pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

STANDARD PROTOCOL (SP-005)

Stationary Internal Combustion Engines

Applicable for Methods 1, 1A, 2, 2C, 3, 3A, 4, 7E, 10, 18, 19, 25A, 205, 320, ASTM D6348-03, ALT-096, and ALT-106

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1. Regulatory Authority and General Description

All performance (i.e., baseline emissions and compliance) stack testing for NO_x, CO, formaldehyde, and VOC (NMEHC or NMHC) emission determinations shall be conducted in accordance with referenced EPA promulgated test methods, operating and control device conditions, Clean Air Act National Stack Testing Guidance, and other applicable regulatory requirements. Pre-approved Standard Protocol 005 (SP-005) is not a guidance document, and the use of this document is voluntary. As an alternative to submitting a site-specific protocol that requires a comprehensive review by DEP's Natural Gas Industry Testing Section (NGITS), the facility may opt to use SP-005 without deviation whose conditions are described herein. The requirements outlined in SP-005: (1) also apply for site-specific test protocol submittals; and (2) do not change or supersede requirements specified in referenced state general permits and state and federal regulations. Persons who are under-trained, unqualified, inexperienced, and without thorough knowledge of referenced EPA promulgated test methods, state permits, state and federal procedures and regulations, and Exemption 38 Policy should not attempt to perform these performance tests. Failure to strictly adhere to the requirements specified in SP-005 will likely result in a rejection and retests of a portion or entire test project. This standard protocol may be revised as needed after notice is provided to and feedback is received from DEP regulatory staff, Air Quality Technical Advisory Committee (AQTAC), and Marcellus Shale Coalition (MSC), Clean Air Act National Stack Testing Guidance, and other applicable regulatory requirements.

2. Definitions

Words and terms that are not otherwise defined in this Standard Protocol 005 (SP-005) shall adhere to the meanings set forth in EPA Methods 1, 1A, 2, 2C, 3 or 3A, 4, 7E (Preferred NO_x method), 10 (Preferred CO

method), 18, 19, 25A, 205, 320, ALT-096 (Preferred VOC method), and ALT-106 (Preferred VOC method); ASTM D6348-03; 40 CFR Part 60.8; 40 CFR Part 60, Subpart JJJJ; 40 CFR 63, Subpart ZZZZ; and BAQ-GPA/GP-5/GP-5A unless the context indicates otherwise and should be referenced before performing any stack test. The meanings set forth in applicable definitions in the Code of Federal Regulations (CFR) that are included in the above subparts shall also apply to SP-005.

Authorization ID Numbers Starting with AG5 and GP5 – The approval of application for authorization to use general permit or plan approval (i.e., BAQ-GP5/GP5A) allows for the construction and operation of specific sources at natural gas facilities. General Permit authorization types created in eFACTS provides a unique code for each General Permit type currently issued by the Bureau of Air Quality. For instance, authorization code AG5 or GP5 identifies that General Permit 5 is being used. After a General Permit authorization is granted, DEP assigns unique authorization identification (ID) numbers like unique plan approval and operating permit ID numbers. Up until 2018, regional permitting staff determined and manually inputted these plan approval and operating permit ID numbers 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 plan approval and operating permit ID numbers in eFACTS. To avoid overlap with previously issued authorizations, DEP created a new format of AG5-XX-YYYYYZ, where “XX” is the county code, “YYYYY” is a facility identifier, and “Z” is a letter assigned to each authorization. Except for showing whether the ID numbers were manually inputted or generated automatically, there is no difference between an authorization that has an ID starting with “GP5” or “AG5” that are included in test protocols and reports.

Baseline Emission Testing – For the purposes of this SP, any test performed to quantify the emissions of specific pollutants being emitted through stacks, ducts, or flues at a facility apply. Results are used to determine compliance with emission limits and assess the effectiveness of control devices.

Brake Power – Per 40 CFR Part 1054, “brake power means the usable power output of the engine, not including power required to fuel, lubricate, or heat the engine, circulate coolant to the engine, or to operate aftertreatment devices”. Engine horsepower (HP) and brake horsepower (BHP) are generally used interchangeably in stationary engine regulations (Subpart JJJJ and ZZZZ).

Clean Air Act National Stack Testing Guidance – A document developed by EPA to assist state and local air pollution control agencies in implementing stack test policies and improving the uniformity of stack test emission data across states.

Code of Federal Regulations (CFR) – Means 40 CFR, Part 60 and 40 CFR, Part 63.

Compliance Testing – For the purposes of SP-005, any performance test conducted to demonstrate compliance with the applicable emissions standards specified in GP-5/GP-5A and federal subparts JJJJ and ZZZZ apply. For sources subject to state (i.e., GP-5 and GP-5A) and federal (i.e., Subpart JJJJ and ZZZZ) standards, the more stringent standard applies for emissions determination of each pollutant.

Cyclonic Flow – 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.

