

Standard Guide for Self-Assessment of Quality System Practices in Petroleum Products and Lubricant Testing Laboratories¹

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1. Scope

1.1 This guide covers and provides direction for the self-assessment of the quality system practices in a laboratory testing petroleum products and lubricants in the oil industry. This guide is intended to satisfy requirements of international laboratory quality standards to conduct periodic self-assessments. It is not intended for comparing laboratory performance among a laboratory group or for use in external certification programs.

1.2 Other forms of assessment formats may also be acceptable as long as they cover the essential elements of this guide regarding laboratory capability.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

- D94 Test Methods for Saponification Number of Petroleum Products
- D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
- D892 Test Method for Foaming Characteristics of Lubricating Oils
- D1265 Practice for Sampling Liquefied Petroleum (LP) Gases, Manual Method
- D3244 Practice for Utilization of Test Data to Determine Conformance with Specifications
- D3700 Practice for Obtaining LPG Samples Using a Floating Piston Cylinder

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- D3764 Practice for Validation of the Performance of Process Stream Analyzer Systems
- D4051 Practice for Preparation of Low-Pressure Gas Blends
- D4057 Practice for Manual Sampling of Petroleum and Petroleum Products
- D4177 Practice for Automatic Sampling of Petroleum and Petroleum Products
- D4178 Practice for Calibrating Moisture Analyzers
- D4296 Practice for Sampling Pitch
- D4306 Practice for Aviation Fuel Sample Containers for Tests Affected by Trace Contamination
- D4307 Practice for Preparation of Liquid Blends for Use as Analytical Standards
- D4378 Practice for In-Service Monitoring of Mineral Turbine Oils for Steam, Gas, and Combined Cycle Turbines
- D4418 Practice for Receipt, Storage, and Handling of Fuels for Gas Turbines
- D5185 Test Method for Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)
- D5842 Practice for Sampling and Handling of Fuels for Volatility Measurement
- D5854 Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products
- D6046 Classification of Hydraulic Fluids for Environmental Impact
- D6122 Practice for Validation of the Performance of Multivariate Online, At-Line, and Laboratory Infrared Spectrophotometer Based Analyzer Systems
- D6299 Practice for Applying Statistical Quality Assurance and Control Charting Techniques to Evaluate Analytical Measurement System Performance
- D6304 Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration
- D6595 Test Method for Determination of Wear Metals and Contaminants in Used Lubricating Oils or Used Hydraulic Fluids by Rotating Disc Electrode Atomic Emission Spectrometry
- D6596 Practice for Ampulization and Storage of Gasoline and Related Hydrocarbon Materials

- D6792** Practice for Quality System in Petroleum Products and Lubricants Testing Laboratories
- D6849** Practice for Storage and Use of Liquefied Petroleum Gases (LPG) in Sample Cylinders for LPG Test Methods
- D6969** Practice for Preparation of Calcined Petroleum Coke Samples for Analysis
- D6970** Practice for Collection of Calcined Petroleum Coke Samples for Analysis
- D7235** Guide for Establishing a Linear Correlation Relationship Between Analyzer and Primary Test Method Results Using Relevant ASTM Standard Practices
- D7260** Practice for Optimization, Calibration, and Validation of Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) for Elemental Analysis of Petroleum Products and Lubricants
- D7343** Practice for Optimization, Sample Handling, Calibration, and Validation of X-ray Fluorescence Spectrometry Methods for Elemental Analysis of Petroleum Products and Lubricants
- D7372** Guide for Analysis and Interpretation of Proficiency Test Program Results
- D7482** Practice for Sampling, Storage, and Handling of Hydrocarbons for Mercury Analysis
- E29** Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- E77** Test Method for Inspection and Verification of Thermometers
- E548** Guide for General Criteria Used for Evaluating Laboratory Competence (Withdrawn 2002)³
- E882** Guide for Accountability and Quality Control in the Chemical Analysis Laboratory
- E898** Test Method of Testing Top-Loading, Direct-Reading Laboratory Scales and Balances
- E994** Guide for Calibration and Testing Laboratory Accreditation Systems General Requirements for Operation and Recognition (Withdrawn 2003)³
- E1323** Guide for Evaluating Laboratory Measurement Practices and the Statistical Analysis of the Resulting Data
- IEEE/ASTM SI 10** American National Standard for Metric Practice

2.2 ISO Standards:⁴

- ISO 4259** Petroleum Products – Determination and Application of Precision Data in Relation to Methods of Test
- ISO 9000** Quality Management Standards
- ISO 17025** General Requirements for the Competence of Testing and Calibration Laboratories

