IMM STANDARD

IMM MFIP-01:2024

MATERIALS FAILURE INVESTIGATION PRACTITIONERS COMPETENCY LEVELS OF SKILL PERSONS: BASIS FOR SKILLS CERTIFICATION SCHEME

INSTITUTE OF MATERIALS, MALAYSIA

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For further information on this Standard, please contact:

Institute of Materials, Malaysia
Suite 1006, Level 10, Block A, Kelana Centre Point,
No. 3, Jalan SS7/19, Kelana Jaya,
47301 Petaling Jaya, Selangor, Malaysia

Tel: +6018 9113480

https://www.iomm.org.my
Email: secretariat@iomm.org.my

FOREWORD

The Institute of Materials, Malaysia (IMM) was established in 1987 as a non-profit professional society dedicated to the development of Materials Science, Technology and Engineering training, education, research & development, and skills certification. The work of preparing IMM Skills Certification Standards is carried out by the respective IMM Technical Working Committees in collaboration with the IMM Standards Development Committee.

The development of this Skills Certification Standard has been referenced to ISO-18436-2 Standard for Condition Monitoring and Diagnostics of Machines – Requirements for Qualification and Assessment of Personnel; and ISO-15257 Competency Levels of Cathodic Protection Persons: Basis for a Certification Scheme.

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This document was prepared by the IMM Materials Failure Investigation Practitioners (MFIP) Working Sub-Committee under the IMM Education Committee of 2022-2024 Term. The final document was reviewed and approved by the IMM Corrosion Committee's Technical Sub-Committee.

INTRODUCTION

This document enables the competence of Materials Failure Investigation (MFI) personnel carrying out destructive and non-destructive testing of materials, physical and chemical analysis of materials, spectroscopic analysis of materials, data collection & analysis, results analysis, troubleshooting, and report writing to be defined and verified.

The relevant application sectors cover all machinery, equipment, structures, facilities and materials used in all industries exposed internally and externally to all service environments.

Demonstration of competence is possible by certification. This document offers a certification scheme in accordance with ISO/IEC 17024 Conformity Assessment – General Requirements for Bodies Operating Certification of Persons.

In preparation of Sections 4 and 5, a detailed Job Task Analysis (JTA) was undertaken by consensus of the experts in the IMM MFIP Working Sub-Committee. It is considered that Sections 4 and 5, constitute a rigorous JTA.

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Materials Failure Investigation

Competency Levels of Materials Failure Investigation Practitioners: Basis for Certification Scheme

1. SCOPE

This document specifies skill framework for establishing critical knowledge, skills and performance levels that a practitioner working in the field of Materials Failure Investigation (MFI) shall have in order to carry out the investigation on failure of **Materials (1.3.13)**.

This Standard defines practitioners' competence levels and their minimum requirements. The levels of competence (details in Clause 4) include but not limited to physical and chemical analyses, spectroscopic analysis, operating testing equipment, handling of chemicals and materials, data collection & analysis, results analysis, troubleshooting, and report writing.

A list of equipment and methodology used in the investigation of materials is given in Annex E. The above descriptions of testing and analytical activities are not exhaustive and shall include new developments and new technologies over time.

Competence levels and their minimum requirements shall be defined according to best practices and requirements in specific application sector such as oil & gas, marine, utility, electronics, etc.

This document specifies the requirements to be used for establishing a certification scheme as defined in ISO/IEC 17024. This certification scheme is detailed in Annexes A, B and C.

2. NORMATIVE REFERENCES

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the reference document (including any amendments) applies.

ISO/IEC 17024, Conformity Assessment – General Requirements for Bodies Operating Certification of Persons.

ISO/IEC 17000, Conformity Assessment – Vocabulary and General Principles.

ISO-18436-2, Standard for Condition Monitoring and Diagnostics of Machines – Requirements for Qualification and Assessment of Personnel.

ISO-15257, Competency Levels of Cathodic Protection Persons: Basis for a Certification Scheme.

3. TERMS AND DEFINITIONS

For the purposes of this document, the terms and definitions given in ISO/IEC 17000 and the following apply

3.1. Assessment Committee

Group appointed by the **Certification Body (3.3)** who reviews applications and examination results and determines compliance with the requirements for Materials Failure Investigation skills certification offered by the Certification Body.

3.2. Certificate

Document issued by a Certification Body indicating that the named person has fulfilled the **Certification Requirements (3.5)**

3.3. Certification Body

Organization that meets the requirements of ISO/IEC 17024 for third-party certification bodies and issues a certificate of conformity.

3.4. Certification Candidate

Person who undertakes the certification scheme. Once the person has fulfilled the certification requirements, he or she becomes a certified person.

3.5. Certification Requirements

Set of specified requirements, including requirements of the scheme to be fulfilled in order to establish or maintain certification.

3.6. Competence

Ability to apply knowledge and skill to achieve results.

3.7. Examination Centre

Place for the examination of competence in materials failure investigation.

3.8. Examiner

Person competent to conduct and score an examination, where the examination requires professional judgement.

3.9. Examination Moderator

Person competent to review the Examination Questions and Answers and co-ordinate the arrangement of multiple sets of Questions and Answers for the Questions & Answers Bank.

3.10. Expert Witness

Person whose level of competence and knowledge in a particular field qualifies them to present their opinion about the facts of an investigation case of a material during legal proceedings

3.11. Good laboratory practice

Principles to ensure and promote safety, consistency, high quality, and reliability of laboratory testing.

3.12. Invigilator

Person authorized by the Certification Body to supervise examinations but does not evaluate the competence of the candidate.

3.13. Materials

Objects made from true metals or alloys, polymers or composites, ceramic, etc.

3.14. Peer Review Panel

A group of qualified individuals, with similar or better competencies, appointed by the Certification body to review and assess candidates applying for Level 4 certification in this document

3.15. Safety issue

Issue that encompasses one or more contributing factors and other unsafe conditions

3.16. Significant Interruption

Period of time in which a Materials Failure Investigation person has not practised the duties or undertaken training corresponding to their level of competence

3.17. Technical Instruction

Written description, method statement or written instruction stating the precise steps to be followed in Materials Failure Investigation activities to an established Standard, Code, Specification or Procedure

3.18. Technical Report

Written report intended to transmit scientific information of a complex, analytical nature

3.19. Training

Theoretical and practical instructions given in conformity to a pre-established programme in order to furnish or increase the knowledge and the ability of the skill persons in carrying out their duties

3.20. Training Centre

A Centre where training for Materials Failure Investigation persons is carried out. The Training Centre shall possess demonstration and testing facilities to simulate the conditions that normally exist in real situations of materials failure investigation.

