

**THE HONG KONG INSTITUTION OF ENGINEERS  
ENGINEERING GRADUATE TRAINING SCHEME “A”**

**MODEL TRAINING GUIDE**

**MATERIALS ENGINEERING**

**Model Training Guide (MTG)**

The Model Training Guide advises employers on the practical experience and formal training required for Professional Materials Engineers.

The outline set out below is for guidance. It is expected that employers will endeavor to provide training in as many areas as possible according to their industry and if necessary permit short-term placements in other companies to broaden the scope of training and topics covered.

The purpose of this training guide is to ensure that candidates applying for corporate membership of the Hong Kong Institution of Engineers (HKIE) have gained sufficient experience to meet the training requirements and professional interview criteria.

**Training Program (TP)**

The Training Programme is the plan prepared by a Company which is designed to meet the experiences listed in the MTG and to meet the objectives set out in the Record of Objectives. This ‘plan’ is presented for approval on Form TD1 Part 2 as a part of the Assessment/Reassessment procedures.

The TP must cover the experiences necessary to ensure that Trainees can meet the objectives set out in the Record-of-Objectives. The Training Program should include a schedule of Training Objectives leading to the achievement of technical and professional competence as required by the Institution.

The scheme is set against the background of a continuous theme embracing the administration, management, external and internal relations, safety, quality and financial controls appropriate to the employing organization. Within the schedule there are three main groups of training activities:

- **Professional and General** - These represent the “**Common Core**” of the Training Objectives and are mandatory for all Engineering Disciplines.
- **Core Objectives of Materials Engineering** - These cover mandatory aspects of materials engineering.
- **Industry-Specific Elements** - These represent “**Specific**” Objectives and are dependent on the industry and nature of business involved.

A checklist (Appendix 2) provides guidance on the above.

The Professional and General Training Objectives reflect the Common Core of general objectives that all trainees should meet, irrespective of engineering discipline.

The Core Objectives relate directly to Materials Engineering and constitute the

knowledge and expertise required of all professional Material Engineers from technical, administrative and management perspectives.

The Industry-Specific Objectives are optional and dependent on the nature of the business concerned. Training objectives in this group will be set by the Company. A list of the optional Industry-Specific Objectives is provided as a guide to Employers. This is not intended to be exhaustive and other additional topics may be substituted by the Employer to suit business needs provided they are approved by the HKIE.

Management, although not expressly stated in some components of the Training Program, should be emphasized.

Graduates from non-accredited courses may be required to enhance their academic background by further study of Materials Engineering. This may be done in parallel with the scheme “A” training and would be expected for satisfactory completion of Scheme “A”.

### **Training Period - Minimum 2 years**

The length of the training is based on meeting the objectives and not determined by time. The times shown below are only indicative of the minimum time (based on a minimum training period of 2 years) that a trainee would take to meet the relevant objectives.

The training period may well be longer than the minimum training period indicated. Training structure is summarised in Table below while training content is presented in page 3 - 10.

### **Training Structure**

<b>Training duration : (104 weeks)</b>	
Stage (1) training: (4 weeks minimum)	<u>Trainee Induction:</u> Introduction to the Company and to the Company Scheme "A" (A general company/training objectives and method introduction)
Stage (2) training: Spanning duration of Training.	<u>Professional and General - Common Core Objectives</u> Mandatory Common Objectives for a Professional Engineer
Stage (3) training: (70 weeks minimum)	<u>Core Objectives - Mandatory Elements for Materials Engineers</u>
Stage (4) training: (30 weeks minimum)	<u>Industry-Specific Engineering Design &amp; Practice:</u> Optional elements selected by the Employer that are related to nature of business.
Stage (5) training: (nominally from 2-6 weeks)	<u>Engineering Placement: Optional</u> Materials utilization in relevant engineering companies/ organisations

Note: Stages do not have to be completed as sequential blocks. Part of the technical training can also be performed in other well-established companies, testing laboratories and tertiary institutes outside the company.

Stage (5) is optional and dependent on the needs of the individual but is recommended for well-rounded training.