3. Terminology

3.1 Definitions:

3.1.1 *bias*, *n*—a systematic error that contributes to the difference between a population mean of the measurements or test results and an accepted reference or true value. **D6299**

3.1.2 *calibration*, *n*—the determination of the values of the significant parameters by comparison with values indicated by a set of reference standards. **D6595**

3.1.3 *calibration standard*, *n*—a material with a certified value for a relevant property, issued by or traceable to a national organization such as NIST, and whose properties are known with sufficient accuracy to permit its use to evaluate the same property of another sample. **D6792**

3.1.4 *certificate of analysis (COA)*, *n*—a document provided by a supplier to a customer giving results from analyses of required parameters to show how the material is in conformance with the product specifications or not.

3.1.5 *certified reference material*, *n*—a reference material one or more of whose property values are certified by a technically valid procedure, accompanied by a traceable certificate or other documentation which is issued by a certifying body. **D6792**

3.1.6 *control limits*, *n*—limits on a control chart that are used as criteria for signaling the need for action or for judging whether a set of data does or does not indicate a state of statistical control. **D6299**

3.1.7 *good laboratory practices*, *n*—guidelines for the management of laboratory experiments which are published by regulatory agencies or other recognized groups and are concerned with the organizational process and the conditions under which laboratory studies are planned, performed, monitored, recorded, and reported. **D6046**

3.1.8 *ICP-AES*, *n*—a high temperature discharge generated by passing an ionizable gas through a magnetic field induced by a radio frequency coil surrounding the tubes that carry gas. The light emitted by this process is measured at fixed wavelengths specific to elements of interest and converted to their concentrations in a sample.

3.1.9 *proficiency testing*, *n*—determination of a laboratory's testing capability by evaluating its test results in interlaboratory exchange testing or crosscheck programs. One example is the ASTM D02 Committee's proficiency testing programs in a wide variety of petroleum products and lubricants, many of which may involve more than a 100 laboratories. **D6792**

3.1.10 *quality control*, *n*—a planned system of activities whose purpose is to provide a level of quality that meets the needs of users; also the uses of such a system. **D6792**

3.1.11 *reference material*, *n*—a material with accepted reference value(s), accompanied by an uncertainty at a stated level of confidence for desired properties, which may be used for calibration or quality control purposes in the laboratory. Sometimes these may be prepared “in-house” provided the reference values are established using accepted standard procedures. **D6792**

3.1.12 *sigma*, *n*—a measure of variance; also called standard deviation.

3.1.13 *test performance index (TPI)*, *n*—an approximate measure of a laboratory's testing capability, defined as the ratio of test method reproducibility to site precision. **D6792**

3.1.14 *traceable*, *n*—property of the result of a measurement or the value of a standard whereby it can be related to a

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, <http://www.iso.org>.

references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties.

D6792

3.1.15 *Z-score*, *n*—standardized and dimensionless measure of the difference between an individual result in a data set and the arithmetic mean of the data set, re-expressed in units of standard deviation of the data set (by dividing the actual difference from the mean by the standard deviation for the data set).

D7372

3.2 Acronyms:

3.2.1 *ILCP*—ASTM D02 Committee proficiency testing program for interlaboratory cross-check program.

3.2.2 *ISO*—International Organization for Standardization based in Geneva, Switzerland.

3.2.3 *MSDS*—Material Safety Data Sheet.

3.2.4 *NIST*—National Institute of Standards and Technology based in Gaithersburg, MD.

3.2.5 *TMC*—ASTM Test Monitoring Center headquartered in Pittsburgh, PA.

4. Summary of Guide

4.1 Petroleum products and lubricants are regularly analyzed in refinery and plant laboratories using specified standard test methods. This guide provides management with a tool to assist in determining how well their laboratory is performing relative to established laboratory quality practices. A scoring scheme is suggested to assist the laboratory in identifying essential elements and to prioritize corrective actions.

5. Significance and Use

5.1 This guide can be used to evaluate the performance of a laboratory with regards to its adherence to established laboratory quality practices for the essential elements of managing a well-performing laboratory. The suggested scoring system can be used to identify the laboratory areas which need improvement in performance.

5.2 The assessment guide (**Table 1**) should be adjusted or modified to reflect the specific laboratory quality system that the laboratory follows. This guide is based on Practice **D6792**.

5.3 Similar but more generic schemes can be found in other ASTM standards such as Guide **E548**, **E882**, **E994**, and **E1323**. But this guide is the first one to attempt a numerical evaluation for the petroleum products and lubricants testing laboratories in the oil industry.