Delegated Administrator Authority – For purpose of SP-005 and per 40 CFR § 63.90, refers to the authority delegated (or transferred) by the Environmental Protection Agency (EPA) to the state Administrator (DEP) to implement, approve, and enforce applicable source-specific determinations, procedures, clarifications, and reporting that reflect the flexibility allowed by the promulgated methods.

Department of Environmental Protection – Means Department or DEP.

Engine Source ID Names and Nos. – DEP assigns an engine’s source identification (ID) name and number (no.) to each source, control device, and stack at each Natural Gas Industry source 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.

Flame Ionization Detector (FID) – Is a detector sensitive to hydrocarbons with sensitivity decreasing for oxygenated and halogenated compounds (ppm level).

FR – Means “Federal Register” Notices Formally approving broadly applicable alternative test methods.

Frequently Asked Questions (FAQs) – EPA’s frequently asked questions for promulgated air quality test methods are intended to assist users with conducting performance tests in an acceptable manner by providing clarification and setting policy for undefined technical areas for the methods, monitoring, and performance specifications. In addition, FAQs are intended to promote consistent reviews within DEP and consistent testing and reporting by the regulated community and testing contractors.

Gas Chromatography (GC) – Gas chromatography is a process of separating volatile organic compound mixtures according to the specific chemical properties of each compound. After separation, individual compounds are measured by a detector – flame ionization detector (FID), electron capture detector (ECD), etc.

M – Means EPA Test Method which is followed by the method number.

Multi-Source to be Tested – A multi-source means that there are compressor stations or sites with more than one natural gas-fired compressor drivers (or engines).

Multi-Sites to be Tested – A multi-site or multi-facility means that there are multiple compressor stations (or multi-sites) with one or more natural gas-fired compressor drivers (or engines) at each site.

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”.

Natural Gas Industry Testing Section (NGITS) – This section is responsible for protocol reviews, test observations, and final report reviews of sources in the natural gas industry related to the production, processing, liquification, distribution, storage, and loading of natural gas (NG). The Source Testing Section handles testing of all other source categories, not related to the natural gas industry.

Non-Methane Hydrocarbons (NMHC) – Defined as total organic compounds that excludes methane (CH_4) expressed on an “as propane” (C_3H_8) basis.

Non-Methane/Ethane Hydrocarbons (NMNEHC) – Defined as total organic compounds that excludes methane (CH_4) and ethane (C_2H_6) expressed on an “as propane” (C_3H_8) basis.

Peak (or Highest Achievable) Load – Defined as the maximum load or brake horsepower that an engine can handle. This load may change depending on the engine’s site conditions at the time of initial and/or reoccurring testing and may not be equal to the engine’s rated capacity. Highest Achievable Load (or peak load in BHP) can but does not necessarily equal the rated capacity. This determination of peak load should be based on the results of operational logs of daily operations, since most recent test project, and over previous years (whichever is more accurate). Section C, Condition (b)(i) of GP-5/GP-5A and Section 60.4244(a) of 40 CFR Part 60, Subpart JJJJ states that, each performance test shall conduct three test runs of at least one-hour duration within 10 percent of 100 percent peak (or the highest achievable) load. In addition, Section, C, Condition C(4)(c) of GP-5 states that, “if at any time the owner or operator does not operate 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”.

Preferred Test Method(s) – For the purposes of SP-005, preferred test method(s) use is not mandatory but is recommended over the use of other more complicated test method(s) to directly measure NO_x, CO, and VOC (NMEHC or NMHC) emissions. For instance, the preferred test method options in SP-005 are Method 7E for NO_x, Method 10 for CO, and ALT-106 or ALT-096 for VOC (NMEHC or NMHC) in lieu of using Method 320 or ASTM D6348-03. More rigorous analyses, technically advanced equipment, and experience is required to conduct performance testing using FTIR methods (Method 320 or ASTM D6348-03) than using FID methods (Method 7E and 10) and FID-GC Backflush methods (ALT-096 or ALT-106).

Rated Capacity – Defined as the highest rated operational load, capacity, or power in units of brake-horsepower (BHP) each engine can achieve as determined by the manufacturer.

Rated Speed – Means the maximum full-load governed speed for governed engines and the speed of maximum power for ungoverned engines per 40 CFR 1048.801.

Rec. – Means “recommended” or “suggested” conditions that are not mandatory to verify baseline emissions or demonstrate compliance with applicable regulations.

Reqd. – Means “required” or minimum conditions that must be met to verify baseline emissions or demonstrate compliance with applicable regulations.

Response Factor – The relationship between the detector output and the organic compound concentration. Also, the relationship between the detector output for one organic compound compared to the detector output of a second organic compound. For purpose of SP-005, response factors will be established using a gas standard of known concentration per Equations 4-6 of § 60.4244(g) of 40 CFR Part 60, Subpart JJJJ.

Stack Testing – Performance or source test that 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 to verify emissions from a source or the accuracy of a monitor or gauge.