3.21. Trustees

Person who establishes the examination elements of the scheme in accordance with this document.

4. LEVELS OF COMPETENCE AND AUTHORITY

4.1. General

The competence of Materials Failure Investigation Practitioner 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.

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 specialisation of certified personnel in relevant field shall be mentioned in a bracket behind each competency level. This shall be applicable to Level 3 and above.

4.2. Certified Materials Failure Investigation Practitioner Level 1

Level 1 certified personnel shall have knowledge about the behaviour of materials, physical and chemical properties of the materials, related characterisation techniques, good laboratory practice, safety issues and applicable standards relating to specific testing of materials. The certified personnel shall also demonstrate good communication skills, both verbally and in writing.

Level 1 certified personnel shall be competent in at least one or more scientific testing instruments. The certified personnel shall be able to learn and operate at least one scientific testing instrument in routine or non-routine fashion including experimental set-up, verification of instruments, validation of results, and troubleshooting.

Level 1 certified personnel shall get approval from Level 3 and above certified personnel for the test methods and characterization techniques required for the investigation of materials.

Level 1 certified personnel shall not be responsible for the interpretation of test results and report writing, but they shall be allowed to verify the test results for internal usage. Level 1 certified personnel shall not have the authority to endorse (stamp) a report.

Level 1 certified personnel can act as “Expert Witness” according to the skills and knowledge as per Section 5, Table 2.

4.3. Certified Materials Failure Investigation Practitioner Level 2

Level 2 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 2 certified personnel shall be competent in at least three or more scientific testing instruments. The Level 2 certified personnel shall demonstrate good knowledge in at least three scientific testing instruments including basic operation of the instruments, standard methodology, data collection and data analysis. Level 2 certified personnel shall be able to troubleshoot, to verify the performance of instruments and to validate the accuracy of data collection.

Level 2 certified personnel shall propose test methods based on the available standards to carry out an investigation, but shall not modify the test method without approval from Level 3 and Level 4 certified personnel. Level 2 certified personnel are able to guide the Level 1 certified personnel.

Level 2 certified personnel shall not be responsible for the interpretation of test results and report writing. The Level 2 certified personnel shall verify the tests report by Level 1 certified personnel.

The Level 2 certified personnel shall work under the supervision of Level 3 and above certified personnel.

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

4.4. Certified Materials Failure Investigation Practitioner 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.

4.5. Certified Materials Failure Investigation Practitioner Level 4 (specialization)

Level 4 certified personnel shall possess the knowledge and experience to analyse results, evaluate data, draw conclusions and make recommendations.

Level 4 certified personnel shall have the authority to endorse the test results for external usage. The Level 4 certified personnel shall be able to verify the tests (both internal and external) reported by Level 1-3 certified personnel.

The Level 4 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 4 certified personnel shall have the required knowledge, skills and experience to act as an “Expert Witness” as per Section 5, Table 2.

4.6. Designation of Competence levels

Levels 1 to 4 are definitive terms. The Certification Body may use any appropriate name for the certification level. The eligibility for competence assessment for Levels 1 to 4 shall comply to ANNEX A, Table A.1.

4.7. Additional Assessment Requirements

The Certification Body may impose additional assessment requirements for assessing the competency of a Level 1 to 4 candidate to ensure the candidate has sufficient experience and expertise covering (i) the specific area of industry / range of industries, or (ii) specific materials / range of materials, or a combination of both.

5. REQUIREMENTS FOR COMPETENCE OF CERTIFIED PERSON

5.1. General

Certified personnel for competence levels 1 to 4 shall be knowledgeable in the **Knowledge Categories** and topics in Table 1 and shall be competent to undertake the tasks detailed in Table 2. The certified person shall have the knowledge and skill to properly and safely undertake these tasks, to understand their purposes, to recognize possible problems with their execution and the significance of the data arising from them.

All work by Level 1 and Level 2 certified persons shall be according to technical instructions issued by certified persons of Level 3 or Level 4. Higher-level certified person retains the responsibility for the work performed by lower-level certified person.

Certified person of a particular level shall not undertake tasks at a higher level, as defined in Table 2.

5.2. Knowledge Categories

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 For All Levels 1 - 4	Specific Topics for Level 1 & Level 2 Assessment
Specialization	**Materials**	
1	**Selection of Materials** • Understanding the importance of correct selection of materials for the right applications to avoid failures • Appreciation of what failures can occur should the wrong materials be selected for the respective applications	i. Selecting materials based on strength for structural facilities ii. Selecting materials for pipelines carrying different fluids iii. Selecting materials for corrosion and chemical resistance
2	**Properties of Materials** • Understanding what properties of materials are important to avoid failures • Appreciation of the various properties of materials and how they affect the performance of materials in their respective applications	i. Understanding mechanical and chemical properties of materials ii. Relationship of each material property to failure mechanisms
3	**Testing of Materials Failures** • Understanding the various types of testing methods required for failure investigation. The test methods include but not limited to	i. Knowledge of operating each type of materials testing equipment correctly ii. Sample preparation techniques for each test method

	○ Mechanical tests, such as hardness, tensile, impact tests ○ Chemical tests, such as optical emission spectroscopy, X-ray fluorescence, X-ray diffraction, energy dispersive spectroscopy ○ Visual examination ○ Micrography, such as scanning electron microscopy ○ Other required techniques • Appreciation of the correct and incorrect types of testing to be conducted during failure investigations • Appreciation of the test results and how to analyse the test results • Appreciation of the potential flaws in certain testing techniques	
4	**Failure Investigation Methodology** • Planning the investigation and understanding the preliminary actions to be taken • Appreciation of the equipment required for on-site and laboratory investigations • Understanding the difficulties associated with sample extraction and preservation • Predicting the testing required • Understanding the need for established standards • Understanding the need for established procedures • Writing the failure report	
5	**Failure Analysis** • Understanding the problems associated with data acquisition • Knowing when to use finite element analysis or other stress evaluation tools • Understand when there is a need for statistical analysis • Appreciation of root cause analysis techniques such as 5 Why's. FMEA etc. • Organising the data in tables and trees • Understanding the need for feedback of information into the investigation process	

6	**Writing Failure Investigation Reports** • Key elements of a failure investigation report • Avoid rushing into making conclusions • Compilation of different inputs (e.g. literature, process experts, asset owners, test data etc) from various sources where necessary	
7	**Other Factors that Influence Failure** • Process • Human factors • Act of nature • Biohazard	i. Factors in the Test Laboratory which can affect the results
8	**Standards and Codes of Practice relevant in materials failure investigation** • Understanding the importance of Standards and Codes of Practice in Materials Failure Investigation • Ability to identify important points in each Standard and Code of Practice • Ability to cross-reference between Standards and Codes of Practice	
9	**Health, Safety and Environmental issues relating to materials failure investigation tasks** • Safety of personnel in handling samples • Safety of personnel in handling test equipment • Safety of facilities while testing materials • Safety of personnel while investigating failure sites	
10	**Code of Ethics and Professional Conduct of Materials Failure Investigation persons** • Professionalism in conducting testing of materials with accurate reporting of results • Professionalism in conducting failure investigation with accurate reporting of findings • Non-compromise on Code of Ethics when reporting controversial results and findings	

	• Practice of impartiality in delivery of deductions and conclusions in technical report Free from corrupt practices	
11	**Interpersonal Communication Skills** • Ability to communicate instructions to subordinates clearly to avoid error in sample collection and testing • Ability to communicate effectively with peers to ensure collective agreement on the process of materials failure investigation • Ability to deliver technical presentation of results and findings clearly to audience • Ability to communicate findings and conclusions.	