6. Scoring System

6.1 The suggested scoring system is given in **Table 2**. Laboratory areas to be self-assessed are arranged by rational groups. The areas and maximum aggregate scores for these are given in **Table 2**.

6.1.1 Usually safety practices in a laboratory would be covered by a separate organizational structure. However, given that safety should be an integral part of laboratory operations, brief and salient points from this aspect are included in this guide, but without a corresponding numerical score. A separate and more complete safety assessment would be desirable.

6.1.2 It is recognized that a laboratory's performance can be measured by other criteria such as customer satisfaction which involves other factors than those assessed here.

6.1.3 Judgment must be used by an assessor regarding whether the laboratory practice fully meets, partially meets, or does not meet the stated requirements. Thus, partial credit can be given depending upon the extent of compliance. A weight should be given to each question based on its importance since not all requirements are of the same critical nature. Thus, the assessor's observation associated with a specific to a question from **Table 1** could be:

Yes	Good	All : Max Score
Partially	Satisfactory	Most : < Max Score
No	Poor	Some : Zero
N/A	N/A	None : N/A

6.2 Most of the questions in **Table 1** have been assigned a maximum of 10 or 20 rating points. Calibration and quality control sections carry the greatest total weight in the scoring since these two areas are perhaps the most important ones associated with producing accurate and precise data. All answers should be supported by available documents in the laboratory.

6.3 If a particular question does not apply to the activity of the laboratory in question, the maximum score possible should be reduced by the test score allocated to that item.

6.4 In many cases notes are provided at the end of the **Table 1** to help the assessor to understand the intent of the questions.

6.5 For scoring purposes guide in **Table 3** may be used. The laboratory may find it necessary to provide additional guidance for scoring when there is only a partial fulfillment of the requirement.

6.6 An assessment grade can be established as indicated in **Table 4**. The grade can be based on either a maximum possible score of 1300, or as a percentage of the maximum score for a modified scheme.

6.7 A laboratory or an assessor may use a different scoring system so long as it remains consistent with the essential elements cited in this Guide and weighting provided in **Table 2**.

6.8 **Appendix X1** provides examples responses for some of the questions from **Table 1** as it may relate to a hypothetical issue.

6.9 For some questions in this guide there is no quantitative answer. The assessor should use discretion in reviewing such answers. An assessor should particularly pay attention whether the laboratory response is adequate as a good practice.

6.10 The most critical areas for a laboratory's proficiency are test method compliance, calibration and statistical quality control. Thus, these three areas carry 650 points in this scheme (about 50 % of total).

7. Report

7.1 Laboratories and assessors should document their investigations. In the spirit of continuous improvement, laboratories are encouraged to share their findings from the investigations, and take steps to implement changes to improve the laboratory technical management.



Documents

Document Sharing Hub

TABLE 1 Laboratory Assessment Guide to Good Laboratory Practices

NOTE 1—When the sampling is within the control of the laboratory, documents other than quoted above may detail the sampling process (not only ASTM). For example, company procedures. These should be assessed as well to check compliance to industry standards and then to ensure the laboratory complies with these procedures.

NOTE 2—Samples, when received by the laboratory from customers, should question the integrity of the sample and make some reference on the final test report to the fact that tests were completed on samples as received. If sample container was not appropriate, a similar caveat should be included. Instruction/procedure on how to deal with these situations should be documented and the laboratory assessed against it.

NOTE 3—In-house instructions/operating procedures also need to be assessed where used/written for each test method.

