pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

7

STANDARD PROTOCOL (SP-005)

Stationary Spark Ignition Internal Combustion Engines

Applicable for Methods 1, 2, 2C, 3, 3A, 3B, 4, 19, 205, 320, ASTM Method D6348-03, and ALT-106

SECTION A. GENERAL REQUIREMENTS

1. Regulatory Authority and General Description

All performance (i.e., baseline emissions and compliance and periodic monitoring stack testing shall be conducted in accordance with below specified EPA test methods, operating and control device conditions, and the provisions of BAQ-GPA/GP-5, 40 CFR Part 60.8 – Performance Tests, 40 CFR Part 60 Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines, 40 CFR Part 60 Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines, 40 CFR, Part 60, Subpart JJJJ / 40 CFR Part 63, Subpart ZZZZ – National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines, Clean Air Act National Stack Testing Guidance, and other applicable regulatory requirements and documents. As an alternative to submitting a site-specific protocol, Stationary Spark Ignition Internal Combustion Engines that operate under any combination of GP-5 Permit, 40 CFR Part 60 Subpart JJJJ, and 40 CFR Part 63, Subpart ZZZZ may opt to utilize this Standardized Protocol 005 (SP-005), without deviation whose conditions are described herein. The sampling, recovery, calibration, analytical, source/control device operation, and reporting requirements outlined in this SP-005 for the referenced pollutants, methodologies, and source also apply for site-specific protocol reviews. To obtain reliable results, persons using this Standard Protocol should minimally have a thorough knowledge of referenced EPA test methods [Methods 1, 2, 2C, 3, 3A, 3B, 4, 19, 205, 320, and Alt 106], GP-5 Permit, 40 CFR Part 60 Subpart JJJJ, and 40 CFR Part 63, Subpart ZZZZ. Persons unfamiliar with basic elements of FTIR spectroscopy should not attempt to use Method 320. Rejection of the test results may occur if the Standard Protocol requirements are not met. This Standard Protocol may be revised without public notice in the future to amend, or reflex changes in GP-5, EPA methodology and state and federal procedures and regulations. The owner and operator bear the burden to ensure that the most recent Standard Protocol is used during each test project. Nothing in this Standard Protocol shall affect regulatory requirements.

2. Contents

Section B. Stationary Natural Gas-Fired Spark Ignition Internal Combustion Engines

3. Definitions

Words and terms that are not otherwise defined in this Standard Protocol (SP) shall have the meanings set forth in 40 CFR Part 60.8, 40 CFR Part 60, Subpart JJJJ, and BAQ-GPA/GP-5, including 25 Pa Code § 139.5(f) and 139.11(2) unless the context indicates otherwise. The meanings set forth in applicable definitions codified in the Code of Federal Regulations (CFR), included in the referenced subpart shall also apply to this SP. Note that the definitions of terms used in this Standard Protocol is not all inclusive. Strict conformance with the definitions in this section of SP-005 is critical!

(a) Applicable Federal Regulations

Applicable Regulations	Definitions
40 CFR Part 60.8	Is a section of the Code of Federal Regulations that contains requirements for performance testing and notifications of force majeure events. Except that § 60.8 only applies to owners and operators who are subject to performance testing in subpart JJJJ.
40 CFR, Part 60, Subpart JJJJ	A federal regulation that sets standards of performance for stationary spark ignition internal combustion engines which means any internal combustion engine, except combustion turbines, that converts heat energy into mechanical work and is not mobile. Stationary ICE differ from mobile ICE in that a stationary internal combustion engine is not a nonroad engine as defined at 40 CFR 1068.30 (excluding paragraph (2)(ii) of that definition), and is not used to propel a motor vehicle, aircraft, or a vehicle used solely for competition. Stationary ICE includes reciprocating ICE, rotary ICE, and other ICE, except combustion turbines. The regulation applies to engines that were constructed (ordered) after June 12, 2006 and manufactured on or after certain dates, depending on the engine size and type. The regulation aims to reduce emissions of air pollutants such as nitrogen oxides, carbon monoxide, and volatile organic compounds.
40 CFR, Part 63, Subpart ZZZZ	Establishes national emission limitations and operating limitations for hazardous air pollutants (HAP) emitted from stationary reciprocating internal combustion engines (RICE) located at major and area sources of HAP emissions. This subpart also establishes requirements to demonstrate initial and continuous compliance with the emission limitations and operating limitations.

(b) Applicable State Regulations

Applicable Regulations	Definitions
25 Pa. Code Chapter 139.11(2)	"The Department will consider test results for approval where sufficient information is provided to verify the source conditions existing at the time of the test and where adequate data is available to show the manner in which the test was conducted. Information submitted to the Department shall include, as a minimum", the provisions specified in *25 Pa. Code Chapter 139.11(2)(i through vii)*. The reports of the sampling and testing are accurate and comprehensive.
AG5 Authorization No. (or GP-5 Authorization No.)	PA DEP Permitting Section in Central Office defines AG5 Authorization No. as "Authorizations to use GP-5 are given program specific IDs, similar to unique plan approval and operating permit numbers. Up until 2018, these were determined by regional permitting staff and input manually into eFACTS. They usually took the form of GP5-XX-YYYYY, where "XX" is the county code and "YYYYY" is a facility identifier. In 2018, due to ePermitting, DEP Permitting Section was tasked to automate the numbering of the IDs in eFACTS. In doing so, DEP created a new format to avoid overlap with previously issued authorizations. The new format is AG5-XX-YYYYYZ, where "XX" is the county code, "YYYYY" is a facility identifier, and "Z" is a letter assigned to each authorization. Other than showing whether the ID number was input manually or generated automatically, there is no difference between an authorization that has an ID starting with "GP5" and that has an ID starting with "AG5".
General Permit BAQ-GPA / GP-5	The General Plan Approval and/or General Operating Permit for sources located at natural gas compressor stations, natural gas processing facilities, or natural gas transmission stations. The current GP-5 became effective on August 2018. The GP-5 is applicable only to non-major facilities. See, Overview of GP-5A, GP-5, and Exemption 38 at: https://crawler.dep.state.pa.us/Air/AirQuality/AQPortalFiles/Methane/GP-5%20GP-5A%20and%20Ex%2038%20Overview%20Jun%202018.pdf.

(c) EPA Test Methods

EPA Test Method	Regulatory Citation	Definitions
Method 1 of 40 CFR 60, appendix A-1	Table 2 to 40 CFR Part 60, Subpart JJJJ	"Selection of the sampling port location and the number/location of traverse points at the exhaust of the stationary internal combustion engine. Alternatively, for CO, NO_x, O_2, and moisture measurement, ducts ≤6 inches in diameter may be sampled at a single point located at the duct centroid and ducts >6 and ≤12 inches in diameter may be sampled at 3 traverse points located at 16.7, 50.0, and 83.3% of the measurement line (`3-point long line'). If the duct is >12 inches in diameter and the sampling port location meets the two and half-diameter criterion of Section 11.1.1 of Method 1 of 40 CFR part 60, Appendix A, the duct may be sampled at `3-point long line'; otherwise, conduct the stratification testing and select sampling points according to Section 8.1.2 of Method 7E of 40 CFR part 60, Appendix A".
Method 2 or 2C of 40 CFR 60, appendix A-1 (If Applicable)	Table 2 to 40 CFR Part 60, Subpart JJJJ	"Selection of the sampling port location and the number/location of traverse points at the exhaust of the stationary internal combustion engine. Alternatively, for CO, NO_x, O_2, and moisture measurement, ducts ≤6 inches in diameter may be sampled at a single point located at the duct centroid and ducts >6 and ≤12 inches in diameter may be sampled at 3 traverse points located at 16.7, 50.0, and 83.3% of the measurement line (`3-point long line'). If the duct is >12 inches in diameter and the sampling port location meets the two and half-diameter criterion of Section 11.1.1 of Method 1 of 40 CFR part 60, Appendix A, the duct may be sampled at `3-point long line'; otherwise, conduct the stratification testing and select sampling points according to Section 8.1.2 of Method 7E of 40 CFR part 60, Appendix A. Method 2C is determination of stack gas velocity and volumetric flow rate from small stacks or ducts (standard pitot tube)".
Method 3, 3A, or 3B of 40 CFR 60, appendix A-2	Table 2 to 40 CFR Part 60, Subpart JJJJ	"This method is used for determination of Oxygen (O_2) and carbon dioxide (CO_2) concentration of the Stationary Internal Combustion Engine Exhaust. Measurements to determine the exhaust flowrate must be made at the same time as the measurement for NO_x, CO, Formaldehyde, and VOC concentration".
Method 4 of 40 CFR part 60, appendix A-3	Table 2 to 40 CFR Part 60, Subpart JJJJ	"This method is used for determination of Moisture at Stationary Spark Ignition Internal Combustion Engines. Measurements to determine the exhaust flowrate must be made at the same time as the measurement for NO_x, CO, Formaldehyde, and VOC concentration. Results of this test consist of the average of the three 1-hour or longer runs".
Method 19 of 40 CFR part 60, appendix A-7 (If Applicable)	Table 2 to 40 CFR Part 60, Subpart JJJJ	"This method is used for determination of Exhaust Flowrate of the Stationary Internal Combustion Engine Exhaust. Measurements to determine the exhaust flowrate must be made at the same time as the measurement for NO_x, CO, Formaldehyde, and VOC concentration".
EPA Method 205 of 40 CFR part 51, appendix M	§ 1.1 of M205	"A gas dilution system can provide known values of calibration gases through controlled dilution of high-level calibration gases with an appropriate dilution gas". The instrumental test methods in 40 CFR part 60 - e.g., Methods 3A, 25A and ALT-106.

EPA Test Method	Regulatory Citation	Definitions
Method 320 of 40 CFR part 63, appendix A or ASTM Method D6348-03	Table 2 to 40 CFR Part 60, Subpart JJJJ	"This method is used for measuring vapor phase organic and inorganic emissions by extractive Fourier transform infrared (FTIR) spectroscopy. This method will be used for determination of Moisture, NO_x, CO, Formaldehyde, and VOC concentrations at Stationary Spark Ignition Internal Combustion Engines. Volatile Organic Compounds (VOC) measured according to Method 320 of 40 CFR part 63, appendix A, expressed on an "as propane" (C_3H_8) basis. Results of this test consist of the average of the three 1-hour or longer runs".
ALT-106 of Federal Register / Vol. 80, No. 35 / Monday, February 23, 2015 / Notices	EPA's Approval Letter for ALT-106 dated June 6, 2014	Section B, Condition 4(b)(iv)(C) of GP-5 Permit approves the use of ALT-106 measures VOC (or NMEHC) directly rather than difference and involves separation of methane and ethane components of the emission gas from the remaining VOC. Methane and ethane are separated and measured by flame ionization detector (FID), followed by a backflush of the chromatographic column to measure NMEOC in post combustion emissions. See, ALT-106 Approval of Alternative VOC Measurements for Engines at: https://www.epa.gov/sites/default/files/2020-08/documents/alt106.pdf.

(d) Laboratory Analysis

Laboratory Analysis	Regulatory Citation	Definitions
Analyte Spiking	§ 8.6.2, 9.2 and 13.0 of Method 320	QA spiking is a calibration procedure used before testing to verify that the sampling system can transport the analytes from the probe to the FTIR system.
Analyte(s) and Tracer Gas	§ 7.1 of M320	"Obtain a certified gas cylinder mixture containing all of the analyte(s) at concentrations within ±2 percent of the emission source levels (expressed in ppm meter/K). If practical, the analyte standard cylinder shall also contain the tracer gas at a concentration which gives a measurable absorbance at a dilution factor of at least 10:1. Two ppm SF6 is sufficient for a path length of 22 meters at 250 °F".
Calibration Standards	EPA's QA Handbook Vol II, Section 12.0 Revision No: 1 Date: 12/08 Page 2 of 11	Calibration standards are: (1) Reagents of high grade (2) Gaseous standards of known concentrations that are certified as EPA protocol gasses (3) Instruments and or standards of high sensitivity and repeatability.

(e) List of Acronyms Used in Compliance Summary Tables

Terms and acronyms used in compliance summary tables definition was extracted from Section 60.4244(C) of 40 CFR Part 60, Subpart JJJJ and Compliance Requirements for Stationary Engines website at: https://www.epa.gov/stationary-engines/compliance-requirements-stationary-engines#existarea.

General Terms	Regulatory Citation	Definitions
Lean Burn Engine	§ 60.4244(C) of 40 CFR Part 60, Subpart JJJJ	"Means any two-stroke or four-stroke spark ignited engine that does not meet the definition of a rich burn engine".
Rich Burn Engine		"Means any four-stroke spark ignited engine where the manufacturer's recommended operating air/fuel ratio divided by the stoichiometric air/fuel ratio at full load conditions is less than or equal to 1.1. Engines originally manufactured as rich burn engines, but modified prior to June 12, 2006, with passive emission control technology for NO_X (such as pre-combustion chambers) will be considered lean burn engines. Also, existing engines where there are no manufacturer's recommendations regarding air/fuel ratio will be considered a rich burn engine if the excess oxygen content of the exhaust at full load conditions is less than or equal to 2 percent".
2SLB	Compliance Requirements for Stationary Engines website	2-stroke lean burn
4SLB		4-stroke lean burn
4S		4-stroke
CFR		Code of Federal Regulations
ULSD		Ultra-Low Sulfur Diesel

(f) Operating Conditions

Operating Conditions	Regulatory Citation	Operating Definitions
10 Percent of 100 Percent Peak (or Highest Achievable) Load	§ 60.4244(C) of 40 CFR Part 60, Subpart JJJJ	"Each performance test must be conducted within 10 percent of 100 percent peak (or the highest achievable) load and according to the requirements in § 60.8 and under the specific conditions that are specified by Table 2 to 40 CFR Part 60, Subpart JJJJ".
	§ C(4)(b)(i) of GP-5	"The owner or operator should conduct the three test runs of at least one-hour duration within 10% of 100% peak (or the highest achievable) load".
Operational Load During Testing	DEP Definition	The actual operational load, capacity, or power each engine achieves during each test run.
Peak (or Highest Achievable) Load	DEP Definition	Means 100 percent of the manufacturer's design or rated capacity of each combustion engine will be operated during testing. This highest operational load, capacity, or power is expressed in units of brake-horsepower (BHP).
		The highest operational load, capacity, or power that each engine can achieve is ideally based on operational data logs for at least one year prior to testing or the most recent test project.
		The percent peak (or highest achievable) load does not equal have to the engine's horsepower rated capacity can be established at the time of initial and/or reoccurring testing.
Rated Capacity	DEP Definition	Highest rated operational load, capacity, or power in units of brake-horsepower (BHP) each engine can achieve as determined by the manufacturer.
Rated Speed	40 CFR 1048.801	"Means the maximum full-load governed speed for governed engines and the speed of maximum power for ungoverned engines".

(g) Quality Assurance (QA) / Quality Control (QC)
QA / QC definition was were extracted from Method 7E referred by § of Method 3A at:
https://www.epa.gov/sites/default/files/2020-12/documents/method_7e_2.pdf.

QA / QC Term	Regulatory Citation	EPA Method 3A Definitions
Analyzer Calibration Error	§ 3.1 of M3A	"For non-dilution systems, means the difference between the manufacturer certified concentration of a calibration gas and the measured concentration of the same gas when it is introduced into the analyzer in direct calibration mode".
Calibration Gas	§ 3.3 of M7E (or § 7.1 of M3A)	"Means the gas mixture containing NO_x at a known concentration and produced and certified in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards," September 1997, as amended August 25, 1999, EPA-600/R-97/121 or more recent updates. The tests for analyzer calibration error, drift, and system bias require the use of calibration gas prepared according to this protocol. If a zero gas is used for the low-level gas, it must meet the requirements under the definition for "zero air material" in 40 CFR 72.2 in place of being prepared by the traceability protocol".
Calibration Span	§ 3.3 of M7E	"Means the upper limit of the analyzer's calibration that is set by the choice of high-level calibration gas. No valid run average concentration may exceed the calibration span. To the extent practicable, the measured emissions should be between 20 to 100 percent of the selected calibration span. This may not be practicable in some cases of low concentration measurements or testing for compliance with an emission limit when emissions are substantially less than the limit. In such cases, calibration spans that are practicable to achieving the data quality objectives without being excessively high should be chosen".
Drift	§ 3.9 of M7E	"Means the difference between the pre- and post-run system bias (or system calibration error) checks at a specific calibration gas concentration level (i.e. low-, mid- or high-)".
Response Time	§ 3.14 of M7E	"Means the time it takes the measurement system to respond to a change in gas concentration occurring at the sampling point when the system is operating normally at its target sample flow rate or dilution ratio".
System Bias	§ 3.16 of M7E	"Means the difference between a calibration gas measured in direct calibration mode and in system calibration mode. System bias is determined before and after each run at the low- and mid- or high-concentration levels. For dilution-type systems, pre- and post-run system calibration error is measured rather than system bias".
System Calibration Error	§ 3.17 of M7E	"Applies to dilution-type systems and means the difference between the measured concentration of low-, mid-, or high-level calibration gas and the certified concentration for each gas when introduced in system calibration mode. For dilution-type systems, a 3-point system calibration error test is conducted in lieu of the analyzer calibration error test, and 2-point system calibration error tests are conducted in lieu of system bias tests".

QA / QC definitions was extracted from Method 25A referred by Method ALT-106 at: https://www.epa.gov/sites/default/files/2017-08/documents/method_25a.pdf.

QA / QC Term	Regulatory Citation	EPA Method 25A Definitions
Calibration Drift	§ 3.1 of M25A	"Means the difference in the measurement system response to a mid-level calibration gas before and after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place".
Calibration Error	§ 3.2 of M25A	"Means the difference between the gas concentration indicated by the measurement system and the known concentration of the calibration gas".
Calibration Gas	§ 3.3 of M25A	"Means a known concentration of a gas in an appropriate diluent gas".
Organic Analyzer	§ 3.4.2 of M25A	"Means that portion of the measurement system that senses the gas to be measured and generates an output proportional to its concentration".
Response Time	§ 3.5 of M25A	"Means the time interval from a step change in pollutant concentration at the inlet to the emission measurement system to the time at which 95 percent of the corresponding final value is reached as displayed on the recorder".
Span Value	§ 3.6 of M25A	"Means the upper limit of a gas concentration measurement range that is specified for affected source categories in the applicable part of the regulations. The span value is established in the applicable regulation and is usually 1.5 to 2.5 times the applicable emission limit. If no span value is provided, use a span value equivalent to 1.5 to 2.5 times the expected concentration. For convenience, the span value should correspond to 100 percent of the recorder scale".
Zero Drift	§ 3.7 of M25A	"Means the difference in the measurement system response to a zero-level calibration gas before or after a stated period of operation during which no unscheduled maintenance, repair, or adjustment took place".
Calibration Gases	§ 7.1 of M25A	"The calibration gases for the gas analyzer shall be propane in air or propane in nitrogen. Alternatively, organic compounds other than propane can be used; the appropriate corrections for response factor must be made. Calibration gases shall be prepared in accordance with the procedure listed in Citation 2 of Section 16. Additionally, the manufacturer of the cylinder should provide a recommended shelf life for each calibration gas cylinder over which the concentration does not change more than ±2 percent from the certified value. For calibration gas values not generally available (i.e., organics between 1 and 10 percent by volume), alternative methods for preparing calibration gas mixtures, such as dilution systems (Test Method 205, 40 CFR Part 51, Appendix M), may be used with prior approval of the Administrator".

(h) Terms Associated With Sampling Equipment

Equipment definition was extracted from Method 320 at: https://www.epa.gov/sites/default/files/2019-06/documents/method_320.pdf.

