



Designation: D7453 – 22

Standard Practice for Sampling of Petroleum Products for Analysis by Process Stream Analyzers and for Process Stream Analyzer System Validation¹

This standard is issued under the fixed designation D7453; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

The primary focus of sampling petroleum product is the timely presentation of the sample for (1) analysis by online analyzers, (2) validation of an analyzer system and (3) collecting a composite sample for batch physical property determination. Sediment, free water, rust, and other contaminants found in the sample may be removed in the sample conditioning system to protect the hardware and analytical systems. If a sample is being collected for later analysis, the sample must be collected, stored, and transported in a manner that does not affect the property of interest. If a sample is being fed to an analyzer or sampled for later determination of water or particulate contamination then filtering is not an option.

1. Scope*

1.1 This practice covers the performance requirements for sample systems employed to deliver process stream samples (1) to analyzer system for analyses or (2) for analyzer validation or (3) for composite sample systems. It also outlines the selection and operation of line or batch sampling equipment intended for analyzer flow proportioned average property value system validation. Sample handling, mixing, and conditioning procedures are required to ensure that a representative sample of the liquid petroleum product is collected from the sampling source.

1.2 *Applicable Fluids*—This practice is applicable to single liquid phase petroleum products whose vapor pressure at sampling and sample storage conditions is less than or equal to 110 kPa (16.0 psi), and, with a D86 final boiling point less than or equal to 400 °C (752 °F).

1.2.1 Specialized sample handling may be necessary to maintain sample integrity of more volatile materials at high temperatures or extended residence time in the receiver. Such handling requirements are not within the scope of this practice. Users should consult the analytical methods to be performed on the sample for special sample storage or conditioning requirements.

¹ This practice is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.25 on Performance Assessment and Validation of Process Stream Analyzer Systems.

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1.3 Some or all of the processes outlined in this practice may be applicable to other liquids. Applying this practice to other liquids will require the consideration of additional methods and practices. It is the responsibility of the user of this standard to identify any and all applicable safety and sampling considerations and establish appropriate procedures to handle these additional considerations.

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*²

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.

*A Summary of Changes section appears at the end of this standard

- D1265** Practice for Sampling Liquefied Petroleum (LP) Gases, Manual Method
- D3700** Practice for Obtaining LPG Samples Using a Floating Piston Cylinder
- D3764** Practice for Validation of the Performance of Process Stream Analyzer Systems
- D4057** Practice for Manual Sampling of Petroleum and Petroleum Products
- D4177** Practice for Automatic Sampling of Petroleum and Petroleum Products
- D5842** Practice for Sampling and Handling of Fuels for Volatility Measurement
- D6122** Practice for Validation of the Performance of Multi-variate Online, At-Line, Field and Laboratory Infrared Spectrophotometer, and Raman Spectrometer Based Analyzer Systems
- D6624** Practice for Determining a Flow-Proportioned Average Property Value (FPAPV) for a Collected Batch of Process Stream Material Using Stream Analyzer Data
- D7278** Guide for Prediction of Analyzer Sample System Lag Times
- D7453** Practice for Sampling of Petroleum Products for Analysis by Process Stream Analyzers and for Process Stream Analyzer System Validation
- D8009** Practice for Manual Piston Cylinder Sampling for Volatile Crude Oils, Condensates, and Liquid Petroleum Products
- D8340** Practice for Performance-Based Qualification of Spectroscopic Analyzer Systems

3. Terminology

3.1 Definitions:

3.1.1 *analyzer unit response time, n*—time interval between the introduction of a step change in property characteristic at the inlet of the analyzer unit and when the analyzer output indicates a value corresponding to 99.5 % of the subsequent change in analyzer results. **D3764**

3.1.2 *automatic sample collector, n*—device used to repetitively extract a grab and collect a representative sample of a batch or process stream.

3.1.3 *automatic sampling system, n*—system consisting of a sample probe, sample fast cycle loop, sample supply line stream conditioning, an automatic sample collector and an associated controller, a flow measuring device, and sample holding, mixing and handling capabilities.

3.1.4 *batch, n*—discrete shipment of commodity defined by a specified quantity, a time interval, or quality. **D4177**

3.1.5 *flow proportional sampler, n*—sampler designed to automatically adjust the sampling rate to be proportional to the flow rate of the stream.

3.1.6 *grab, n*—volume of sample extracted from a batch by a single actuation of the sample extractor.

3.1.7 *lag time, n*—the time required for material to travel from point A to point B in the total analyzer system (points A and B are user-defined). **D3764**

3.1.8 *line sample, n*—process material that can be safely withdrawn from a sample port or associated facilities without

significantly altering the property of interest so that the material can be used to perform analyzer system validation; the material is withdrawn in accordance with Practices **D1265**, **D3700**, **D4057**, **D4177**, **D5842**, **D7453**, or **D8009**, whichever is applicable, during a period when the material flowing through the analyzer is of uniform quality and the analyzer results are practically constant. **D3764**

3.1.9 *liquid petroleum product and fuels, n—in relation to process analyzers*, any single-phase liquid material that is produced at a facility in the petroleum and petrochemical industries and will be in whole or in part of a petroleum product; it is inclusive of biofuels, renewable fuels, blendstocks, alternative blendstocks, and additives. **D8340**

3.1.10 *primary test method (PTM), n*—the analytical procedure used to generate the reference values against which the analyzer is both calibrated and validated. **D3764**

3.1.11 *sample conditioning unit lag time, n*—the time required for material to flow from the sample conditioning unit inlet to the analyzer unit inlet. **D3764**

3.1.12 *sample fast cycle loop, n*—a system that continually and rapidly transports a representative sample of process material from the sample probe past the sample supply line and returns the remaining material to the process.

