FIELD LUBRICANT ANALYST CERTIFICATION GUIDE

MIBoC Certification according
to ISO 18436-1 and 18436-4

CATEGORY I-III

MOBIUS INSTITUTE BOARD of CERTIFICATION

Mobius Institute Board of Certification

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Welcome

Thank you for your interest in Mobius Institute Board of Certification (MIBoC), an ISO/IEC accredited certification body having certified condition monitoring personnel from over 175 countries. MIBoC certification is delivered globally through MIBoC authorized examination centers. See our Authorized Partners Map to locate an authorized examination center near you.

In addition to receiving your certification through a MIBoC examination center, you also have the convenient option to sit your certification examination at a time and location of your choice using our secure online examination software.

When considering your field lubricant analysis certification provider, you can be assured that the certification provided by MIBoC does meet the ISO 18436 specification that field lubricant analysts are measured to.

Getting Started

MIBoC is here to help you. We have friendly and knowledgeable staff that will guide you along your way through your field lubricant analysis certification. Never hesitate to contact us with your questions. Because we serve customers through all world time zones, it is best to contact us by email at mobiussupport@mobiusinstitute.com and we will respond promptly with an email.

Thank you

We hope that this Certification Guide provides you with a good understanding of what field lubricant analysis certification is all about. If you have any further questions, please don't hesitate to contact us.

We wish you the greatest success as you educate yourself and become a certified Field Lubricant Analyst.

Contents

Introduction

This Certification Guide has been written to provide the reader with the essential information, in layman's terms, about the field lubricant analysis certification scheme of the Mobius Institute Board of Certification.

This guide also outlines a roadmap of MIBoC's field lubricant analysis certification, as well as the benefits which certification brings, and the requirements that need to be fulfilled to become certified.

This guide should be read in conjunction with the scheme documents, particularly the General Scheme Requirements (ED002) and the Field Lubricant Analysis Scheme Requirements (ED183). These documents can be downloaded from the website.

MIBoC's Field Lubricant Analysis Roadmap

MIBoC's scheme covers certification for Field Lubricant Analysis Category I, Category II and Category III. Our classification of the field lubricant analysis categories is based on those outlined in standard ISO 18436-4.

Field Lubricant Analysts who are certified through MIBoC should be justifiably proud of their achievements.

Field Lubricant Analyst Category I

Field Lubricant Analysts certified to Category I will have a good understanding of the fundamentals. They are qualified to perform field lubricant analysis according to established and recognized procedures. They will also be able to

- understand maintenance strategies, fundamentals of lubrication and lubricant selection.
- dispense, re-lubricate, and inspect lubricants,
- maintain lubrication devices and equipment,
- use sampling hardware,
- acquire lubricant samples from machine systems, equipment, and/or storage containers in accordance with established procedures.
- understand and apply onsite lubrication testing methodologies.
- prepare samples for transport and/or testing in accordance with established procedures
- understand effective filtration techniques.

Field Lubricant Analyst Category II

In addition to having the knowledge and capability of a Category I Field Lubricant Analyst, a Category II Field Lubricant Analyst is able to

- identify and select the appropriate lubricant, based on operating and environmental conditions.
- set up instruments for basic on-site testing,
- perform calibration checks,
- establish procedures for sample acquisition, preparation and transport,
- select sample point locations, methods and hardware,
- apply selected test methods for on-site testing and wear debris analysis,
- classify, interpret and evaluate basic test results,
- employ basic lubricant analysis techniques to troubleshoot,
- maintain a database of analysis schedules, results and diagnoses,
- prepare lubricant machine condition reports, recommend corrective actions,
- be aware of the use of alternative or supplementary condition monitoring technologies
- provide guidance and supervision to Category I personnel.