General Terms	Regulatory Citation	Definitions
Flame ionization analyzer (FIA).	§ 3.4.2 of M25A	"Means that portion of the measurement system that senses the gas to be measured and generates an output proportional to its concentration".
Fourier Transform Infrared (FTIR) Spectrometer	Appendix A To Addendum To M320	"Means an analytical system that employs a source of mid-infrared radiation, an interferometer, an enclosed sample cell of known absorption pathlength, an infrared detector, optical elements that transfer infrared radiation between components, and a computer system. The time-domain detector response (interferogram) is processed by a Fourier transform to yield a representation of the detector response vs. infrared frequency".

(i) Terms Used to Describe Test Purpose

General Terms	Definitions
Baseline Testing	Baseline emission stack testing is a method used to measure the amount of specific pollutants being emitted through stacks at a facility. It is used to determine compliance with emission limits and assess the effectiveness of control devices.
Compliance Testing	Any performance testing conducted for the purposes of determining and demonstrating compliance with the applicable standards of 40 CFR Parts 60, 61, and 63 using promulgated test methods, other test methods or procedures cited in the applicable subpart(s), or alternative test methods approved by the Administrator under §§ 60.8, 61.13, or 63.7.
Periodic Monitoring	Means reoccurring collection and use of measurement data or other information to control the operation of a process or pollution control device or to verify a work practice standard relative to assuring compliance with applicable requirements.
Stack Testing	Performance or source test measures the amount of a specific regulated pollutant, pollutants, or surrogates being emitted; determines a facility's compliance with emission limits. Any standardized procedure of actions using calibrated tools to determine a rate or concentration in order to verify emissions from a source or the accuracy of a monitor or gauge.

(j) Terms Used To Describe Type of Protocol

Except for natural gas compressor station defined in Section A, Condition 3 of GP-5 Permit, the following definitions were defined DEP's NGITS.

General Terms	Definitions
Natural Gas Compressor Station	Section A, Condition 3 of GP-5 Permit defines a "Natural Gas Compressor Station is "[a] facility that compresses and/or processes natural gas, coal bed methane, or gob gas prior to the point of custody transfer using processes including, but not limited to, gas dehydration, compression, pigging, and storage".
Multi-Source	A multi-source means that there a compressor station or site with more than one sources (i.e., engines).
Multi-Sites	A multi-site or multi-facility means that there are multiple compressor stations (or multi-sites with separate PFIDs) with one or more sources (i.e., engines) at each site.
Standardized Protocol	A Standard Protocols provide general guidance on conducting stack tests and reporting the emission results at PA facilities. This Standard Protocol applies to DEP personnel, testing contractors, permittees, and facility personnel, however, it is not intended to provide step-by-step instructions on preparing a site-specific stack testing protocol, observing or conducting emission tests, or preparing or reviewing emission test reports. It does contain references for specific test methods, specific state and federal regulations and related material. Collectively, with permit, and EPA and federal testing requirements and promulgated sampling guidance documents, it outlines source sampling techniques and measurement requirements approved by DEP for use in conducting emissions testing on Stationary Spark Ignition Internal Combustion Engines. Any source conducting stack testing in PA must comply with the testing requirements of its air permit, or with a state or federal regulation, should be familiar with this Standard Protocol, as should any stack testing company retained by the source to conduct the testing.
	Standardized Protocols are a set of pre-approved procedures and test methods for conducting emission source sampling (i.e., stack testing) at facilities regulated by DEP and may be carried out by consultants (or testing firms) with DEP input, written approval. It provides a written plan for basically each phase of the performance test. Standardized Protocols are important because (1) provides clarification on how test should be performed and reported; (2) provides maximum required information in a standardize format, (3) provides a written plan of each stage of baseline and compliance test, (4) reduces the number of site-specific protocols facilities are required to submit, (5) significantly reduces or expedites the time it takes for approvals of each project, (6) eliminates facility costs associated with site-specific protocols, and (7) ensures that testing and reporting is performed in an acceptable manner without unapproved deviations and standardize reporting. DEP reserves the discretion to deviate the requirements in this Standard Protocol if circumstances warrant.

(k) Terms Used in Sampling Referenced Methods

General Terms	Regulatory Citation	Commonly Used Sampling Definitions
Cyclonic Flow	DEP Definition	Cyclonic, swirling, turbulent, or non-parallel flow is defined to exist in the stack when the average flow at designated sample points in the stack average greater than 20 degrees off parallel with stack walls.
Engine Source ID Names and Nos.	DEP Definition	DEP assigns an engine's source identification (ID) name and number (no.) to each source, control device, and stack at each compressor station in eFacts. These source ID names and nos. documented in the test report must exactly match what is listed in eFacts. If source ID names and numbers are not listed in eFacts, the report should list a generic source name and list "TBD" to indicate "To Be Determined" for the source ID Nos.
Fd Factor	§ 12.0, 12.2, and Table 19-2 of M19	The dry F factor (Fd) includes all components of combustion less water or the "fuel-specific oxygen-based F factor, dry basis, [scf / million Btu]".
Fc-Factor	§ 12.0, 12.2, and Table 19-2 of M19	The carbon F factor (Fc) includes only carbon dioxide or the "fuel-specific carbon dioxide-based F factor, dry basis [scf / million Btu]".
Monitoring	DEP Definition	The test procedure used to determine periodic monitoring, baseline, or compliance emissions could be a test method or a monitoring procedure.
Source Test Manual (Revision 3.3)	Page 1-2 of PA Source Testing Manual (Revision 3.3)	"The purpose of this document is to provide detailed information on source test methods, procedures and guidance for the reporting of emissions to the Department. The policies and procedures outlined in this guidance document are intended to supplement existing requirements. Nothing in the policies and procedures shall affect regulatory requirements. The policies and procedures herein are not an adjudication or a regulation".
	DEP Definition	Except as noted in this Standard Protocol, GP-5 Permit, 40 CFR Part 60 Subpart JJJJ, and 40 CFR Part 63, Subpart ZZZZ regulation, the policies and procedures outlined in this guidance document must be followed.
Standard Conditions	Footnote, Table 19-2 of EPA M19	Results determined at standard conditions: 68°F (528°R) and 29.92 inches Hg (14.7 psia)(average pressure at sea level).
Test Method	40 CFR, Section 63.2	"A validated procedure for sampling, preparing, and analyzing for an air pollutant specified in a relevant standard as the performance test procedure".
Non-Methane/Ethane Hydrocarbon (NMEHC)	§ 1.3.3.6 of PA Source Testing Manual (Revision 3.3)	"The sum of all volatile organic compounds and all exempted compounds listed in), except methane and ethane".
Volatile Organic Compounds (VOC)	40 CFR §51.100(s)(1)	"Means volatile organic compounds as defined in 40 CFR 51.100(s)".
	DEP Requirement	NGITS requires 9 organic compounds and recommends 5 organic compounds are measured at each compressor station, engine, and during each run.

(l) Terms Used in Sampling of Stationary Spark Ignition Internal Combustion Engines
These definitions were all extracted from § 60.4248 of 40 CFR Part 60, Subpart JJJJ at: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-60/subpart-JJJJ.

General Terms	Regulatory Citation	Definitions
Compression Ignition (CI)	§ 60.4248 of 40 CFR Part 60, Subpart JJJJ	"Compression Ignition (diesel) means relating to a type of stationary internal combustion engine that is not a spark ignition engine".
Four Stroke Engine (4-stroke)		"Means any type of engine which completes the power cycle in two crankshaft revolutions, with intake and compression strokes in the first revolution and power and exhaust strokes in the second revolution.: power cycle completed in 2 revolutions of crankshaft".
Lean Burn Engine		Means any two-stroke or four-stroke spark ignited engine that does not meet the definition of a rich burn engine.: higher air/fuel ratio (fuel-lean).
Rich Burn Engine		"Means any four-stroke spark ignited engine where the manufacturer's recommended operating air/fuel ratio divided by the stoichiometric air/fuel ratio at full load conditions is less than or equal to 1.1. Engines originally manufactured as rich burn engines, but modified prior to June 12, 2006, with passive emission control technology for NO_X (such as pre-combustion chambers) will be considered lean burn engines. Also, existing engines where there are no manufacturer's recommendations regarding air/fuel ratio will be considered a rich burn engine if the excess oxygen content of the exhaust at full load conditions is less than or equal to 2 percent".
Spark Ignition (SI)		"Means relating to either: a gasoline-fueled engine; or any other type of engine with a spark plug (or other sparking device) and with operating characteristics significantly similar to the theoretical Otto combustion cycle. Spark ignition engines usually use a throttle to regulate intake air flow to control power during normal operation. Dual-fuel engines in which a liquid fuel (typically diesel fuel) is used for compression ignition and gaseous fuel (typically natural gas) is used as the primary fuel at an annual average ratio of less than 2 parts diesel fuel to 100 parts total fuel on an energy equivalent basis are spark ignition engines".
Two Stroke Engine (2-stroke)		"Means a type of engine which completes the power cycle in single crankshaft revolution by combining the intake and compression operations into one stroke and the power and exhaust operations into a second stroke. This system requires auxiliary scavenging and inherently runs lean of stoichiometric".
Volatile Organic Compounds		"Means volatile organic compounds as defined in 40 CFR 51.100(s)".

4. Applicability/Scope

The Natural Gas Industry Testing Section (NGITS) is responsible for all testing related to the production, processing, liquefication (e.g. LNG), distribution, storage, and loading of natural gas (NG). Testing of engines, combustion turbines, or natural gas fired sources is not covered exclusively by either section. The Source Testing Section handles all other testing, not related to the natural gas industry, which includes landfill gas (LFG) and LFG-fired sources, renewable natural gas (RNG), liquified petroleum gas (LPG), the petroleum industry, emergency generators, or electric generating units (EGUs), to name a few. Specifically, this Standard Protocol 005 (SP-005) provides general guidance on determination of referenced emissions

from Stationary Spark Ignition Internal Combustion Engines under GP-5, Federal Subparts 40 CFR Part 60, Subpart JJJJ, and 40 CFR Part 63, Subpart ZZZZ, where federal Subparts takes precedence over applicable state requirements. This Standard Protocol is applicable under the following:

(i) Sampling a single compressor station or site with one or more sources. or

(ii) Sampling multiple compressor stations (or multi-sites) with one or more sources at each site.

(iii) Sampling at facilities that operate under or subject to GP-5 Permit; or

(iv) Sampling at facilities that operate under or subject to Subject to GP-5 Permit and 40 CFR, Part 60, Subpart JJJJ; or

(v) Sampling at facilities that operate under or subject to Subject to GP-5 Permit, 40 CFR, Part 60, Subpart JJJJ, and 40 CFR Part 63, Subpart ZZZZ.

5. Prohibited Use of SP-005

Unless specified in SP-005, this Standard Protocol may **not** be used for determination of NO_x, CO, Formaldehyde, and VOC (or NMEHC) emissions at Stationary Spark Ignition Internal Combustion Engines to establish baseline emissions, demonstrate compliance, and perform periodic monitoring when:

(a) Any proposal to test other pollutants different than NO_x, CO, Formaldehyde, and VOC (or NMHC) specified in this Standard Protocol is not acceptable.

(b) Any proposal to test source category different than Stationary Spark Ignition Internal Combustion Engines specified in this Standard Protocol is not acceptable.

(c) Any proposal to use test method(s) different than Methods 1, 2, 2C, 3, 3A, 3B, 4, 19, 205, 320, ASTM Method D6348-03, and ALT-106 specified in this Standard Protocol is not acceptable.

(d) Any proposal to use sampling and testing procedures, and guidance different than specified or referenced in Methods 1, 2, 2C, 3, 3A, 3B, 4, 19, 205, 320, ASTM Method D6348-03, and ALT-106 and this Standard Protocol is not acceptable if not preapproved by EPA and DEP.

(e) A notification letter to use of SP-005 is not provided 90 days prior to testing specified in this Standard Protocol, the test results may be deemed unacceptable, and the source may be required to test again.

6. Requests for Approval of Minor/Major Modifications/Alternatives to Testing Procedures

If a facility wishes to deviate from required sampling and testing procedures, and guidance from referenced in Methods 1, 2, 2C, 3, 3A, 3B, 4, 19, 205, 320, ASTM Method D6348-03, and ALT-106 and this Standard Protocol, the facility will need to gain approval from the applicable delegated agency in advance of the test. Specifically, to receive approval for minor/major changes to test methods procedures and guidance, the facility must review and strictly adhere to the following in sequential order:

(a) <u>Identify Delegated Authority (State/Local/Region)</u>

The delegated office with lead responsibility for responding to requests deviations from the specified testing methods or procedures depends on whether the changes to a test method are considered major, intermediate, or minor, as summarized in Table 1 below and defined in 40 CFR § 63.90(a) (reproduced in Appendix C). EPA offices receiving a request for an alternative test method may consult with Office of Air and Radiation (OAR)/ Office of Air Quality Planning and Standards (OAQPS)/Air Quality Assessment Division (AQAD)/ Sector Policies and Programs Division, Measurement Policy Group (MPG) to confirm whether the request constitutes a major, intermediate, or minor change in test method.

(b) Request Consideration of Request from Applicable Delegated Authority

The facility must receive prior written approval for deviations from a test method from the appropriate delegated agency. Written request to delegated authority for an alternative test method procedures approval must minimally include: (1) name(s), location(s), and affected units for facilities to which requested testing alternative is to apply; (2) detailed description of the alternative testing procedure(s); 3) supporting information/justification for alternative testing procedure; (4) names, addresses, and e-mails for responsible state/local agency and EPA regional office contacts; requestor name, address, telephone number, and e-mail address to allow timely contact should the request be deficient or need clarification.

Table 1. Major, Intermediate, and Minor Changes to Test Methods

Type	Criteria	Regulatory Contacts
Major[1]	Any of the following: • Uses unproven technology or procedures or • Entirely new method or • Broadly applicable (not site-specific)	EPA's Office of Air Quality Planning and Standards (OAQPS)
Intermediate[1]	All of the following: • Uses proven technology • Within an existing method • Site-specific Plus, any of the following: • Potential to set national precedent or • Potential to decrease stringency of standard	EPA Region 3 [with Enforcement and Compliance Assurance Division (ECAD) and Offices of Regional Counsel (ORC)]
Minor	All of the following: • Uses proven technology • Within an existing method • Site-specific, accommodating site-specific constraints • No national significance or precedent • No potential to decrease stringency of standard	Compliance with a Federal Subpart EPA Region 3 and Compliance with a State Requirement Delegated Air Agency (aka DEP)

[1] Must be validated using EPA Method 301.

(c) Receive an Official Letter of Approval From Applicable Delegated Authority

Delegated authority (EPA) will review request for approval process for major or intermediate changes to test methods and issue official letter of approval/disapproval. If the deviation is to be approved by a state/local agency, it should be in consultation with EPA, or as otherwise required by the delegation. Most importantly, acceptance of an alternative test method procedures shall be based on substantive technical support information. **Written approval from a responsible official from EPA** on their letterhead must be received by DEP for approval of any request for deviation to sampling procedures of reference method testing.

(d) References

For a more thorough understanding of these policies, we suggest that the reader review the documents in their entirety.

(i) See Clean Air Act National Stack Test Guidance at https://www.epa.gov/sites/default/files/2013-09/documents/stacktesting_1.pdf.

(ii) See also, 40 CFR § 60.8(b) (NSPS); 40 CFR § 61.13(h)(1) (NESHAP); 40 CFR § 63.7(e)(2) (MACT).

(iii) See also, "EPA Process Manual for Responding to Requests Concerning Applicability and Compliance Requirements of Certain Clean Air Act Stationary Source Programs" at: https://www.epa.gov/sites/default/files/2020-07/documents/111-112-129_process_manual.pdf.

(iv) See also, Presentation from Robin Segall | Leader, Measurement Technology Group, US EPA Office of Air Quality Planning and Standards (OAQPS), Air Quality Assessment Division, "Alternative Test Method and Monitoring Approval" at: https://www3.epa.gov/ttn/emc/meetnw/2010/altmetrs.pdf.

(v) See also, Emission Measurement Center Guideline Document (GD-022R5), "Requests For Approval of Alternatives/Modifications To Test Methods and Testing Procedures" at: https://www.epa.gov/ system/files/documents/2022-09/gd-022r5.pdf

7. Authorization to Use SP-005

(a) *Test Notification Letter for Authorization to Use SP-005*. Any person proposing to sample Stationary Natural Gas-Fired Spark Ignition Internal Combustion Engine(s) listed in Section A, Condition 4 of this Standard Protocol must submit an Test Notification Letter for Authorization to Use SP-005 to DEP's Natural Gas Industry Testing Section (NGITS) reviewer and DEP's applicable Regional Office Resource Account at least 30 calendar days prior to testing. DEP's NGITS Reviewer for the applicable project will be responsible for authorizing the use of the Standard Protocol. If approval is granted, this Standard Protocol Test Notification letter will be uploaded into PSIMS as a miscellaneous document and emailed to all interested parties. A copy of this authorization letter which must be included in the final test report.

(b) *Required Information in Authorization Request Letter to Use SP-005.* This Standard Protocol Test Notification letter shall minimally include: 1) the source owner/operator's name, mailing address, contact person (including their job title), and telephone number; 2) the testing firm's name, mailing address, contact person (including their job title), and telephone number; 3) facility ID no(s); 4) proposed test date(s); 5) submittal date; the 6) the source names and source id numbers per eFacts; 7) listing of pollutant(s) to be measured in units of the permit limit(s); 8) name of Standard Protocol; 9) the permit limit(s) for each pollutant measured; 10) the permit number(s) where the limit was obtained; 11) statement of baseline, compliance, or periodic monitoring determination(s); and 12) all applicable federal subpart.

(c) *Terms of Authorization to Use SP-005*. This Standard Protocol replaces the requirement to submit a site-specific protocol and authorizes baseline and/or performance testing of Stationary Natural Gas-Fired Spark Ignition Internal Combustion Engines at the specific facility or facilities as detailed in DEP's NGITS approval letter for a term 6 months from the date of authorization. The authorization to perform baseline and/or performance testing will expire 6 months from the date of the authorization if the owner or operator fails to perform baseline and/or performance testing within this period. DEP may extend the 6-month period upon an owner or operator providing satisfactory justification for an extension up to the original date of the 6-month term. All requests for extension shall be submitted to DEP's NGITS at least 30 days prior to the end of the 6-month period and are only valid upon receipt of written approval by DEP's NGITS. The expiration of the *Authorization to Use SP-005* will require a new Test Notification Letter for Authorization to Use SP-005 if an extension is not requested and granted.

(d) *Delay in Testing.* If there is a delay of testing, DEP must be notified 30 days prior to testing or as soon as possible.

(e) *Transfer of Ownership.* The Authorization to Use this Standard Protocol may be transferred from the owner or operator of a facility.

(f) *Modification, Suspension, or Revocation or Authorization to Use SP-005.*

(i) DEP may modify, suspend, or revoke and reissue this Standard Protocol.

(ii) This Standard Protocol may be modified, suspended, or revoked if DEP determines that the Stationary Natural Gas-Fired Spark Ignition Internal Combustion Engine(s) cannot be accurately tested under this Standard Protocol.

(iii) An Authorization to Use SP-005 may be suspended or revoked if DEP determines that, at any time, the owner, operator, and/or their subcontractor(s) has failed to test the source(s) in accordance with the terms and conditions of this Standard Protocol.

(iv) Upon suspension or revocation of an Authorization to Use SP-005, the owner or operator shall immediately cease use of this Standard Protocol.

(v) Failure to strictly adhere to this Standard Protocol will likely result in a rejection of the test results and may lead to a requirement to retest.