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.

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 category 1-11 except 4, 5 and 6). Level 3 and Level 4 requires knowledge and skills to perform failure investigation (knowledge category 1-11).

5.3 Tasks to be fulfilled in all application sectors for Levels 1 to 4

Table 2 details the tasks for each level of competence from Levels 1 to 4.

Table 2: Tasks to be fulfilled by the various competency levels.

Task Number	Description of Task	Level 1	Level 2	Level 3	Level 4
1	Collect background information (such as drawings, type of materials, how it fails, when it fails, service history, etc.) and document them	Yes	Yes	Yes	Yes
2	Visit to failure site for further collection of information/evidence	Yes	Yes	Yes	Yes
3	Perform sample extraction on-site (e.g. soil/water sampling)	Yes	Yes	Yes	Yes
4	Collect/receive test sample from customer	Yes	Yes	Yes	Yes
5	Prepare technical instructions/proposal	No	Yes	Yes	Yes

6	Select test methods based on available Standards/Code of Practice	No	Yes	Yes	Yes
7	Ability to propose modified test methods	No	Yes	Yes	Yes
8	Perform calibration of equipment	No	No	No	No
9	Verify calibration of selected equipment(s)	No	Yes	Yes	Yes
10	Set up testing equipment and verify equipment settings	Yes	Yes	Yes	Yes
11	Perform checks on health, safety & environmental compliances before commencement of testing	Yes	Yes	Yes	Yes
12	Supervise the testing of materials work carried out by others	No	Yes	Yes	Yes
13	Understand the working principle and operation of equipment and machines performing the testing of materials	Yes (at least one)	Yes (at least three)	Yes (at least six)	Yes (at least six)
14	Troubleshoot selected equipment and machines performing the testing of materials	No	No	No	No
15	Perform sample preparation in a dedicated place (e.g. laboratory)	Yes	Yes	Yes	Yes
16	Record test data	Yes	Yes	Yes	Yes
17	Analyse test results	No	No	Yes	Yes
18	Report the data and test results	Yes (basic)	Yes (basic)	Yes (comprehensive)	Yes (comprehensive)
19	Verify and validate the data and test results conducted by others	No	No	Yes (Internal only)	Yes (Internal and external)
20	Perform risk assessment of health, safety & environmental requirements to conduct the testing and investigation	No	No	Yes	Yes
21	Monitor health, safety & environment compliances of the activities of testing and failure investigation	Yes	Yes	Yes	Yes
22	Perform failure investigation (determine damage mechanisms/mode of failure; determine root cause of failure)	No	No	Yes	Yes
23	Derive tentative conclusions from the data and test results	No	No	Yes	Yes
24	Provide corrective actions/suggestions to prevent recurrence (e.g. improve	No	No	Yes	Yes

	design and operating procedure, improve safety, increase reliability, etc.)				
25	Prepare full technical draft report for review and discussions	No	No	Yes	Yes
26	Prepare full technical final report for submission to customer	No	No	Yes	Yes
27	Authorized to stamp and sign on the test data and results (from third-party)	No	Yes	Yes	Yes
28	Authorized to stamp and sign on Full Technical Report	No	No	Yes	Yes
29	Authorized to act as an Examination Moderator (3.9)	No	No	Yes	Yes
30	Expert Witness (3.10) in the Court of Law. The testimony shall be relevant to the expertise of each level.	Yes	Yes	Yes	Yes
31	Provide full-course failure investigation training	No	No	Yes[#]	Yes
32	Train a trainer	No	No	Yes	Yes
33	Authorized to dispute an investigation case done by others	No	No	Yes	Yes

[#]Given enough work experience, Level 3 certified candidate can conduct partial or full-course in failure investigation training.

ANNEX A

(Normative)

CERTIFICATION SCHEME: ELIGIBILITY FOR COMPETENCE ASSESSMENT FOR LEVELS 1 TO 4.

A.1 General

The eligibility of Materials Failure Investigation person for competence assessment shall be demonstrated in sufficient detail by documentation giving personal information which includes a declaration of education, training and experience.

The competent Materials Failure Investigation person shall fulfil the requirements for materials failure investigation experience as defined in this section and shall pass the relevant assessment as detailed in Annex B.

A.2 Eye Acuity Test

When required, Materials Failure Investigation Person shall have an annual vision test to ensure natural or corrected near distance acuity in at least one eye such that the applicant is capable of reading a minimum Jaeger Number 2 or equivalent type and size letter at the distance designated on the chart but not less than 12 inches (30.5 centimetre) 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 should be conducted upon initial certification and at five-year intervals thereafter.

Vision examinations expire on the last day of the month of expiration.

A.3 Work Experience

The minimum requirements for duration of materials failure investigation work experience to be gained prior to certification shall not be less than that indicated in Table A.1. The time in these tables refers to a minimum of 25% activity in materials failure investigation. For example, 12 months' work experience shall refer to 25% of 40 working hours per week over 12 months.

Table A.1 is for candidates with and without previous materials failure investigation work experience to the knowledge and tasks as detailed in Section 5.

Tables A.1 is translated into a Process Flow Chart in Annex D.

Table A.1 – Minimum education and experience requirements for each level of candidates with and without previous certification.