### **Training Aim**

It is important to note that the Scheme “A” Graduate Training is designed to be the fast track by which a graduate can obtain full Professional status. The training therefore covers both Technical and Professional matters.

The training programme should be designed to achieve the goal as stated in the "Mission, Scope and Definition of the Materials Discipline" appended (Appendix 1) to this MTG.

Materials Engineering covers a wide range of materials, industries and applications but most trainees will inevitably specialise in a particular industrial field. This is recognised in the structure of the training programme. To ensure the candidate gains broad experience, the final stage of training (optional) allows for limited placement (up to 8 weeks) in other companies to cover those areas not available with the employer.

Training must be aimed at developing the skills and knowledge required of a professional materials engineer. This may involve attendance at special courses dealing with particular technologies.

### **Continuing Professional Development (CPD)**

An implicit part of the Scheme “A” training is related to CPD which should be an integral and relevant part of the development of the graduate trainee.

In addition to practical experience, all trainees are required to undertake Continuing Education and Training for the equivalent of at least 45 hours of formal instruction each year during their preparation for the Professional Review. This is the first stage of the Institution’s policy for CPD which is something to be continued throughout a member’s working life.

All CPD will be recorded for reference in the "CPD Log Book”.

### **Training Content**

#### **1. Stage (1): Trainee Induction**

The trainee will be formally inducted into the Scheme “A” training programme by his employer and instructed on training requirement.

##### **1.1 Information about the company**

- (a) Size, history, subsidiaries if any
- (b) Products, markets and competitors
- (c) Management structure and functions
- (d) Communication systems
- (e) Location and layout of the facilities

- (f) Safety, health and welfare
- (g) Joint consultation arrangements if any

## 1.2 Information about training programs, prospects and career development

- (a) Specialist skills
- (b) Work of related disciplines
- (c) Management techniques
- (d) Sources of guidance

## 2. Stage (2): Professional and General (Common Core Objectives)

### 2.1 HKIE Activities

The candidate is expected to demonstrate an interest in HKIE affairs, its history, role and organisational structure. The candidate is expected to attend divisional technical meetings and make use of opportunities to become involved with the HKIE generally, e.g. attendance at AGM's.

### 2.2 Professionalism

The candidate should understand the inherent responsibilities and role of the Engineer in society and the HKIE rules of conduct, specifically with regard to ethics, codes of behaviour and professionalism.

### 2.3 Knowledge of Current Affairs

To keep up-to-date with current technical and commercial developments related to your discipline is achieved by reading 'Hong Kong Engineer' and relevant local, regional and international publications and periodicals. To take an interest in current affairs both locally/regionally and internationally.

### 2.4 CPD - Continuing Professional Development

The trainee is required to maintain a record of Continuing Professional Development (CPD) attendance in a CPD Log Book and satisfy their Engineering Supervisor as to the value of each activity attended.

### 2.5 Personal Qualities

A professional engineer is expected to demonstrate technical competence, creativity and innovative problem solving ability. Personal qualities also include professional and social confidence.

### 2.6 Occupational Safety & Health (S&H)

The trainee must be aware and demonstrate compliance with relevant safety and health legislation and the understand responsibilities of professional engineers to employers, employees and the public in general. They must become familiar with statutory obligations for Health, Safety and Environmental Protection, understand the purposes of legislation and be prepared to respond to future legislative demands.

## 2.7 Environment

The candidate must demonstrate a thorough knowledge of relevant HK legislation relevant to their particular industry and the interrelationship of technology and the environment in the work place and in society in general.

## 2.8 Communication

The candidate must be able to communicate confidently and accurately in a professional manner. This covers oral, graphic and written presentation such as reports, memos, letters and other correspondence, both internally and with external clients.

## 2.9 Human Resources

The candidate should be able to demonstrate an appreciation of employment criteria, interview practice, labour deployment procedures and general training of subordinates.

## 2.10 Leadership & Management

The candidate is expected to have the inherent qualities required of a good leader and manager and understand the responsibilities and relationships relating thereto.

## 2.11 Organisational Awareness

The candidate should understand the structure of their employers organisation and the key roles and responsibilities of the company management. They should be aware of the organization's purpose, expressed in a mission statement or similar document, and its structure. This awareness should include the contribution made by all departments to the operation of the business and how these contributions are measured against business objectives. To become aware of the Employment Ordinance and the role of the work force and their relationship with management.

