# INSTITUTE OF MATERIALS, MALAYSIA

## IMM CERTIFIED MATERIALS FAILURE INVESTIGATION PRACTITIONER - LEVEL 3 (MFIP-L3)

### INTRODUCTION

IMM Certified Materials Failure Investigation Practitioner (MFIP) Level 3 Certification Examination will assess candidates who have the necessary experience and have undergone training in the field of Materials Failure Investigation.

The competence of Materials Failure Investigation Practitioners shall be classified into different levels according to required knowledge and competence.

A detailed description of the requirements of knowledge and competence is given in Section 5 of IMM-MFIP-01:2024 Certification Standard.

Each defined level of competence shall also include the competence of the corresponding lower levels. The level of authority shall be defined for each level.

The current levels of certification will not have specialization. All current levels of certification shall cover for Materials as a whole. In the future, IMM may embark on assessments for different specializations such as Metals, Non-Metals, Polymers, Ceramics, etc. This shall be applicable to Level 3 and above.

IMM has been accredited to ISO-17024 International Standard for Recognition of Skill Personnel Certification Bodies by the Department of Standards Malaysia Accreditation no: ACB PS 0006 since March 2021 for 4 certification programs to-date i.e., IMM Coating Inspector Level 1 & 2 Certifications and IMM Mechanical Joint Integrity Technician Certifications. In contrast to other types of conformity assessment bodies, one of the characteristic functions of the ISO-17024 Accredited Certification Body for skill personnel is to conduct an examination which uses objective criteria to measure competence and scoring. It is recognized that such an examination, if well planned and structured by the Certification Body, can substantially serve to ensure impartiality of operations and reduce the risk of conflict of interest. ISO-17024 serves as the basis for the recognition of the Certification Body for skill personnel and the certification schemes under which the persons are certified, in order to facilitate their acceptance at the national and international level.

### COMPETENCY AND AUTHORITY OF MFIP LEVEL 3

Level 3 certified personnel shall have knowledge about the behaviour of materials including degradation phenomenon, physical and chemical properties of the materials, related characterisation techniques, engineering drawings, methodology to perform failure investigation, good laboratory practice, safety issues and applicable standards relating to specific testing of materials.

Level 3 certified personnel shall be competent in at least six or more scientific testing instruments. The Level 3 certified personnel shall be able to demonstrate knowledge of at least six scientific testing instruments including basic operation of the instruments, standard methodology, data collection and

data analysis. Level 3 certified personnel shall be able to identify errors / issues, to check the reliability of instruments (e.g., calibration file) in order to validate the accuracy of data collection.

Level 3 certified personnel shall propose test methods, from both standards and modified standards, to carry out an investigation. Level 3 certified personnel shall guide the Level 1 & 2 certified personnel by providing the standard and modified test methods.

Level 3 certified personnel shall be responsible for the interpretation of test results, report writing and preliminary recommendations.

The Level 3 certified personnel shall be allowed to endorse the test results for external usage. The Level 3 certified personnel are able to verify the tests (internal) report by Level 1 & Level 2 certified personnel.

The Level 3 certified personnel shall be able to work independently in an investigation (including establishing suitable test methods, analysing results, correlating and identifying modes of failures, and provide recommendations) as well as demonstrate leadership in guiding technical team (e.g. engineers / scientists / technologists or equivalent) in failure investigation.

Level 3 certified personnel can act as "Expert Witness" according to the skills and knowledge as per Section 5, Table 2.

## REFERENCE STANDARDS
**(Reference shall refer preferably to the latest published document):**

1. IMM MFIP-01:2024 Materials Failure Investigation Practitioners - Competency Levels of Skill Persons: Basis for Skills Certification Scheme.
2. All Domestic and International Technical Standards covering all relevant Materials Testing techniques and methods listed in the Bibliography of IMM MFIP-01:2024 Standard.

## WHO CAN APPLY

Candidates with relevant engineering, technology, or scientific discipline degree/diploma plus specialized training and education in the field of materials can apply for Level 3 MFIP certification and examination, as specified in IMM MFIP-01:2024 Certification Standard.

## CANDIDATE'S ELIGIBILITY FOR ASSESSMENT

| Level | Education | Minimum experience in materials failure investigation |
|---|---|---|
| 3 | Relevant engineering, technology, or scientific discipline degree plus specialized training and education in the field of materials | 3r + 3m + logbook + A |

r having prepared number of reports for materials failure investigation as the main contributor within the last five years

m having been involved in failure investigation work covering different modes of failures

A evaluation by Assessment Committee appointed by Certification body

Logbook refers to a log of training acquired by candidate as listed out in section A.4 of IMM MFIP-01:2024 Certification Standard.

Candidates shall submit evidence of reports (r) with collectively different number of modes of failures (m) plus logbook together with application to sit for the examination.

## KNOWLEDGE CATEGORIES

The following table lists the knowledge titles and topics to be acquired by candidates. Candidates are required to have undergone the appropriate training before registering for the Certification Examinations. The questions for the certification examinations will be set based on this list of Knowledge Topics.