Field Lubricant Analyst Category III

In addition to having the knowledge and capability of a Category II Field Lubricant Analyst, a Category III Field Lubricant Analyst is qualified to perform and direct all types of field lubricant testing and analysis. They will also be able to

- design and develop an appropriate lubricant analysis program.
- interpret and evaluate test methods, select the appropriate machinery lubricant analysis technique,
- specify appropriate instrumentation hardware and software,
- design and manage calibration programs,
- establish lubricant monitoring programmes, perform advanced on-site test and wear debris analysis,
- classify, interpret and evaluate advanced test results and prepare reports
- perform Failure Mode, Effect and Criticality Analysis (FMECA),
- perform prognostics for fault conditions,
- evaluate the performance of outside lubricant analysis services
- make major maintenance corrective action recommendations and report on effectiveness of repairs/changes
- be able to manage condition monitoring programmes, evaluate alarm sets, write working procedures and specify accepted testing procedures
- recommend the use of alternative condition monitoring technologies,
- review accrued data on lubricants currently used and make recommendations of changes
- assess the influence of physical/chemical properties on the stability of rotor in bearings, turbine control systems, wear of gears and hydrodynamic seals
- provide guidance and supervision to Category I and II personnel.

About MIBoC

Mobius Institute began certifying Vibration Analysts in 2005.

The Mobius Institute Board of Certification (MIBoC) was formed in 2011 to provide independent and impartial certification for personnel involved in condition monitoring and diagnostics of machines.

In 2017 MIBoC expanded its certification scheme to include Infrared Thermography and Ultrasound, added Asset Reliability Practitioner certification in 2018, and Field Lubrication Analysis certification began in 2023.

MIBoC's aim is to provide access to asset reliability and condition monitoring certification around the world, and in as many languages as possible. We believe that if an analyst wants to become certified, they should not be impeded by location, language or socio-economic situation.

In 2012 MIBoC was formally accredited by the Joint Accreditation System of Australia and New Zealand (JAS-ANZ) to the international standard ISO/IEC 17024 to provide personnel certification in the condition monitoring field.

JAS-ANZ has formal arrangements with a number of international accreditation organizations including the International Accreditation Forum (IAF), the Pacific Accreditation Cooperation (PAC), the Asia Pacific Laboratory Accreditation Cooperation, and the European cooperation for Accreditation (EA).

Other IAF member organizations include ANSI in the United States, SAS in Switzerland, UK AS in the United Kingdom and the Korea Accreditation Board (KAB).

This means that certification through MIBoC is recognized internationally.

Committees

The activities and strategic direction of the Mobius Institute Board of Certification are governed by a management team and a number of committees which collectively represent the scheme's stakeholders.

Governing Body

The remit of the Governing Body is to ensure that the activities of the MIBoC Board, management team and committees meet the needs of the condition monitoring community, including employers, clients, vendors and training companies. Additionally, it is responsible for safeguarding the independence and impartiality of MIBoC at all levels, including its organizational structure, policies and procedures.

Scheme Committee

MIBoC's scheme committee is responsible for the development, review and approval of the organization's policies and procedures.

Members of the scheme committee represent stakeholders at a number of different levels, including condition monitoring functionality, industry and geographical region.

Technical Committee

MIBoC has established separate Technical Committees for each of the condition monitoring technologies in its certification scheme: Vibration Analysis, Thermography, Ultrasound, Asset Reliability and Field Lubricant Analysis.

Members of MIBoC's Technical Committees provide expertise on the technical aspects of the certification scheme, including

- the development, review and approval of the examination questions,
- the review and approval of training courses from other organizations,
- providing an escalation point for technical decisions relating to certification, appeals and complaints.

MIBoC's Certification Scheme

The field lubricant analysis certification program of the Mobius Institute Board of Certification is based on the requirements of international standards ISO/IEC 17024, ISO 18426-1 and ISO 18436-4:

- ISO/IEC 17024 is the ISO standard which outlines how personnel certification programs should be conducted in general.
- ISO 18436-1 is the ISO standard which outlines how personnel certification should be conducted specifically for personnel engaged in Condition Monitoring and Diagnostics of Machines.
- ISO 18436-4 is the ISO standard which outlines the technical requirements that are specific to certification of field lubricant analysts.