Number	Issue	Comment	Maximum Score
1.0 PERSONNEL & TRAINING			
1.1	Is there an organization chart available for the lab?		/ 5
1.2	Is there a management approved policy, directive, endorsement or the like for the goals and operations of the laboratory?		/ 10
1.3	Are job descriptions provided for all laboratory associates?		/ 5
1.4	Are personnel qualification records including training maintained for all lab personnel?		/ 5
1.5	Are technicians trained in all pertinent tests?		/ 10
1.6	Are newly hired technicians trained by approved trainers?		/ 10
1.7	Before new technicians perform routine analysis, are they evaluated to produce correct results by analyzing quality control standards?		/ 10
1.8	Are technicians provided instrument training courses where necessary?		/ 10
1.9	Are there back-up technicians for each test?		/ 5
1.10	Is there a documented system for training and is it being followed?		/ 5
1.11	Is there a system to recognize innovative ideas from technicians?		/ 5
1.12	Are there quality improvement teams organized in the lab?		/ 5
1.13	Are results of these teams' work readily available?		/ 5
1.14	Does management review the work of these quality teams?		/ 5
TOTAL			/195
2.0 SAMPLE PREPARATION			
2.1 ^A	Has a representative sample been obtained per Practice D4057 or D4177 protocols?		/ 5
2.2 ^B	If the sample analysis involves LPG, does the sampling and storage follow instructions in Practice D6849 ?		/ 5
2.3 ^B	Are LPG samples obtained according to Practice D3700 if using a floating piston cylinder?		/ 5
2.4 ^B	Are LPG samples collected using manual method Practice D1265 ?		/ 5
2.5 ^B	For the analysis of calcined petroleum coke, is Practice D6969 followed for sample preparation?		/ 5
2.6 ^B	For collection of calcined petroleum coke, is Practice D6970 followed?		/ 5
2.7 ^B	For ampulization and storage of gasoline is Practice D6596 being followed?		/ 5
2.8 ^B	If volatility measurements are conducted on fuel samples, is Practice D5842 being followed?		/ 5
2.9 ^B	Is Practice D4296 being followed in sampling of pitch?		/ 5
2.10 ^B	Are aviation fuel samples stored in containers suitable according to Practice D4306 ?		/ 5
2.11 ^B	Are gas turbine fuels handled in accordance with Practice D4418 ?		/ 5
2.12 ^B	If in-service monitoring of fluids is done, is Practice D4378 being followed?		/ 5
2.13	Are appropriate sample containers being used, checked for their integrity, cleanliness, and compatibility?		/ 5
2.14 ^B	Is liquid sample mixing done using Practice D5854 protocol?		/ 5

TABLE 1 Continued

Number	Issue	Comment	Maximum Score
		TOTAL	/ 175
3.0 TEST METHOD COMPLIANCE			
3.1	Are all test methods used in the lab available to all staff members?		/ 10
3.2	Is a current site specific lab manual available?		/ 10
3.3	Are the methods specified in the product specifications used for analysis?		/ 10
3.4	Are all tests performed in the lab following the exact language of the written test methods?		/ 30
3.5 ^c	Has the lab modified any of the specified test methods?		?
3.6	If so, has it been shown that the modified method gives results equivalent to those obtained by the specified method?		/ 20
3.7	If a method is modified, is the customer informed about this change?		/ 5
3.8	Are all tests specified in the product specifications performed?		/ 10
3.9	If not, has approval been given in writing by the process leaders and/or customers not to carry out all tests?		/ 5
3.10	Does the lab have appropriate instrument for the analysis?		/ 10
3.11	Is an equipment inventory list available and is it up-to-date?		/ 5
3.12	Are major instruments included in service contracts?		/ 5
3.13	If not, has arrangement been made to get the instrument speedily repaired or use of a back-up lab for analysis?		/ 5
3.14	Are logs kept of all downtime and service problems of all instruments?		/ 5
3.15	Is there a system of backup in case of instrument failure?		/ 5
3.16	Is there a long range plan of upgrading and replacing older instrumentation?		/ 5
3.17	Has a maintenance schedule been established for all equipment in the lab?		/ 10
3.18	Is a record of special or routine or preventive maintenance kept and is it up-to-date?		/ 5
3.19	If a duplicate analysis is done for some reason, are the results checked to see that they meet Practice D3244 or ISO 4259 criteria for replicate testing?		/ 10
3.20	In reporting the results, are protocols given in Practice E29 and IEEE/ASTM SI 10 standards followed regarding rounding of the test results?		/ 10
		TOTAL	/ 175
4.0 CALIBRATION OF INSTRUMENTS			
4.1	Are all pertinent calibration standards available in the lab?		/ 10
4.2	Are they all stored in clean, safe, and contamination-free environment?		/ 10
4.3 ^b	Is Practice D4307 followed for preparing liquid blends for use as analytical standards?		/ 5
4.4 ^b	Is Practice D4051 used for the preparation of low-pressure gas blends?		/ 5
4.5	Are the calibration standards traceable to national or international standards?		/ 5
4.6	Where appropriate, are the values for reference materials produced by following the appropriate NIST or other standards issuing body certification protocol?		/ 10
4.7 ^b	If used, are crude oil samples for mercury analysis handled as per Practice D7482 ?		/ 5
4.8	Is relevant calibration done on all instruments before sample analysis?		/ 10
4.9	Has a calibration schedule been established for lab equipment?		/ 5
4.10	Are calibration procedures documented and available to all lab personnel?		/ 10