8. Applicable Federal Regulations

This Standard Protocol is intended for source operations required to perform baseline emissions and compliance stack emission tests as a condition of Federal regulations, etc., including but not limited to:

(a) It is the duty of the Responsible Official, as defined in 25 Pa. Code § 121.1, to ensure that the facility is in compliance with all applicable federal, state, and local laws and regulations, including 25 Pa. Code, Subpart C, Article III. Nothing in this Standard Protocol relieves the Responsible Official from this obligation to comply.

(b) Applicable federal regulations may include, but are not limited to, the following New Source Performance Standards (NSPS), codified at 40 CFR Part 60 and incorporated by reference in 25 Pa. Code § 122.3, and National Emission Standards for Hazardous Air Pollutants (NESHAP), codified at 40 CFR Part 63 and incorporated by reference in 25 Pa. Code § 127.35. The following applicable federal regulations in below table, of this section shall apply for this Standard Protocol:

(i) **40 CFR Part 60, Subpart JJJJ** – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines

(ii) **40 CFR Part 63, Subpart ZZZZ** – National Emission Standards for Hazardous Air Pollutants (NESHAP) for Reciprocating Internal Combustion Engines

(iii) **40 CFR Part 60.8** – Performance tests

9. Applicable State Regulations

This Standard Protocol is intended for source operations required to perform baseline emissions and compliance stack emission tests as a condition of operating permit approval and state regulations, etc., including but not limited to:

(a) Applicable state regulations may include, but are not limited to, the following Section 6.1(f) of the Pennsylvania Air Pollution Control Act (APCA), 35 P.S. § 4006.1(f) and 25 Pa. Code Chapter 127, Subchapter H, 25 Pa. Code Chapter 139, the Department of Environmental Protection (Department or DEP) hereby issues this General Plan Approval and/or General Operating Permit (**General Permit or GP-5**) for new or modified natural gas compressor stations, processing plants, and transmission stations (facility or facilities) constructed, modified, or operated in this Commonwealth.

(i) **25 Pa. Code Chapter 139.11(2)** – General requirements of sampling and testing.

(ii) **AG5 Authorization No.** – Authorizations to use GP-5.

(iii) **GP-5** – General Plan Approval and/or General Operating Permit BAQ-GPA/GP-5. 2700-PM-BAQ0267 Rev. 6/2018.

10. Best Available Technology (BAT) Requirements

New sources are required to control the emission of air pollutants to the maximum extent, consistent with best available technology (BAT) as determined by the Department as of the date of issuance of the plan approval for the new source as required under 25 Pa. Code § 127.1. Condition 1 (BAT Compliance Requirements) of Section B of this Standard Protocol are determined to meet the BAT requirements.

11. Test Notification Requirements

(a) Any person proposing to use this Standard Protocol for Stationary Spark Ignition Internal Combustion Engines shall submit a test notification letter at least 90-days in advance, unless otherwise approved by DEP.

(b) Acceptance of all testing is contingent upon the review of, and conformance to, the information in the FAQs: https://www.dep.pa.gov/Business/Air/BAQ/BusinessTopics/SourceTesting/Pages/default.aspx. Failure to obtain DEP approval may result in rejection of test results and possible enforcement action. Final acceptance of the test results is also contingent upon fulfillment of all the applicable requirements specified in the most current version of DEP's Source Testing Manual.

12. Sample Postponements and Stoppages

Postponements or stoppages of a scheduled performance test must be immediately communicated to DEP's Natural Gas Industry Testing Section and applicable DEP's Responsible Regional Office contact for Stationary Spark Ignition Internal Combustion Engine. Per pages 17-18, Section 6.0 of the Clean Air Act National Stack Testing Guidance, the following must be strictly followed regrading stoppages during stack tests at https://www.epa.gov/sites/default/files/2013-09/documents/stacktesting_1.pdf:

(a) It is acceptable to postpone a scheduled test or suspend a test in progress if the discontinuation is due to equipment failure beyond the facility's control, construction delays beyond the facility's control, severe meteorological conditions, and situations that would jeopardize the safety of the testing contractors and/or operators. If the test is underway, the permittee should make every effort to complete the test run. All recoverable test information (process & sample data) must be available for DEP review.

(b) It is unacceptable to postpone or suspend a test run in progress if it is discontinued because the source is not able to comply with an emission limit, verify an existing emission factor, or comply with a control equipment performance standard. The permittee must provide DEP written documentation explaining the reasons for the postponement or stoppage, and any data collected prior to the stoppage. DEP will review the documentation and all available stack test data to determine if a violation occurred.

13. Recordkeeping Requirements

For each engine, the owner or operator shall maintain the following records onsite or at the nearest local field office for a minimum number years specified by the applicable regional contact and may be maintained in electronic format:

(a) All records relating to this stack are required must be maintained onsite or at the nearest local field office indefinitely or until the applicable DEP Regional approves and may be maintained in electronic format.

(b) The owner or operator of the facility shall generate and maintain records that clearly demonstrate to the Department that the facility is not a Title V facility and that the facility is in compliance with facility-wide emission limitations. At a minimum, the records shall be maintained on a monthly basis, and the actual emissions shall be calculated on a 12-month rolling sum. The Department reserves the right to request additional information necessary to determine compliance with the General Permit.

(c) The owner or operator of the facility shall keep records of all written notifications required under permit conditions and this Standard Protocol.

14. Reporting Requirements

(a) The owner or operator of a natural gas compressor station, processing plant, or transmission station shall submit to the Air Program Manager of the appropriate DEP Regional Office all requests, reports, applications, submittals, and other communications concerning applicable federal NSPS and NESHAP.

(b) The test report must conform to (1) the requirements in the Source Test Reports section of the current version of DEP's Source Testing Manual (Revision 3.3, November 2000), located at: https://www.dep.pa.gov/Business/Air/BAQ/BusinessTopics/SourceTesting/Pages/default.aspx, and (2) this Standard Protocol.

(c) For test report submittals, refer to the current information in the Source Testing FAQs: https://www.dep.pa.gov/Business/Air/BAQ/BusinessTopics/SourceTesting/Pages/default.aspx;

(d) The test report must contain all data collected from the Stationary Spark Ignition Internal Combustion Engines plant relating to the performance testing program, such as pre-compliance, preliminary, and informational testing in preparation of the performance test (i.e, include all certified gas calibration, field, and laboratory data sheets in the test report).

(e) If DEP develops a document on the preparation of emission test reports, the submitted report should be formatted as specified in that document. Until then, the submitted report should be formatted as specified in EPA Emission Measurement Center Guideline Document (GD-043) Preparation and Review of Emission Test Reports (December 1998): https://www.epa.gov/sites/default/files/2020-08/documents/gd-043.pdf.

(f) Reported test results must be rounded to two or three significant figures. See EPA Emission Measurement Center Technical Information Document (TID-024) Memo on Rounding and Significant Figures (June 6, 1990), located at: https://www.epa.gov/emc/technical-information-document-024-memo-rounding-and-significant-figures.

(g) In accordance with 40 CFR §§ 60.4 and 63.10, copies of all test notifications, reports, and other communications shall also be submitted to the EPA via the Compliance and Emissions Data Reporting Interface (CEDRI) accessible at https://cdx.epa.gov.

(h) The first page of the test report shall be a Test Results Summary (TRS). The TRS shall contain a table listing the following: the test date(s); the source and source ID numbers; the average result(s) of each pollutant measured in units of the permit limit(s); the permit limit(s) for each pollutant measured; the permit number(s) where the limit was obtained; and whether the results demonstrate compliance or non-compliance with the permit limit(s)".

(i) Sections 2.1.2.6 and 2.1.2.11.1 of DEP's Source Test Manual (Revision 3.3) requires that a statement signed by the on-site supervisor of the test team, a source owner/operator representative, and laboratory manager is required certifying that "to the best of their knowledge" the source test report has been checked for completeness, and that the results presented therein are accurate, error-free, legible, and representative of the actual emissions measured during testing.

(j) The test report must contain a statement clarifying if the engine is new, existing, modified, and/or has been replaced. If modified and/or replaced, the supporting information such as modified/installation dates listed in this table for the previous and modified or replaced engine must also be included in the test report.

(k) All documentation of sampling equipment calibrations and analytical results should be maintained for a minimum of five years. In general, the unanalyzed portions (aliquots) of the source test samples must be preserved up to the maximum holding times as specified by method. Sample filters gravimetrically analyzed for particulate matter are to be archived for a minimum of 6 months. However, sample archiving specifications pertaining to laboratory glassware is left to the discretion of the analyzing laboratory and the testing contractor.

15. Natural Gas Industry Testing Section (NGITS) Requirements

These requirements must be followed when conducting source testing in PA. More stringent requirements in state and federal regulations, or operating permits supersede the requirements herein.

(a) Source Sampling General Requirements

(i) All testing, except for periodic monitoring, shall be performed in accordance with any applicable federal regulations, 25 Pa. Code, Chapter 139, GP-5 Permit, 40 CFR, Part 60, Subpart JJJJ, 40 CFR Part 63, Subpart ZZZZ, and the current version of the DEP's Source Testing Manual, or other test method as approved by this Standard Protocol.

(ii) One electronic copy Authorization Request Letter to Use SP-005 shall be submitted sent to the Air Program Manager of the appropriate DEP Regional Office and to the PSIMS Administrator for the Natural Gas Industry Testing Section in DEP's Central Office.

(iii) All submittals, except for periodic monitoring data, shall meet the applicable requirements specified in the most current version of the DEP's Source Testing Manual and this Standard Protocol.

(iv) At least 90 calendar days prior to commencing an emission testing program to demonstrate compliance required by this Standard Protocol, a Standard Test Protocol shall be submitted in accordance with (e) above for review and approval. An operator may request an approval from the DEP for a test protocol that covers testing of all currently operated sources in service at that operator's various facilities. In such a request, the operator will submit the Standard Protocol in accordance with (e) above for review and approval and include a list of currently permitted sources. If the owner or operator has a previously approved Standard Protocol by DEP, a new Standard Protocol does not need to be submitted for review/approval for 90 days from the approval date, provided that there are no changes, including the testing contractor, and the owner/operator agrees to comply with all conditions of acceptance in the letter approving the Standard Protocol.

(v) At least 30 calendar days prior to commencing an emission testing program to demonstrate compliance required by this General Permit, written notification of the date and time of testing shall be provided to the Department's Division of Source Testing and Monitoring and the appropriate DEP Regional Office so that an observer may be present. The Department is under no obligation to accept the results of any testing performed without adequate advance written notice to the Department of such testing.

(b) Applicable State Regulations

(i) Per 25 Pa. Code Chapter 139.11(1), performance tests shall be conducted while the source is operating under such other conditions, within the capacity of the equipment, as may be requested by the Department.

(iv) Per 25 Pa. Code Chapter 139.11(2), "[t]he Department will consider test results for approval where sufficient information is provided to verify the source conditions existing at the time of the test and where adequate data is available to show the manner in which the test was conducted. Information submitted to the Department shall include, as a minimum, all of the following specified in 25 Pa. Code Chapter 139.11(2)(I through vii).

c. Applicable Federal Regulations

(i) For all testing projects performed to satisfy federal testing requirements (e.g. NSPS, NESHAPs, or MACT), approval for modifications and alterations of federal testing requirements must follow the procedures outlined in the Emission Measurement Center Guideline Document GD-022R5. As per this guideline, minor changes to test methods and procedures may be approved by DEP's NGITS personnel. All other changes must be approved by EPA.

(ii) Minor change to a test method is a modification to a federally enforceable test method that (a) does not decrease the stringency of the emission limitation or standard; (b) has no national significance (e.g., does not affect implementation of the applicable regulation for other affected sources, does not set a national precedent, and individually does not result in a revision to the test method); and (c) is site-specific, made to reflect or accommodate the operational characteristics, physical constraints, or safety concerns of an affected source.

(d) Permit, Federal Subpart, Sampling, and/or Operating Deviations

(i) Documentation of any deviations shall be clearly identified as "Permit, Federal Subpart, Sampling, or Operational Deviation(s)" in the executive summary section or first three pages of the report and must include an evaluation of the impact of the deviation on the test data.

(ii) All testing shall be performed in accordance with the approved Standardize protocol. Unapproved deviation from the protocol is not acceptable and will be justification to require repetition of the test project.

(iii) If a DEP representative is not on-site during field activities, approval from any DEP's NGITS and/or Source Testing Section representative for sampling or DEP's Regional Office representative for operational issues may be obtained. Changes not acknowledged by the DEP could be basis for invalidating an entire test run and potentially the entire testing program.

(iv) Per Section A, Condition 6 of this SP-005, DEP must be notified of any changes in the source test plan and/or the specified methods prior to or during testing. Significant changes or deviations from the specified testing methods or procedures not acknowledged by the DEP and EPA could be the basis for invalidating a test run and potentially the entire testing program.

(v) Any excess emissions or other permit deviations that occur during the test program must be reported to applicable DEP representatives asap and be explained in the test report.

(vi) The facility representative and/or consultant must address any significant emission changes in the final test report for each pollutant tested. This includes, but is not limited to, any significant emission changes for an outlier test run and from test project to test project.

(vii) Any process upsets that occur, and any failures to achieve the operating conditions or parameters specified in GP-5, 40 CFR Part 60, Subpart JJJJ, and/or 40 CFR, Part 63, Subpart ZZZZ, during each test run must be reported to applicable DEP representatives asap and explained in the test report.

(e) Sample Postponements & Stoppages

(i) It is acceptable to postpone a scheduled test or suspend a test in progress if the discontinuation is due to equipment failure beyond the facility's control, construction delays beyond the facility's control, severe meteorological conditions, and situations that would jeopardize the safety of the testing contractors and/or operators. If the test is underway, the

permittee should make every effort to complete the test run. All recoverable test information (process & sample data) must be available for DEP review.

(ii) It is unacceptable to postpone or suspend a test run in progress if it is discontinued because the source is not able to comply with an emission limit, verify an existing emission factor, or comply with a control equipment performance standard. The permittee must provide DEP written documentation explaining the reasons for the postponement or stoppage, and any data collected prior to the stoppage. DEP will review the documentation and all available stack test data to determine if a violation occurred.

(f) Operational Conditions

Operating requirements, clarifications, monitoring suggestions, and recording requirements for baseline and performance tests are specified by GP-5 permit, federal subparts, EPA clarification documents, and this Standard Protocol. For instance:

Item #	Description	Regulatory Citation	Requirement / Comments
(i)	Applicability	DEP Requirement	To determine baseline emissions and/or demonstrate compliance for each pollutant at required operating conditions, the owner or operator must conduct the source test on each natural gas-fired spark ignition internal combustion engine constructed under and authorized to operate to not cause the results to be biased where repeating testing will be required.
(ii)	State Operational Requirement	§ C(4)(b)(i) of GP-5	The owner or operator should conduct three test runs of at least one-hour duration within 10% of 100% peak (or the highest achievable) load.
(iii)	Federal Operational Requirement	§ 60.4244(a) of 40 CFR Part 60, Subpart JJJJ	"Each performance test must be conducted within 10 percent of 100 percent peak (or the highest achievable) load and according to the requirements in § 60.8 and under the specific conditions that are specified by Table 2 to this subpart".
		§ 60.4244(b) of 40 CFR Part 60, Subpart JJJJ	"You may not conduct performance tests during periods of startup, shutdown, or malfunction, as specified in § 60.8(c). If your stationary SI internal combustion engine is non-operational, you do not need to start up the engine solely to conduct a performance test; however, you must conduct the performance test immediately upon startup of the engine".
(iv)	Retest Requirement Due To Unacceptable Operational Load	EPA's Question and Answer (Q&A) Document (See Requirement Column)	Question 46, Implementation Question and Answer Document for National Emission Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines and New Source Performance Standards for Stationary Compression Ignition and Spark Ignition Internal Combustion Engines dated April 2, 2013 at: https://www.epa.gov/sites/default/files/2014-03/documents/4_2_2013_qa_stationary_rice_neshap_nsps_stationaryci_si_ice.pdf, states that "[t]he test should be conducted within 10% of the highest achievable load for the engine at the engine's site conditions. If operating conditions change such that the highest achievable load for the engine at the engine's site conditions changes and the original test load is not within 10% of the new highest achievable load, then the engine must be retested".
		§ Section C(4)(c) of GP-5	If at any time the owner or operator does not operates the engine at 10% of the highest achievable load, the owner or operator may be required to perform a stack test within 180 days from the anomalous operation.
(v)	Regulatory Contacts for Operational Questions	DEP Requirement	Prior to testing and/or during testing, the owner, operator, or tester should contact the applicable DEP regional office employee with questions/issues regarding the process operating and control device parameters/loads or to verify the highest achievable and targeted operating loads change to receive approval. The facility should understand that changes to operational loads may limit the operating capacity at these sources until a new test is performed. The NGITS should be notified of all operational questions to applicable DEP Regional staff.
(vi)	Recommended Daily Operational Monitoring Recordings	DEP Requirement	If not done already, DEP's NGITS recommends that the facility contact DEP's regional staff regarding the frequency that operational and control device data is to be recorded during testing. During inspections and records reviews, all pertinent operational and control device documentation should be provided to DEP's regional staff, who ensure that operations do not significantly exceed the levels during testing. Ideally, these logs, for at least the year prior to testing, should be used to establish 10 percent of 100 percent peak (or the highest achievable) load operating conditions operating conditions for daily operations.
(vii)	Recording Requirements	§ 2.1.1.11 of DEP's Source Testing Manual (Revision 3.3)	These parameters in Recording Requirements of Section B in this SP-005 must be minimally recorded every 15 minutes, to verify the operating conditions at the time of testing, and must be included in the final test report.

(g) Significant Figures & Rounding Procedures

State of Oregon Department of Environmental Quality,, AR 340-200-0035, DEQ Source Sampling Manual (Most Recent Revision November 2018) states that the following:

(i) Significant Figures
All federal emission standards have at least two (2) significant figures but no more than three (3). For example, 0.04 g/bhp-hr is considered to be 0.040 g/bhp-hr and 90 ppmvd is considered to be 90. ppmvd.

Generally, DEP emission standards have at least two (2) significant figures. However, the number of significant figures for DEP standards are defined by the standards themselves. For example, 40 lbs/hr is considered to be 40. lbs/hr and 0.1 g/bhp-hr does not include additional significant figures.

It is imperative to maintain an appropriate number of significant figures within the intermediate calculations to minimize the discrepancy of results due to rounding inconsistencies. In general, at least five (5) significant figures should be retained throughout the intermediate calculations.

(ii) Rounding Procedures
The procedure for rounding of a figure or a result may mean the difference between demonstrating compliance or demonstrating a violation. The following procedure must be used:

If the first digit to be discarded is less than five (5), the last digit retained should not be changed. When the first digit discarded is greater than five (5), or if it is a five (5) followed by at least one digit other than zero (0), the last figure retained should be increased by one unit. When the first digit discarded is exactly five, followed only by zeros (0s), the last digit retained should be rounded upward if it is an odd number, but no adjustment made if it is an even number.

For example, if the emission standard is 0.040 gr/dscf, then 0.040341 would be rounded to 0.040, 0.040615 would be rounded to 0.041, 0.040500 would be rounded to 0.040, and 0.041500 would be rounded to 0.042 (note that five significant figures were retained prior to rounding).