Target Level	Education	Minimum experience in materials failure investigation
1	Technical vocational education (minimum Level 4), technician certificate or equivalent, plus specialized training and education in the field of materials.	Logbook + A
	SPM/STPM (requires basic mathematical skills) plus specialized training and education in the field of materials	Logbook + A
2	Technical vocational education (minimum Level 4), technician certificate or equivalent, plus specialized training and education in the field of materials.	Level 1 MFIP + 3r$^{\#}$ + 3m + logbook + A
	SPM/STPM (requires basic mathematical skills) plus specialized training and education in the field of materials	Level 1 MFIP + 3r$^{\#}$ + 3m + logbook + A
	Diploma plus specialized training and education in the field of materials	3r$^{\#}$ + 3m + logbook + A
3	Relevant engineering, technology, or scientific discipline degree plus specialized training and education in the field of materials	3r + 3m + logbook + A
4	Relevant engineering, technology, or scientific discipline degree plus specialized training and education in the field of materials	5r + 4m + dossier + PR

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

r$^{\#}$ having participated in the report as co-author or one of the contributors that leads to the success of investigation cases

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

A evaluation by Assessment Committee appointed by Certification body

PR assessment by Peer Review Panel appointed by Certification body

Logbook refers to a log of training acquired by candidate as listed out in section A.4

Dossier to refers to the list of documentation required as per Annex B Clause B.4.5

A.4 Training

A.4.1 Training for Levels 1, 2, and 3.

Materials failure investigation person shall provide documentary proof that they have completed a period of training covering the Knowledge Categories at the respective Level within 3 years prior to taking the certification examination/assessment. The training period, method and syllabus shall be sufficient in order to deliver the knowledge and skill as detailed in Section 5. Documentation may be retrospective. Training may be by the employer or through accredited course(s) at a training centre.

Training shall be delivered by persons at or above the Level of the training to be delivered. A logbook and proof of related trainings or certifications shall be kept by the candidate. They shall be stored in a centralized repository (e.g. IMM website) where the candidate can follow-up their development progress.

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

a). Level 1: documented on-the-job training[1] (in the form of logbook) relating to materials testing within 3 years prior to taking the certification examination/assessment

b). Levels 2 & 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

For all levels, candidate shall provide evidence of continuous professional development such as but not limited to attending or providing/delivering presentations at training courses, seminars, conferences, etc. relating to materials development / failure investigation / degradation and related subjects and/or active participation in technical committees of scientific societies or engineering societies or technological associations.

Materials failure investigation person without Level 1 certification shall undertake a minimum accumulative total of 10 days formal training for eligibility to take the Level 2 certification assessment.

At all Levels, training days shall include both practical, theory components and case studies either at own company premises or at external training facilities.

[1] The on-the-job training is related to their personal involvement and contribution in specific area of materials failure investigation

A.4.2 Training Centre

The establishment of a training centre is not mandatory. A training centre may be situated at an employer's premises or independently such as at universities.

A training centre shall provide the following components, any of which may be combined:

i. A demonstration and testing facility or laboratory or a workshop, with appropriate tools and equipment and/or scientific instruments, that allow candidates to undergo practical training and testing related to the failure investigation of materials
ii. A classroom having appropriate equipment and facilities for teaching the theoretical principles

All instruments, devices, equipment, test leads, probes, electrodes etc at the demonstration and testing facilities / laboratory / workshop shall be maintained in good condition and they shall be calibrated where applicable.

ANNEX B

(Normative)

CERTIFICATION SCHEME: EXAMINATION AND ASSESSMENT

B.1 General

Bodies performing certification of the competence levels of materials failure investigation persons shall be in accordance with ISO/IEC 17024 and shall establish a certification scheme as defined in that International Standard.

Demonstration of competence shall be achieved through examinations organized in an examination centre approved by the certification body.

B.2 Certification Scheme Development Committee

A Working Committee shall be established to prepare the documents for the certification scheme. The certification body shall appoint qualified and experienced individuals to prepare the documents for the certification examination including but not limited to the following list of documents:-

No.	Documents for Certification Scheme
1	Technical Standard for Certification of Skill Personnel if no international ISO, ASTM or other Skill Certification Standards are available
2	Examination Brochure for Level 1 Certification
3	Examination Brochure for Level 2 Certification
4	Examination Brochure for Level 3 Certification
5	Examination Brochure for Level 4 Certification
6	Examination Centre Facility & Equipment Check List
7	Schedule and Timetable of Theory and Practical Exams
8	Theory Examination Papers with Questions & Answers for each Level. A Question Bank shall be established
9	Practical Examination Paper for each Level. Pass/Fail Test Parameters/Criteria for Practical Examination (if required)
10	Peer Review Examination Paper for Level 4
11	Examiner and Invigilator Qualification Requirements and their Scope of Duties & Responsibilities
12	Costing Sheet for the Examination Fees covering fees for examiners, invigilators, paper markers, examination venue facilities, equipment provision for practical examination, and administrative costs of the certification body

Members of the Working Committee to develop the certification scheme documents shall be selected by the certification body and shall consist of persons whose terms of reference are such that the confidence of all interested parties as to its competence, impartiality and integrity shall be maintained. The Working Committee shall consist of at least six (6) members and the activities shall be coordinated by the certification body.

The prepared documents shall be vetted and approved by a Technical Review Committee consisting of at least three (3) technically-qualified personnel of minimum Level 3 certification or equivalent in qualifications and experience.
The vetted and approved sets of Questions and Answers shall be additionally reviewed by a team of Examination Moderators who shall check the Questions and Answers to ensure quality of assessment as required in the Standard will be met and that re-arrangement of questions into separate sets for the Question Bank will be carried out with consistency. The Examination Moderators shall also carry out periodic review of the Questions and Answers Bank to ensure the assessment take into account of updated and latest technologies and developments in the field. The Examination Moderators shall initiate an exercise to develop new Questions and Answers at least once every five (5) years to meet technology changes.

All final documents after final review and amendments shall be secured and filed by the Examination Committee of the Certification Body.

B.3 Assessment Committee

An Assessment Committee shall be established to review applications for certification and examination results. The Assessment Committee shall review candidate's application documentation, work history and other relevant information to determine the individual's competence and compliance with qualification requirements for any level. The Assessment Committee shall review and approve all examination results, including review of any appeals from candidates.

The Assessment Committee shall be appointed by the certification body and shall consist of persons whose terms of reference are such that the confidence of all interested parties as to its competence, impartiality and integrity shall be maintained.

The assessment committee shall consist of at least three members, all of them having the same or higher certification level of the examination to be assessed. All assessment committee members shall be minimum Level 2 and there shall be at least two with higher than Level 2 certification.

B.4 Examination and Assessments for Levels 1 to 4

B.4.1 General

The examination system shall be established and maintained in order to assess the competence in accordance to Section 5.

The knowledge topics and tasks listed in Section 5 shall be assessed either by theoretical or practical examination or both.

B.4.2 Examination Centre

An examination centre shall

a) have adequately qualified staff, suitable premises and sufficient equipment to ensure successful examinations for the levels concerned,
b) apply a documented quality management procedure,
c) have the resources needed to administer examinations, including the calibration and control of any equipment used,
d) prepare and conduct examinations under the responsibility of examiner(s),
e) use only test facilities suitable for the practical examinations conducted at the centre, and

f) include testing facilities to simulate the conditions that normally exist in real materials failure investigation activities.