Site-Specific Test Protocols – Before conducting a required performance test (i.e., stack test), the owner or operator of an affected source must develop and submit a site-specific test protocol (or plan) to the Administrator (i.e., DEP) that addresses each phase of the performance test. Site-specific test protocols (or plans) are subject to a comprehensive review by a source test reviewer. The site-specific protocol (or plan) must describe in detail the procedures that the testing contractor intends to use during the test, including, but not limited to: the specific test methods, sampling train and equipment specifications, sampling locations, process operations, calibration standards, sample data collection sheets and calculations specified in Section 2.1.1 (Pretest Procedural Protocols) of DEP’s Source Test Manual (Revision 3.3). In addition, site-specific test plan should contain references and brief descriptions for specific test methods, operational/control parameters, state permits, state and federal regulations, and justification for all proposed deviations from above requirements associated with testing. The submission and review of site-specific test protocols helps to ensure that the testing requirements are interpreted correctly, and reference methods are followed; minimize potential problems encountered during the test; and reduce the possibility of testing errors. The format of such protocols may vary, however, certain basic elements should be addressed in a protocol to ensure that a complete and representative stack test is conducted. DEP requests that site-specific test protocols are received via email at least 90 days prior to testing to ensure adequate time for review. Testing without a protocol review and failure to provide adequate test notification could lead to rejection of test results.

Standardized Test Protocols – This document is similar to site-specific test protocols except that this protocol was created by DEP. It includes pre-approved procedures, test methods, reporting, and other associated testing related requirements for conducting required performance testing (i.e., stack testing) at facilities regulated by DEP. Standardized test protocols are designed to ensure standardization and uniformity of stack testing conducted to accurately verify baseline emissions and demonstrate compliance with state test requirements and federal standards. Field testing is performed by facility or consultant (or testing firms) personnel.

Electing to adhere to SP-005 expedites DEP approval to perform testing. DEP reserves the discretion to deviate the requirements in SP-005 if circumstances warrant.

Source Test Manual (Revision 3.3) – This is the guidance document that applies to anyone conducting source tests at stationary sources or submitting the resultant source test data to the Department. This document provides detailed information on source test methods, procedures and reporting of emissions to the Department.

Stratification Test – This pretest test is required per Section 8.1.2 to be performed prior to sampling to determine: (1) if concentrations are uniform across axis of the sampling location; and (2) the appropriate number of sample traverse points are used during testing. However, no stratification test is required to be performed when a 3D probe is used at sampling locations that meets the requirements of Table 2 to Subpart JJJJ of Part 60.

Stationary Internal Combustion Engine – Per 40 CFR Part 60 Subpart JJJJ, “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”.

Stationary Spark Ignition (SI) Internal Combustion Engines (ICE) – 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.

Stationary Spark Ignition (SI) Reciprocating Internal Combustion Engines (RICE) –BAQ’s Technical Support Document General Permit GP-5 January 31, 2013, defines this source as “[i]n the natural gas industry, spark ignition reciprocating internal combustion engines (SI-RICE) are used mainly as prime movers to drive compressors. There are different types of spark ignition reciprocating internal combustion engines used in the natural gas industry.

In an SI-RICE engine, a mixture of air and fuel is burned within the engine cylinder, and the energy of expanding gases is converted into mechanical work at the engine crank shaft. The relative proportions of air and fuel in the combusted mixture is called the air-to-fuel (A/F) ratio. The A/F ratio is called "stoichiometric," if the mixture contains the minimum amount of air that supplies sufficient oxygen for complete combustion of the fuel with no oxygen or fuel left over after combustion.

Reciprocating engines are grouped into two general categories based on the combustion model used in their design: “rich-burn” and “lean-burn”. The primary distinction between the two is the amount of excess air admitted prior to combustion. Rich-burn engines operate with a minimum amount of air required for combustion and lean-burn engines use 50% to 100% more air than is necessary for combustion”.

Test Report – Emission Measurement Center Guideline Document (GD-042) states that, “after the test is performed, an emission test report is prepared to provide the information necessary to document the data collected and provide evidence that proper procedures were used to accomplish the test objectives. The emission test report presents the information gathered according to the emission test plan. Therefore, the contents of the test plan serve as the foundation for the test report”.

Total Hydrocarbons (THC) – TOCs measured according to the procedure in EPA Method 25A, subject to the state additions, expressed on an “as propane” (C_3H_8) basis. This includes methane and ethane.

“Users” of SP-005 – SP-005 was designed for a broad audience and “users” who are defined as facilities, consultants, DEP regulatory staff, advisory committees, relevant stakeholders, and other interested parties.

Volatile Organic Compounds (VOC) – "Means volatile organic compounds as defined in 40 CFR 51.100(s) that participates in atmospheric photochemical reactions and vaporizes readily at moderate temperatures." NGITS requires 9 organic compounds and recommends 5 organic compounds are measured for each run.