(h) Reporting Content & Format

At a minimum, the content of the source sampling report must be consistent with the requirements outlined in most current version of the Department's Source Testing Manual (Revision 3.3) and this Standard Protocol. DEP recognizes that the presentation and format of the reports will vary between sampling projects and testing contractors. However, the report must comprehensively include all essential information and maintain sufficient detail to satisfactorily communicate the test objectives and results that includes but not limited to:

(i) As of July 29, 2021, the Natural Gas Industry Testing Section (NGITS) has gone paperless. An individual NGITS reviewer may request a hard copy from the facility or the consultant. Note that the section will continue to require electronic submissions of protocols and reports to the resource email account (RA-EPstacktesting@pa.gov or by disk and snail mail when the file is over 35 MBs). Test notifications must be submitted to the test protocol reviewer at least 30 calendar days prior to testing via email to NGITS' reviewer. The test reviewer for this project is listed above in "To" field of this email. For more detail on report submittal requirements, refer to Question 4, Frequently Asked Questions (FAQs) for Source Testing and Natural Gas Industry Testing Section. Questions regarding submittals should be directed to DEP's PSIMS Administrator/ Air Quality Program Specialist at mafelion@pa.gov.

(ii) Confidential Operational and Control Device Data Submissions – Any confidentiality claims should be accompanied by a notice of confidentiality. The notice should contain sufficient supporting information to allow DEP to evaluate whether such information satisfies the requirements related to trade secrets or how the information could cause substantial harm to the facility's competitive edge. If the facility and DEP has deemed any process and/or control device information is confidential, two copies of the test report must be submitted: one complete copy with the confidential information with each page marked "CONFIDENTIAL and a second copy for the public record with the confidential information removed/redacted. There are circumstances where it may not be possible to fulfill the items in this guidance document. In those cases, the facility will need to submit for approval any variances or unfulfilled items listed in this document a minimum of 30 days prior to testing.

(i) Sampling Duration

Unless otherwise specified by permit, state rule, federal regulation, or Department letter, each source test must consist of three test runs per pollutant (NOx, CO, Formaldehyde, & VOCs or NMEHC) with minimum sampling times of one (1) hour long.

(j) Sampling Methods

For engines being certified to the voluntary certification standards in below Tables 1, 2, 3, 4, 5, 6, 7, 8,9, 10, 10a, 10b, 11a, and 11b of this Standard Protocol, the VOC measurement shall be made by following the procedures in 40 CFR part 1065, subpart C, to determine the NO_x, CO, Formaldehyde, and NMEHC emissions using EPA Methods 1, 2, 2C, 3, 3A, or 3B, 4, 19, 205, 320, ASTM Method D6348-03, and Alt 106. The following requirements must be met:

Table 2. EPA Method 1 (Sampling Location and Traverse) Requirements

Item #	Description	Regulatory Citation	Requirement / Comments
(i)	Measured Parameters	§ 1.1 of M1	Measured Parameters. The purpose of the method is to provide guidance for the selection of sampling ports and traverse points at which sampling for air pollutants will be performed pursuant to regulations set forth in this part.
(ii)	Verification of Absence of Cyclonic Flow.	§ 1.2 and 11.4 of M1	Refer to for clarification on requirements and restrictions on verification of absence of cyclonic flow at each sampling location. Please note that, to prevent the dilution of sample and flow stream and rejection of emission results, all sampling ports must remain stuffed/blocked and clean during all traverse point sampling, cyclonic flow, and emission tests. Failure to measure and record the cyclonic flow test results will result in an immediate rejection of the volumetric flow and emission rate test results.
	Cyclonic Flow Test Exemption	DEP Requirement	Cyclonic flow test is not required at any sampling location that has at least eight stack (or duct) upstream diameters and two downstream stack (or duct) diameters from any flow disturbance because the flow at theses sampling locations should be stable and should be free of cyclonic or non-parallel flow.
	Unacceptable Cyclonic Flow & Alternative Methodology	§ 11.4.2 of EPA M1	M1 states that, "[i]f the average value of α is greater than 20°, the overall flow condition in the stack is unacceptable, and alternative methodology, subject to the approval of the Administrator, must be used to perform accurate sample and velocity traverses". Failure to perform or record cyclonic flow checks during each test program will result in an immediate rejection of the volumetric and emission rate test results".
	Cyclonic Flow Alternative Methodology	EPA's Guideline Document 008 (GD-008)	One of the four possible alternatives from EPA's Guideline Document 008 (GD-008) for sampling in cyclonic flow at: https://www3.epa.gov/ttn/emc/guidlnd/gd-008r.pdf must be implemented in **sequential** order, when conducting emission testing or flow determinations, if cyclonic or nonparallel flow patterns exist.
(iv)	Cyclonic Flow Observer Checklist	EPA's Guideline Document 054 (GD-54)	Refer to Observer Checklist – EPA's Guideline Document 054 (GD-54) at: https://www.epa.gov/sites/default/files/2021-02/documents/epa_source_test_observation_and_report_review_checklists_m1-5_v1.pdf for guidance on selection of sampling ports and traverse points and performing cyclonic flow tests. Checklist for Method 1 is used to assist the on-site observer during a performance or compliance test. These checklists were developed with the expectation that the observer has a general working knowledge of the applicable test method(s).

Table 3. EPA Method 2 or 2C (Volumetric Flowrate or VFR) Requirements

Item #	Description	Regulatory Citation	Requirement / Comments
(i)	Applicability	§ 1.1 of M2	This method is applicable for the determination of the average velocity and the volumetric flow rate of a gas stream.
		§ 1.2 of M2	This method is not applicable at measurement sites that fail to meet the criteria of Method 1, section 11.1. Also, the method cannot be used for direct measurement in cyclonic or swirling gas streams; section 11.4 of Method 1 shows how to determine cyclonic or swirling flow conditions. When unacceptable conditions exist, alternative procedures, subject to the approval of the Administrator, must be employed to produce accurate flow rate determinations. Examples of such alternative procedures are: (1) to install straightening vanes; (2) to calculate the total volumetric flow rate stoichiometrically, or (3) to move to another measurement site at which the flow is acceptable.
(ii)	Alternative When M19 Cannot Be Used	DEP Requirement	During testing at each compressor station, EPA Method 2 or 2C must be used in lieu of EPA Method 19 when: (1) a permanent mounted or temporary installed fuel meter was not available for each source; or (2) per Question 2 of FAQ of M19, a permanent mounted or temporary installed fuel meter was not calibrated and meet the requirements of EPA Method 2A or an equivalent procedure for each natural gas fired engine subject to 40 CFR 60, Subpart JJJJ.
(iii)	Cyclonic Flow Requirements	§ 1.2 of M2	When EPA Method 2 or 2C is performed, a cyclonic flow check is required to be performed on each source and sampling location. However, per Section 1.2 of Method 2, this the method cannot be used for direct measurement in cyclonic or swirling gas streams.
(iv)	Pitot Tube Requirements	§ 10.1.5.2.1 and 10.1.5.2.2 of M2	Pitot tube openings must be of proper shape and undamaged. If the face opening alignment is no longer within the specifications of Figure 2-2 and Figure 2-3 of Method 2, either repair the damage or replace the pitot tube (calibrating the new assembly, if necessary). A damaged pitot will void all volumetric flow and mass emission rate data.
	Pitot Tube / Probe Calibrations Requirements	§ 6.8 and 10.1.4.2 of M2	Pitot tube and probe calibrations must meet all requirements specified in the respective methods. Data from previous test projects will not be accepted and the associated emission data will be rejected.
(v)	EPA Method 2 Observer Checklist	EPA's Guideline Document 054 (GD-54)	EPA's Guideline Document 054 (GD-54) for guidance on performing acceptable volumetric flowrate tests. Checklist for Method 2 is used to assist the on-site observer during a performance or compliance test. These checklists were developed with the expectation that the observer has a general working knowledge of the applicable test method(s).
(vi)	Volumetric Flow Rate Requirement	25 PA Code and PA Source Test Manual	§ 139.11(2)(iv) of 25 PA Code and § 2.1.2.4 of DEP's Source Testing Manual (Revision 3.3) requires that volumetric flow rates and emission rates are required to convert emission concentrations (mg, ppm) to emission rates (lb/hr).
(vi)	Velocity (V_s) and Volumetric Flow Rate Sample Calculations	§ 12.0 of EPA M2	Average Stack Gas Velocity (V_s) and Average Stack Gas Dry Volumetric Flow Rate (Q) calculations must be performed. These calculation formulas for velocity and volumetric flowrate calculations are shown in Section B(7) of SP-005.
(vii)	Unacceptable Sampling Procedure	§ 1.1 of M2	A shepherd hook cannot be used, and the volumetric tests must be performed inside the duct or stack at each sampling port or location.

Table 4. EPA Method 3 (Stack Gas Molecular Weight) Requirements

Item #	Description	Regulatory Citation	Requirement / Comments
(i)	Applicability	§ 1.2 of M3	This method is applicable for the determination of CO_2 and O_2 concentrations and dry molecular weight of a sample from an effluent gas stream of a fossil-fuel combustion process or other process.
(ii)	EPA Method 3 Observer Checklist	EPA's Guideline Document 054 (GD-54)	Refer to Observer Checklist – EPA's Guideline Document 054 (GD-54) for guidance on performing acceptable volumetric flowrate tests. Checklist for Method 3 is used to assist the on-site observer during a performance or compliance test. These checklists were developed with the expectation that the observer has a general working knowledge of the applicable test method(s).

Table 5. EPA Method 3A (Stack Gas Molecular Weight) Requirements

Item #	Description	Regulatory Citation	Requirement / Comments
(i)	Applicability	§ 1.0 of M3A	"A procedure for measuring oxygen (O_2) and carbon dioxide (CO_2) in stationary source emissions using a continuous instrumental analyzer".
(ii)	Stratification Test and Sampling Points	§ 8.1 of M3A	Prior to sampling, or as part of the first test run, a **stratification check** must be performed in accordance with Section 8.1.2 of Method 7E to determine number of concentration sample points by verifying if the concentrations are uniform across axis of sampling location. If more than one instrumental method that requires stratification check is being performed, the stratification check need only be done on one of them. A stratification check is not required for stacks < 4 inches in diameter. Failure to perform or record stratification checks during each test program will result in an immediate rejection of the emission concentration test results.
(iii)	EPA Traceability Protocol Gas Requirements	§ 2.12.1 of PA Source Testing Manual (Revision 3.3)	Tests conducted with any expired calibration gases must be voided. Alternatively, the expired gases may be reanalyzed, and the recertification value shall be used.
(iv)	Span	§ 9.0 of M3A	§ 3.4 of EPA Method 7E requires that the average concentrations must be 20-100% of the span. (i.e. Acceptable O_2 Conc. Ranges = Span 20 ppm x 0.2 (or 20%) and 1.0 (100%) = 4-20 ppm). Verification if average run concentration was 20-100% of span must be performed.
(v)	Method Performance	§ 13.0 of M3A	"The specifications for the applicable performance checks are the same as in section 13.0 of Method 7E except for the alternative specifications for system bias, drift, and calibration error. In these alternative specifications, replace the term "0.5 ppmv" with the term "0.5 percent O_2" or "0.5 percent CO_2" (as applicable)".
(vii)	EPA Method 3A Observer Checklist	EPA's Guideline Document 054 (GD-54)	Refer to Observer Checklist – EPA's Guideline Document 054 (GD-54) for guidance on performing acceptable volumetric flowrate tests. Checklist for Method 3A is used to assist the on-site observer during a performance or compliance test. These checklists were developed with the expectation that the observer has a general working knowledge of the applicable test method(s).

Table 6. EPA Method 3B (Stack Gas Molecular Weight) Requirements

Item #	Description	Regulatory Citation	Requirement / Comments
(i)	Applicability	§ 1.2 of M3B	This method is applicable for the determination of O_2, CO_2, and CO concentrations in the effluent from fossil-fuel combustion processes for use in excess air or emission rate correction factor calculations.

Table 7. EPA Method 4 (Moisture)

Item #	Description	Regulatory Citation	Requirement / Comments
(i)	Applicability	§ 1.2 of M4	The method is applicable for the determination of the moisture content of stack gas.
(ii)	Calibration and Standardization	§ 10.0 of M4	Post-test thermocouple calibration must meet all requirements specified in EPA Method 4. Data from previous test projects will not be accepted and the associated emission data will be rejected.
(iii)	EPA Method 4 Observer Checklist	EPA's Guideline Document 054 (GD-54)	Refer to Observer Checklist – EPA's Guideline Document 054 (GD-54) for guidance on performing acceptable moisture tests. Checklist for Method 4 is used to assist the on-site observer during a performance or compliance test. These checklists were developed with the expectation that the observer has a general working knowledge of the applicable test method(s).
(iv)	Moisture Calculation	§ 12.0 of EPA M4	Average Moisture Content calculations must be performed per Section 12.0 of EPA Method 2. These calculation formulas for Moisture calculations are shown in Section B(7) of SP-005.

Table 8. EPA Method 19 (Volumetric Flowrate) Requirements

Item #	Description	M19 Requirements
(i)	Applicability	Oxygen (O_2) or carbon dioxide (CO_2) concentrations and appropriate F factors (ratios of combustion gas volumes to heat inputs) are used to calculate pollutant emission rates from pollutant concentrations.
Item #	**Description**	**Question 1, FAQs of M19 Requirements**
(i)	Prohibited Default F-Factor(s) Use Clarification	"EPA does not sanction the use of the default F-factor for fuels published in Table 19-2 of Method 19, for emission flow rate calculations".
	F-Factor(s) Calculation Determination	"The output of the fuel analyses is then used with Equation 19-13 or 19-15, in Method 19, Section 12.3.2.1, to calculate a test specific Fd or Fc factor, respectively. This factor is then used in calculating the emission flow rate with the corresponding equation below".
(iii)	Collection of Fuel Samples	"The source must obtain from their supplier an ultimate and heat content analysis of the fuel combusted on test day. Method 19, Sections 12.3.2.3 and 12.3.2.4, describe the methods for these analyses. Alternatively, the source may collect fuel samples as specified in Method 19, Section 12.5.2.1 or 12.5.2.2 during the emission testing and submit these samples to a lab for analysis with the methodology listed above".
(iv)	Fuel Meter Calibration Criteria	"Fuel meter calibration must meet the requirements of EPA Method 2A, Section 6.1, and the calibration must be conducted using the same fuel type (e.g. natural gas) as that being measured by the fuel meter during the testing".
(v)	O_2 or CO_2 Measurements	"The source must also measure a diluent gas, either O_2 or CO_2, in the emission gas stream. Diluent measurement must be made by EPA Method 3A or Method 3B, concurrent with the pollutant measurements and fuel meter readings".
(vi)	Temporary Installed Fuel Meter Requirement	"A posttest calibration of the natural gas fuel meter installed for use during testing must be conducted, and documentation must accompany the source test report. Where a test meter has not been installed for the measurement of gas flow during testing".
(vii)	Permanently Mounted Fuel Meter Requirement	"A permanently mounted meter has been used to measure the amount of fuel burned during each test, a pretest calibration value will be acceptable provided that the calibration criteria is met".
(viii)	Sample Calculations	Calculation of the average stack gas flow rate (Q_s) using: (1) a dry O_2 reading and an oxygen-based F factor, dry basis (F_d); or (2) a carbon dioxide-based F factor, dry basis (F_c). These calculation formulas for stack gas flow rate (Q_s) calculations are shown in Section B Condition 7 of this Standard Protocol.
		The unacceptable calculation formula for stack gas flow rate (Q_s) using engine horsepower and brake specific fuel consumption value (BSFC) are shown in Section B Condition 7 of this Standard Protocol.
Item #	**Description**	**Question 4, FAQs of M19 Requirements**
(x)	Prohibited Use of Brake Horsepower and Fuel Consumption to Determine Volumetric Flow	A facility/owner/operator may not make use of a formula that calculates exhausts flow rate using manufacturer information/curves that relate to Brake Horsepower output and fuel consumption, or some combination of other operating curves to an exhaust flow rate and use that value for demonstrating compliance with 40 CFR 60, Subpart JJJJ, nor is its use allowed in Method 19. EPA has determined this procedure to be **unacceptable** and Method 2, 2C, or 19 must be used during each test run.

Table 9. EPA Method 205 (Verification of Gas Dilution Systems For Field Instrument Calibrations) Requirements

Item #	Description	Regulatory Citation	Requirement / Comments
(i)	Applicability	§ 1.1 of M205	A gas dilution system can provide known values of calibration gases through controlled dilution of high-level calibration gases with an appropriate dilution gas. The instrumental test methods in 40 CFR part 60 - e.g., Methods 3A, 6C, 7E, 10, 15, 16, 20, 25A and 25B—require on-site, multi-point calibration using gases of known concentrations.
(ii)	Recalibrated Gas Dilution System Requirements	§ 2.1.1 of M205	"The gas dilution system shall be recalibrated once per calendar year using NIST-traceable primary flow standards with an uncertainty ≤0.25 percent. You shall report the results of the calibration by the person or manufacturer who carried out the calibration whenever the dilution system is used, listing the date of the most recent calibration, the due date for the next calibration, calibration point, reference flow device (ID, S/N), and acceptance criteria. Follow the manufacturer's instructions for the operation and use of the gas dilution system. A copy of the manufacturer's instructions for the operation of the instrument, as well as the most recent calibration documentation, shall be made available for inspection at the test site".
(iii)	Manufacturers Mass Flow Controllers Requirements	§ 2.1.2 of M205	"Some manufacturers of mass flow controllers recommend that flow rates below 10 percent of flow controller capacity be avoided; check for this recommendation and follow the manufacturer's instructions. One study has indicated that silicone oil from a positive displacement pump produces an interference in SO_2 analyzers utilizing ultraviolet fluorescence; follow laboratory procedures similar to those outlined in Section 3.1 in order to demonstrate the significance of any resulting effect on instrument performance".
(iv)	Field Evaluation (Required)	§ 3.2 of M205	"Field Evaluation (Required). The gas dilution system shall be evaluated at the test site with an analyzer or monitor chosen by the source owner or operator. It is recommended that the source owner or operator choose a precalibrated instrument with a high level of precision and accuracy for the purposes of this test. This method is not meant to replace the calibration requirements of test methods. In addition to the requirements in this method, all the calibration requirements of the applicable test method must also be met".
(v)	Gas Dilution System Requirements	§ 3.2.1 of M205	"Prepare the gas dilution system according to the manufacturer's instructions. Using the high-level supply gas, prepare, at a minimum, two dilutions within the range of each dilution device utilized in the dilution system (unless, as in critical orifice systems, each dilution device is used to make only one dilution; in that case, prepare one dilution for each dilution device). Method 205 1/14/2019 3 Dilution device in this method refers to each mass flow controller, critical orifice, capillary tube, positive displacement pump, or any other device which is used to achieve gas dilution".
(vi)	Predicted Concentration Calculation Requirements	§ 3.2.4 of M205	"Repeat the procedure in Section 3.2.3 two times, i.e., until three injections are made at each dilution level. Calculate the average instrument response for each triplicate injection at each dilution level. No single injection shall differ by more than ±2 percent from the average instrument response for that dilution".