MIBoC's policies, processes and procedures are reviewed and approved by its committees to ensure that they are impartial and meet the needs of the various stakeholder groups. The certification program is reviewed regularly and updated when necessary to reflect changes in the ISO standards or requirements of industry.

Benefits of MIBoC Certification

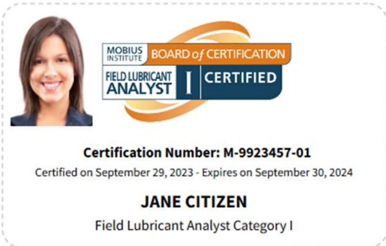
Certification is required by many employers, and a growing list of companies will not use consultants that have not been certified.

Certification by Mobius Institute Board of Certification is the most highly recognized certification available anywhere. MIBoC is recognized as certifying practical condition monitoring personnel, not just people with good memorization skills.

You do not need to be trained by Mobius Institute to obtain MIBoC certification. As long as you meet the training requirements outlined in this Guide (along with the other certification requirements), you will be eligible to apply for MIBoC certification.

We do not charge annual fees to maintain your certification. Once you have obtained your certification, you will not need to pay anything further until its expiry date when you may wish to renew it.

When you are certified by MIBoC you will receive a digital certificate and card as evidence of your qualification. You will also receive your own personalized certification logo, and (if you consent) your name will be displayed on our website's list of certified analysts.



Field Lubricant Analysis Certification Requirements

As per the requirements of ISO 18436-4, in addition to passing the certification exam, candidates for certification need to have a combination of education, training, and experience to ensure they understand the principles and procedures which apply to field lubricant analysis.

Education

Whilst candidates do not need to provide evidence of any formal education, it is recommended that candidates for Category I and II have at least secondary school graduation diploma or its equivalent.

Category II and III candidates must be able to manipulate simple algebraic equations, use a basic scientific calculator and be familiar with the operation of personal computers.

For Category III candidates it is highly recommended that they have successfully completed two or more years of mechanical technology or mechanical engineering at a college, university, or technical school.

Training

To be eligible for the MIBoC field lubricant analysis certification examination, candidates shall provide evidence of successful completion of approved training based on the requirements of Annex A and which follows the requirements of ISO 18436-3, or which is otherwise recognized by the MIBoC FLA

Technical Committee based on the Body of Knowledge specified in Annex A. The minimum training hours are specified in Table 1 below.

Table 1 – Minimum training (hours)

Category I	Category II	Category III
24	24	32

MIBoC recognizes a number of training courses as meeting the training requirements for certification. For a complete list of recognized courses, please refer to document ED182, which can be downloaded from our website.

If you have attended a course which covers the required topics outlined in the Body of Knowledge specified in Appendix A but is not listed as a recognized course in ED182, then you can still apply to have your training recognized by sending us details of the course and training provider, using form ED041.

In addition to the training hours shown in Table 1, it is recommended that candidates attend tribology and lubrication management training, of at least a similar duration to that specified in Table 1. If undertaken, the additional training should cover the design, installation and operation of lubrication and lubricant analysis systems and programmes, maintenance principles of machines and components, the failure modes and mechanisms associated with each principle, and the typical tribological aspects associated with each mechanism.

Examination

To be eligible for certification, candidates must pass the MIBoC field lubricant analysis certification examination. As per ISO 18436-4 the required pass mark is 70%.

For more details of the exam, please refer to the *Certification Examination* section below.

Experience & previous certification

Candidates must provide evidence of their practical work experience in the field of lubricant-analysis-based machinery condition monitoring.

Candidates will be asked to provide the contact details of a manager/supervisor who can verify the work experience details submitted by the candidate. The validation process for all categories requires the signature (or electronic sign-off) on the documentary evidence.