3. Applicability/Scope

This section discusses the applicability of using SP-005 to conduct performance testing for emissions determination of NO_x, CO, formaldehyde, and VOC (or NMHC) on natural gas-fired stationary internal combustion engines at natural gas compressor stations. In addition, for purposes of SP-005, this section discusses the applicability for conducting performance tests under one of the two below testing scenarios subject to one or any combination of the referenced (or applicable) federal regulations, state regulation (including RACT), state permits, and/or Exemption 38 Policy:

(a) *Testing Scenarios*

(i) **Scenario 1**: Emission testing at a single compressor station or site with one or more engines.

(ii) **Scenario 2**: Emission testing at multiple compressor stations (or multi-sites) with one or more engines at each station (or site).

(b) *Applicable Federal Regulations*

(i) **40 CFR Part 60.8 –** Performance tests. Contains requirements for performance testing and notification of force majeure events. According to section 60.8(1) of the regulation, if a force majeure event occurs that may cause or caused a delay in testing beyond the regulatory deadline, the owner or operator of the facility shall notify the Administrator in writing as soon as practicable. Section 60.8(1)(a)(2), (a)(3), and (a)(4) of the regulation requires the owner or operator of the facility to conduct performance tests and furnish the Administrator a written report of the results of such performance tests within 60 days after achieving the maximum production rate at which the affected facility will be operated.

(ii) **40 CFR Part 60, Subpart JJJJ** – BAQ's Technical Support Document General Permit GP-5 January 31, 2013, defines this federal regulation as, "Standards of Performance for Stationary Spark Ignition Internal Combustion Engines. This subpart establishes emission standards and compliance requirements for the control of emissions from stationary spark ignition (SI) internal combustion engines (ICE) that commenced construction, modification or reconstruction after June 12, 2006, where the SI ICE is manufactured on or after specified manufacture trigger dates. The manufacture trigger dates are based on the engine type, fuel used, and maximum engine horsepower. The most recent revision to 40 CFR Part 60, Subpart JJJJ must be used to ensure that the relevant emission standards applicable to the engines being tested is used".

(iii) **40 CFR Part 63, Subpart ZZZZ** – BAQ's Technical Support Document General Permit GP-5 January 31, 2013, defines this federal regulation as "National Emission Standards for Hazardous Air Pollutants (NESHAP) for Reciprocating Internal Combustion Engines (RICE). This rule establishes national emission limitations and operating limitations for HAPs emitted from stationary RICE. This rule applies to owners or operators of new and reconstructed stationary RICE of any horsepower rating which are located at a major or area source of HAP emissions. While all stationary RICE located at major or area sources are subject to the final rule (promulgated January 18, 2008, amending the final rule promulgated June 15, 2004), there are distinct requirements for regulated stationary RICE depending on their design, use, horsepower rating, fuel, and major or area HAP emission status. The most recent revision to 40 CFR Part 63, Subpart ZZZZ must be used to ensure that the relevant emission standards applicable to the engines being tested is used".

(b) *Applicable State Regulations*

(i) **25 Pa. Code Chapter 139.1** – Sampling facilities. Refers to sampling and testing facilities in Pennsylvania. It is part of Pennsylvania Code (Rules and Regulations) and outlines requirements and procedures for sampling and testing methods.

(ii) **25 Pa. Code Chapter 139.2** – Sampling by others. Outlines the rules for sampling and testing done by persons other than the Department. The Department must be provided reasonable notice and opportunity to observe and participate in sampling and testing.

(iii) **25 Pa. Code Chapter 139.3** – General requirements. Outlines the methods used by the Department to assess emissions from stationary sources or ambient levels of air contaminants.

(iv) **25 Pa. Code Chapter 139.11(1)** – Performance tests shall be conducted while the source is operating at maximum routine operating conditions or under such other conditions, within the capacity of the equipment, as may be requested by the Department. Such conditions may be stipulated in a plan approval, permit, order, DEP response letter to site-specific protocol, or standard protocol.

(v) **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, all of the following specified in 25 Pa. Code Chapter 139.11(2)(i through vii).

(c) *Applicable Reasonably Available Control Technology (RACT) Regulations*

Engines located at major NO_x or VOC emitting facilities are subject to RACT test and emission standard requirements. The specific RACT emission standards may be found at the citations shown in (i) through (iii) below based on the date of commencement of operation.

(ii) **RACT I (On or before January 15, 1994)** – 25 Pa. Code §§ 129.91 -129.95.

(ii) **RACT II (On or before July 20, 2012)** – 25 Pa. Code §§ 129.96 - 129.100.

(iii) **RACT III (On or before August 3, 2018)** – 25 Pa. Code §§ 129.111 - 129.115.

(d) *Applicable State Permits*

(i) **General Permit BAQ-GPA / GP-5** – General Plan Approval and/or General Operating Permit BAQ-GPA/GP-5. 2700-PM-BAQ0267 Rev. 6/2018. This permit is applicable and limited to new or modified, mid-stream natural gas compressor stations, processing plants, and transmission stations (facility or facilities) that are minor air contamination facilities and constructed, modified, or operated in this Commonwealth (Issued June 9, 2018, effective for new facilities on August 8, 2018). The most recent revision to GP-5 must be used to ensure that the relevant emission standards applicable to the engines being tested is used.