The Knowledge Categories and their respective titles and topics detailed in Table 1 constitute a common core for certification examination/assessment for all levels. These Knowledge Categories shall also be used for the pre-requisite training programs. The term materials cover both structural and functional materials.

**Table 1: Knowledge Categories required by persons for all levels**

| Knowledge Category Number | Title and Topics of Knowledge |
|---|---|
| 1 | **Selection of Materials**<br>• Understanding the importance of correct selection of materials for the right applications to avoid failures<br>• Appreciation of what failures can occur should the wrong materials be selected for the respective applications |
| 2 | **Properties of Materials**<br>• Understanding what properties of materials are important to avoid failures<br>• Appreciation of the various properties of materials and how they affect the performance of materials in their respective applications |
| 3 | **Testing of Materials Failures**<br>• Understanding the various types of testing methods required for failure investigation. The test methods include but not limited to<br>  ○ Mechanical tests, such as hardness, tensile, impact tests<br>  ○ Chemical tests, such as optical emission spectroscopy, X-ray fluorescence, *X*-ray diffraction, energy dispersive spectroscopy<br>  ○ Visual examination<br>  ○ Micrography, such as scanning electron microscopy<br>  ○ Other required techniques<br>• Appreciation of the correct and incorrect types of testing to be conducted during failure investigations<br>• Appreciation of the test results and how to analyse the test results<br>• Appreciation of the potential flaws in certain testing techniques |

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| **4** | **Failure Investigation Methodology**<br>• Planning the investigation and understanding the preliminary actions to be taken<br>• Appreciation of the equipment required for on-site and laboratory investigation<br>• Understanding the difficulties associated with sample extraction and preservation<br>• Predicting the testing required<br>• Understanding the need for established standards<br>• Understanding the need for established procedures<br>• Writing the failure report |
| **5** | **Failure Analysis**<br>• Understanding the problems associated with data acquisition<br>• Knowing when to use finite element analysis or other stress evaluation tools<br>• Understand when there is a need for statistical analysis<br>• Appreciation of root cause analysis techniques such as 5 Why's. FMEA etc.<br>• Organising the data in tables and trees<br>• Understanding the need for feedback of information into the investigation process |
| **6** | **Writing Failure Investigation Reports**<br>• Key elements of a failure investigation report<br>• Avoid rushing into making conclusions<br>• Thinking outside the box<br>• Compilation of different inputs from various experts where necessary<br>• Getting second and third opinions, if necessary |
| **7** | **Other Factors that Influence Failure**<br>• Process<br>• Human factors<br>• Act of nature<br>• Biohazard |
| **8** | **Standards and Codes of Practice relevant in materials testing and failure investigation**<br>• Understanding the importance of Standards and Codes of Practice in Materials Testing & Failure Investigation<br>• Ability to identify important points in each Standard and Code of Practice<br>• Ability to cross-reference between Standards and Codes of Practice |
| **9** | **Health, Safety and Environmental issues relating to materials testing & failure investigation tasks**<br>• Safety of personnel in handling samples<br>• Safety of personnel in handling test equipment<br>• Safety of facilities while testing materials<br>• Safety of personnel while investigating failure sites |

| | |
|---|---|
| **10** | **Code of Ethics and Professional Conduct of Materials Failure Investigation persons**<br>• Professionalism in conducting testing of materials with accurate reporting of results<br>• Professionalism in conducting failure investigation with accurate reporting of findings<br>• Non-compromise on Code of Ethics when reporting controversial results and findings<br>• Practice of impartiality in delivery of deductions and conclusions in technical reportFree from corrupt practices |
| **11** | **Interpersonal Communication Skills**<br>• Ability to communicate instructions to subordinates clearly to avoid error in sample collection and testing<br>• Ability to communicate effectively with peers to ensure collective agreement on the process of materials testing and failure investigation<br>• Ability to deliver technical presentation of results and findings clearly to audience<br>• Ability to communicate deductions and conclusions convincingly to audience |

The level of knowledge in Table 1 shall be progressively increased from Level 1 to Level 4 in order to conform to the levels of competency defined in Section 4 of IMM-MFIP-01:2024 Certification Standard.

Certified personnel are not required to be an expert in all the knowledge category listed in Table 1. However, Level 1 and Level 2 certified candidate needs to have basic knowledge about material properties (knowledge categories 1-11 except 4, 5 and 6). Level 3 and Level 4 requires full knowledge and skills to perform failure investigation (knowledge categories 1-11).

## EXAMINATION FORMAT

The certification assessment for IMM Certified Materials Failure Investigation Practitioner Level 3 is a two-part process consisting of Theory Examination Paper and Practical Assessment. The Theory Examination Paper shall be made up of Multiple Choice and Subjective Questions. For the Practical Assessment, each candidate shall be given a failed component to investigate (either physical sample or photograph or video or in combination). Background information about the failed component will be provided. The candidate can apply to bring their own sample for the practical assessment and demonstrate how he/she conducts the failure investigation. The candidate must provide the failed sample (either in physical or photograph or video form) with a write-up of the background about the component and circumstances surrounding the failure, at least one week before the date of the examination. The candidate shall analyze and evaluate the failure in written form (e.g., investigation assessment and work scope) and make a presentation of his/her evaluation to the examiner (will be recorded in video).