The minimum experience requirements are shown in Table 2 below.

Table 2 – Minimum experience (months)

Category I	Category II	Category III
12	24	36

Note: the experience months are based on 16 hours minimum per month of lubricant-analysis-based machinery condition monitoring experience.

Certification at Category II and III requires previous certification at the lower category.

Candidates applying for certification at Category II only, who have at least 36 months of verifiable field lubricant analysis work experience, may apply as mature candidates, allowing them to bypass (at MIBoC's discretion) the requirement of having to obtain previous certification at Category I.

Code of Ethics

Candidates certified by MIBoC are expected to maintain the highest standards of personal integrity, professional competence, and ethical principles, and will be required to agree to a Code of Ethics in accordance with ISO 18436-1.

Certification Exam

MIBoC certification examinations consist of a number of multiple-choice questions, selected from MIBoC's exam question database. The content is based on the Body of Knowledge specified in Annex A. The questions are of a practical nature yet test the candidate on the concepts and principles required to conduct field lubricant analysis. They may involve the interpretation of charts and plots. Simple mathematical calculations using a basic scientific calculator are required; a summary of common formulae will be provided with the exam questions if required.

The duration and the number of questions in MIBoC's certification examinations are outlined in Table 3 below.

Table 3 –Specifications of certification examinations by category

	Number of Questions	Exam Duration (hours)
Category I	70	2
Category II	100	3
Category III	100	3

Examination Development Process

MIBoC's certification examinations are developed and reviewed using a rigorous psychometric analysis process to ensure the fairness and validity of each exam.

The examination specification is based on the requirements of ISO 18436-4. All questions are reviewed and approved by members of the Field Lubricant Analysis Technical Committee to ensure they are fair, accurate and appropriate to the category.

Additionally, detailed analysis is carried out on the way the exam questions are answered by candidates to identify any potential anomalies or outliers.

How to apply for an exam

Candidates may sit for a certification examination at one of MIBoC's many Authorized Examination Centers (AECs) around the world. You will find a list of AECs and their contact details on our website.

If you are unable to get to an AEC location you may take the exam using our independent invigilation process, which allows you to take the exam at a date and location of your choice, supervised by an invigilator or proctor nominated by you. The invigilator **must** be someone who is independent and has no involvement or background in condition monitoring or reliability-based maintenance in any manner. Examples include a Human Resource Representative, Training Coordinator, University or Community College exam center.

Invigilated exams are taken in an online format only using our secure online platform.

To apply for an invigilated exam, please contact mobiussupport@mobiusinstitute.com.

Reporting of Results

Examination results are e-mailed directly to the candidate around 5-10 days after the examination is received at MIBoC's Australian office. Candidates will receive a score range indicating their performance in each of the sections on the exam, as well as an overall score range and a Pass/Fail result.

Due to privacy regulations, regardless of who paid for the certification application, results will be made available only to the candidate themselves. However, if the candidate consents, the exam score range will also be made available to the candidate's AEC where the exam was taken.

Special Consideration

Candidates may apply for accommodation of special needs, e.g., conditions which may require some form of consideration or compensation, such as language or disabilities. An example of compensation could be extended time for the candidate to complete the exam.

Accommodation for special needs is granted at MIBoC's discretion and candidates may apply using form ED033 which can be downloaded from our website.

Distribution of Certificates

Certificates and certification cards are issued digitally to successful candidates, who are notified by email. Issuing digital certificates usually occurs around 10-14 days after the examination results are sent to the candidate.

Appeals & Complaints

Candidates or other parties may lodge a complaint or appeal.

A complaint may be in the form of a criticism of MIBoC's policies/procedures or how these were carried out by MIBoC or an AEC.

An appeal can be lodged against a failure by MIBoC to certify, renew or re-certify a candidate, or against a decision by MIBoC to withdraw or cancel a candidate's certification. Details of the Appeals/Complaints process can be found on form ED007 which can be downloaded from our website.

