Lubrication Certification Requirements for ICML Certifications including:

- MLA I, II, III

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ICML

The International Council for Machinery Lubrication (ICML) is a vendor-neutral, not-for-profit organization founded to serve global industry as the world-class authority on machinery lubrication that advances the optimization of asset reliability, utilization and costs.

Scope

ICML was originally established to be a vehicle for the exchange of ideas and best practices, to assure the skills of those who work in our field, to recognize excellence and accomplishments, and to invite new participants to join our industry.

Today they support individuals and organizations through programs that strengthen machinery lubrication and oil analysis as technical fields of endeavor. They are a certification body, a standards body, a membership body, and an awards body.

Skills-based Testing and Certification

Certification is the mark of a professional. It helps to ensure that individuals who practice a craft, be it lubricant analysis or medicine, have a defined measure of skills. For the field of machine lubrication, formal certification serves these three vital purposes:

- Creates a formal framework of knowledge
- Raises the profiles of those working in the field
- Provides managers with assurance of skills

ICML – MLA I

Level I, MLA (Machine Lubricant Analyst ISO 18436-4, I)

Education and/or Experience - Candidates must have at least 12 months experience in the field of lubricant-analysis-based machinery condition monitoring (based on 16 hours minimum per month of experience).

Training - Candidate must have received 24 hours of documented formal training as outlined in the Body of Knowledge of the MLA I. For online or recorded training, exercises, lab tasks, practice exams, and review exercises may be included in the training time total but shall not exceed four hours of the required course time. Candidate shall be able to provide a record of this training to ICML that shall include the candidate's name, the name and signature of the instructor, the dates of the training, and the number of hours spent in the training.

Note: ICML does not require, recommend, endorse or authorize any specific training course as official or approved. It is the responsibility of each candidate to research the training options available in his/her area and make a decision as to the training provider of his/her choice. ICML recommends the outline of the course of choice be compared to the exam's Body of Knowledge. It is in the person's best interest and their responsibility as an ICML candidate to ensure they are being trained in the same subject areas in which they will be tested. ICML's Bodies of Knowledge are of public domain and can be utilized by companies in the development of courses, as well as by any prospective candidate for evaluating the appropriateness of chosen training.

Examination - Each candidate must successfully pass a 100 question, multiple-choice examination that evaluates the candidate's knowledge of the topic. Candidates have three hours to complete the closed-book examination. A score of 70% is required to pass the examination and achieve certification. Contact ICML about the availability of the exam in other languages.

Body of Knowledge MLA I

The Level I MLA Body of Knowledge is an outline of concepts that a candidate shall have in order to pass the exam, in accordance with ISO 18436-4, Category I, Annex A.

References from which exam questions were derived can be found in the Domain of Knowledge.

I. Maintenance Strategies (10%)

A. Why machines fail
B. The impact of poor maintenance on company profits
C. The role of effective lubrication in failure avoidance
D. Lube routes and scheduling
E. Oil analysis and technologies to assure lubrication effectiveness.
F. Equipment tagging and identification.

II. Lubrication Theory/Fundamentals (18%)

A. Fundamentals of tribology
B. Functions of a lubricant
C. Hydrodynamic lubrication (sliding friction)
D. Elasto-hydrodynamic lubrication (rolling friction)
E. Mixed-film lubrication
F. Base-oils
G. Additives and their functions
H. Oil lubricant physical, chemical and performance properties and classifications.
I. Grease lubrication
   1. How grease is made
   2. Thickener types
   3. Thickener compatibility
   4. Grease lubricant physical, chemical and performance properties and classifications.

III. Lubricant Selection (10%)

A. Viscosity selection
B. Base-oil type selection
C. Additive system selection
D. Machine specific lubricant requirements
   1. Hydraulic systems
   2. Rolling element bearings
   3. Journal bearings
   4. Reciprocating engines
   5. Gearing and gearboxes
E. Application and environment related adjustments.