(ii) **General Permit BAQ-GPA / GP5A** – General Plan Approval and/or General Operating Permit BAQ-GPA/GP-5A. 2700-PM-BAQ0267 Rev. 6/2018. This permit has been finalized for the Oil and Gas industry and is applicable to new or modified unconventional natural gas well site operations and remote pigging stations (facility or facilities) constructed, modified, or operated in this Commonwealth (Issued June 9, 2018, effective August 8, 2018). The most recent revision to GP-5A must be used to ensure that the relevant emission standards applicable to the engines being tested is used (include standard language).

(e) *Exemption 38 Policy*

Sources located at the natural gas well sites are exempt from permitting requirements only if the owner or operator meets all applicable requirements established in the Category No. 38 Exemption Criteria. While a source may be exempt from permitting requirements, the owner or operator of the source must still comply with all applicable federal and state laws and regulations.

4. Prohibited Use of SP-005

This section clarifies that SP-005 may not be used for any of the following reasons:

(a) Tests on any source category other than natural gas-fired stationary internal combustion engines.

(b) Determination of emissions for any pollutant other than NO_x, CO, formaldehyde, and VOC (i.e., NMEHC or NMHC).

(c) Use of any test methods other than M1, M1A, M2, M2C, M3, M3A, M4, M7E, M10, M18, M19, M25A, M205, M320, ASTM D6348-03, ALT-096, and ALT-106.

(d) Use of any guidance documents other than DEP's Source Testing Manual (Revision 3.3) and EPA's National Stack Test Guidance.

(e) Tests under any state permits and policy other than GP-5, GP-5A, and Exemption 38 Policy.

(f) Tests under any state regulations other than 25 Pa. Code, Sections 139.1, 139.2, 139.3, 139.11(1) and 139.11(2).

(g) Tests under any federal regulation and subparts other than 40 CFR Part 60.8, 40 CFR Part 60, Subpart JJJJ and 40 CFR Part 63, Subpart ZZZZ.

(h) Deviations from test methods, procedures, regulations, and requirements specified in SP-005.

(i) Cases where DEP did not receive a test notification letter via email within required deadline of at least 30 days prior to testing to verify that SP-005 will be used (see example test notification letter to use SP-005 in Appendix A).

5. Requests for Deviations

This section clarifies that, as noted above, for purposes of SP-005, performance tests shall be conducted in accordance with the test methods, procedures, permits, policy, regulations, and requirements described herein without deviations (or changes). For review of deviations, site-specific test protocols must be submitted for each test project or until SP-005 is revised to reflect any approved changes. For instance, during site-specific test protocol reviews, users should be aware that the following agencies has delegated authority for approval or rejection of the below proposed deviations:

(a) DEP has delegated authority to approve minor changes to promulgated test methods.

(b) DEP has delegated authority to approve changes to DEP requirements.

(c) DEP source test reviewer has delegated authority to approve the reuse of a previously submitted test protocol and corresponding response letter.

(d) Administrator authority to approve major changes to promulgated test methods is delegated to EPA's Office of Air Quality Planning and Standards (OAQPS) (MTG Group Leader).

(e) Administrator authority to approve major changes to monitoring is delegated to EPA Regional Offices.

(f) Administrator authority to change clarifications specified in EPA's frequently asked questions (FAQ) for promulgated test methods is delegated to EPA Regional Offices.

(g) Administrator authority to remove (or exclude) any test method option(s) permitted in GP-5/GP-5A and Table 2 to Subpart JJJJ of Part 60 is delegated to EPA Regional Offices.

During each site-specific review and prior to testing, users should clearly understand that unless otherwise identified all such methods and referenced changes must have prior approval or conditional approval from DEP or EPA. For instance, DEP must receive a written approval letter from a responsible (or delegated) official from EPA on their letterhead to make major changes to promulgated test methods and monitoring, make changes to FAQ clarifications, and/or remove (or exclude) any test methods option(s) specified in GP-5/GP-5A and Table 2 to Subpart JJJJ of Part 60. For more information on obtaining EPA approval of test deviations and alternatives, see "EPA Process Manual for Responding to Requests Concerning Applicability and Compliance Requirements of Certain Clean Air Act Stationary Source Programs**"**, "Requests For Approval of Alternatives/Modifications To Test Methods and Testing Procedures", an owner or field tester employing such methods or deviations from the test methods or other referenced changes without obtaining prior approval does so at the risk of subsequent disapproval and retesting with approved or conditionally approved procedures, methods, and site-specific protocols.