Table 10. EPA Method 320 or ASTM Method D6348-03 (Vapor Phase Organic and Inorganic Emissions by Extractive FTIR) Requirements

Item #	Description	Regulatory Citation	General Requirements
(i)	Applicability	§ 1.1.2 of M320	This method is used to determine compound-specific concentrations in a multi-component vapor phase sample, which is contained in a closed-path gas cell.
(iii)	Minimum Test Runs, Test Duration & Conc. Recordings	DEP Requirement	Each VOC test program for natural gas fired engines shall consist of: (1) three test runs for each compound and source tested, (2) a minimum test duration of 1 hour, and (3) a minimum number of 60, 1-minute VOC sample concentration (ppm) recordings. An example table with these requirements are shown in Section B, Condition 7 of this Standard Protocol.
Item #	**Description**	**Regulatory Citation**	**Quality Assurance (QA) / Quality Control (QC) Requirements**
(iii)	QA/QC Data Results	§ Sections 8.6.2, 9.0 and 13.0 of M320	QA/QC data results, obtained while conducting the required procedures must be included in the test report.
(vi)	FTIR QA Validation Summary Table	DEP Requirement	FTIR been validated for the source under consideration. Provide a separate FTIR Quality Assurance Validation Summary Table, primarily for MKS analyzers, for each source tested as specified in Section B, Condition 4(g) of this Standard Protocol which indicate required fields/information and denoting a preferred format.
(v)	Method Validation Procedure	§ 13.0 of M320	David G. Nash, Ph.D. of USEPA/OAQPS/AQAD/Measurement Technology Group clarified that facilities should submit the actual validation data they collected (if they are performing it themselves) or submit to DEP the validation from another source that they are requesting be used in lieu of them performing their own validation. He additionally stated that DEP is the compliance authority and will decide whether the substitute validation is acceptable.
Item #	**Description**	**Regulatory Citation**	**Reporting Requirements**
(vi)	Emissions Recording Requirements	DEP Requirement	All M320 emission results must be accurately and completely recorded and documented in the test report that includes but not limited to raw field data, response times, and sample calculations for one run of each test. A summary table for each source indicating all sampling variations [or deviation(s)] to the proposed methods. Unless a variation to the method is proposed, DEP will assume that the testing will follow the reference method, verbatim.
		40 CFR, § 63.7(g)(2)(v)	Where a test method requires you record or report, the following shall be included: Record of preparation of standards, record of calibrations, raw data sheets for field sampling, raw data sheets for field and laboratory analyses, chain-of-custody documentation, and example calculations for reported results.

Table 10a. EPA Method 320 or ASTM Method D6348-03 (Vapor Phase Organic & Inorganic Emissions by Extractive FTIR) Requirements

Item #	Description	Regulatory Citation	Response Factor Determinations (Optional)
(vii)	Proper Response Factors	Pages B-4 and B-6 of EPA Manual 340/1-91-008	This document entitled, "Manual for Coordination of VOC Emissions Testing Using EPA Methods 18, 21, 25, and 25A" states that, response factors are important because (1) different detectors can have a different response factor for the same compound, (2) each detector can have a different response factor for different compounds, and (3) the same detector can give a different response factor for the same compound at different conditions.
(viii)	Response Factors & Corrected VOC Concentrations	Equations 4-6 of § 60.4244(g) of 40 CFR Part 60, Subpart JJJJ	"If the owner/operator chooses to measure VOC emissions using either Method 18 of 40 CFR part 60, appendix A, or Method 320 of 40 CFR part 63, appendix A, then it has the option of correcting the measured VOC emissions to account for the potential differences in measured values between these methods and Method 25A. The results from Method 18 and Method 320 can be corrected for response factor differences using Equations 4 and 5 of this section. The corrected VOC concentration can then be placed on a propane basis using Equation 6 of this section".
Item #	**Description**	**Regulatory Citation**	**Sample Calculation Determinations**
(x)	Sample Calculation	DEP Requirement	A complete set of sample calculations for one run of each pollutant tested and for each engine must be included in the test report. These calculation formulas for response factors (RFs), and VOC corrected emissions are shown in Section B Condition 7 of this Standard Protocol.
Item #	**Description**	**Regulatory Citation**	**Sampling Requirements (Minimum List of VOC Compounds)**
(xi)	Required Nine VOC Compounds	DEP Requirement	The measurement of nine (9) VOCs accounts for >95% of VOCs in lean burn, rich burn, and 2/4-stroke engines is required and include acetaldehyde, acetylene, acrolein, benzene, butane, ethylene, methanol, propylene, and propane. VOC results must be reported in terms of propane and exclude formaldehyde (HCHO).
(xii)	Recommended Five VOC Compounds	DEP Requirement	The measurement of the below five (5) VOCs accounts for approximately 5% of VOCs in lean burn, rich burn, and 2/4-stroke engines is recommended (or additional) and include formic acid, 1,3-butadiene, octane, toluene, and isobutane. If performed, these five (5) recommended volatile organic compounds must be measured in conjunction with the nine (9) required VOC using Method 320. VOC results must be reported in terms of propane and exclude formaldehyde (HCHO).

Table 10b. EPA Method 320 or ASTM Method D6348-03 (Vapor Phase Organic & Inorganic Emissions by Extractive FTIR) Requirements

Item #	Description	Regulatory Citation	Spiking Requirements
(xiii)	Compound Spiking Requirements	Presentation by Dave Nash of EPA entitled, "FTIR: Theory, Testing, and Updates" dated January 30, 2020	A Presentation by Dave Nash of EPA entitled, "FTIR: Theory, Testing, and Updates" dated January 30, 2020 outlines some of the minimal requirements to receive DEP approval for spiking each compound which include: 1) identify what compounds are being spiked; 2) clarify if spike(s) is being performed dynamically; 3) ensure that spikes being introduced at the back of the sample probe and traveling through the entire sampling system; (4) ensure that compounds being used for QA spiking are appropriate. Note that Method 320 allows for surrogates, however, surrogates should be appropriate for the actual compound being measured (should not be spiking ethylene when you intend to measure formaldehyde). It is recommended that the compound of interest always be spiked if it is available; and (5) ensure that standards being used for QA spiking of appropriate quality. For example, (± 2% for Protocol gases where available and ± 5% for other certified gases.
(xiv)	Formaldehyde Spike Requirement	DEP Requirement	Formaldehyde must be used as the analyte spike recovery gas for formaldehyde determinations and certified standards should be available at appropriate concentrations to meet the requirements specified in Method 320. DEP also accepts Formaldehyde with the balance of nitrogen or with sulfur hexafluoride (SF6) tracer for the formaldehyde spiking.
		DEP Requirement	Formaldehyde must be used as the spike recovery gas for formaldehyde determinations and certified standards should be available at appropriate concentrations to meet the requirements specified in Method 320. DEP also accepts Formaldehyde with the balance of nitrogen. DEP also accepts Formaldehyde with sulfur hexafluoride (SF6) tracer for the formaldehyde spiking. If appropriate standards are not available, acetaldehyde may not be used as a surrogate used to measure the target analytic. Any proposal to perform spiking using Acetaldehyde is unacceptable. Negative SF_6 native concentration cannot be subtracted from the SF_6 spike
(xv)	Certified Standard	DEP Requirement	If appropriate standards are not available, acetaldehyde may not be used as a surrogate used to measure the target analytic. Any proposal to perform spiking using Acetaldehyde is unacceptable. Negative SF6 native concentration cannot be subtracted from the SF6 spike.
(xvi)	Formaldehyde Dynamic Spiking	§ 8.6.2 of M320	Formaldehyde (HCHO) must be used as the spike recovery gas for the formaldehyde determination, to meet the requirements of EPA Method 320. A surrogate for the dynamic spike, required by Section 8.6.2, will not be accepted.
(xvii)	Surrogate	§ 8.6.2 of M320	If the target analyte is formaldehyde (HCHO), ammonia (NH3), or hydrogen chloride (HCl), a surrogate is not acceptable for the dynamic spike.
(xviii)		§ 9.2 of M320	Dave Nash of EPA stated that tested compounds OR any surrogates that DEP allows in lieu of spiking those compounds, should be spiked 3 times. All individual spiking is required to be performed on each source and sampling location on the first day of testing.

Table 11. EPA Method ALT-106 (Non-Methane/Ethane Hydrocarbon (NMEHC) Requirements

Item #	Description	Regulatory Citation	General Requirements
(i)	Applicability	Federal Register / Vol. 80, No. 35 / Monday, February 23, 2015	ALT-106 Approval of Alternative VOC Measurements for Engines is an alternative that measures VOC directly rather than difference and involves separation of methane and ethane components of the emission gas from the remaining VOC. Methane and ethane are separated and measured by flame ionization detector (FID), followed by a backflush of the chromatographic column to measure NMEOC in post combustion emissions.
	EPA Approval Statement	Page 1 of EPA's Approval Letter for ALT-106 dated June 6, 2014	Use an alternative testing approach using GC to separate and measure methane and ethane, followed by GC back-flush procedures to measure NMEOC in post-combustion emissions with caveats stipulated in the agency's approval letter dated June 6, 2014.
(ii)	Minimum Test Duration	§ 2.4 of PA Source Testing Manual (Revision 3.3)	Each VOC (or NMEHC) test program shall consist of three test runs per pollutant with minimum sampling time duration of one hour per run.
Item #	**Description**	**Regulatory Citation**	**Calibration Requirements**
(iii)	Sample Collection, QC, and Calibration	§ 8, 9, and 10 of M25A	"You must also follow the appropriate procedures to ensure that linearity, calibration drift error, and drift are within the Method 25A limits."
(iv)	Calibration Procedures	Page 2 of EPA's Approval Letter for ALT-106 dated June 6, 2014	"You must calibrate the instrument with a mixture of ethane, propane and the required NMEOC hydrocarbon in Method 25A or the applicable rule if it is different from propane. This requirement assumes methane is separated from ethane and passes through the separator column prior to ethane. The ethane and propane are necessary in the mixture to confirm the separation of ethane from the NMEOC while not retaining additional NMEOC, which would bias the NMEOC results low. The ethane may be calibrated at a single high point on the calibration curve to demonstrate proper ethane to NMEOC separation. Linearity, calibration error, and calibration drift must be demonstrated using the NMEOC hydrocarbon specified in the applicable rule or propane according to Method 25A."
			"If you are required to measure and report methane, ethane, and NMEOC, you must calibrate the instrument with a mixture of methane, ethane, and propane (or the required NMEOC hydrocarbon in Method 25A or the applicable rule if it is different from propane). The methane and ethane in this calibration gas are necessary to generate quantitative concentrations for these components, as well as to confirm the separation of methane and ethane from other NMEOC while not retaining additional NMEOC, which would bias the NMEOC results low. If you are required to report all three components independently, you must check linearity, calibration error, and calibration drift using methane, ethane, and the required NMOC hydrocarbon.

Table 11a. EPA Method ALT-106 (Non-Methane/Ethane Hydrocarbon (NMEHC) Requirements

Item #	Description	Regulatory Citation	Protocol Gas Requirements
(v)	EPA Traceability Protocol Gas Requirements	§ 7.1 and 16.0 of M25A	All gases must be prepared in accordance with EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards, when commercially available.
		§ 2.12.1 of PA Source Testing Manual (Revision 3.3)	Tests conducted with any expired calibration gases must be voided. Alternatively, the expired gases may be reanalyzed, and the recertification value shall be used.
Item #	**Description**	**Regulatory Citation**	**Recording Requirements**
(vi)	EPA's Minimum Sample Points Requirement	Page 2 of EPA's Approval Letter for ALT-106 dated June 6, 2014	"You must collect the measured data required in the bullets above for each test run at a minimum of one measurement every 15 minutes".
(vii)	DEP's Mandatory Minimum Sample Points Requirement	§139.11(2) of 25 Pa Code	"The Department will consider test results for approval where sufficient information is provided to verify the source information is provided to verify the source conditions existing at the time of the test and where adequate data is available to show the manner in which the test was conducted". DEP minimally requires that 60, 1-minute NMEHC recordings rather than EPA required 4, 15-minutes recordings during each one hour run. DEP will likely deem the emission results unacceptable if less than 60, 1-minutes are performed during each hour.
(vii)	Methane and Ethane Separation Recording Requirement	Page 2 of EPA's Approval Letter for ALT-106 dated June 6, 2014	"You must report calibration results for each organic compound required to demonstrate compliance. You must also report results demonstrating proper separation of methane or ethane from the required NMOC or NMEOC hydrocarbons."
(viii)	Methane, Ethane, and NMEOC Recording Requirement	Page 2 of EPA's Approval Letter for ALT-106 dated June 6, 2014	You must collect the measurement data required for each test run at a minimum of one measurement every 15 minutes.
Item #	**Description**	**Regulatory Citation**	**Sample Calculation Determinations**
(x)	Sample Calculation	Section 11.0 of EPA M25A and § 135.5 of 25 Pa Code	A complete set of sample calculations for one run of each pollutant tested and for each engine. These calculations (1) must show all the formulas and input values used to calculate the response factors (RFs) and emissions that must be included in the test report; (2) are shown in emissions are shown in Section B Condition 7 of this Standard Protocol.

Table 11b. EPA Method Alt-106 (Non-Methane/Ethane Hydrocarbon (NMEHC) Requirements

Item #	Description	Regulatory Citation	Sampling Requirements
(xi)	Calibration Sampling Requirements	§ 2.12. of PA Source Testing Manual (Revision 3.3)	Reliable, accurate equipment is fundamental to quality source testing. During sampling, there are many separate measurements where bias fluctuations can significantly affect the final test results. An effective quality assurance program will minimize the effect of these equipment-related variables. The Department will not accept the results of a source test unless it has the assurance that appropriate equipment calibrations have been conducted. Prior to and after testing, equipment calibration and routine maintenance must be performed in accordance with the requirements specified in the Quality Assurance Handbook for Air Pollution Measurement Systems.
		§ 8, 9, and 10 of EPA Method 25A	You must follow the appropriate procedures to ensure linearity, calibration drift error, and drift are within the Method 25A limits.
(xii)	Methane, Ethane, and NMEHC Sampling Requirements	Page 2 of EPA's Approval Letter for ALT-106 dated June 6, 2014	"If you are required to measure and report methane, ethane, and NMEOC, you must calibrate the instrument with a mixture of methane, ethane, and propane (or the required NMEOC hydrocarbon in Method 25A or the applicable rule if it is different from propane). The methane and ethane in this calibration gas are necessary to generate quantitative concentrations for these components, as well as to confirm the separation of methane and ethane from other NMEOC while not retaining additional NMEOC, which would bias the NMEOC results low. If you are required to report all three components independently, you must check linearity, calibration error, and calibrate drift using methane, ethane, and the required NMOC hydrocarbon."
Item #	**Description**	**Regulatory Citation**	**Sampling System Heating Requirements**
(xiii)	Sampling System Heating Requirements	Page 2 of EPA's Approval Letter for ALT-106 dated June 6, 2014	You must use direct interface and heating sampling line from the sampling point to the gas chromatographic injection valve. All sampling components leasing to the analyzer must be heated to greater than 110°C (220°F) throughout the sampling period (unless safety reasons are present as described in Section 5.2 of Method 25A).
		DEP Requirement	All components of the sampling system (sample probe, sample line, and analyzer, at a minimum) must be heated to at least 375°F±25°F. Sampling system temperatures must always be above the boiling point of the analytes.
(xiv)	Selection of Sample Point Location	Page 7-4 of EPA Manual 340/1-91-008	This document entitled, "Manual for Coordination of VOC Emissions Testing Using EPA Methods 18, 21, 25, and 25A" states that, [t]he selection of a sampling point is done in one of three ways: (1) the probe can be placed at a single point in the center of the duct or stack, (2) the probe can be placed at a single point at a point in the duct or stack with average gas velocity, (3) or a rake-type probe may be used".
(xi)	Span	§ 3.6 of EPA Method 25A and DEP	The NMEHC results will likely be rejected if the instrument span is not 1.5-2.5 times the actual emission concentration, measured during testing. However, a NMEHC span of 10 ppm is required and must be used when the average concentration is ≤ 4 ppm.

(k) Safety Considerations During Testing

Stack sampling and source evaluation exposes DEP officials and consultants to potential safety hazards in the field. Ensuring the safety of all field personnel at facilities is an issue that the DEP takes very seriously. To ensure the safety of all field personnel, stack sampling platforms, both permanent and temporary, and access ways leading to and from the platforms or testing locations, must be designed and erected in such a manner as to conform to published safety laws and regulations. If DEP observer identifies an unsafe condition that poses an undue risk DEP, test consultant or facility field staff, the test will be postponed at his/her discretion.

(1) Disclaimer. The referenced methods may involve hazardous materials, operations, and equipment. These test methods may not address all safety problems associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to performing this test method. The analyzer user's manual should be consulted for specific precautions to be taken with regard to the analytical procedure.

(2) Explosive Atmosphere. The referenced methods are often applied in highly explosive areas. Caution and care should be exercised in choice of equipment and installation.

(3) Pre-Test & On-Site Safety Discussions. A discussion of safety considerations including any special equipment required by the facility operator is necessary. The owner/operator is required to notify all DEP observers, test consultants, and other interested parties of potential hazards, special safety requirements and/or PPE (special respirators, etc.) including any safety limitations prior to and during testing.

(4) A short list of safety concerns that could result in a test cancellation is as follows. This list is by no means all-inclusive.

(i) Respiratory hazards not addressed by PPE.

(ii) Improper scaffold assembly and/or tie off.

(iii) Corroded and/or structurally compromised surfaces.

(iv) Unsafe, inappropriate or nonexistent (but necessary) climbing equipment, or other PPE.

(v) Unsecured electrical hazards.

(vi) Dangerously icy, wet, or hot surfaces.

(vii) High winds.

SECTION B. STATIONARY NATURAL GAS-FIRED SPARK IGNITION INTERNAL COMBUSTION ENGINES

1. 40 CFR, Part 60, Subpart JJJJ Compliance Requirements

(a) Table 1 of 40 CFR Part 60 Subpart JJJJ applies to NOx, CO, and VOC emission standards for Stationary Non-Emergency SI Engines ≥100 HP (Except Gasoline and Rich Burn LPG), and Stationary Emergency Engines >25 HP:

(b) For each natural gas-fired spark ignition internal combustion engine that were constructed (ordered) after June 12, 2006 and manufactured on or after certain dates, depending on the engine size and type, the owner or operator shall:

(i) Ensure the engine does not exceed the emissions standards specified in the following Table 1:

Engine type and fuel	Maximum engine power	Manufacture date	Emission Standards[a]					
			g/BHP-hr			ppmdv @ 15% O_2		
			NO_x	CO	VOC[d]	NO_x	CO	VOC[d]
Non-Emergency SI Natural Gas[b] and Non-Emergency SI Lean Burn LPG[b]	100≤HP<500	7/1/2008	2.0	4.0	1.0	160	540	86
		1/1/2011	1.0	2.0	0.7	82	270	60
Non-Emergency SI Lean Burn Natural Gas and LPG	500≤HP<1,350	1/1/2008	2.0	4.0	1.0	160	540	86
		7/1/2010	1.0	2.0	0.7	82	270	60
Non-Emergency SI Natural Gas and Non-Emergency SI Lean Burn LPG (except lean burn 500≤HP<1,350)	HP≥500	7/1/2007	2.0	4.0	1.0	160	540	86
	HP≥500	7/1/2010	1.0	2.0	0.7	82	270	60
Emergency	25<HP<130	1/1/2009	[c]10	387	N/A	N/A	N/A	N/A
	HP≥130		2.0	4.0	1.0	160	540	86

[a] Owners and operators of stationary non-certified SI engines may choose to comply with the emission standards in units of either g/HP-hr or ppmvd at 15 percent O_2.

[b] Owners and operators of new or reconstructed non-emergency lean burn SI stationary engines with a site rating of greater than or equal to 250 brake HP located at a major source that are meeting the requirements of 40 CFR part 63, subpart ZZZZ, Table 2a do not have to comply with the CO emission standards of Table 1 of this subpart.

[c] The emission standards applicable to emergency engines between 25 HP and 130 HP are in terms of NO_x + HC.

[d] For purposes of this subpart, when calculating emissions of volatile organic compounds, emissions of formaldehyde should not be included.