IV. Lubricant Application (18%)

A. Basic calculations for determining required lubricant volume.
B. Basic calculations to determine re-lube and change frequencies.
C. When to select oil; when to select grease.
D. Effective use of manual delivery techniques.
E. Automatic delivery systems.
1. Automated deliver options.
a) Automated grease systems
b) Oil mist systems
c) Drip and wick lubricators
2. Deciding when to employ automated lubricators.
3. Maintenance of automated lubrication systems.

V. Lube Storage and Management (10%)

A. Lubricant receiving procedures.
B. Proper storage and inventory management.
C. Lube storage containers
D. Proper storage of grease-guns and other lube application devices.
E. Maintenance of automatic grease systems.
F. Health and safety assurance.

VI. Lube Condition Control (10%)

A. Filtration and separation technologies.
B. Filter rating.
C. Filtration system design and filter selection.

VII. Oil Sampling (10%)

A. Objectives for lube oil sampling
B. Sampling methods
C. Managing interference
1. Bottle cleanliness and management
2. Flushing
3. Machine conditions appropriate for sampling

VIII. Lubricant health monitoring (10%)

A. Lubricant failure mechanisms
1. Oxidative degradation
a) The oxidation process
b) Causes of oxidation
c) Effects of oxidative degradation
2. Thermal degradation
a) The thermal failure process
b) Causes of thermal failure
c) Effects of thermal degradation
3. Additive depletion/degradation
a) Additive depletion mechanisms
b) Additives at risk for depletion/degradation by the various mechanisms.
B. Testing for wrong or mixed lubricants

1. Baselining physical and chemical properties tests
2. Additive discrepancies

C. Fluid properties test methods and measurement units - applications and limitations.

1. Kinematic Viscosity (ASTM D445)
2. Absolute (Dynamic) Viscosity (ASTM D2893)
3. Viscosity Index (ASTM D2270)
4. Acid Number (ASTM D974 et al)
5. Base Number (ASTM D974 et al)
6. Fourier Transform Infrared (FTIR) analysis
7. Rotating Pressure Vessel Oxidation Test (ASTMD2272)
8. Atomic Emission Spectroscopy

IX. Wear Debris Monitoring and Analysis (4%)

A. Common machine wear mechanisms

ICML – MLA II

Level II, MLA (Machine Lubricant Analyst ISO 18436-4, II)

Education and/or Experience - Candidate must have 24 months experience in the field of lubricant-analysis-based machinery condition monitoring (based on 16 hours minimum per month of experience). This represents a minimum of 384 hours spread consistently over two years.
Complete one of these requirements:

- Hold Level I Machine Lubricant Analyst (MLA) certification or
- Qualify as a Mature Entry Candidate (without Level I MLA certification) by submitting documentation of: At least 576 hours additional work experience in the field of lubricant-analysis-based machinery condition monitoring. This brings total work hours to 960 when combined with the 384 hours already listed above.
  Minimum 24 hours training relevant to the MLA I Body of Knowledge, accumulated through any combination of instructor-led events (such as workshops, seminars, or classes) and/or specific hands-on practice or observation.

Training - Candidate must have received 24 hours of documented formal training as outlined in the Body of Knowledge of the MLA II. For online or recorded training, exercises, lab tasks, practice exams, and review exercises may be included in the training time total but shall not exceed four hours of the required course time. These 24 hours are in addition to the previous 24 hours of training required for MLA I or Mature Candidate Entry, for a total cumulative training of 48 hours. Candidate shall be able to provide a record of this training to ICML that shall include the candidate's name, the name and signature of the instructor, the dates of the training, and the number of hours spent in the training.

Note: ICML does not require, recommend, endorse or authorize any specific training course as official or approved. It is the responsibility of each candidate to research the training options available in his/her area and make a decision as to the training provider of his/her choice. ICML recommends the outline of the course of choice be compared to the exam's Body of Knowledge. It is in the person's best interest and their responsibility as an ICML candidate to ensure they are being trained in the same subject areas in which they will be tested. ICML's Bodies of Knowledge are of public domain and can be utilized by companies in the development of courses, as well as by any prospective candidate for evaluating the appropriateness of chosen training.