B.4.3 Theoretical Examination Session for Levels 1 to 3

The theoretical examination session shall require candidates to demonstrate their knowledge and competence to undertake tasks in accordance with Section 5.

The theoretical examination session shall include a series of multiple choice and/or written questions on the principles, processes and failure investigation procedures used.

The time allowed for candidates to complete each examination shall be based upon the number and difficulty of the questions.

B.4.4 Practical Examination Session for Levels 2 to 3

A practical examination session organized on failed components or samples in physical and/or video/photo format shall be conducted. The practical examination may include oral assessment or interview to enable examiners to assess the candidate's competence. Candidates shall be required to demonstrate their competence to fulfil the requirements of Section 5.

B.4.5 Peer Review Examination Session for Level 4

Level 4 certified personnel shall be examined via a Peer Review conducted by at least three (3) examiners who have similar level with at least 10 years of experience each in the field of Materials Failure Investigation. The Peer Review will consist of a review of the candidate's dossier detailing and documenting the following:-

- Educational, scientific, or engineering qualifications.
- Examples of work documents, reports or technical papers prepared by the candidate to demonstrate the broad range of understanding and competence in all areas of materials failure investigation.
- Proof of Continuing Professional Development in the areas related to materials failure investigation.
- Participation in at least one technical committee in professional societies or associations in materials science and engineering fields within the last fifteen (15) years.
- Executed at least five (5) materials failure investigation projects with sole or primary responsibility within the last five (5) years. Candidates shall submit list of titles and brief descriptions of the failure investigation reports. The full reports shall not be submitted to the examination body. The candidates can show the full reports to examiners during the oral assessment. The full reports will not be retained by the examination body.

The dossier shall demonstrate compliance with all the requirements for the application for Level 4 Certification.

The dossier shall be verified by at least two validators from the candidate's past or present employers, clients, or Level 4 Certified Materials Failure Investigation Practitioners.

The Peer Review shall include a session for the candidate to demonstrate his/her knowledge and experience through presentation/demonstration to the examiners. The Peer Review session will be limited to three hours. The presentation on a particular aspect of the previous materials failure investigation case will be limited to 20 minutes with additional time for demonstration, if required.

B.4.6 Conduct of Examinations

At the examination centre, candidates shall present valid and unambiguous proof of identification (e.g. an identity card, passport or driving license that includes a photograph for verification) and an official notification of the examination, which shall be shown to the examiner or invigilator on demand.

Examinations shall be evaluated and approved by at least one examiner.

At least one examiner shall be responsible for grading the examination.

Examiners shall be impartial in accordance with ISO/IEC 17024. The risk resulting from the following situations has to be assessed and mitigated, for example if:

- the examiner has trained that person in the past two years
- the examiner is employed in the same company
- the examiner has a business relationship with the candidate

The examiners shall attest their independence in their assessment of the candidates and that all information received in the assessment process shall be maintained in confidence.

B.4.7 Grading of Examinations for Levels 1 to 3

At least one examiner shall be responsible for the grading of the examinations by comparison with model answers.

Each examination session and the overall examination shall have minimum pass grades in order that the theoretical knowledge and the practical competence required in Section 5 are properly verified. Candidates shall successfully complete each of the examination sessions.

The examination marking scheme should ensure that there is equal or greater weight allocated to the practical examination session in Level 1 and Level 2 than the theoretical examinations. For Level 3, the theoretical examinations should have equal or greater weight than the practical examination session.

In order that a candidate can be certified, the final grades on each examination shall not be less than the minimum score established by the certification body. The required passing scores shall be based on the difficulty of the examination process and the functionality required by industry of the persons considered to have passed the examinations. The minimum passing scores for each examination may be different.

The theoretical examination paper shall be marked separately from the practical examination paper in order to allow the candidate to re-sit one paper without re-sitting the other.

B.4.8 Assessment for Level 4

Level 4 certified personnel's dossier shall be reviewed and assessed by the **Peer Review Panel (3.14)** and approved for Level 4 certification. Upon approval, the Peer Review Panel shall submit its approval to the Assessment Committee (see Annex B.3) for final endorsement. The Peer Review shall include a session for the candidate to demonstrate his/her knowledge and experience through presentation/demonstration to the examiners. The Peer Review session will be limited to three hours. The presentation on a particular aspect of the previous materials failure investigation case will be limited to 20 minutes with additional time for demonstration, if required.

B.4.9 Final Assessment for Levels 1 to 4

Final assessment of competence of candidates shall be made by the assessment committee, which shall ensure the candidate's compliance with all requirements, including Annex A.

B.4.10 Re-assessment

Candidates failing for reasons of unethical behaviour shall wait for a period of time determined by the certification body before re-applying. Candidates who fail to obtain the pass grade required may retake any of the failed examination sessions (theory or practical) once, provided the re-examination takes place within 12 months after the original examination. Candidates who fail re-examination or do not take re-examination within 12 months may apply for and shall take the examination in accordance with the procedure established for new candidates.

B.5 COMPLAINTS AND APPEALS

Complaints and appeals shall be addressed in accordance with ISO/IEC 17024.

ANNEX C

(Normative)

CERTIFICATION SCHEME : CERTIFICATE, VALIDITY, RE-CERTIFICATION, TRANSITION PERIODS

C.1 Certificate

When materials failure investigation person is assessed to have fulfilled all certification requirements for the level, the certification body shall issue a document or certificate to that person indicating the satisfactory completion of all the requirements.

The certification body shall maintain sole ownership of the certificates. The certificate shall take the form of a letter and/or card or other medium, signed or authorized by a responsible member of the certification body.

The certificate shall be as required in ISO/IEC 17024 and shall contain, as a minimum, the following information:

- name of the certificated person;
- name of the certification body;
- scope of the certification detailing the level of certification;
- effective date of certification and date of expiry;
- reference to this Standards document number as the certification scheme;
- a unique identification.

The certificate shall be designed to reduce the risks of counterfeiting.

C.2 Validity

The period of validity of the certification shall be five (5) years for Level 1 to Level 3. For Level 4, the certification period shall be for life-time. The initial period of validity shall commence when all of the requirements for certification (training, experience, success in competence assessment) are fulfilled.

Certification shall become invalid at the option of the certification body e.g. after reviewing evidence of unethical behaviour incompatible with the certification procedures.

C.3 Re-certification

C.3.1 General

Re-certification shall be by submission every five years of documentary evidence of continued materials failure investigation work activity without significant interruption and updating of technical knowledge. In addition, continuing professional development and/or proof of work as defined in Clause C.3.2 shall be required.