6. Test Notification to Use SP-005

This section discusses test notification to use SP-005. For instance:

(a) *Test Notification Letter to Use SP-005*. DEP does not require facilities to seek authorization to use this optional, pre-approved standardize protocol (SP-005) for any test project. However, for each test project for SP-005, DEP requires that a testing notification letter, or email, is received at least 30-day prior to testing compared to the recommended 90-day minimum testing notification requirement for site-specific test protocol submittals. This submittal time frame is necessary to: (1) verify if preapproved standard protocol (SP-005) or site-specific protocol will be used; (2) verify the specific test method that will be used for the emissions determination of each pollutant; (3) allow DEP to address any questions or concerns related to each test project prior to testing; and (4) allow DEP sufficient time to prepare for potential observations. DEP's NGITS would like to receive testing notifications via email to the applicable protocol reviewer for each project who will upload the letter as a miscellaneous document. Questions regarding the applicable protocol reviewer should be directed to NGITS' Environmental Group Manager, Bryon M. Richwine at brichwine@pa.gov. DEP's SERO, NERO, and SCRO would like to receive test notification letters via email to their applicable regional office resource accounts at: (ra-to ra-epsestacktesting@pa.gov for SERO, ra-epnestacktesting@pa.gov for NERO, and ra-epscstacktesting@pa.gov for SCRO. DEP's NCRO, SWRO, and NWRO would like to receive test notifications via OnBase. Questions regarding test notification submittals via OnBase should be directed to the applicable regional office manager.

(b) *Required Information in Test Notification Letter to Use SP-005.* To facilitate the submittal of test notification letters from the owner or operator for each test project, DEP has included an example test notification letter to use SP-005 in Appendix A of SP-005. This notification letter details required information that must be minimally included in this letter. Test notification letters are required to be included in the final test report.

(c) *Expiration Terms of Notification Letter to Use SP-005*. Test notification letter for each project will expire after 6 months if the owner or operator fails to perform testing within this timeframe. DEP may extend this 6-month period if the owner or operator provides submits satisfactory justification via email for an extension no more than two weeks after the expiration date. DEP's NGITS will review each request for extension and send a response via email to the facility. If granted, another 3-6 months extension period will apply. However, if not granted, a new test notification must be submitted.

(d) *Delay in Testing.* If there is a delay of testing, DEP must be notified 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 Approval to Use SP-005.*

(i) This Standard Protocol may be modified, suspended, or revoked if DEP determines that the natural gas-fired stationary spark ignition internal combustion engine(s) cannot be accurately tested under this Standard Protocol.

(ii) The approval 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.

(iii) Upon suspension or revocation of an approval to use SP-005, the owner or operator shall immediately cease use of this Standard Protocol and, under some circumstances, be required to submit a site-specific protocol.

7. Test Postponements and Stoppages

This section discusses acceptable and unacceptable test postponements and stoppages. For instance, the facility and consultant are responsible to immediately contact DEP's Natural Gas Industry Testing Section and applicable DEP's Responsible Regional Office via telephone to discuss testing related issues that may cause test postponements and/or stoppages and to obtain approval for these testing delays. After these discussions, follow-up email correspondence must be sent as soon as possible to document any agreements or disagreements between DEP and the facility and/or consultant. In addition, this email correspondence must be included in the executive summary section of the final test report. Pages 17-18, Section 6.0 of the Clean Air Act National Stack Testing Guidance states that, "[d]epending on the circumstances surrounding the stoppage, the facility may be found in violation of the requirement to conduct a stack test, the underlying regulatory requirement, or both. For example:

(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".

8. Cyclonic Flow and Stratification Requirements

This section discusses cyclonic flow and stratification requirements. For instance:

(a) *Cyclonic Flow*

As noted below, when M2 or M2C is used, the average angular flow must be less than 20 degrees to verify the absence of cyclonic or non-parallel flow at each sampling location. 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. If a standard pitot tube is being used (M2C) for velocity readings, a mini-S type-pitot should be used to determine cyclonic flow. Average Yaw Angle must be ≤20°. If not, do not use this location or alternatively, modify the source by using straightening vanes or use another location that satisfies M1 criteria.

Table 1. Cyclonic Flow Data Recordings

Sample Point	Angular Flow (or Yaw Angle at Degrees at ΔP=0)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
Total	
Average of Absolute Values of Angular Flow[1]	
Allowable Angular Flow	≤20°

[1] Average Angular Flow= Sum of Absolute Value of Angular Flow / Total No. of Samples with 0° yaw.

(b) *Stratification Test*

The below pre-test stratification test results must be recorded using a 3-point probe per Table 2 to 40 CFR Part 60, Subpart JJJJ or per Section 8.1.2 of M7E 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, CO_2, NO_x, and CO emission concentration test results.

Table 2. Stratification Requirement

Difference From Mean	Stratification Class	Number of Required Sample Points
+ 5%, or ± 0.3% O_2 or CO_2 (as applicable)	Unstratified	A single point that most closely matches the mean.
Between + 5% and + 10% or ± 0.5% O_2 or CO_2 (as applicable)	Minimally Stratified	Three (3) sample points spaced at 16.7, 50.0 and 83.3 percent of the measurement line.[1]
Greater than + 10%, and greater than ± 0.5% O_2 or CO_2 (as applicable)	Stratified	Twelve (12) sample points located consistent with M1 criteria.