Exam Resits

In the event that a candidate is unsuccessful in passing the certification examination, they can apply to re-sit the exam 30 days after the previous exam date.

A candidate who fails three consecutive attempts will be excluded from further examinations for a period of 12 months.

Renewal & Re-certification

The period of certification is 5 years. Within 6 months of the certification expiry date the candidate is able to apply to renew the certification for a further 5 years provided they can provide evidence of continued work experience in the field of field lubricant analysis for the previous five years without significant interruption.

Significant Interruption is defined as an absence from (or change of) work activity which prevents the holder of MIBoC certification from practicing the duties corresponding to the scope of the certification for a continuous period more than 365 days, or a number of periods exceeding two years.

NOTE: Legal holidays, or periods of sickness or courses of less than thirty days are not taken into account when calculating the interruption.

Certified analysts will be invited by e-mail (using the e-mail address specified by the candidate in the student database) to renew their certification.

Renewal of certification can be commenced through your own student profile under the renewals tab.

References

The following ISO standards can be obtained from the International Standards Organization Store at http://www.iso.org/iso/home/store.htm.

- ISO/IEC 17024 - Conformity assessment — General requirements for bodies operating certification of persons
- ISO 18436-1 - Condition monitoring and diagnostics of machines — Requirements for training and certification of personnel - Part 1: Requirements for certifying bodies and the certification process
- ISO 18436-3 - Condition monitoring and diagnostics of machines — Requirements for training and certification of personnel - Part 3: Requirements for training bodies
- ISO 18436-4 - Condition monitoring and diagnostics of machines — Requirements for Training and certification of personnel - Part 4: Field lubricant analysis

Appendix A – Body of Knowledge

Subject	Topics	CAT I	CAT II	CAT III
1. Maintenance strategies		**2.5**	**1**	**-**
1.1	Why machines fail	*		
1.2	The impact of poor maintenance on company profits	*		
1.3	The role of effective lubrication in failure avoidance	*		
1.4)	Fundamental aspects of Reliability- Centred Maintenance (RCM)		*	
1.5	Aspects of Condition-Based Maintenance (CBM)		*	
1.5.a)	Predictive maintenance strategies		*	
1.5.b)	Proactive maintenance strategies		*	
1.5.c)	Lubrication routes and scheduling	*		
1.5.d)	Lubricant analysis and technologies to ensure lubrication effectiveness	*		
1.5.e)	Equipment tagging and identification	*		
2. Lubrication theory and fundamentals		**4**	**1**	**6.5**
2.1	Fundamentals of tribology	*		
2.2	Functions of a lubricant	*	*	
2.3	Lubrication regimes	*	*	*
2.3.a)	Hydrodynamic	*	*	*
2.3.b)	Elasto-hydrodynamic	*	*	*
2.3.c)	Boundary	*	*	*
2.4	Base Oils	*	*	*

Subject	Topics	CAT I	CAT II	CAT III
2.4.a)	Functions	*	*	
2.4.b)	Properties	*	*	
2.4.c)	Characteristics, advantages, and disadvantages	*	*	*
2.5	Additive functions	*	*	*
2.5.a)	Antioxidants/oxidation inhibitors	*		*
2.5.b)	Rust inhibitors			*
2.5.c)	Corrosion inhibitors			*
2.5.d)	Demulsifying agents			*
2.5.e)	Viscosity index (VI) improvers	*	*	*
2.5.f)	Detergents	*	*	*
2.5.g)	Dispersants			*
2.5.h)	Pour-point depressants			*
2.5.i)	Foam inhibitors			*
2.5.j)	Anti-wear (AW) agents	*		*
2.5.k)	Extreme pressure (EP) agents	*		*
2.6	Oil lubricant physical, chemical, and performance properties and classifications	*		
2.7	Grease lubrication	*		
2.7.a)	How grease is made	*		
2.7.b)	Thickener types	*		
2.7.c)	Thickener compatibility	*		*
2.7.d)	Grease lubricant physical, chemical, and performance properties and classifications	*		*
2.8	Solid lubrication	*		
2.8.a)	Types of solid lubricant	*		
2.8.b)	Mechanisms of solid lubrication	*		
2.8.c)	Pressure-velocity (PV) factor equation	*		*
2.8.d)	Specific wear rate equation	*		*
2.9	Gas lubrication	*		
2.9.a)	Advantages of gas lubricated bearings	*		
2.9.b)	Properties of lubricating gases	*		
2.10	Classification systems	*		
2.10.a)	Viscosity (ISO/SAE)	*		
2.10.b)	Grease consistency (NLGI)	*		
2.10.c)	Engine (API/ILSAC)	*		
2.10.d)	API automotive gear oil classification	*		