C.3.2 Continuing Professional Development

Level 1 - 4 persons shall demonstrate their continued competence to meet the requirements of Section 5 by submission of proof of work and/or continuing professional development (CPD) records in accordance to the requirements specified by the certification body.

C.4 Transition Periods

C.4.1 Transition Period for Establishment of a Certification Body

The following requirements apply to the transition period for a certification body implementing the present certification scheme.

The transition period shall last not more than five (5) years after the establishment of the scheme.

In order to establish a certification scheme, or to extend an existing scheme, the certification body shall appoint trustees for the scheme.

The certification body shall consider in appointing the trustees the need to ensure that all participants of the Materials Failure Investigation Industry in a country proposed for inclusion in the scheme are adequately and ideally equally represented. The trustees should include representatives from, for example:

- Operating companies/Users with their own expertise;
- Materials Failure Investigation service companies;
- Materials Failure Investigation consulting companies and individuals;
- Academics with particular competence in materials failure investigation.

The certification body shall appoint a minimum of three trustees who shall not be from the same companies and who shall not be commercially or personally linked.

The trustees shall each at least be qualified above Level 2 certification persons and shall each have a minimum of ten years' experience in materials failure investigation.

The certification body and the trustees shall work together to establish the examination elements of the scheme in accordance with this document.

During the transition period, the examiners shall be appointed from the trustees. After the five years of transition period for the establishment of the scheme, examiners who have been formally assessed and certified to a higher level than Level 2 in accordance with Annex B shall be appointed.

During the transition period, the Assessment Committee shall comprise a minimum of five personnel, each with a minimum of ten years' experience in materials failure investigation, and shall, in addition, include representatives of the certification body.

C.4.2 Transition Period of Existing Certification Schemes and this document

Prior to the publication of this document, certifications that were awarded previously for the competence levels, are considered as fulfilling the requirements of this document.

Consequently, Certificates deemed as equivalent, shall be valid for a maximum period of two years after the publication of this document for acceptance for re-certification. At that time, individuals requiring certification or re-certification shall carry out the requirements of this document.

Equivalent certificates from other recognized and accredited certification bodies can be used to qualify for certain competence level of materials failure investigation in this document.

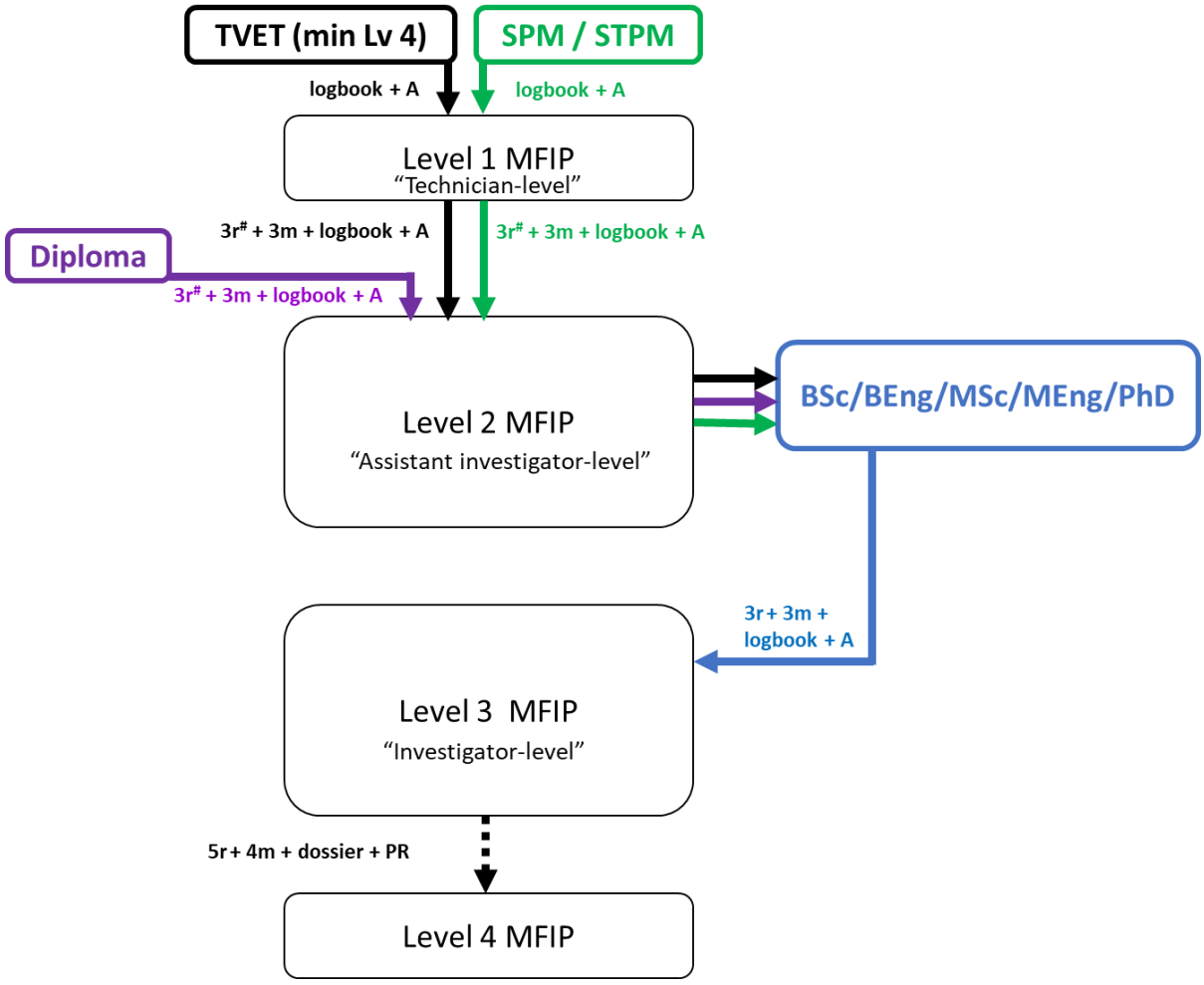
C.4.3 Transition Period for Existing Experienced Personnel

During the initial three (3) years of implementation of this Certification Scheme, personnel with sufficient experience and/or qualifications meeting the requirements specified in Annex A may apply for recognition of their experiences and/or qualifications to be awarded the respective Levels of Certification without any need to sit for the certification assessment nor examination. Their applications shall include evidence of work experience validated by the relevant organizations and/or referees which shall be reviewed by the Assessment Committee.