3.1.12.1 *sample fast loop lag time, n*—time required for material to transport from the product takeoff point of the sample loop to the sample conditioning unit inlet.

3.1.13 *total analyzer system response time, n*—time interval between the when a step change in property characteristic arrives at the sample loop inlet and when the analyzer output indicates a value corresponding to 99.5 % of the subsequent change in analyzer results. **D3764**

3.1.13.1 *Discussion*—The total analyzer system response time is the sum of the sample fast loop lag time, the sample conditioning unit lag time, and the analyzer unit response time. **D3764**

3.1.14 *validation, n—for equipment used in the analysis of liquid petroleum products and fuels*, statistically quantified judgment that the analyzer system or subsystem being assessed, in conjunction with any correlation applied, can produce acceptable precision and bias performance on the prediction deviations (δ for materials that were not used to develop the correlation). **D3764**

4. Summary of Practice

4.1 Analyzer measurement systems require a process sample that is delivered in a timely manner commensurate with the analyzer and process cycle time at pressure, temperature and flow conditions meeting system requirements, is free of contaminants, and is representative of the process stream.

4.2 Line samples collected from the process or blender stream need to accurately reflect the composition of the analyzer feed stream. This is accomplished by taking into account the total analyzer system response time in order to properly validate online analyzer systems.

4.3 This practice describes functional requirements that need to be addressed in the design and operation of automatic

sampling equipment. Automatic sampling equipment is used to obtain a representative batch sample for use in validating an analyzer system or flow proportioned average property value and for manufactured batch quality testing.

5. Significance and Use

5.1 Analyzer systems require representative samples of petroleum products delivered in a timely manner to (1) facilitate the control of process or blending units or (2) calculate a flow proportioned property value.

5.2 Representative samples of petroleum products are required for the determination of chemical and physical properties. These properties are used to establish the relationship between the analyzer system and the primary test method during initial and ongoing validation of the system.

5.3 Representative samples of petroleum products are tested to determine the chemical and physical properties of a batch offered for tender.

6. Sample Delivery and Conditioning Requirements for Process Stream Analyzers

6.1 The sample will be delivered from the sample stream to the analyzer inlet for measurement in the minimum realistic period of time possible.

6.1.1 When sampling from processes that normally operate in steady state mode, not subject to scheduled operational variable(s) step changes that directly impact the measured variable, the sample fast loop lag time shall be as short as practically possible. It is recommended that where possible, the sample fast loop lag time should be less than the analyzer response time. A minimum realistic time is two minutes.

NOTE 1—Guide D7278 can be used for the prediction of analyzer sample system lag times. Refer to Practice D3764 for analyzer unit response time information.

6.1.2 Sampling from processes that are subject to scheduled operational variable(s) step changes that directly impact the measured variable requires knowledge of the shortest interval between scheduled step changes. The total analyzer system response time shall be less than the shortest interval between scheduled step changes

6.2 The sample system shall deliver the sample to the analyzer without alteration of the properties of interest.

6.2.1 The sample systems shall not cause any unintended phase changes in the sample during its transport to the analyzer.

6.3 *Filtration and Coalescing*—The sample stream should be filtered or suitably treated to remove contaminants such as rust, sediments, and foreign matter. Free and dissolved water not intended to be quantified or analyzed should be removed by coalescing, chilling, or filtration. The porosity of the filter should be selected for effective removal of contaminants that can cause immediate or long term damage to the system hardware including build up and plugging of system solenoids and valves.

7. Line Sample Requirements

7.1 The line sample point should be located so that it provides a sample representative of what is being delivered to the analyzer.

NOTE 2—Filters, coalescers, and temperature conditioning units may be required to make the sample stream safe to sample.

7.2 Validate and document the lag time of the line sample point from the sample stream and the lag time from the sample point to the analyzer inlet. This data is required in Practice D3764 or Practice D6122 for analyzer validation. Guide D7278 may also be used.

7.2.1 *Temperature and Pressure*—Sample temperature and pressure shall be conditioned to a safe working range as determined by the governing legal and/or regulatory requirements, sample handling requirements, and equipment limitations. The temperature and pressure conditioning shall not affect the property of interest.

7.3 Use a sample container and any sample container conditioning procedures defined in the PTM.

7.3.1 The sample point shall be flushed with three times the volume of the sample system from the tie into the analyzer sample supply to the sample outlet. See Fig. 1.

7.3.2 The sample probe shall reach the bottom of the sample container when sampling.

7.3.2.1 The bottom of the sample probe shall have a 45° relief cut.

7.3.3 Flush the sample container to remove contaminants and saturate the vapor phase with hydrocarbons.

NOTE 3—Samples to be analyzed for vapor pressure require special handling, and the appropriate standard test method should be reviewed for requirements.

7.3.4 After a container has been flushed with sample, it should be filled immediately so the vapor space in the container stays fully saturated with hydrocarbon and the bottle temperature is similar to the sample.

7.3.5 Throttle the flow into the sample container at the start of the filling process so the sample is introduced slowly, without turbulence, until there is enough volume so that increasing the flow does not cause bubbling or frothing. If the initial fill rate is too fast, properly dispose of the extracted sample and then refill the sample container to maintain sample integrity.

7.3.6 Seal the sample container and label as required.

NOTE 4—The analyzer reading may need to be documented at the time of filling for validation samples.

8. Automatic Sampling systems

8.1 An automatic composite sample collecting system consists of sample conditioning upstream of the sampling location, a device to physically extract a grab from the sample loop, a flow measurement device for flow proportioning, a means to control the total volume of sample extracted, a sample receiver to collect and store the grabs and, depending on the system, a sample receiver/mixing system. See Fig. 2. Unique properties of the petroleum product being sampled may require the individual components or the entire system be insulated, or heated, or both. Since the sample is collected throughout a full