[1] For a minimally stratified stack with an internal diameter greater than 2.4 meters (7.8 feet), the three sampling points may be located at 0.4 meters (1.3 feet), 1.0 meters (3.28 feet) and 2.0 meters (6.56 feet) along the measurement line showing the highest average concentration. This option will only be available if the stratification check consisted of twelve points.

Table 2a. Stratification Data Recordings

Traverse Point	O_2 (%)	CO_2 (%)	NO_x and CO
1			
2			
3			
4			
]5			
6			
7			
8			
9			
10			
11			
12			
Mean Concentration			

9. Operational and Control Requirements and Recommendations

This section discusses required and recommended operational and control data recordings and notifications. In addition, this section clarifies: (1) the difference between required and recommended conditions; (2) specific operational and control parameters that are either required or recommended to be recorded; (3) required and recommended test notifications; and (4) the difference between engine's rated capacity and highest achievable load. For instance:

(a) Required Operational and Control Data Recordings and Notifications

The below table discusses required recordings and corresponding notification during each test run and project to verify operational and control device conditions and address any potential compliance issues.

Table 3. Required Operational and Control Data Recordings and Notifications

Item #	Topic	Reference	Description
(i)	Engine Operating Conditions	DEP Requirement	The source test must be conducted under operational conditions specified in the GP-5 / GP-5A and 40 CFR Part 60, Subpart JJJJ.
(ii)	Data Recordings During Testing	DEP Requirement	The facility or consultant must record the specific information labeled as "Reqd" for "required information" in Table 3 of SP-005. However, for sources that have temporarily or permanently installed control device equipment (i.e., catalyst), SP-005 requires that all control device parameters, labeled as "Rec" for "recommended information" must be recorded during each test run. During testing, the recordings of these control device parameters are essential to determine how much emission reductions of each pollutant is associated with the control device equipment(s). In Table 3, there are only four (4) operational parameters and two (2) rated capacities that are required.
(iii)	Frequency of Data Recordings During Testing	DEP Requirement	Process and control device data must be recorded at least once every 15 minutes to verify the operating and control conditions at the time of testing. These recordings must be included in the final test report.

(iv)	Pretest Notification Procedures	DEP Requirement	Prior to testing and/or during testing, the owner, operator, or tester is required to 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. Changes to operational loads may limit the operating capacity at these sources until a new test is performed. The NGITS must also be notified of all operational questions regarding required recordings.

(b) Recommended Operational and Control Data Recordings and Notifications

The below table discusses recommended (or suggested) recordings and corresponding notification during each test run and project to verify operational and control device conditions and address any potential compliance issues.

Table 4. Recommended Operational and Control Data Recordings and Notifications

Item #	Topic	Reference	Description
(i)	Data Recordings During Testing	DEP Recommendation	DEP recommends and thinks that it is beneficial that the facility or consultant record the specific information labeled as “Rec” for “recommended information”, in Table 3 of SP-005. SP-005 does not require recording of catalyst control device parameters for each engine during testing when a source(s) does not have this existing control device equipment. Additional data not listed in Table 5 can be included in the operational and control data summary table.
(ii)	Frequency of Data Recordings During Testing	DEP Recommendation	Process and control device data should be recorded at least once every 15 minutes to verify the operating and control conditions at the time of testing. These recordings must be included in the final test report.
(iii)	Data Recordings During Daily Operations	DEP Recommendation	The facility should contact DEP’s regional staff regarding the frequency that operational and control device data is to be recorded during daily operations. 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 historical 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.
(iv)	Pretest Notification Procedures	DEP Recommendation	Prior to testing and/or during testing, the owner, operator, or tester should contact the applicable DEP regional office employee with questions/issues regarding recommended, pertinent process operating and control device parameters/loads recordings and to verify the highest achievable and targeted operating loads change and receive

			approval. Changes to operational loads may limit the operating capacity at these sources until a new test is performed. NGITS should also be notified of all operational questions about recommended recordings.

Table 5. Required and Recommended 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]	Reqd	Reqd	Reqd	Reqd
Heat Content/Value, (Btu/scf)[3]	Reqd	Reqd	Reqd	Reqd
Heat Input, (MMBtu/hr)[3]	Reqd	Reqd	Reqd	Reqd
Rated or 100 Percent Peak (or Highest Achievable) Brake-Horsepower, (BHP)[4]	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 Brake-Horsepower, (%)	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]	Reqd	Reqd	Reqd	Reqd
Catalyst Inlet Temperature, (°F)[6]	Reqd	Reqd	Reqd	Reqd
Catalyst Outlet Temperature, (°F)[6]	Reqd	Reqd	Reqd	Reqd
Catalyst Differential Temperature, (°F)[6]	Reqd	Reqd	Reqd	Reqd
Catalyst Pressure Drop, (in H_2O)[6]	Reqd	Reqd	Reqd	Reqd
Suction Pressure, (psi)[6]	Reqd	Reqd	Reqd	Reqd
Discharge Pressure, (psi)[6]	Reqd	Reqd	Reqd	Reqd
Intake Manifold Pressure, (psi)[6]	Reqd	Reqd	Reqd	Reqd
Ambient Temp., (°F)	Reqd	Reqd	Reqd	Reqd
Exhaust Gas Temp, (°F) (From Probe)	Reqd	Reqd	Reqd	Reqd
Intake Manifold Temp, (°F)	Reqd	Reqd	Reqd	Reqd
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 control device data must be recorded during each test run if the source(s) has existing or temporarily control device equipment installed.

