistance of a clothing ensemble	
		2006	ISO 13732:1:2006 Ergonomics of the Thermal Environment: Methods for assessment of human response to contact with surfaces: Part 1: Hot Surfaces	