Mobile Phones must be silenced and kept aside. Scientific calculators may be brought into the Exam Hall.

## EXAMINATION DURATION

Theory Examination Paper 1: 20 Multiple Choice Questions (20%)
Theory Examination Paper 2: 3 Subjective Questions specific to material failure (30%)

Each theory examination session is closed book and limited to two hours.
No external assistance or reference materials are allowed.

Practical Examination 1: Written evaluation (20%)
Practical Examination 2: Presentation evaluation (30%)

Each practical examination session is closed book, and the total examination session is limited to four hours. No external assistance or reference materials are allowed.

## LANGUAGE OF EXAMINATION

The Theory Examination Paper will be written in English. However, the Examiners and Invigilators will assist candidates who are not proficient in English by explaining the questions and answers in Bahasa Malaysia.

The Practical Examination Paper will be written in English. However, the Examiners and Invigilators will assist candidates who are not proficient in English by explaining the questions in Bahasa Malaysia and candidates will be allowed to answer the verbal questions in Bahasa Malaysia.

## CRITERIA FOR CERTIFICATION

Candidates must attain a combined minimum mark of 70% from both Theory and Practical Examinations to pass.

## EYE ACUITY TEST

Candidates shall have an eye vision test to ensure natural or corrected near distance acuity in at least one eye such that the applicant can read a minimum Jaeger Number 2 or equivalent type and size letter at the distance designated on the chart but not less than 12in. (30.5cm) on a standard Jaeger test chart. The ability to perceive an Ortho-Rater minimum of 8 or similar test pattern is also acceptable. For colour contrast differentiation, the examination should demonstrate the capability of distinguishing and differentiating contrast among colours or shades of grey used in the method as determined by the employer. This shall be conducted prior to the certification examination and at five-year intervals thereafter. Vision examinations expire on the last day of the month of expiration.

Eye examinations shall be administered by an Ophthalmologist, Optometrist, Medical Doctor, Registered Nurse or Certified Physician's Assistant or by other ophthalmic medical personnel and must include the Examiner's License/Registration/Certification number. Eye Acuity Examinations shall be

performed not more than one (1) year prior to the date of the certification examination or the expiration date for renewals and recertifications. New visual acuity records do not need to be supplied for retests occurring within one (1) year from the original examination date.

All applicants must pass the Eye Acuity Examination, with or without corrective lenses, to prove near vision acuity on Jaeger J2 at 12 in. or greater (≥30.5 cm). All applicants shall take a colour perception test.

Eye examination results must be documented on the IMM Visual Acuity Examination Record Form (see below) and submitted with the exam application form.

## PRE-REQUISITE TRAINING

Candidates are encouraged to attend an IMM-recognized training course or equivalent such as other technical short-courses or long-duration training programs at vocational training centres or universities/polytechnics which prepares and provides comprehensive guidance and practice aligned to the topics covered in the examination. The training period, method and syllabus shall be sufficient in order to deliver the knowledge and skill as detailed in Clause 4 and Clause 5 of the IMM Standard no. MFIP-01:2024 Materials Failure Investigation Practitioners - Competency Levels of Skill Persons: Basis for Skills Certification Scheme.

The minimum duration of training that shall be undertaken as follows:-

Level 3: documented on-the-job training in the form of logbook relating to materials failure investigation within 3 years prior to taking the certification examination/assessment

Alternately, formal training can be attended at IMM's Authorized Training Bodies or at an employer's premises or independently such as at universities or technical training institutes.

## CERTIFICATE OF AWARD

IMM Certified Materials Failure Investigation Practitioner Level 3.

## VALIDITY PERIOD OF CERTIFICATION

5 years. Certified persons may use the abbreviations "Certified IMM MFIP Level 3 # cert no: 1234".

## INFORMATION ON RE-CERTIFICATION

6 months prior to the expiry of certification (at the end of the 5th year of certification), the candidate can apply for re-certification for another 5 years by providing proof to IMM that he/she has been employed in a related profession.

Prior to the expiry of the 5-year re-certification (at the end of the 10th year of certification), the candidate can continue to be certified for a further 5-year period by

- providing proof to IMM that he/she has been employed in a related profession; and
- attending the relevant Refresher Course for certification (if any).

The candidate must re-sit the certification examination if he/she has been out of the profession for more than 18 months continuously during the 5-year certification or re-certification period.

## INFORMATION FOR EXAM RE-SIT

A candidate who had failed in one or more of the examination parts can apply to re-sit for the failed component(s) of the examination within a year from the date of the last examination. The candidate shall have to pay the full examination fee for the re-sit and without the need to attend any pre-requisite training course.