Subject	Topics	CAT I	CAT II	CAT III
2.10.e)	ATF classifications	*		
2.10.f)	Automatic brake fluid classifications	*		
2.10.g)	AGMA gear classifications	*		
2.10.h)	AGMA gear coupling classifications	*		
2.10.i)	Turbine oil classifications (BSI, DIN, GE, ABB)	*		
2.10.j)	Hydraulic fluids (ISO, Factory Mutual fire resistance grading system, ASTM, various components/system OEM performance specifications)	*		
2.10.k)	USDA/FSIS and NSF food-grade lubricant classification	*		
3. Lubricant selection		**2.5**	**-**	**-**
3.1	When to choose/advantages and disadvantages of: oil, grease	*		
3.2	When to choose/advantages and disadvantages of: solid, gas	*		
3.3	Viscosity selection	*		
3.4	Base-oil type selection	*		
3.5	Additive system selection	*		
3.6	Grease thickener selection	*		
3.7	Machine-specific lubricant requirements	*		
3.7.a)	Hydraulic systems	*		
3.7.b)	Plain bearings	*		
3.7.c)	Rolling element bearings	*		
3.7.d)	Journal bearings	*		
3.7.e)	Reciprocating engines	*		
3.7.f)	Gearing and gearboxes	*		
3.7.g)	Ropes	*		
3.7.h)	Chains	*		
3.7.i)	Steam turbines	*		
3.7.j)	Gas turbines	*		
3.7.k)	Internal combustion engines	*		
3.7.l)	Compressors	*		
3.8	Application and environment-related adjustments	*		
4. Principles of lubricant application		**2.5**	**-**	**-**
4.1	Effective use of manual delivery techniques	*		
4.2	Automatic delivery systems	*		
4.2.a)	Distributed delivery systems	*		
4.2.b)	Automated lubricators	*		
4.2.c)	Maintenance of automated lubrication systems	*		

Subject		Topics	CAT I	CAT II	CAT III
5. Lubricant storage & management			**2.5**	**-**	**-**
5.1		Lubricant receiving procedures	*		
5.2		Proper storage and inventory management	*		
5.3		Lubricant storage containers	*		
5.4		Proper storage of grease guns and other lubricant application devices	*		
5.5		Maintenance of automatic grease systems	*		
5.6		Health and safety assurance	*		
6. Lubricant contamination measurement and control			**2.5**	**6**	**-**
6.1		Particle contamination		*	
6.1.a)		Effects on the machine		*	
6.1.b)		Effects on the lubricant		*	
6.1.c)		Methods and units for measuring particle contamination		*	
6.1.d)		Techniques for controlling particle contamination		*	
6.2		Moisture contamination		*	
6.2.a)		Effects on the machine		*	
6.2.b)		Effects on the lubricant		*	
6.2.c)		States of coexistence		*	
6.2.d)		Methods and units for measuring moisture contamination		*	
6.2.e)		Demulsibility measurement		*	
6.2.f)		Techniques for controlling moisture contamination		*	
6.3		Glycol coolant contamination		*	
6.3.a)		Effects on the machine		*	
6.3.b)		Effects on the lubricant		*	
6.3.c)		Methods and units for measuring glycol contamination		*	
6.3.d)		Techniques for controlling glycol contamination		*	
6.4		Soot contamination		*	
6.4.a)		Effects on the machine		*	
6.4.b)		Effects on the lubricant		*	
6.4.c)		Methods and units for measuring soot contamination		*	
6.4.d)		Techniques for controlling soot contamination		*	
6.5		Fuel contamination (fuel dilution in oil)		*	
6.5.a)		Effects on the machine		*	
6.5.b)		Effects on the lubricant		*	
6.5.c)		Methods and units for measuring fuel contamination		*	
6.5.d)		Techniques for controlling fuel contamination		*	