ANNEX D

(Normative)

CERTIFICATION PROCESS FLOW CHART



r	having prepared number of reports for materials failure investigation
r#	having participated in the report as co-author or one of the contributors that leads to the success of investigation cases
m	having been involved in failure investigation work covering different modes of failures
A	evaluation by Assessment Committee appointed by Certification body
PR	assessment by Peer Review Panel appointed by Certification body

Logbook refers to a log of training acquired by candidate as listed out in section A.4

Dossier to refers to the list of documentation required as per Annex B Clause B.4.5

ANNEX E

(Normative)

FACILITY CHECK LIST
MATERIALS FAILURE INVESTIGATION PRACTITIONERS CERTIFICATION ASSESSMENT

The Test Centre shall provide the following at its premise to conduct the Assessment and Examination for Certification of Materials Failure Investigation Practitioners Level 1, Level 2, Level 3, or Level 4. A Test Centre may conduct the assessment for only one level or all levels subject to their provision of facilities required for each level.

E.1 ASSESSMENT VENUE FOR ALL LEVELS (for theory & oral exams)

ITEM	DESCRIPTION	QUANTITY	CONDITION	
			ACCEPTABLE & REMARKS	NOT-ACCEPTABLE & REMARKS
1	Air-conditioned classroom with tables & chairs for examiners + 1 invigilator + all candidates			
2	Tables & chairs			
3	Writing paper & pen for each candidate			
4	Proper car parking & toilet facilities			
5	Proper security and safety at the premises			
6	Prayer room for Muslims			
7	Simple tea/coffee + refreshment & lunch for examiners, invigilator & all candidates if exam takes more than 6 hours			

Note: For Level 4 Peer Review Assessment, only the above facilities may be required. Peer Review Assessment can also be conducted via online platform.

E.2 VENUE FOR PRACTICAL ASSESSMENT FOR LEVELS 2 & 3.

ITEM	DESCRIPTION	QUANTITY	CONDITION	
			ACCEPTABLE & REMARKS	NOT-ACCEPTABLE & REMARKS
1	Air-conditioned classroom with tables & chairs for examiners + 1 invigilator + all candidates			
2	Writing paper & pen for each candidate			
3	Simple tea + refreshments & lunch for candidates + examiners + invigilator for full day assessment			
4	Mineral water: 3 bottles each for examiners, invigilator & candidates			
5	Covered workshop area for the Practical Assessment (Optional)			
6	Proper car parking & toilet facilities			
7	Prayer room for Muslims			
8	Proper security and safety at the premises			

E.3 MATERIALS TESTING EQUIPMENT FOR LEVEL 2 & 3 PRACTICAL ASSESSMENT

This section shall not be mandatory. These equipment and tools are recommended in the event such practical assessments have been designed into the examinations.

ITEM	DESCRIPTION	LEVEL 2	LEVEL 3
A	APPROPRIATE SAMPLE PREPARATION TOOLS (e.g. bandsaw cutting machine, diamond cutter machine)		
B	VISUAL EXAMINATION TOOLS (e.g. camera, microscope)		
C	CHEMICAL TESTING EQUIPMENT (e.g. ICP-OES, SEM-EDX, XRF, …)		
D	METALLURGICAL TESTING EQUIPMENT (e.g. polishing machine, etching chemicals, optical microscope, electron microscope, …)		
E	ACCESSORIES & TOOLS & CONSUMABLES		
1	Eye wash station or wash basin with water tap		
2	Fire extinguishers		
3	Work bench with stools		
4	Toolbox		
5	First aid kit		
6	Waste disposal area		
7	Cotton gloves		
8	Latex gloves		
9	Cotton rags		
10	Face masks		
11	Face shields or safety goggle		
12	Safety helmet		
13	Ear plugs		
14	Appropriate consumables and tools (e.g. polishing cloth, polishing paste with different grits, chemicals, …)		

E.4 MACHINE & EQUIPMENT OPERATORS

This section shall not be mandatory. These personnel are recommended in the event the equipment in Annex E Clause E.3 are required for the practical examinations.

Facility Provider shall provide one (1) or more Operators to oversee the operating of the equipment and machines during the practical assessment.

E.5 PERSONAL PROTECTIVE EQUIPMENT (PPE) FOR PRACTICAL ASSESSMENT

This section shall not be mandatory. These equipment and tools are recommended in the event the equipment in Annex E Clause E.3 are required for the practical examinations.

All candidates shall be notified to be equipped with their own PPE according to the facility environment requirement such as lab-coats (for laboratory), coverall (for workshop), safety goggles, safety helmet, safety shoes, and face masks throughout the practical assessment session. Appropriate safety equipment and tools shall be provided by the Test Centre.

BIBLIOGRAPHY

[1] ISO/IEC 17024, Conformity Assessment – General Requirements for Bodies Operating Certification of Persons.

[2]. ISO/IEC 17000, Conformity Assessment – Vocabulary and General Principles.

[3]. ISO-18436-2, Standard for Condition Monitoring and Diagnostics of Machines – Requirements for Qualification and Assessment of Personnel.

[4]. ISO-15257, Competency Levels of Cathodic Protection Persons : Basis for a Certification Scheme.

[5]. ISO 8044: Corrosion of Metals and Alloys – Basic terms and definitions.

[6]. ISO 17025: 2017 General requirements for the competence of testing and calibration laboratories

[7]. ISO 12107:2012 - Metallic Materials - Fatigue testing

[8]. ISO 16159:2012 - Facility, System and Equipment Failure Analysis

[9]. ISO 15589-1: Petroleum, Petrochemical and Natural Gas Industries – Cathodic Protection of Pipeline Systems – Part 1: On-land Pipelines.

[10]. ISO 15589-2: Petroleum, Petrochemical and Natural Gas Industries – Cathodic Protection of Pipeline Transportation Systems – Part 2: Offshore Pipelines.

[11]. ASTM G4-01 (2014): Standard Guide for Conducting Corrosion Tests in Field Applications.

[12]. ASTM G96-90 (2018): Standard Guide for Online Monitoring of Corrosion in Plant Equipment (Electrical and Electrochemical Methods).

[13]. ASTM G102-89 (2015): Standard Practice for Calculation of Corrosion Rates and Related Information from Electrochemical Measurements.

[14]. ASTM E-797 (2015): Standard Practice for Measuring Thickness by Manual Ultrasonic Pulse-Echo Contact Method.