## 2.12 Technology/Business

The candidate is expected to have knowledge of Intellectual Property Rights, copyright, productivity and the inter-action between business considerations and technical decisions.

# 3. Stage (3): Core Objectives (Mandatory Elements)

## 3.1 Project Management

The trainee must gain experience in project management during the training period. The training should provide a team work environment at a multi-disciplinary level. Coverage should include, but not be limited to considerations in efficiency, safety, quality control, pollution, environmental protection and energy conservation issues. Training should emphasise the logical approach to:

- (a) Engineering specification

- (b) Work coordination
- (c) Material handling
- (d) Budget planning
- (e) Work programme preparation
- (f) Critical path analysis
- (g) Progress monitoring

The trainee should also understand the importance of supervising and providing clear guidance to subordinates as well as the responsibilities associated with staff development.

### 3.2 Specimen Preparation

Practical experience of sampling and specimen preparation schemes for property testing and structural examination. The understanding of the importance of sample selection and collection in accordance with national/international standards. The ability to design specimen preparation schemes and to interpret microstructural information.

### 3.3 Materials Testing

To learn the importance of testing according to internationally recognized national and/or international standards. To gain experience in determining at least three mechanical properties, at least one physical property and at least one test of chemical resistance. To develop an awareness of the problems associated with testing different materials. To interpret test results and use the information obtained.

### 3.4 Structural and Chemical Characterization

To become familiar with routine techniques used to characterize the structure and composition of materials. To gain in subsequent interpretation of the results of these techniques.

### 3.5 Measurement and Control System

To gain experience in measuring and controlling process variables for at least two items of laboratory equipment or industrial plant. This experience should include the setting up or modification of a control system. An understanding of the advantages and limitations of different measuring systems must be developed. Familiarize with HOKLAS and similar schemes.

### 3.6 Quality Standards and Assurance

To understand the application of quality standards and quality techniques used in industry and commerce to meet recognized International Standards. To be familiar with the Company Quality System, understand the principles of quality control to meet a specification and appreciate or have experience of equipment calibration procedures.

### 3.7 Engineering Practice

Engineering Practice appropriate to the employer activities, e.g. use of tools,

manufacturing process, safety requirements, the property and choice of materials, application and calibration of measurement instruments, choice of engineering control and sampling techniques, use of engineering software packages.

### 3.8 Engineering Drawing

To become familiar with recognized International Standards for hand and computer aided drafting procedures. To understand engineering drawings and communicate with other engineers using drawings.

### 3.9 Workshop Practice

To be aware of safe working practices, able to use hand tools, understand the benefits and limitations of machine tools and other workshop equipment. To obtain experience in the use of machine tools and understand the application of computers in engineering (e.g. CAD, CNC machining and CAE).

### 3.10 Selection and Use of Materials

To become aware of the factors including financial and environmental constraints which affect the selection and use of materials and to demonstrate personal experience of materials selection.

### 3.11 Financial Awareness

To become aware of the financial constraints within which the organization works. Have experience of costing solutions to problems, building up cost-estimates and control of a project budget. Understand the basic forms of contract and show an appreciation of insurance, procurement procedures, tender document preparation and valuation and commercial terms.

NB: It is recognised that the precise experience gained by the candidate in this respect will vary greatly depending on the type of company involved and its organisational structure.

### 3.12 Plan and Execute Projects

To gain experience of planning, controlling and implementing projects to meet defined objectives within time and cost constraints and be aware of techniques for project planning.

## 4. Stage (4): Industry-Specific Elements

Significant experience is required in five of the optional elements listed below. In each case, the theoretical understanding and practical involvement should be a significant extension to previous experience and should develop an awareness of costs. This list is not exhaustive and the Employer may submit other topics for consideration by the HKIE.

### 4.1 Materials Production

To have experience in the operation and control of either a primary

production process or a secondary process involving chemical recycling. Should also be aware of the sources, handling techniques and monitoring of raw materials and gain experience in comparing existing processes with alternative production routes.