[76 FR 37975, June 28, 2011]

2. BAT Compliance Regulations (Refer to *Section C(1) of BAQ-GPA/GP-5)*

(a) For each natural gas-fired spark ignition internal combustion engine constructed under and authorized to operate under GP-5 approved by the Department on or after March 10, 1997 but prior to February 2, 2013, the owner or operator shall:

(i) Operate or equip the engine with air cleaning devices to meet the following emission levels:

(A) NOx (as NO_2) of 2.0 g/bhp-h while operating at rated bhp and speed.

(B) Non-Methane Non-Ethane Hydrocarbon (NMNEHC), as propane, excluding formaldehyde, of 2.0 g/bhp-h while operating at rated bhp and speed. **and**

(C) CO of 2.0 g/bhp-h while operating at rated bhp and speed.

(ii) Ensure that at operating conditions less than rated capacity, the engine shall on a lb/hr basis emit no more than it would emit at rated bhp and speed.

(iii) Ensure the engine meets the applicable requirements of (d) below.

(b) For each natural gas-fired spark ignition internal combustion engine constructed and authorized to operate under GP-5 approved by the Department on or after February 2, 2013, but prior to August 8, 2018, the owner or operator shall:

(i) Ensure the engine does not exceed the emissions standards specified in the following table:

Engine Type	Rated bhp	NO_x	CO	NMEHC (as propane excluding HCHO)	HCHO
Lean-Burn	≤100	2.0 g/bhp-hr	2.0 g/bhp-hr	-	-
Lean-Burn	>100 - ≤500	1.0 g/bhp-hr	2.0 g/bhp-hr	0.70 g/bhp-hr	-
Lean-Burn	>500	0.50 g/bhp-hr	47 ppmvd @ 15% O_2 **or** 93% reduction	0.25 g/bhp-hr	0.05 g/bhp-hr
Rich-Burn	≤100	2.0 g/bhp-hr	2.0 g/bhp-hr	-	-
Rich-Burn	>100 - ≤500	0.25 g/bhp-h	0.30 g/bhp-h	0.20 g/bhp-h	Rich-Burn
Rich-Burn	>500	0.20 g/bhp-h	0.30 g/bhp-h	0.20 g/bhp-h	2.7 ppmvd @ 15% O_2 **or** 76% reduction

(ii) Ensure the engine meets the applicable requirements of (d) below.

(c) For each natural gas-fired spark ignition internal combustion engine constructed and authorized to operate on or after August 8, 2018, the owner or operator shall:

(i) Ensure the engine does not exceed the emissions standards specified in the following table:

Engine Type	Rated bhp	NO_x	CO	NMEHC (as propane excluding HCHO)	HCHO
Lean-Burn	<100	1.0 g/bhp-h	2.0 g/bhp-h	0.70 g/bhp-h	-
Lean-Burn	≥100 - ≤500	1.0 g/bhp-h	0.70 g/bhp-h	0.30 g/bhp-h	-
Lean-Burn	>500 - <2,370	0.50 g/bhp-h	0.25 g/bhp-h	0.25 g/bhp-h	0.05 g/bhp-h
Lean-Burn	≥2,370	0.30 g/bhp-h Uncontrolled **or** 0.05 g/bhp-h with Control	0.25 g/bhp-h	0.25 g/bhp-h	0.05 g/bhp-h
Rich-Burn	<100	1.0 g/bhp-h	2.0 g/bhp-h	0.70 g/bhp-h	-
Rich-Burn	≥100 - ≤500	0.25 g/bhp-h	0.30 g/bhp-h	0.20 g/bhp-h	-
Rich-Burn	>500	0.20 g/bhp-h	0.30 g/bhp-h	0.20 g/bhp-h	2.7 ppmvd @ 15% O2 **or** 76% reduction

(ii) Ensure that for engines that control NOx emissions with a control technology that uses ammonia or urea as a reagent, the exhaust ammonia slip is limited to 10 ppmvd or less corrected to 15% O_2.

(iii) Ensure the engine meets the applicable requirements of (d) below.

(d) The owner or operator of the engine shall also:

i. Comply with the applicable requirements of 40 CFR Part 63, Subpart ZZZZ for engines constructed (as defined in Subpart ZZZZ) prior to June 12, 2006.

ii. Ensure the engine meets the visible emissions standards, as determined by the methods described in 25 Pa. Code § 123.43, by not exceeding the following limitations:

(A) Equal to or greater than 10% for a period or periods aggregating more than three minutes in any one hour. and

(B) Equal to or greater than 30% at any time.

iii. Install, operate, and maintain a non-resettable hour meter.

iv. Limit the engine's time spent at idle during startup or shutdown to a period appropriate for the operation of the engine and air pollution control equipment consistent with good air pollution control practices, not to exceed 30 minutes, during which time the emissions standards in (b) through (d) do not apply.

v. Conduct performance tests and periodic monitoring for the engine as detailed in Conditions 4 and 5 of this section on the following schedule:

Engine Size hp	Initial Compliance Performance Test	Continuous Compliance Performance Test	Periodic Monitoring
<100	None Required	None Required	Every 2,500 hours of operation
≥100 - ≤500	Within 180 days of startup of the engine	Within 180 days of each reauthorization	Every 2,500 hours of operation
>500 and not subject (d)(i)	Within 180 days of startup of the engine	Every 8,760 hours of operation **or** every three years **and** within 180 days of each reauthorization	Every 2,500 hours of operation
>500 and subject to (d)(i)	Not Applicable	Every year	Every 2,500 hours of operation

1. For an engine greater than or equal to 100 hp and less than or equal to 500 hp, if the engine is certified by the manufacturer in accordance with 40 CFR Part 60, Subpart JJJJ and the owner or operator operates and maintains the engine in accordance with the manufacturer's instructions, the performance testing requirements are waived.

2. For an engine greater than 500 hp, if the engine is certified by the manufacturer in accordance with 40 CFR Part 60, Subpart JJJJ and the owner or operator operates and maintains the engine in accordance with the manufacturer's instructions, the continuous compliance performance testing requirements every 8,760 hours of operation or every three years are waived.

3. The Department may alter the frequency of periodic monitoring based on the test results. The frequency of periodic monitoring may be altered upon request of the owner or operator with written Departmental approval.

3. Recordkeeping Requirements

For each engine, the owner or operator shall maintain the following records in accordance with Section A Condition 13 of this Standard Protocol, including information on:

Item #	Recording Keeping Requirements
(i)	The GP-5 authorization number and the date each engine was authorized for use
(ii)	The make, model, and serial number of each engine.
(iii)	The summary for each complete test report described in Section A Condition 14(i) of GP-5 Permit.
(vi)	The emissions calculations for each engine in accordance with 25 Pa. Code § 135.5.
(vii)	Source ID No. for each Source and Control Device
(viii)	Engine modification, construction, and/or manufacture date
(x)	Engine rated capacity/load (g/BHP-hr)
(xi)	Engine load during each test run
(xii)	Engine operating mode (rich or lean burn)
(xiii)	Engine hours of operation
(xiv)	Air pollution control device(s)

4. Reporting Requirements

The on-site supervisor for the test team and a representative of the source owner/operator must record the following information during each test run and at each natural gas-fired spark ignition internal combustion engine operated during the reporting period. This information must be included in the final emissions test report for each compressor station and source.

(a) Contact Information

The contact information for source owner/operator, testing firm, and analytical laboratory that must be included in the final test report for each key personnel.

Facility Information	
Name of Facility	
Mailing Address	
Contact's Person Name	
Contact's Person Job Title	
Telephone Number	
Email Address	
Testing Firm Information	
Name of Testing Company	
Mailing Address	
Contact's Person Name	
Contact's Person Job Title	
Telephone Number	
Email Address	
Analytical Laboratory Information	
Analytical Laboratory	
Name of Analytical Laboratory	
Mailing Address	
Contact's Person Name	
Contact's Person Job Title	
Telephone Number	
Email Address	

(b) Facility & Source Information

The below details are required information for a single facility (or site) or multiple facilities (or Multi-site) with one or more Stationary Spark Ignition Internal Combustion Engines at each site. All information included in the final test report for each compressor station and source **must** match what is being listed in eFacts for each compressor station.

Facility and Source Information	
Compressor Station	
Proposed Test Date(s)	
Proposed Starting and Ending Times for Each Test Run	
Federal Subpart	
State Permit No(s).	
Authorization No(s).	
Compliance or Baseline Testing	
Facility ID No.	
Municipality	
County	
Source Name / ID No.	
Control Device/ ID No.	
Stack/ ID Name / No.	
Serial No.	
Make / Model	
Installation Date	
Manufacture Date	
Type	
Rated Horsepower	
Rated Engine Speed	

(c) Summary of Test Program

This section of the Standard Protocol specifies the test method to be used for each parameter to be tested. For each engine, persons using this Standard Protocol should have a thorough knowledge of and must use the below/required EPA Methods 1, 2, 2C, 3, 3A, or 3B, 4, 19, 205, 320, ASTM Method D6348-03, and Alt 106 to determine accurate stack test parameters and emissions results. The pollutants and corresponding EPA Methods from each compressor station and natural gas-fired spark ignition internal combustion engine operated during the reporting period must be included in the final test report.

Pollutant(s)	Required Test Methodology
Sample / Velocity Traverses	EPA Method 1
Volumetric Flow Rate (VFR)	EPA Method 2 or 2C
Oxygen and Carbon Dioxide Concentration	Method 3, 3A, or 3B
Volumetric Flow Rate (VFR)	EPA Method 19
Volumetric Flow Rate (VFR)	Engine Horsepower / BSFC[1]
Moisture	EPA Method 4 or 320
Gas Dilution Calibrations	EPA Method 205
Nitrogen Oxides (NO_x)	EPA Method 320
Carbon Monoxide (CO)	EPA Method 320
Formaldehyde (HCHO)	EPA Method 320[2]
Volatile Organic Compound (VOC)	EPA Method 320
Non-Methane Hydrocarbon (NMHC)	EPA Method Alt 106

[1] Any proposal to determine VFR using Modified EPA Method 19 (Engine Horsepower / BSFC) is **denied** (see discussion in Table 8 of Section A, Condition 15(i).

[2] CH2O (or HCHO) testing only required for initial testing and core change-outs.

(d) Required Speciated FTIR VOC Compounds

The below nine (9) required VOCs from each natural gas-fired spark ignition internal combustion engine must be operated during the reporting period must be included in the final test report.

List of Required VOC Compounds	Type of VOC Compound	Min. # of Avg. Conc. Recordings Per Run	Sample Time Per Avg. Conc. Recording, (Minutes)	Min. Total Sample Time Per Run, (Minutes)
Acetaldehyde (C_2H_4O)	Aldehyde	60	1	60
Acetylene (C_2H_2)	Alkyne	60	1	60
Acrolein (C_3H_4O)	Aldehyde	60	1	60
Benzene (C_6H_6)	Aromatic	60	1	60
Butane (C_4H_{10})	Alkane	60	1	60
Ethylene (C_2H_4)	Alkenes	60	1	60
Methanol (CH_4O)	Alcohols	60	1	60
Propylene (C_3H_6)	Alkenes	60	1	60
Propane (C_3H_8)	Alkane	60	1	60

(e) Recommended Speciated FTIR VOC Compounds

If performed, the below nine (9) required VOCs from each natural gas-fired spark ignition internal combustion engine must be operated during the reporting period must be included in the final test report of Section A Condition 13(d).

List of Recommended VOC Compounds	Type of VOC Compound	Min. # of Avg. Conc. Recordings Per Run	Sample Time Per Avg. Conc. Recording, (Minutes)	Min. Total Sample Time Per Run, (Minutes)
Formic Acid (CH_2O_2)	Aldehyde	60	1	60
1,3-Butadiene (C_4H_6)	Dienes	60	1	60
Octane (C_8H_{18})	Alkane	60	1	60
Toluene (C_7H_8)	Aromatic	60	1	60
Isobutane (C_4H_{10})	Alkane	60	1	60

(f) Spiking Procedure (Formaldehyde)
The below spike results must be recorded in the test report:

(j) Spike gas introduced directly to the FTIR and several scans were taken until a stable reading is achieved. The direct spike gas concentration is recorded (see Table 13). Alternatively, the certified gas concentrations listed in Table 12 maybe be used.

(ii) Stack gas introduced to the FTIR through the sampling system and several scans were taken until a stable reading is achieved. The native concentration of our surrogate spiking analyte is recorded (see Table 14).

(iii) Spike gas was introduced to the sampling system at a constant flow rate ≤ 10% of the total sample flow rate and a corresponding dilution ratio was calculated along with a system response time (Table 15).

(iv) Matrix spike recovery spectra is recorded and were within the ± 30% of the calculated value of the spike concentration that the method requires. The matrix spike recovery is conducted once at the beginning of the testing and the CTS recovery procedures were repeated following each test run. The corresponding values is recorded (see Table 16).

(v) Matrix spiking will be performed on the sampling system prior to the sampling runs. EPA Method 320 specifies the performance of “surrogate” spiking at each sampling location. All Method 320 spiking at the sampling locations will be performed using a certified cylinder of Formaldehyde with a balance of Nitrogen.

i. DEP and EPA Requirements

Table 12: Spiking Cylinder Information for Source #

Spike and Tracer (SF6) Cylinder ID		Component
Spike Gas Concentration		Formaldehyde
Tracer Gas Concentration		SF6
Instrument ID - Outlet		

Table 13: Direct Spike Values

Date	Time	File	Temperature (°C)	Pressure	Spike (ppm)	Tracer (ppm)
Average	----	----	----	----		

Table 14: Native Values

Date	Time	File	Temperature (°C)	Pressure	Spike (ppm)	Tracer (ppm)
Average	----	----	----	----		

Table 15: Spike Values

Date	Time	File	Temperature (°C)	Pressure	Spike (ppm)	Tracer (ppm)
Average	----	----	----	----		

Table 16: Summary of Spikes

Source	
Date	
Time	
Analyte	Formaldehyde
Direct	
Native	
Spiked	
Dilution Factor	
Spike Recovery	

(g) Method Validation

(i) Below table provides clarification of some NO_x, CO, HCHO, and VOC spiking and method validation reporting requirements.

(ii) Provide a separate EPA Method 320 FTIR Quality Assurance Validation Summary Table for each source tested. Example table denoted below in the preferred format. For each source, a separate summary table with the following must be incorporated in the test report. Example table denoted below in the preferred format. If the target analyte is formaldehyde (HCHO), ammonia (NH_3), or hydrogen chloride (HCl), a surrogate is not acceptable for the dynamic spike.

FTIR Instrument	**make/model:**		**serial number:**	
Instrumental Checks		**Reading**	**Specification**	**(Pass or Fail)**
Signal Intensity			> 0.50 Volts	
Detector Linearity			< 0.005 Volts	
Instrument Resolution			< 0.50 cm^{-1}	
Instrument Frequency Precision			3920.095 +/- 0.010 cm^{-1}	
Direct Calibrations		**Reading**	**Specification**	**(Pass or Fail)**
Calibration Transfer Standard (CTS)			Within 5% of certified value	
Calibration Gas "A" (specify)			Within 5% of certified value	
Calibration Gas "B" (specify)			Within 5% of certified value	
Calibration Gas "C" (specify)			Within 5% of certified value	
Calibration Gas “D” (specify)			Within 5% of certified value	
System Response Times		**Reading**	**Specification**	**(Pass or Fail)**
CTS to >95% and <5% of full scale			<5 minutes	
System CTS Reading			Within 5% of direct CTS value	
Minimum Detectable Concentrations		**Calculated MDL**	**Units**	
Target Analyte "A" (specify)			ppm	
Target Analyte "B" (specify)			ppm	
Target Analyte "C" (specify)			ppm	
Target Analyte "D" (specify)			ppm	
Spike Compound		**% Spike Recovery (avg. of 3 spikes)**	**Specification**	**(Pass or Fail)**
Spike Compound "A" (specify)			70 - 130%	
Spike Compound "B" (specify)			70 - 130%	
Spike Compound "C" (specify)			70 - 130%	
Spike Compound "D" (specify)			70 - 130%	
Run Validation:	**Automated vs Manual**	**Target Analyte(s)**	**Specification**	**(Pass or Fail)**
3 runs for each turbine type and target analyte			All within 20%	
(2 points for each target analyte)				
FTIR data collected an analysis performed by -			name:	
FTIR data validated by -			name:	

(h) Cyclonic Flow

The below pre-test cyclonic flow results must be recorded in the field on the day of testing and before the first test run is performed. Failure to measure and record the cyclonic flow test results will result in a rejection of the volumetric flow and emission rate test results.

Sample Point	Angle ($\Delta P=0$)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
Total	
Average of Absolute Values	

(i) Stratification Test

The below pre-test stratification test results must be recorded in the field on the day of testing and before the first test run is performed. Failure to measure and record the stratification test results will result in a rejection of the O_2 and CO_2 emission concentration test results.

Traverse Point	O_2 (%)	CO_2 (%)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
Mean Concentration		
Unstratified 5% of Mean (Single Sample Point)[1]		
Minimally Stratified 5-10% of Mean (3 Sample Points)[2]		
Stratified 10% of Mean (12 Sample Points)[3]		
Status (or Minimum Traverse Requirement)	Un-stratified, Minimally Stratified, or Stratified	Un-stratified, Minimally Stratified, or Stratified

[1] For Single Point Sampling: (Mean Concentration) x 0.05 (or 5%).
[2] For 3 Points Sampling: (Mean Conc.) x 0.05 (or 5%) to (Mean Conc.) x 0.10 (10%).
[3] For 12 Points Sampling: Mean Concentration x 0.10 (or 10%).

(j) Process and Control Device Data

Operating and control device parameters specified in section of this Standard Protocol listed in below Table 17 is required while the engine operates at 10 percent of 100 percent peak (or the highest achievable) load operating conditions. The process and control device parameters listed in below table must be monitored and recorded every 15-minutes during performance testing. If a parameter is not applicable, “N/A” must be entered into below table.

Table 17. Process Data Summary[1]
NO_x, CO, HCHO, and VOC (or NMHC) Test Results Summary (TRS)
Source Name / ID No. [2] / Stack/ ID Name / No.[2]

Test Date	Reqd	Reqd	Reqd	**Average**
Test Run Number	1	2	3	N/A
Natural Gas Flow, (scf/hr)[3]	Rec	Rec	Rec	Rec
Heat Content/Value, (Btu/scf)[3]	Rec	Rec	Rec	Rec
Heat Input, (MMBtu/hr)[3]	Rec	Rec	Rec	Rec
Rated or 100 Percent Peak (or **Highest Achievable**) Brake-Horsepower, (BHP)[4]	Reqd	Reqd	Reqd	N/A
10 Percent of 100 Percent Peak (or Highest Achievable) Load Range, (BHP)[5]	Reqd	Reqd	Reqd	Reqd
Brake-Horsepower, (BHP)	Reqd	Reqd	Reqd	Reqd
Engine Speed, (RPM)	Reqd	Reqd	Reqd	Reqd
Rated Engine Speed, (RPM)		Reqd		N/A
Engine Speed, (%)	Reqd	Reqd	Reqd	Reqd
Catalyst (Yes or No)[6]	Rec	Rec	Rec	Rec
Catalyst Inlet Temperature, (°F)[6]	Rec	Rec	Rec	Rec
Catalyst Outlet Temperature, (°F)[6]	Rec	Rec	Rec	Rec
Catalyst Differential Temperature, (°F)[6]	Rec	Rec	Rec	Rec
Catalyst Pressure Drop, (in H_2O)[6]	Rec	Rec	Rec	Rec
Suction Pressure (psi)[6]	Rec	Rec	Rec	Rec
Discharge Pressure (psi)[6]	Rec	Rec	Rec	Rec
Intake Manifold Pressure (psi)[6]	Rec	Rec	Rec	Rec
Ambient Temp., (°F)	Rec	Rec	Rec	Rec
Exhaust Gas Temp (°F) (From Probe)	Rec	Rec	Rec	Rec
Intake Manifold Temp (°F)	Rec	Rec	Rec	Rec
Barometric Press (in Hg)	Reqd	Reqd	Reqd	Reqd

1 Reqd is the abbreviation for “required information” and Rec is the abbreviation for “recommended information”. All recommended data, if available, especially control device data, is required to recorded during each run and pollutant.
2 Per public eFacts on the Web @ https://www.ahs.dep.pa.gov/eFACTSWeb/default.aspx/default.aspx.
3 If possible, record natural gas flow, heat content/value, and heat input.
4 Highest Achievable Load (BHP) can equal rated capacity, or highest load based on operational logs, or highest load since most recent test project.
5 Highest Achievable Load Range = 0.9 x Highest Achievable Load to 1.0 x Highest Achievable Load (i.e., 0.9 x 1,380 BHP and 1.0 x 1,380 BHP = 1.242 to 1,380 BHP.
6 If possible, record control device data.