[15]. ASTM D610 Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces in the list of reference standard

[16]. ASTM G 161 (2018) - Standard Guide for Corrosion Related Failure Analysis,

[17]. ASTM E8/E8M-22 - Standard test methods for tension testing of Metallic Materials

[18]. ASTM A 1351 (2020) - Standard Practise for Production and Evaluation of Field Metallographic Replicas

[19]. ASTM E 407 (2015e1)- Standard practise for microetching metals and alloys

[20]. ASTM A 370 (2024) - Standard Test Methods and Definitions for Mechanical Testing of Steel Products

[21]. ASTM D 638-14 - Standard Test method for tensile properties of Plastics

[22]. ASTM E18-22 - Standard Test methods for Rockwell hardness of metallic materials

[23]. ASTM E10-18 - Standard Test methods for Brinell hardness of metallic materials

[24]. ASTM E2332 Standard Practice for Investigation and Analysis of Physical Component Failures

[25]. NACE RP0497-2004: Standard Recommended Practice Field Corrosion Evaluation Using Metallic Test Specimens.

[26]. NACE SP0192-2012: Standard Practice Monitoring Corrosion in Oil and Gas Production with Iron Counts.

[27]. NACE SP0775-2018: Preparation and Installation of Corrosion Coupons and Interpretation of Test Data in Oilfield Operations.

[28]. NACE SP0104-2020: The Use of Coupons for Cathodic Protection Monitoring Applications.

[29]. NACE 3T199-2013: Techniques for Monitoring Corrosion and Related Parameters in Field Applications.

[30]. ASM Handbook (1987): Volume 13 – Corrosion, ASM International, Materials Park, Ohio, USA.

[31]. ASM Handbook (2021) Vol. 11: Failure Analysis and Prevention, ASM International, Materials Park, Ohio, USA.

[32]. ASM Handbook Vol. 9 - Metallography and Microstructures, ASM International, Materials Park, Ohio, USA.

[33]. ASM Handbook Vol. 10 - Materials Characterization, ASM International, Materials Park, Ohio, USA.

[34]. ASM Handbook Vol. 12 – Corrosion, ASM International, Materials Park, Ohio, USA.

[35]. EN 12495: Cathodic Protection of Fixed Steel Offshore Structures.

[36]. Stamatis, D. H. (2003). Failure mode and effect analysis : FMEA from theory to execution (2nd ed., rev. and expanded). ASQ Quality Press.

ACKNOWLEDGEMENTS

This IMM Skills Certification Standard was drafted by the IMM Materials Failure Investigation Practitioners Working Sub-Committee comprising of the following qualified and experienced professionals from both the IMM Education Committee and IMM Corrosion Committee:

Members of the IMM Materials Failure Investigation Practitioners Working Sub-Committee (2022-2024)

No.	NAME	DESIGNATION	ORGANIZATION
1	Abdul Rohim Said	Ir.	TNB Repair & Maintenance Sdn. Bhd.
2	Agus Geter Edy Sutjipto	Assoc. Prof. Dr.	Universiti Malaysia Pahang
3	Amirah Amalina Binti Ahmad Tarmizi	Dr.	Universiti Teknologi MARA
4	Anasyida Abu Seman @ Haji Ahmad	Assoc. Prof. Dr. Ir.	Universiti Sains Malaysia
5	Andrew Spowage	Assoc. Prof. Dr.	Queen Mary University of London
6	Andri Andriyana	Assoc. Prof. Dr.	Universiti Malaya
7	Ang Bee Chin	Assoc. Prof. Dr.	Universiti Malaya
8	Azzura Binti Ismail	Dr.	Universiti Tun Hussein Onn Malaysia
9	Basab Bhattacharya	Dr.	Element Materials Technology Spore Pte. Ltd.
10	Calvin Kok Wai Chee	Mr.	CSI Systems Sdn. Bhd.
11	Cheong Kuan Yew	Prof. Ir.	Universiti Sains Malaysia
12	Chew Khoon Hee	Ts. Dr.	Tunku Abdul Rahman University of Management and Technology
13	Chia Kok Chua	Mr.	PTTEP Malaysia
14	Ivy Cheong Hui Meng	Ms.	PETRONAS Carigali Sdn. Bhd.
15	Choong Wai Heng	Dr.	Universiti Malaysia Sabah
16	Douglas Grant Bennet	Mr.	Intertek ITS Testing Services (M) Sdn. Bhd.
17	Hasmaliza Mohamad	Assoc. Prof. Dr. Ts. Ir.	Universiti Sains Malaysia
18	Ismaliza Ismail	Dr.	Malaysian Rubber Board
19	Edwin Jong Nyon Tchan	Ir. Assoc. Prof. Dr.	AMW Technology Sdn. Bhd.
20	Kee Kok Eng	Dr.	Universiti Teknologi PETRONAS
21	Leow Chun Ho	Mr.	Sarawak Shell Berhad
22	Mahmood Anwar	Dr.	Curtin University Malaysia
23	Mariatti Jaafar @ Mustapha	Prof. Dr. Ir.	Universiti Sains Malaysia
24	Max Ong Chong Hup	Ir.	Norimax Sdn. Bhd.
25	Maxine Yee Swee Li	Asst. Prof. Dr.	University of Nottingham

			Malaysia
26	Muhamad Azizi Mat Yazid	Assoc. Prof. Ts. Dr.	Universiti Teknologi Malaysia
27	Nazatul Liana Binti Sukiman	Dr.	Universiti Malaya
28	Nigel Patrick Brewitt	Assoc. Prof. Eur-Ing.	MTIS Sdn. Bhd.
29	Nor Fazilah Abdullah	Puan	UCSI University
30	Nurjaimi Ali	Puan	PETRONAS GTS
31	Nurulakmal Mohd Sharif	Assoc. Prof. Dr.	Universiti Sains Malaysia
32	Nurul Fatah Asyqin	Dr.	Universiti Teknologi MARA
33	Ong Hock Guan	Ir.	Sarawak Shell Berhad
34	Puteri Sri Melor Binti Megat Yusoff	Assoc. Prof. Dr.	Universiti Teknologi PETRONAS
35	Rajkumar Durairaj	Prof. Ir. Dr.	Universiti Tunku Abdul Rahman
36	Raymond Lam Choong Meng	Ir.	PETRONAS Carigali Sdn. Bhd.
37	Sharifah Adzila Binti Syed Abu Bakar	Dr.	Universiti Tun Hussein Onn Malaysia
38	Siti Haslina Ramli	Puan	PETRONAS GTS
39	Suhaila Idayu Binti Abdul Halim	Dr.	Eco Power Synergy Sdn. Bhd.
40	Tan Su Anne	Ts.	PETRONAS GTS
41	Wan Mohd Arif Bin Wan Ibrahim	Ts.	Universiti Malaysia Perlis
42	Leoni Woo Hui Moi	Ts.	PETRONAS Carigali Sdn. Bhd.
43	Yoga Sugama Salim	Dr.	Cetim Asia Pacific Sdn. Bhd.
44	Yu Lih Jiun	Asst. Prof. Dr.	UCSI University