#### 4.2 Synthesis of Materials

To demonstrate an understanding of the parameters which govern the purity and yield of a product and be able to identify the controlling variables from practical experience. To understand what steps would have to be taken to develop the process to a production scale.

#### 4.3 Materials Design

To make an experimental or theoretical contribution to “tailoring” the structure of a material to suit its intended use. To utilize theoretical concepts of structure property relationships to achieve desired properties which should then be measured and correlated with appropriate structural information.

#### 4.4 Modeling

To experience the development, testing or use of an analogue or mathematical model of the structure, processing or properties of a material. The result should be tested against actual performance and the trainee should be aware of the relative costs of modeling and empirical approaches.

#### 4.5 Jointing

To gain practical experience of at least two different methods of jointing and understand those factors which affect the integrity and properties of the joint. This must include preparation of the materials to be jointed, control of the joining process and subsequent treatments of the joint.

#### 4.6 Thermal Treatment

To gain practical experience of the operation and control of ovens, furnaces or stoves to thermally treat materials of prime concern to your professional development (e.g. heat treatment of metals, firing of ceramics). The trainee should take account of temperature variations within the furnace and the thermal stresses induced during heating or cooling (particularly during quenching of metals). Methods of mitigating these problems should be considered for at least two processes.

#### 4.7 Surface Engineering

Methods of producing controlled surfaces using chemical, physical or mechanical methods should be evaluated as appropriate to the material and surface condition required. The trainee should undertake detailed study of two or more processes

#### 4.8 Component Manufacture

The trainee should have experience of one or more of the manufacturing processes used in the production route for a component.



#### 4.9 Chemical Characterization

The trainee should become familiar with both conventional chemical methods of analyzing bulk samples and electron optical and X ray techniques for characterizing small volumes of materials. The trainee should become competent in two or more techniques.

#### 4.10 Structural Characterization

The trainee should become competent in the operation of two or more methods of structural characterization. The trainee's understanding should include the capabilities and limitations of a range of techniques and methods of interpreting the results.

#### 4.11 Physical Testing of Materials

This should be an extension of the routine testing contained within the mandatory elements. The trainee's knowledge of structure-property relationships must be applied to make most effective use of existing testing procedures or lead to the development of new test techniques. The trainee must have experience of at least three different techniques which cover determination of different mechanical, electrical, magnetic or optical properties.

#### 4.12 Electronic Materials

The trainee must have experience of two techniques of characterizing electronic materials or fabricating and testing the resultant devices.

#### 4.13 Non-Destructive Evaluation

The trainee should be aware of the limitations of various test methods. At least two techniques should be considered in detail and a high level of practical and theoretical competence demonstrated.

#### 4.14 Fracture Mechanics and Effects Analysis

The trainee should have direct experience of at least two significant investigations of the causes of, or methods of preventing failure. The trainee should understand the methodology used in fractography and be able to apply this to appropriate materials.

#### 4.15 Degradation

The trainee must have direct experience of both long term and accelerated tests of performance in an aggressive environment and become familiar with a range of testing techniques appropriate to the material the trainee is concerned with.

#### 4.16 Stress Analysis

The trainee is required to have experience of at least two methods of stress analysis. The trainee should understand the contribution made by both experimental and mathematical approaches and know the advantages and

limitations of the techniques.

#### 4.17 Design Oriented Activities

Coverage should extend to material specification, codes of practice, standards, design utilisation, critical analysis and objective evaluations of design; maintainability, safety, health and environmental considerations, standards and regulations.

#### 4.18 Process or Production Oriented Activities

The training should include involvement in the production process. Typical aspects may include raw materials sourcing and requirements. Effects of material variability on final quality. Processing variable and their effect on quality. Quality control technique and sampling storage and delivery.

#### 4.19 Other topics

Other topics which are formally approved by the HKIE may also be offered. If the company wishes to offer a topic not listed above, they should contact the HKIE to confirm that it is acceptable at an early stage.

### 5. Stage (5): Engineering Placement (Optional)

Short-term placements in other companies to broaden the scope of topics which can be covered should be arranged.