Subject	Topics	CAT I	CAT II	CAT III
6.6	Air contamination (air in oil)		*	
6.6.a)	Effects on the machine		*	
6.6.b)	Effects on the lubricant		*	
6.6.c)	States of coexistence		*	
6.6.d)	Methods and units for measuring air contamination		*	
6.6.e)	Techniques for controlling air contamination		*	
6.7	Filtration and separation technologies	*		
6.8	Filter rating	*		
6.9	Filtration system design and filter selection	*		
7. Oil Sampling		**2.5**	**7**	**-**
7.1	Objectives for lubricant sampling	*		
7.2	Equipment-specific sampling		*	
7.2.a)	Gearboxes with circulating systems		*	
7.3	Sampling methods	*	*	
7.3.a)	Non-pressurized systems		*	
7.3.b)	Pressurized systems – low		*	
7.3.c)	Pressurized systems – high		*	
7.4	Managing interference	*	*	
7.4.a)	Bottle cleanliness and management	*	*	
7.4.b)	Flushing	*	*	
7.4.c)	Machine conditions appropriate for sampling	*	*	
7.5	Sampling process management	*	*	
7.5.a)	Sampling frequency	*	*	
7.5.b)	Sampling procedures (to include sampling point selection)	*		
7.5.c)	Sample processing	*		
8. Lubricant health monitoring, diagnostics, prognostics, and generic maintenance recommendations		**2.5**	**5**	**8**
8.1	Lubricant failure mechanisms	*	*	*
8.1.a)	Oxidative degradation – the process, causes, and effects	*	*	*
8.1.b)	Oxidative degradation – at-risk lubricants and applications; strategies for deterring it; strengths, limitations, and applicability of tests used to detect and troubleshoot oxidation (AN, viscosity, FTIR, RPVOT, sensory inspection)			*
8.1.c)	Thermal degradation – the process, causes, and effects	*	*	*
8.1.d)	Thermal degradation – strengths, limitations, and applicability of tests used to detect and troubleshoot thermal failure (AN, viscosity, FTIR, thermal stability test, ultracentrifuge detection of carbon insolubles, sensory inspection)			*

