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

<table>
<thead>
<tr>
<th>Topic</th>
<th>Title</th>
<th>Time allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Thermal Spectrum</td>
<td>5%</td>
</tr>
<tr>
<td>2</td>
<td>Principles</td>
<td>10%</td>
</tr>
<tr>
<td>3</td>
<td>Effects of Temperature Extremes</td>
<td>10%</td>
</tr>
<tr>
<td>4</td>
<td>Thermal Comfort</td>
<td>5%</td>
</tr>
<tr>
<td>5</td>
<td>Evaluation of Hot Environments</td>
<td>15%</td>
</tr>
<tr>
<td>6</td>
<td>Control of Hot Environments</td>
<td>15%</td>
</tr>
<tr>
<td>7</td>
<td>Thermal Surveys</td>
<td>10%</td>
</tr>
<tr>
<td>8</td>
<td>Evaluation of Cold Environments</td>
<td>10%</td>
</tr>
<tr>
<td>9</td>
<td>Control of Cold Environments</td>
<td>15%</td>
</tr>
<tr>
<td>10</td>
<td>Approaches to Risk Assessment</td>
<td>5%</td>
</tr>
</tbody>
</table>

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
3.3.2 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

<table>
<thead>
<tr>
<th>Scheduled contact hours: (Note these timings are indicative only)</th>
<th>Lectures</th>
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<tbody>
<tr>
<td></td>
<td>Seminars</td>
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<td>Practical Sessions</td>
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<td>Tutorials</td>
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<tr>
<td></td>
<td>Examinations (including mock examination)</td>
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<td>Other Scheduled Time</td>
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Guided independent study
Note: include in guided independent study; preparation for scheduled sessions, follow up work, wider reading or practice, revision

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<th>Independent coursework</th>
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<tr>
<td></td>
<td>Independent laboratory work</td>
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<td></td>
<td>other non-scheduled time</td>
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| Total hours                               | 45 |
Assessment details:

<table>
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<tr>
<th>Methods of Assessment</th>
<th>Practical Assessment</th>
<th>Open Book Examination</th>
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<tr>
<td>Grading Mode</td>
<td>Formative</td>
<td>Summative</td>
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<td>Weighting %</td>
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<td>Pass Mark</td>
<td>NR</td>
<td>Set by Examination Board</td>
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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

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

Indicative course materials and reading:

<table>
<thead>
<tr>
<th>ISBN Number</th>
<th>Author</th>
<th>Date</th>
<th>Title</th>
<th>Publisher</th>
</tr>
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<tbody>
<tr>
<td>Year</td>
<td>Reference</td>
<td>Department of Mineral Resources, Republic of South Africa</td>
<td></td>
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<tr>
<td>------</td>
<td>--------------------------------------------------------------------------------------------</td>
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<td>2015</td>
<td><strong>Guideline for Compilation of a Mandatory Code of Practice for an Occupational Health Programme (Occupational Hygiene and Medical Surveillance) on Thermal Stress</strong></td>
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<td>2007</td>
<td>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)</td>
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<td>2005</td>
<td>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</td>
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<td>2001</td>
<td>ISO 12894:2001 Ergonomics of the thermal environment – Medical supervision of individuals exposed to extreme hot or cold environments</td>
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<tr>
<td>2004</td>
<td>BS EN 14058 Protective clothing garments for protection against cool environments</td>
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<tr>
<td>2006</td>
<td>BS EN 511: 2006 Protective Gloves Against Cold</td>
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<td>Year</td>
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