Examination - Each candidate must successfully pass a 100 question multiple choice examination that evaluates the candidate's knowledge of the topic. Candidates have three hours to complete the closed-book examination. A score of 70% is required to pass the examination and achieve certification. Contact ICML about the availability of the exam in other languages.

Body of Knowledge MLA II

The Level II MLA Body of Knowledge is an outline of concepts that a candidate shall have in order to pass the exam, in accordance with ISO 18436-4, Category II, Annex A.

References from which exam questions were derived can be found in the Domain of Knowledge.

I. Lubricant roles and functions (4%)

A. Base oil
   1. Functions
   2. Properties

B. Additive functions
   1. Surface active additives and their functions
   2. Bulk oil active additives and their functions

C. Synthetic lubricants
   1. Synthetic lubricant types
   2. Conditions dictating their use

D. Lubrication regimes
   1. Hydrodynamic
   2. Elasto-hydrodynamic
   3. Boundary

II. Oil Analysis Maintenance Strategies (4%)

A. Fundamental aspects of Reliability-Centered Maintenance (RCM)

B. Fundamental aspects of Condition-Based Maintenance (CBM)
   1. Predictive maintenance strategies
   2. Proactive maintenance strategies

III. Oil Sampling (29%)

A. Objectives for lube oil sampling

B. Equipment specific sampling:
   1. Gearboxes with circulating systems
   2. Engines
   3. Single and multi-component circulating oil systems with separate reservoirs
   4. Hydraulic systems
   5. Splash, ring and collar lubricated systems

C. Sampling methods
   1. Non-pressurized systems
   2. Pressurized systems - Low
   3. Pressurized systems - High

D. Managing interference
   1. Bottle cleanliness and management
   2. Flushing
   3. Machine conditions appropriate for sampling

E. Sampling process management
   1. Sampling frequency
   2. Sampling procedures
   3. Sample processing

IV. Lubricant health monitoring (21%)

A. Lubricant failure mechanisms
   1. Oxidative degradation
      a) The oxidation process
      b) Causes of oxidation
      c) Effects of oxidative degradation
   2. Thermal degradation
      a) The thermal failure process
      b) Causes of thermal failure
      c) Effects of thermal degradation
   3. Additive depletion/degradation
      a) Additive depletion mechanisms
      b) Additives at risk for depletion/degradation by the various mechanisms.

B. Testing for wrong or mixed lubricants
   1. Baselining physical and chemical properties tests
   2. Additive discrepancies

C. Fluid properties test methods and measurement units
   1. Kinematic Viscosity (ASTM D445)
   2. Absolute (Dynamic) Viscosity (ASTM D2983)
   3. Viscosity Index (ASTM D2270)
   4. Acid Number (ASTM D974 et al)
   5. Base Number (ASTM D974 et al)
   6. Fourier Transform Infrared (FTIR) analysis
   7. Rotating Pressure Vessel Oxidation Test (ASTMD2272)
   8. Atomic Emission Spectroscopy

V. Lubricant contamination measurement and control (25%)

A. Particle contamination
   1. Effects on the machine
   2. Effects on the lubricant
   3. Methods and units for measuring particle contamination
   4. Techniques for controlling particle contamination

B. Moisture contamination
   1. Effects on the machine
   2. Effects on the lubricant
   3. States of coexistence
   4. Methods and units for measuring moisture contamination
   5. Demulsibility measurement
   6. Techniques for controlling moisture contamination

C. Glycol coolant contamination
   1. Effects on the machine
   2. Effects on the lubricant
   3. Methods and units for measuring glycol contamination
   4. Techniques for controlling glycol contamination

D. Soot contamination
   1. Effects on the machine
   2. Effects on the lubricant
   3. Methods and units for measuring soot contamination
   4. Techniques for controlling soot contamination

E. Fuel contamination (fuel dilution in oil)
1. Effects on the machine
2. Effects on the lubricant
3. Methods and units for measuring fuel contamination
4. Techniques for controlling fuel contamination

F. Air contamination (air in oil)
1. Effects on the machine
2. Effects on the lubricant
3. States of coexistence
4. Methods for assessing air contamination
   a) Air release characteristics (ASTM D3427)
   b) Foam stability characteristics (ASTM D892)
5. Techniques for controlling air contamination