Subject	Topics	CAT I	CAT II	CAT III
8.1.e)	Additive depletion/degradation – mechanisms; additives at risk	*	*	*
8.1.f)	Additive depletion/degradation – risk assessment for common mechanisms (neutralization, shear down, hydrolysis, oxidation, thermal degradation, water washing, particle scrubbing, surface adsorption, rubbing contact, condensation settling, filtration, aggregate adsorption, evaporation, centrifugations); strengths, limitations, and applicability of methods for measuring additive depletion/degradation (atomic emission spectroscopy, FTIR, AN, BN, VI, RPVOT, blotter spot test)			*
8.1.g)	Testing for wrong or mixed lubricants (base-lining physical and chemical properties test, additive discrepancies)	*	*	*
8.1.h)	Fluid properties test methods and measurement units – viscosity (kinematic and absolute, VI), AN/BN, elemental spectroscopy, FTIR, RPVOT, atomic emission spectroscopy, other tests	*	*	*
9. Wear debris monitoring and analysis		**1**	**4**	**11.5**
9.1	Common machine wear mechanisms	*	*	*
9.1.a)	Abrasive wear: two-body and three-body abrasive wear	*	*	*
9.1.b)	Surface fatigue: two-body and three-body	*	*	*
9.1.c)	Adhesive wear	*	*	*
9.1.d)	Corrosive wear	*	*	*
9.1.e)	Fretting wear	*		*
9.1.f)	Erosive wear	*		*
9.1.g)	Electrical wear		*	*
9.1.h)	Cavitation wear: gaseous and vaporous cavitation		*	*
9.2	Common machine-specific wear modes			*
9.2.a)	Gearing			*
9.2.b)	Plain bearings			*
9.2.c)	Rolling element bearings			*
9.2.d)	Hydraulics			*
9.3	Wear particle types, origins, and probable causes	*		*
9.3.a)	Cutting wear particles			*
9.3.b)	Spherical particles			*
9.3.c)	Chunky particles			*
9.3.d)	Laminar particles			*
9.3.e)	Red oxide particles			*
9.3.f)	Black oxide particles			*
9.3.g)	Corrosion particles			*
9.3.h)	Non-ferrous particles			*

Subject	Topics	CAT I	CAT II	CAT III
9.3.i)	Friction polymers			*
9.4	Wear debris analysis techniques	*	*	*
9.4.a)	Ferrogram preparation		*	
9.4.b)	Filtergram preparation		*	
9.4.c)	Light effects		*	*
9.4.d)	Magnetism effects		*	*
9.4.e)	Heat treatment		*	*
9.4.f)	Chemical treatment		*	*
9.4.g)	Morphology		*	*
9.4.h)	Surface detail		*	*
9.5	Atomic emission elemental spectroscopy		*	*
9.5.a)	Basic determination of wear particle metallurgy from elemental composition			*
9.5.b)	Evaluating sequential trends			*
9.5.c)	Evaluating lock-step trends			*
9.5.d)	Particle size limitation of common atomic emission spectrometers			*
9.5.e)	ICP spectroscopy		*	
9.5.f)	Arc-spark emission spectroscopy		*	
9.5.g)	Wear particle density measurement		*	
9.5.h)	Advanced techniques (acid/micro-wave digestion, rotrode filter spectroscopy)			*
9.5.i)	X-ray fluorescence (XRF) and other advanced elemental spectroscopy methods			*
10. Lubricant analysis programme development and programme management		**-**	**-**	**6**
10.1	Machine-specific test slate selection			*
10.2	Optimizing frequency of analysis			*
10.3	Setting alarms and limits			*
10.3.a)	Setting goal-based limits for contamination			*
10.3.b)	Statistically derived level limits: editing data, calculating averages and standard deviation, setting upper and lower limits using the mean and standard deviation, how changes in system operation or maintenance influence statistically derived inferences			*
10.3.c)	Rate-of-change limits: calculating rate of change, slope-based alarms, statistically derived rate-of-change limits			*
10.3.d)	Setting aging limits for fluid properties: physical, chemical, and additive properties			*
10.3.e)	Trend analysis			*

Subject	Topics	CAT I	CAT II	CAT III
10.4	Managing lubricant analysis information			*
10.5	Creating and managing lubricant analysis procedures			*
10.6	Scoping lubricant analysis training and examination for reliability technicians, trades people, and management			*
10.7	Performing cost/benefit analysis for lubricant analysis and contamination control programmes			*
10.7.a)	Calculating programme costs			*
10.7.b)	Estimating programme benefits			*
10.7.c)	Calculating return on investment metrics			*
10.7.d)	Generating an effective business proposal			*
10.8	Quality assurance			*
10.8.a)	Of on-site lubricant analysis			*
10.8.b)	Of off-site lubricant analysis providers			*
TOTAL HOURS		**24**	**24**	**32**
Note 1: Category II includes the knowledge of Category I; Category III includes the knowledge of Category I and II. Note 2: * indicates topics to be taught at indicated category.				