(k) Summary of Emissions Results Data

The emissions from each natural gas-fired spark ignition internal combustion engine operated during each run listed in Tables 18, 18a, 19, 20, and 21 must be included in the final test report.

Table 18. VOC Test Results Summary (TRS) Per Method 320 or ASTM Method D6348-03
Source Name / ID No. [1] / Stack/ ID Name / No.[1]

Test Date				Average	GP-5 Permit Standard	Quad JJJJ / ZZZZ Standard	Compliance Status Pass/Fail
Test Run Number	1	2	3				
Sampling/Stack Data Summary							
Oxygen, (%)							
Volumetric Flowrate (dscfm by M19)[2]							
Volumetric Flowrate (dscfm by M 2/2C)[2]							
Acetaldehyde (C_2H_4O) Emission Results							
Emission Conc., (ppmvd)							
Emission Rate, (lb/hr)							
Emission Rate, (g/BHP-hr)							
Acetylene (C_2H_2) Emission Results							
Emission Conc., (ppmvd)							
Emission Rate, (lb/hr)							
Emission Rate, (g/BHP-hr)							
Acrolein (C_3H_4O) Emission Results							
Emission Conc., (ppmvd)							
Emission Rate, (lb/hr)							
Emission Rate, (g/BHP-hr)							
Benzene (C_6H_6) Emission Results							
Emission Conc., (ppmvd)							
Emission Rate, (lb/hr)							
Emission Rate, (g/BHP-hr)							
Butane (C_4H_{10}) Emission Results							
Emission Conc., (ppmvd)							
Emission Rate, (lb/hr)							
Emission Rate, (g/BHP-hr)							

[1] Per public eFacts on the Web @ https://www.ahs.dep.pa.gov/eFACTSWeb/default.aspx/default.aspx.

[2] Volumetric flowrate, (dscfm) can be determined by EPA Method 2, 2C, or 19.

Table 18a. VOC Test Results Summary (TRS) Per Method 320 or ASTM Method D6348-03
Source Name / ID No.[1] / Stack/ ID Name / No.[1]

Test Date				Average	GP-5 Permit Standard	Quad JJJJ / ZZZZ Standard	Compliance Status Pass/Fail
Test Run Number	1	2	3				
Sampling/Stack Data Summary							
Oxygen, (%)							
Volumetric Flowrate (dscfm by M19)[2]							
Volumetric Flowrate (dscfm by M 2/2C)[2]							
Ethylene (C_2H_4) Emission Results							
Emission Conc., (ppmvd)							
Emission Rate, (lb/hr)							
Emission Rate, (g/BHP-hr)							
Methanol (CH4O) Emission Results							
Emission Conc., (ppmvd)							
Emission Rate, (lb/hr)							
Emission Rate, (g/BHP-hr)							
Propylene (C_3H_6) Emission Results							
Emission Conc., (ppmvd)							
Emission Rate, (lb/hr)							
Emission Rate, (g/BHP-hr)							
Propane (C_3H_8) Emission Results							
Emission Conc., (ppmvd)							
Emission Rate, (lb/hr)							
Emission Rate, (g/BHP-hr)							
Total VOC (as C_3H_8) Emission Results							
Emission Conc., (ppmvd)							
Emission Concentration (ppmdv @ 15% O_2)							
Emission Rate, (lb/hr)							
Emission Rate, (g/BHP-hr)							

[1] Per public eFacts on the Web @ https://www.ahs.dep.pa.gov/eFACTSWeb/default.aspx/default.aspx.
[2] Volumetric flowrate, (dscfm) can be determined by EPA Method 2, 2C, or 19.

Table 19. NMEHC (or VOC) Test Results Summary (TRS) Per Alt 106
Source Name / ID No.[1] / Stack/ ID Name / No.[1]

Test Date				Average	GP-5 Permit Standard	Quad JJJJ / ZZZZ Standard	Compliance Status Pass/Fail
Test Run Number	1	2	3				
Sampling/Stack Data Summary							
Oxygen, (%)							
Volumetric Flowrate (dscfm by M19)[2]							
Volumetric Flowrate (dscfm by M 2/2C)[2]							
Methane Emissions (as Propane/C_3H_8) Emission Results							
Emission Conc., (ppmvd)							
Emission Rate, (lb/hr)							
Emission Rate, (g/BHP-hr)							
Ethane Emissions (as Propane/C_3H_8) Emission Results							
Emission Conc., (ppmvd)							
Emission Rate, (lb/hr)							
Emission Rate, (g/BHP-hr)							
NMEHC (as Propane/C_3H_8) Emission Results							
Span Used During Testing (ppm)							
Is Run Average concentration <4 ppm?							
Is Run Avg. Conc. Ranges = Span / 2.5 to 1.0?							
Emission Conc., (ppmvd)							
Emission Concentration (ppmdv @ 15% O_2)							
Emission Rate, (lb/hr)							
Emission Rate, (g/BHP-hr)							

[1] Per public eFacts on the Web @ https://www.ahs.dep.pa.gov/eFACTSWeb/default.aspx/default.aspx.
[2] Volumetric flowrate, (dscfm) can be determined by EPA Method 2, 2C, or 19.

Table 20. Formaldehyde Test Results Summary (TRS) Per Method 320 or ASTM Method D6348-03
Source Name / ID No.[1] / Stack/ ID Name / No.[1]

Test Date				Average	GP-5 Permit Standard	Quad JJJJ Standard	Compliance Status Pass/Fail
Test Run Number	1	2	3				
Sampling/Stack Data Summary							
Oxygen, (%)							
Volumetric Flowrate (dscfm by M19)[2]							
Volumetric Flowrate (dscfm by M 2/2C)[2]							
Formaldehyde Emission Results							
Emission Conc., (ppmvd)							
Emission Concentration (ppmdv @ 15% O_2)							
Emission Rate, (lb/hr)							
Emission Rate, (g/BHP-hr)							

[1] Per public eFacts on the Web @ https://www.ahs.dep.pa.gov/eFACTSWeb/default.aspx/default.aspx.
[2] Volumetric flowrate, (dscfm) can be determined by EPA Method 2, 2C, or 19.

Table 21. NO_x and CO Test Results Summary (TRS) Per Method 320 / ASTM Method D6348-03
Source Name / ID No.[1] / Stack/ ID Name / No.[1]

Test Date				Average	GP-5 Permit Standard	Quad JJJJ Standard	Compliance Status Pass/Fail
Test Run Number	1	2	3				
Sampling/Stack Data Summary							
Oxygen, (%)							
Volumetric Flowrate (dscfm by M19)[2]							
Volumetric Flowrate (dscfm by M 2/2C)[2]							
NO_x (as NO_2) Emission Results							
Emission Conc., (ppmvd)							
Emission Rate, (lb/hr)							
Emission Rate, (g/BHP-hr)							
CO Emission Results							
Emission Conc., (ppmvd)							
Emission Concentration (ppmdv @ 15% O_2)							
Emission Rate, (lb/hr)							
Emission Rate, (g/BHP-hr)							

[1] Per DEP's website: https://www.ahs.dep.pa.gov/eFACTSWeb/default.aspx/default.aspx.
[2] Volumetric flowrate, (dscfm) can be determined by EPA Method 2, 2C, or 19.

(l) Summary of EPA Method 205 –Field Calibration of Dilution System

Verification of Gas Dilution System For Field Instruments Calibrations Based on EMTIC TM-205 and EPA Method 320 from each natural gas-fired spark ignition internal combustion engine operated during each test run must be included in the final test report (see below Tables 22-25).

Table 22: Analyzer Information Per EMTIC TM-205 and Method 205

Verification Date:	
Analyzer Make:	
Analyzer Model:	
Analyzer SN:	
Component/Balance Gas:	
Cylinder Gas ID (Dilution):	
Cylinder Gas Concentration (Dilution), ppm:	
Cylinder Gas ID (Mid-Level):	
Cylinder Gas Concentration (Mid-Level), ppm:	
Most Recent Calibration Date:	
Next Calibration Date:	

Table 23: Dilution System Verification Per EMTIC TM-205 and Method 205

Target Mass Flow Controllers	Target Dilution (%)	Target Flow Rate, (lpm)	Target Conc. (ppm)	Actual Conc., (ppm)	Injection 1 Analyzer Conc., (ppm)	Injection 2 Analyzer Conc., (ppm)	Injection 3 Analyzer Conc., (ppm)	Average Analyzer Conc., (ppm)	Difference (ppm)	Average Error (±2%)

Table 24: Dilution System Results Per Method 205

Average Analyzer Conc., (ppm)	Injection 1 Error, (±2%)	Injection 2 Error, (±2%)	Injection 3 Error, (±2%)

Table 25: Mid-Level Supply Gas Calibration Direct to Analyzer Results Per Method 205

Calibration Gas Conc. (ppm)	Actual Conc., (ppm)	Injection 1 Analyzer Conc., (ppm)	Injection 2 Analyzer Conc., (ppm)	Injection 3 Analyzer Conc., (ppm)	Average Analyzer Conc., (ppm)	Difference (ppm)	Average Error (±2%)

(m) Summary of Quality Assurance (QA) / Quality Control (QC) Data

The QA / QC (pretest calibration error and pre-and-post test system bias, and drift) for Methods 3A and ALT-106 from each natural gas-fired spark ignition internal combustion engine operated during each test run must be included in the final test report (see below Tables 26-32).

Table 26: Oxygen (O_2) and Carbon Dioxide (CO_2) Calibration Error, System Bias, and Drift Per Method 3A

Run # / Span (Must be performed for O_2 and CO_2)	Calibration Gas Level	Manufacturer Certified Cylinder Value (C_v)	Analyzer Calibration Response (C_{Dir})	Analyzer Calibration Error (ACE ≤ 2% of Span)[1]	Initial Values		Final Values		Drift (D ≤ 3% of Span)[3]	Pass (Yes/No)[4]
					System Response (C_s)	System Bias (SB ≤ 5% of Span)[2]	System Response (C_s)	System Bias (SB ≤ 5% of Span)[2]		
Run 1 Calibration Span (CS)	Low (or Zero)									
	Mid									
	High									
Run 2 Calibration Span (CS)	Low (or Zero)									
	Mid									
	High									
Run 3 Calibration Span (CS)	Low (or Zero)									
	Mid									
	High									

1 ACE = $[(C_{Dir} - C_v) / CS] * 100\%$.

2 SB = $[(C_s – C_{Dir}) / CS] * 100$.

3 D = $|SB_{final} - SB_i|$

4 Note: If the difference is greater than 3 percent, the measurement system is not acceptable.

Table 27: Methane (CH_4), Ethane (C_2H_6), & Non-Methane/Ethane (NMEHC) Calibration Error Per ALT-106[1]

Run # (Must be performed for CH_4, C_2H_6, and THC)	Calibration Gas Level	Manufacturer Certified Cylinder Concentration (C_v, ppmdv)	Analyzer System Response (ppmdv)[2]	Predicted Response (C_p, ppmdv)[3]	Analyzer System Response (C, ppmdv)[4]	Analyzer Calibration Error (ACE ≤ 5% of Cal. Gas)[5]	Pass (Yes/No)[6]
Run 1	Zero						
	Low						
	Mid						
	High						
Run 2	Zero						
	Low						
	Mid						
	High						
Run 3	Zero						
	Low						
	Mid						
	High						

1 Conduct immediately prior to the test series (within 2 hours of the start of the test).

2 Introduce zero gas and high-level calibration gas at the calibration valve. The "zero" response and the "high gas" response, should be equal to the cylinder response but the actual analyzer system responses must be recorded. The method assumes measured zero and high gas values are equal to the cylinder values for the purpose of developing a calibration curve, with the zero as the intercept and the "high gas" as the slope.

3 Calculate the predicted response (C_p) for the low-level and mid-level gases based on a linear response line between the zero and high-level responses. $C_p = mx + b$ = (slope)x + (Y-intercept).

4 Introduce the low-level and mid-level calibration gases successively to the measurement system. Record the analyzer responses for low-level and mid-level calibration gases and determine the differences between the measurement system responses and the predicted responses.

5 Calculate the analyzer calibration error (ACE) for the low-level and mid-level gases. ACE = $[(C - C_p) / C_v] * 100\%$.

6 If the low and mid-level ACE is greater than ± 5 percent of the span value, the measurement system is not acceptable.

Table 28: Methane (CH_4), Ethane (C_2H_6), & Non-Methane/Ethane Hydrocarbon (NMEHC) Response Time Test Per ALT-106

	Organic Analyzer
Run #	Upscale (seconds)
1	
2	
3	
Average	

[1] Upscale time is 95% of the step change.

Sample Point	Start Time	Stop Time	Response	Organic Conc., (ppmdv)
Average Conc., C_{avg}				

1 Introduce zero gas.

2 Record the time from the concentration change to the time at which 95 percent of the corresponding final value is reached.

3 Repeat the test 3 times and average the results.

Table 29: Methane (CH_4), Ethane (C_2H_6), & Non-Methane/Ethane (NMEHC) Drift Per ALT-106

Run # / Span (Must be performed for CH_4, C_2H_6, and THC)	Calibration Gas Level	Manufacturer Certified Cylinder Value (C_v, ppmvd)	Analyzer System Response (C, ppmvd)[1,2]		Difference, (%)[3]	Drift (D ≤ 3% of Span)[4]	Pass (Yes/No)[5]
			Initial	Final	(Initial – Final)		
Run 1 Calibration Span (CS)	Zero						
	Mid						
Run 2 Calibration Span: (CS)	Zero						
	Mid						
Run 3 Calibration Span: (CS)	Zero						
	Mid						

1 Reintroduce the zero and mid-level calibration gases, successively into the measurement system.
2 Record the analyzer response.
3 D = [(Difference) / CS] * 100.
4 If the drift values exceed the specified limits, invalidate the test data preceding the check and adjust the measurement system.
5 The zero and calibration drift must be less than ± 3 percent of the span value.

Table 30: Sampling System Temperature Heating Requirements Per DEP and ALT-106[1,2]

Number of Readings	Probe Temp., (°F)	Sampling Line Temp., (°F)	Analyzer Temp., (°F)
1			
2			
3			
4			
Average			

1 The sampling system minimally consist of a heated probe, sample line, and analyzer. Unless the boiling points (b.p.) of all VOCs at the sampling location are known, DEP requires a sampling system temperature of 375±25°F.

2 These temperatures must be recorded at least every **15-minutes** during each run and sampling location and be provided in the final test report.

Table 31: Pre-Test Calibration Procedure To Choose Between Two NMEHC Spans @ End of Run[1]

Cal. Gas	Calibration Gas Requirements[2]	Proposed Span A (ppm) Cert. Cal. Gas Concentrations	Higher Span B (ppm) Cert. Cal. Gas Conc.
Zero	<0.1% of Span	<0.1% x Proposed Span (A)	<0.1% x Proposed Span (A)
Low	25-35% of Span	(25-35%) x Proposed Span (B)	(45-55%) x Proposed Span (C)
Mid	45-55% of Span	(45-55%) x Proposed Span (C)	(80-90%) x Proposed Span (D)
High	80-90% of Span	(80-90%) x Proposed Span (D)	Additional Certified Gas (80-90%) x Higher Span (E)[3]

1 Pre-test calibration procedure to introduce additional gas or gases into the according to ALT-106 requirements to select between more than one NMEHC span at end of test run (see above example).

2 EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards gases or certified gas standards with an accuracy of ±2% or better must be used.

3 Additional **high** cal. gas recommended to be used during pretest analyzer calibration error (ACE) checks to, based on average run concentration (ppm), choose between two spans at end of test run.

Table 32: NMEHC Span Requirements

Test Run Number	1	2	3
Acceptable Conc. Ranges for NMEHC Span of 10 ppm[1]	0-10	0-10	0-10
Acceptable Conc. Ranges for NMEHC Span of 16.7 ppm[2]	6.7-16.7	6.7-16.7	6.7-16.7
Acceptable Conc. Ranges for NMEHC Span of 20 ppm[3]	8-20	8-20	8-20
Acceptable Conc. Ranges for NMEHC Span of 30 ppm[4]	12-30	12-30	12-30
Acceptable Conc. Ranges for NMEHC Span of 40 ppm[5]	16-40	16-40	16-40
Acceptable Conc. Ranges for NMEHC Span of 50 ppm[6]	20-50	20-50	20-50
Acceptable Conc. Ranges for NMEHC Span of 100 ppm[7]	40-100	40-100	40-100
Acceptable Conc. Ranges for NMEHC Span of 150 ppm[8]	60-150	60-150	60-150

1 Acceptable Conc. Ranges = Span 10 ppm must be used when avg. conc**.** during any run is <4 ppm (10 ppm / 2.5 = 4 ppm).

2 Acceptable Conc. Ranges for Span 16.7 ppm = [(2.5-1.0) / 16.7 ppm] = 6.7-16.7 ppm.

3 Acceptable Conc. Ranges for Span 20 ppm = [(2.5-1.0) / 20 ppm] = 8-20 ppm.

4 Acceptable Conc. Ranges = Span 30 ppm = [(2.5-1.0) / 30 ppm] = 12-30 ppm.

5 Acceptable Conc. Ranges = Span 40 ppm = [(2.5-1.0) / 40 ppm] = 16-40 ppm.

6 Acceptable Conc. Ranges = Span 50 ppm = [(2.5-1.0) / 50 ppm] = 20-50.

7 Acceptable Conc. Ranges = Span 100 ppm = [(2.5-1.0) / 100 ppm] = 40-100 ppm.

8 Acceptable Conc. Ranges = Span 150 ppm = [(2.5-1.0) / 16.7 ppm] = 60-150 ppm.

5. Engine Performance Testing Requirements

(a) When conducting a performance test for an engine, the owner or operator must submit the test protocol described in Section A. Condition 14(f) for review and approval.

(b) The owner or operator should conduct the following test procedures:

(i) Conduct three test runs of at least one-hour duration within 10% of 100% peak (or the highest achievable) load.

(ii) Select the sampling port location and the number and location of traverse points at the exhaust using 40 CFR Part 60, Appendix A-1, Method 1 or 1A depending on stack diameter, or the sampling points selected according to 40 CFR Part 60, Appendix A-4, Method 7E Section 8.1.2.

(iii) Determine the effluent characteristics by either:

(A) Calculating the exhaust flow in accordance with 40 CFR Part 60, Appendix A-7, Method 19 and measuring the O_2 concentration using 40 CFR Part 60, Appendix A-2, Method 3A; or

(B) By measuring:

(1) The flow velocity, stack temperature, static pressure, and barometric pressure using 40 CFR Part 60, Appendix A-1, Method 2 or 2C depending on stack diameter;

(2) The gas density using 40 CFR Part 60, Appendix A-2, Method 3A; and

(3) The moisture content using 40 CFR Part 60, Appendix A-3, Method 4.