VI. Wear Debris Monitoring and Analysis (17%)

A. Common wear mechanisms
1. Abrasive wear
   a) Two-body
   b) Three-body
2. Surface fatigue (contact fatigue)
   a) Two-body
   b) Three-body
3. Adhesive wear
4. Corrosive wear
5. Cavitation wear

B. Detecting abnormal wear
1. Atomic emission spectroscopy methods
   a) Inductively coupled plasma (ICP) spectroscopy
   b) Arc-spark emission spectroscopy
2. Wear particle density measurement

C. Wear debris analysis
1. Ferrogram preparation
2. Filtergram preparation
3. Light effects
4. Magnetism effects
5. Heat treatment
6. Basic morphological analysis

ICML – MLA III

Level III, MLA (Machine Lubricant Analyst ISO 18436-4, III)

Education and/or Experience - Candidates must have 36 months experience in the field of lubricant-analysis-based machinery condition monitoring (based on 16 hours minimum per month of experience).

Hold Level I Machine Lubricant Analyst (MLA) certification.

Training - Candidate must have received 32 hours of documented formal training as outlined in the Body of Knowledge of the MLA III. For online or recorded training, exercises, lab tasks, practice exams, and review exercises may be included in the training time total but shall not exceed five hours of the required course time. These 32 hours are in addition to the previous 48 hours of training required for MLA I and MLA II, for a total cumulative training of 80 hours. Candidate shall be able to provide a record of this training to ICML that shall include the candidate's name, the name and signature of the instructor, the dates of the training, and the number of hours spent in the training.

Note: ICML does not require, recommend, endorse or authorize any specific training course as official or approved. It is the responsibility of each candidate to research the training options available in his/her area and make a decision as to the training provider of his/her choice. ICML recommends the outline of the course of choice be compared to the exam's Body of Knowledge. It is in the person's best interest and their responsibility as an ICML candidate to ensure they are being trained in the same subject areas in which they will be tested. ICML's Bodies of Knowledge are of public domain and can be utilized by companies in the development of courses, as well as by any prospective candidate for evaluating the appropriateness of chosen training.

Examination - Each candidate must successfully pass a 100 question multiple choice examination that tests the candidate's mastery of the body of knowledge. Candidates have three hours to complete the closed-book examination. A score of 70% is required to pass the examination and achieve certification. Contact ICML about the availability of the exam in other languages.

Body of Knowledge MLA III

The Level III MLA Body of Knowledge is an outline of concepts that a candidate shall have in order to pass the exam, in accordance with ISO 18436-4, Category III, Annex A.

References from which exam questions were derived can be found in the Domain of Knowledge.

I. Lubrication Fundamentals (20%)

A. Lubrication Regimes
1. Hydrodynamic
2. Elasto-hydrodynamic
3. Boundary

B. Base oils
1. Common mineral oil characteristics
   a) Paraffinic
   b) Naphthenic
2. Common synthetic oil characteristics, advantages and disadvantages
   a) Synthesized hydrocarbons
   b) Phosphate esters
   c) Dibasic acid esters
   d) Polyglycols

C. API and other base oil classifications

D. Basic lubricant additive functions
1. Antioxidants/oxidation inhibitors
2. Rust inhibitors
3. Corrosion inhibitors
4. Demulsifying agents
5. Viscosity index (VI) improvers
6. Detergents
7. Dispersants
8. Pour-point depressants
9. Foam inhibitors
10. Anti-wear (AW) agents
11. Extreme pressure (EP) agents

II. Fundamentals of Machine Wear (15%)

A. Common Machine Wear Mechanisms
1. Abrasive wear
   a) Two-body abrasive wear
   b) Three-body abrasive wear
2. Adhesive wear
3. Surface fatigue
4. Corrosive wear
5. Fretting wear
6. Erosive wear
7. Electrical wear
8. Cavitation wear
   a) Gaseous cavitation
   b) Vaporous cavitation