#### **N.B.**

1. The minimum training period must not be less than 24 months.
2. The programme set out is for guidance only but substantial departure should not be made. Employers should endeavour to provide training to their trainees in as many areas as possible as is appropriate to the sector of employment.
3. This guide should be read in conjunction with Section 3 of the Membership Admission Requirements booklet.
4. During their training, each trainee is required to maintain a Graduate Training Log Book, CPD Logbook and Record of Objectives.

## **APPENDIX 1**

### **MISSION, SCOPE AND DEFINITION OF THE MATERIALS DISCIPLINE**

#### **Mission Statement**

Our mission is three-fold:

- To maintain and continuously improve the standards of education and work experience required of practicing, professional, materials engineers.
- To help promote and develop all aspects of materials engineering through the activities of the Materials Division, specifically: public understanding, technical forums and conferences, technical publications and appropriate media dissemination.
- To provide a first class service to our members.

Our objective is to achieve these goals by:

1. Applying and maintaining consistent standards of professional assessment matching those established internationally
2. Recognising the importance of practical, current work experience as well as educational background
3. Providing an accountable and readily understood system of professional standards and assessment
4. Supporting a philosophy of continuous professional development in terms of education, technical standards and experience for practicing materials engineers at all levels
5. Promoting materials technology through the Materials Division and its membership
6. Fostering relationships with local industry and recognised centres of educational excellence

Our Mission commits the Materials Discipline to developing long-term improvements which will enhance materials engineering standards of practice, the role of the professional materials engineer and public interest in materials technology.

#### **Scope and Definition**

The Material Discipline encompasses the application of engineering activities, ranging from those associates with construction and fabrication to those involved with the production and manufacture of goods as well as the assessment of nature's primary material resources.

It covers expertise associated with general construction materials technology involving metallurgy, geology, chemistry, the manufacturing and production technologies associated with plastics, wood, rock, concrete products, glass microchip and other materials technologies as well as engineering research and development relating to new materials.

Corporate and Associate Members must be able to demonstrate a knowledge and understanding of the production, fabrication and service performance of engineering materials and be deemed competent by Council to practise as Engineers at the time of election. They are expected to exercise independent technical judgment, requiring both practical experience and the application of engineering principles.

Corporate members will normally have direct responsibility for the management or guidance of technical staff and other sources.

**APPENDIX 2**

**SCHEME "A" TRAINING CHECK LIST FOR  
HKIE MATERIALS DISCIPLINE**

Description	Training Location	Approx. Date		Initial of Trainer
		From	To	
<b>2. Professional and General</b>				
HKIE Activities				
Professionalism				
General Personal Development				
Knowledge of Current Affairs				
CPD-Continuing Professional Development				
Personal Qualities				
Occupational safety and Health (S&H)				
Environment				
Communication				
Human Resources				
Leadership and Management				
Organizational Structure				
Technology/Business				
<b>3. Core Objectives</b>				
Project Management				
Specimen Preparation and Sampling				
Materials Testing and Standards				
Structural & Chemical Characterization				
Quality Standards & Assurance				
Measurement & Control System				
Engineering Practice				
Engineering Drawing				
Workshop Practice				
Selection & Use of Materials				
Financial Awareness				
Plan & Execute Projects				

Description	Training Location	Approx. Date		Initial of Trainer
		From	To	
<b>4. Industry-Specific Elements (five areas required)</b>				
Materials Production				
Synthesis of Materials				
Materials Design				
Modeling				
Design of Production Process				
Joining				
Thermal Treatments				
Surface Engineering				
Component Manufacture				
Chemical Characterization				
Physical Testing				
Electronic Materials				
Non-destructive Evaluation				
Fracture Mechanisms & Effect Analysis				
Degradation				
Stress Analysis				
Other Topics				

#### CERTIFICATION OF AUTHENTICITY

I certify that the above list is an accurate reflection of training completed by

Name: \_\_\_\_\_ HKIE membership number: \_\_\_\_\_

Job title: \_\_\_\_\_

Certified by: \_\_\_\_\_ HKIE Membership number: \_\_\_\_\_

Job title: \_\_\_\_\_ Organization: \_\_\_\_\_