(iv) Simultaneous to the determination of the O2 concentration in (iii)(A) or (B) above, determine:

(A) The NO_x concentration of the exhaust gas using 40 CFR Part 60, Appendix A-4, Method 7E;

(B) The CO concentration of the exhaust gas using 40 CFR Part 60, Appendix A-4, Method 10;

(C) The NMNEHC concentration, as propane, excluding formaldehyde of the exhaust gas using ALT-106; and

(D) The formaldehyde concentration of the exhaust gas, if applicable, using 40 CFR Part 63, Appendix A, Method 320.

(c) If at any time the owner or operator operates the engine in excess of the highest achievable load plus 10%, the owner or operator must perform a stack test within 180 days from the anomalous operation.

6. Engine Periodic Monitoring Requirements

(a) When conducting periodic monitoring on an engine, the owner or operator may follow the procedures in (b) below. If the owner or operator decides to deviate from those procedures, they must submit a request to use an alternate procedure, in writing, at least 60 days prior to performing the periodic monitoring. In the alternate procedure request, the owner or operator must demonstrate the alternate procedure's equivalence to the standard procedure to the satisfaction of the Division of Source Testing and Monitoring.

(b) Standardized Periodic Monitoring Procedure.

(i) Conduct three test runs of at least 20 minutes duration within 10% of 100% peak (or the highest achievable) load.

(ii) Determine NO_x and CO emissions and O_2 concentrations in the exhaust with either an electro-chemical cell portable gas analyzer used and maintained in accordance with the manufacturer's specifications and following the procedures specified in the current version of ASTM D6522 or by following the procedures in 4(b) (ii) – (iv) (A) and (B) of this section.

(iii) If the measured NO_x or CO emissions concentrations are in exceedance of the emissions limit, the owner or operator must perform a stack test in accordance with the Performance Testing Requirements of Condition 4 within 180 days of the periodic monitoring.

(c) The 2,500 hours of operation count resets after any performance test performed in accordance with Condition 4 above.

(d) For engines constructed (as defined in that subpart) prior to June 12, 2006, that installed a continuous parametric monitoring system (CPMS) to monitor the catalyst inlet temperature, the owner or operator must install, operate, and maintain the CPMS according to 40 CFR § 63.6625(b)(1) through (6).

7. Sample Calculations

(a) Calculate the Certified Calibration Gas Per EPA Method 3A as follows:

Calibration Gas	Calibration Span, (ppm)	Calibration Gas Requirements	Certified Calibration Gas Concentrations, (ppm)
Zero (or Low)	Span	<20% of Span	<0.20 x Span
Mid		40-60% of Span	0.40 x Span to 0.60 x Span
High		Equal to Span	Equal to Span

(b) Calculate the Blended Certified Calibration Gas to Be Used Per EPA Method ALT-106 as follows:

Calibration Gas	Calibration Span, (ppm)	Calibration Gas Requirements	Certified Calibration Gas Concentrations, (ppm)
Zero	Span	<0.1% of Span	<0.1 x Span
Low		25-35% of Span	0.25 x Span to 0.35 x Span
Mid		45-55% of Span	0.45 x Span to 0.55 x Span
High		80-90% of Span	0.8 x Span to 0.9 x Span

(c) Calculate the Analyzer Calibration Error using EPA Method 3A, ACE (%) as follows:

Analyzer Calibration Error Per EPA Method 3A

$$ACE = [(C_{Dir} - C_v) / C_v] * 100\%$$

Where: ACE = Analyzer Calibration Error (ACE ≤ 2% of Span)
C_{Dir} = Analyzer Calibration Response, (ppm)
C_v = Manufacturer Certified Cylinder Value, (ppm)

(d) Calculate the Slope, (m) as follows:

Slope Per EPA Method ALT-106

$$m = [\Delta y) / \Delta x]$$

Where: m = slope of a line is the ratio of the rise to the run (dimensionless quantity)
Δy (or Rise) = Calculate the difference in the y-coordinates (y2-y1) or between the zero and high-level analyzer system responses (ppm)
Δx (or Run) = Calculate the difference in the x-coordinates (x2-x1) or between the zero and high-level manufacturer certified cylinder concentrations (ppm)

(e) Calculate the Predicted Response, (C_p, ppmdv) as follows:

Predicted Response Per EPA Method ALT-106

$$C_p = C_p = mx + b = (\text{slope})x + (\text{Y-intercept})$$

Where: C_p = Predicted Response (C_p, ppm).
m = slope (dimensionless quantity)
x_{low} = Manufacturer Certified Cylinder Concentration for low-level gas, (ppm)
x_{mid} = Manufacturer Certified Cylinder Concentration for mid-level gas, (ppm)
b = Y-intercept for zero or high gas, (ppm)

(f) Calculate the Analyzer Calibration Error using EPA Method ALT-106, ACE (%) as follows:

Analyzer Calibration Error Per EPA Method ALT-106

$$ACE = [(C_{Dir} - C_v) / C_v] * 100\%$$

Where: ACE = Analyzer Calibration Error (ACE ≤ 5% of Span)
C_{Dir} = Analyzer Calibration Response, (ppm)
C_v = Manufacturer Certified Cylinder Value, (ppm)

(g) Calculate the System Bias using EPA Method 3A, SB (%) as follows:

System Bias Per EPA Method 3A

$$SB = [(C_s – C_{Dir}) / CS] * 100$$

Where: SB = System Bias (SB ≤ 5% of Span)
C_s = System Response, (ppm)
C_{Dir} = Analyzer Calibration Response, (ppm)
CS = Analyzer Span, (ppm)

(h) Calculate the Drift using EPA Method 3A, D (%) as follows:

Drift Per EPA Method 3A

$$D = |SB_{final} - SB_{intial}|$$

Where: D = Drift (D ≤ 3% of Span)
$SB_{initial}$ = Initial System Bias
SB_{final} = Initial System Bias

(i) Calculate the Drift using EPA Method ALT-106, D (%) as follows:

Drift Per EPA Method ALT-106

$D = |SB_{final} - SB_{intial}| / CS$

Where: D = Drift (D ≤ 3% of Span)
$SB_{initial}$ = Initial System Bias
SB_{final} = Initial System Bias

(j) Calculate optional response factors for each VOC compound as follows using below Equations 4 of Section 60.4244(g) of 40 CFR Part 60:

Formula used to calculate **Optional** Response Factor of compound i when measured with EPA Method 25A.

$RF^i = C_{Mi} / C_{Ai}$ (Eq. 4)

Where:

RF^i = Response factor of compound i when measured with EPA Method 25A.

C^{Mi} = Measured concentration of compound i in ppmv as carbon.

C^{Ai} = True concentration of compound i in ppmv as carbon.

(k) Calculate the Correct Concentration using Response Factor, C^{icorr} (ppm) for each VOC compound as follows using below Equations 5 of Section 60.4244(g) of 40 CFR Part 60 as follows:

Formula to calculate concentration of compound i corrected to the value that would have been measured by EPA Method 25A, ppmv as carbon.

$C^{icorr} = RF_i \times C_{imeas}$ (Eq. 5)

Where:

C^{icorr} = Concentration of compound i corrected to the value that would have been measured by EPA Method 25A, ppmv as carbon.

C^{imeas} = Concentration of compound i measured by EPA Method 320, ppmv as carbon.

(l) Calculate the RF Corrected Concentration from ppm to DSCM, C^{peq} (DSCM) for each VOC compound as follows using below Equations 6 of Section 60.4244(g) of 40 CFR Part 60 as follows:

Formula to calculate concentration of compound i in mg of propane equivalent per DSCM.

$C^{peq} = 0.6098 \times C_{icorr}$ (Eq. 6)

Where:

C^{peq} = Concentration of compound i in mg of propane equivalent per DSCM.

(m) Calculate the Standard Volume Metered using EPA Method 4, $V_{m(std)}$ (dscf) as follows:

Standard Volume Metered Per EPA Method 2 or 2C

$$V_{m(std)} = V_m * Y * (T_{std} / P_{std}) * [(Pb + \Delta H / 13.6)]$$

$$V_{m(std)} = CF * 17.647 * (\text{in Hg} / °R) = \text{dscf}$$

Where: $V_{m(std)}$ = Standard Volume Metered [dscf]
V_m = Dry gas volume measured by dry gas meter, (dcf)
Y = is the Dry Gas Meter Calibration Factor
T_{std} = Standard Absolute Temperature, (528 °F)
P_{std} = Standard Absolute Pressure, 760 mm Hg (29.92 in. Hg)
T_{std} / P_{std} = 17.64 °R/in. Hg for English units
P_b = Stack Absolute Pressure [dscf]
ΔH = Average pressure differential across orifice [in H_2O]

(n) Calculate the Moisture Content of Stack Gas using EPA Method 4, B_{ws} (%)) as follows:

Molecular Weight of Stack Gas Per EPA Method 2 or 2C

1. H_2O collected in impingers in standard cubic feet

$$V_{wc(std)} = K * (V_f - V_i) = 0.04707 \text{ ft}^3/\text{ml} * (Vf - Vi) = \text{scf}$$

2. H_2O collected in silica gel in standard cubic feet

$$V_{wsg(std)} = K * (W_f - W_i) = 0.04715 \text{ ft3/ml} * (W_f - W_i) = \text{scf}$$

3. Moisture content of stack gas (B_{ws})

$$B_{ws} = [V_{wc(std)} + V_{wsg(std)}] / [V_{wc(std)} + V_{wsg(std)} + V_{m(std)}] = \%$$

Where: B_{ws} = Moisture Content of Stack Gas, (%)
K = 0.04716 ft^3 /g for English units.
V_f = Final weight of condenser water plus impinger, (g)
Vi = Initial weight, if any, of condenser water plus impinger, (g)
$V_{wc(std)}$ = H_2O collected in impingers in standard cubic feet [scf]
W_f = Final weight of silica gel or silica gel plus impinger, (g)
W_i = Initial weight of silica gel or silica gel plus impinger, (g)
$V_{wsg(std)}$ = H_2O collected in silica gel in standard cubic feet [scf]
$V_{m(std)}$ = Standard Volume Metered [dscf]
B_{ws} = Moisture content of stack gas [%]

(o) Calculate the Molecular Weight of Stack Gas using EPA Method 3, M_d (lb-lb-mole) as follows:

Molecular Weight of Stack Gas Per EPA Method 3

MW = M_d (Dry Molecular Weight) or M_s (Wet Molecular Weight)

1. $M_d = \sum M_x B_x = (0.44 * \% CO_2) + (0.32 * \% O_2) + (0.28 * \% CO) + (0.28 * N_2)$ = lb/lb-mole

2. $M_s = Md * (1-Bws) + 18 * Bws$ = lb/lb-mole

Where: M_d = Dry Molecular Weight [lb/lb-mole]
M_s = Wet Molecular Weight [lb/lb-mole]
CO_2 = stack carbon dioxide concentration, dry basis [%]
O_2 = stack oxygen concentration, dry basis [%]
CO = stack carbon monoxide concentration, dry basis [%]
N_2 = stack nitrogen concentration, dry basis [%]
B_{ws} = Moisture Content of Stack Gas, (%)

(p) Calculate the Average Stack Velocity Determinations using EPA Method 2 or 2C, V_s (ft/sec) as follows:

Average Stack Velocity Per EPA Method 2 or 2C

$$Vs = (K_p) * (C_p) * * [T_{s(abavg)}) / (P_s / M_s)]^{0.5} * (\Delta p)^{0.5}{}_{avg}$$

$$V_s = (85.49 \text{ ft/sec}) [(\text{lb/lb-mole (in Hg)}) / (°R (\text{in } H_2O)]^{0.5} * [(°R) / (\text{in Hg}) / (\text{lb/lb-mole})]^{0.5} * (\text{in } H_2O)^{0.5}$$

Where: V_s = Stack Flow Rate [Ft/Sec]
K_p = Velocity Equation constant = 85.49 (ft/sec) $[(\text{lb/lb-mole (in Hg)})]^{0.5}$
C_p = Pitot tube coefficient, dimensionless
B_{ws} = Moisture Content of Stack Gas, (%)
A = Area of Stack, (ft^2)
P_{std} = Standard Absolute Pressure, (29.92 in Hg)
T_s = Average Stack Temperature, (°F)
$T_{s(abavg)}$ = Average Absolute Stack Temperature (°R) = 460 + Ts (°F)
P_s = Stack Absolute Pressure, (in Hg)
M_s = Wet Molecular Weight
$(\Delta p)^{0.5}{}_{avg}$ = Velocity Head Measured by the Type S Pitot Tube $(\text{in } H_2O)^{0.5}$

(q) Calculate the Stack Gas Flow Rate Qs (dscf/hr) using EPA Method 2 or 2C, Q_s (dscf/hr) as follows:

Volumetric Flowrate (VFR, dscfm) Per EPA Method 2 or 2C

$$Q_s = (3600 \text{ sec/hr}) * (V_s) * (A_s) * (1-B_{ws}) * (T_{std} / P_{std}) * (P_s / T_s)$$

$$Qs = (3600 \text{ sec/hr}) * (\text{ft/sec}) * (\text{ft}^2) * (1-\_\_\_) * (17.647) * (\text{in Hg} / °R)$$

Where: Q_s = Stack Flow Rate [dscf/hr]
V_s = Average Stack Gas Velocity, (ft/sec)
A_s = Area of Stack, (ft^2)
B_{ws} = Moisture Content of Stack Gas, (%)
T_{std} = Standard Absolute Temperature, (528 °F)
P_{std} = Standard Absolute Pressure, (29.92 in Hg)
P_s = Stack Absolute Pressure, (in Hg)
Ts = Average Stack Temperature, (°F)
3600 = Conversion Factor, sec/hr

(r) **Unacceptable** Stack Gas Flow Rate Qs (dscf/hr) determinations using Engine Horsepower / Brake Specific Fuel Consumption

Volumetric Flowrate Using Manufacturers Information/Curves

$$Q_s = (HP) * (BSFC) * [20.9 / (20.9 - \%O_{2d})] / (1.0E+06 * 60)$$

Where: Q_s = Stack Flow Rate [dscf/hr]
F_d = Fuel F factor, dry basis, from Method 19 [scf / 10^6 Btu] (Default)
HP = Engine Brake Work, horse-power-hour (HP-hr) from Monitoring System
BSFC = Brake Specific Fuel Consumption, (Btu/HP-hr) from Monitoring System
CO_2 = stack carbon dioxide concentration, dry basis [%]

(s) Calculate the Stack Gas Flow Rate Qs (dscf/hr) using a dry O_2 reading and an oxygen-based F factor, dry basis (F_d), as follows:

Fd-Based Volumetric Flowrate (VFR, dscfm) Per Question 1, FAQs, of EPA Method 19

$$Q_s = (F_d) * (HI) / [20.9 / (20.9 - \%O_{2d})]$$

$$Q_s = (F_d) * [(FF_{NG} * GCV_{NG}) / 1{,}000{,}000] / [20.9 / (20.9 - \%O_{2d})]$$

Where: Q_s = Stack Flow Rate [dscf/hr]
F_d = Fuel-specific oxygen-based F factor, dry basis, from Method 19 [scf / 10^6 Btu]
FF_{NG} = Natural Gas (NG) Fuel Flow, (scf/hr) from Fuel Meter
GCV_{NG} = Natural Gas (NG) Heating Content, (Btu/scf) from Ultimate Analysis
$HI = (FF_{NG} * HHV_{NG}) / 1{,}000{,}000$
O_2 = stack oxygen concentration, dry basis [%]

(t) Calculate the Stack Gas Flow Rate Qs (dscf/hr) using a dry CO_2 reading and a carbon dioxide-based F factor, dry basis (F_c), as follows:

Fc-Based Volumetric Flowrate (VFR, dscfm) Per Question 1, FAQs, of EPA Method 19

$$Q_s = (Fc) * (HI)/ [100 / (CO_{2d})]$$

$$Q_s = (F_c) * [(FF_{NG} * GCV_{NG})/ 1{,}000{,}000] / [100 / (\%CO_{2d})]$$

Where: Q_s = Stack Flow Rate [dscf/hr]
Fc = Fuel-specific carbon dioxide-based F factor, dry basis, from Method 19 [scf / 10^6 Btu]
FF_{NG} = Natural Gas (NG) Fuel Flow, (scf/hr) from Fuel Meter
GCV_{NG} = Natural Gas (NG) Heating Content, (Btu/scf) from Ultimate Analysis
$HI = (FF_{NG} * HHV_{NG}) / 1{,}000{,}000$
CO_2 = stack carbon dioxide concentration, dry basis [%]

(u) Calculate the Emission Concentration from wet (ppmvw) to dry basis (ppmvd), (C) as follows:

Emission Concentration @ (ppmvd)

$$C\ (ppmvd) = (C)\ (ppmvw) / [(1 - Bws)]$$

Where: C = Emission Concentration [ppmvd]
C_{vw} = Measured Emission Concentration, [ppm wet basis or ppmvw]
B_{ws} = Moisture Content of Stack Gas, (%)

(v) Calculate the Emission Concentration (C), (ppmvd @ 15% O_2) as follows:

Emission Concentration @ 15% O_2 (ppm @ 15% O_2)

$$C\ (ppm\ @\ 15\%\ O_2) = [(C)\ (ppmvd) * [(20.9 - O_{2d}, \text{corrected}) / (20.9 - \%O_{2d}, \text{measured})]$$

Where: $C_{(15\%O2)}$ = Emission Concentration [ppm @ 15% O_2]
C = Measured Emission Concentration, [ppm dry basis or ppmvd]
O_2, corrected = stack oxygen concentration corrected to 15%, dry basis [%]
O_2, measured = stack oxygen concentration measured during test, dry basis [%]

(w) Calculate the Emission Rate (E), (lb/hr) as follows:

Emission Rate (lb/hr)

$$E\ (lb/hr) = [(C)\ (ppmvd) / 1{,}000{,}000)] * Q_s\ (std\ ft^3/hr) * [MW / 385]\ (lb/ft^3) \text{ or}$$

$$E\ (lb/hr) = C\ (ppmvd) * 10^{-6} * Qs\ (scfh) * (MW / 385]\ (lb/ft3)$$

Where: E = Emission Rate [lb/hr]
C = Measured Emission Concentration, [ppm dry basis or ppmvd]
Qs = Stack Flow Rate, dry basis [std ft^3/hr or dscf/hr]
MW = Molecular Weight, [44 lb/lb-mole]
V_{molar} = 385 scf/lb-mole = Is the number of cubic feet in a pound mole of gas at 68°F

(x) Calculate the Emission Rate (E), g/HP-hr as follows:

Emission Rate (g/HP-hr)

E (g/HP-hr) = (E) (lb/hr) * (454 grams / 1 lb) / BHP)

Where: E = Emission Rate [g/BHP-hr]
E = Emission Rate [lb/hr]
BHP = Brake-Horsepower
454 = Is the number of grams in a pound mole of gas at 68°F

(y) Calculate the Heat Input (HI), MMBtu/hr as follows:

Heat Input (MMBtu/hr)

HI (MMBtu/hr) = Fuel Flow (scfh) * Gross Calorific Value (Btu/scf) / 10^6 (1MMBtu/Btu)

Where: HI = Emission Rate [MMBtu/hr]
FF_{NG} = Fuel Flow, [scfh]
GCV = Gross Calorific Value (or Higher Heating Value, HHV), [btu/scf)]
Conversion Factor = 10^6 Btu = 1 MMBtu)