B. Common Machine-specific Wear Modes
1. Gearing
2. Plain bearings
3. Rolling element bearings
4. Hydraulics

III. Wear Debris Analysis (21%)

A. Analytical ferrography
1. Wear debris analysis techniques
a) Light effects
b) Magnetism effects
c) Heat treatment
d) Chemical treatment
e) Morphology
f) Surface detail
2. Wear particle types, origins and probable causes
a) Cutting wear particles
b) Spherical particles
c) Chunky particles
d) Laminar particles
e) Red oxide particles
f) Black oxide particles
g) Corrosion particles
h) Non-ferrous particles
i) Friction polymers

B. Atomic emission elemental spectroscopy
1. Basic determination of wear particle metallurgy from elemental composition
2. Evaluating sequential trends
3. Evaluating lock-step trends
4. Particle size limitations of common atomic emission spectrometers
5. Advanced techniques
a) Acid/microwave digestion
b) Rotrode filter spectroscopy
6. X-ray fluorescence (XRF) and other advanced elemental spectroscopy methods

IV. Analyzing lubricant degradation (25%)

A. Oxidative base oil failure
1. Causes of oxidative base oil failure
2. Recognizing at-risk lubricants and applications
3. Strategies for deterring or mitigating base oil oxidation
4. Recognizing the effects of base oil oxidation
5. Strengths, limitations and applicability of tests used to detect and troubleshoot base oil oxidation
a) Acid number
b) Viscosity
c) Fourier Transform Infrared (FTIR) analysis
d) Rotating Pressure Vessel Oxidation Test
e) Sensory inspection

B. Thermal failure of base oil
1. Causes of thermal degradation

a) Hot surface degradation
b) Adiabatic compression induced degradation

2. Strengths, limitations and applicability of tests used to detect and troubleshoot thermal failure of the base oil
a) Acid number
b) Viscosity
c) Fourier Transform Infrared (FTIR) analysis
d) Thermal stability test (ASTM D 2070-91)
e) Ultracentrifuge detection of carbon insolubles
f) Sensory inspection

C. Additive depletion/degradation
1. Assessing risk for common additive depletion/degradation mechanisms
a) Neutralization
b) Shear down
c) Hydrolysis
d) Oxidation
e) Thermal degradation
f) Water washing
g) Particle scrubbing
h) Surface adsorption
i) Rubbing contact
j) Condensation settling
k) Filtration
l) Aggregate adsorption
m) Evaporation
n) Centrifugation

2. Strengths, limitations and applicability of methods for measuring additive depletion / degradation
a) Atomic emission spectroscopy
b) Fourier Transform Infrared (FTIR) spectroscopy
c) Acid number
d) Base number
e) Viscosity index (VI)
f) Rotating Pressure Vessel Oxidation Test
g) Blotter spot test

D. Detecting wrong lubricant addition
1. Viscosity
2. Neutralization number (AN/BN)
3. Elemental spectroscopy
4. Fourier Transfer Infrared Analysis
5. Other Tests

V. Oil analysis program development and program management (19%)

A. Machine-specific test slate selection
B. Optimizing frequency of analysis
C. Setting alarms and limits
1. Setting goal-based limits for contamination

2. Statistically derived level limits
   a) Editing data
   b) Calculating averages
   c) Calculating standard deviation
   d) Setting upper and lower limits using the mean and standard deviation
   e) How changes in system operation or maintenance influence statistically derived inferences

3. Rate of Change Limits
   a) Calculating rate of change
   b) Slope-based alarms
   c) Statistically derived rate of change limits
4. Setting aging limits for fluid properties
   a) Physical properties
   b) Chemical properties
   c) Additive properties

D. Managing oil analysis information
E. Creating and managing oil analysis procedures
F. Scoping oil analysis training for reliability technician, trades people and management
G. Performing cost/benefit analysis for oil analysis and contamination control programs
   1. Calculating program costs
   2. Estimating program benefits
   3. Calculating return on investment metrics
   4. Generating an effective business proposal
H. Quality Assurance
   1. Off onsite oil analysis
   2. Off offsite oil analysis providers