[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 (or peak load in BHP) can but does not necessarily equal the rated capacity. This determination of peak load should be based on the results of operational logs of daily operations, since most recent test project, and over previous year (whichever is more accurate).
[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] The recording of control device data is not required unless equipment is temporarily or permanently installed. If installed, control device data must be recorded during each run.

10. Alternative ASTM Test Method Clarification

The National Technology Transfer Act provides guidance to EPA's Measurement Technology Group (MTG) of the Office of Air Quality Planning and Standards (OAQPS) to review the ASTM standards and, where they are determined to be equivalent, EPA allow them to be used as voluntary consensus standards in our rules. Once those rules are published, subsequent changes to the ASTM methods are not allowed for compliance determinations because the test method defines the pollutant and where a method was revised this allows the reviser to modify the method such that compliance may be more easily obtained. For this reason, EPA does not put the "pen of compliance" in the hands of ASTM. Rather, when the rule comes around for review, EPA will evaluate the most recent versions of an ASTM method and update those reference in the rule, where appropriate. In the interim, users that insist that the latest ASTM method is better/cheaper/more repeatable/fewer interferences, etc., EPA can consider adaptation of that ASTM standard thorough an Alternate Test Method request.

When a method is incorporated by reference, only that version is incorporated without an update to the regulation. The equivalency of that specific version of the method has been deemed equivalent to the corresponding method in the regulation, and use of an alternative to that specific version would need to follow the same process as any other alternative method. This is briefly outlined in 40 CFR Part 60.17(a)(1) relating to incorporations by method (IBF) – "To enforce any edition other than that specified in this section, the U.S. Environmental Protection Agency (EPA) must publish a document in the Federal Register and the material must be available to the public."

If you wish to use the most current ASTM method approved, EPA must publish notice of the change in the *Federal Register*. The amendment the *Code of Federal Regulations 40 CFR Part 60, Subpart JJJJ* is not required. For instance, a federal register (FR) notice of a final rule is required to include additional alternative methods such as ASTM D6348-12e1 (Standard Test Method for Determination of Gaseous Compounds by Extractive Direct Interface Fourier Transform Infrared (FTIR) Spectroscopy) in SP-005. To include the use of ASTM D6348-12e1 for that specific subpart also requires notice and comment rulemaking to update the incorporations by reference (IBR). See at 60.17(h)(195) and (196) which shows that the current IBR status for ASTM D6348-12e1 has not been incorporated by reference for Subpart JJJJ. Alternative Test Method request is the method for using an alternative to the methods specifically stipulated in the federal subpart or register. If granted by EPA, these additional alternative methods by reference will be automatically approved by DEP in SP-005 on the effective date of the final federal subpart or register.

11. Promulgated Test Methods Sampling Requirements and Recommendations

This section contains, although not all inclusive, a listing of promulgated test method, procedures, regulatory citations, and description of requirements and recommendations shown in below tables. Users must follow the requirements and should follow recommendations when conducting source testing at each engine and compressor station:

Table 6. EPA M1 and M1A (Sampling Location and Velocity Traverses) Recommendation and Requirements

Item #	Topic	Citation	Description
(i)	Measured Parameters	§ 1.1 of M1	"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." Also see, Table 2 to 40 CFR Part 60, Subpart JJJJ.
(ii)	Verification of Absence of Cyclonic Flow	DEP Clarification	Cyclonic flow test must be performed before testing even if it was conducted during a previous performance test.
(iii)		§ 1.2 of M1	When M2 or M2C is used, cyclonic flow test is not required at any sampling location that has at least eight stack (or duct) downstream diameters and two upstream stack (or duct) diameters from any flow disturbance such as a bend, expansion, or contraction in the stack, or from a visible flame. The flow at theses sampling locations should be stable and should be free of cyclonic or non-parallel flow.
		§ 1.2 of M1A	When M2 or M2C is used, sampling Location and Traverses with Small Stacks or Ducts. A cyclonic flow test is not required for small ducts, stacks, and flues that are less than 4 inches in diameter.
		DEP Clarification	When M19 is used, cyclonic flow test is not required at any sampling location to verify the presence or absence of cyclonic flow.
		§ 11.4.2 of M1	If 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 and record cyclonic flow check during each test program will result in rejection of the volumetric and emission rate test results. Also see, § 1.2 of M2 for measurements sites that to meet the criteria of M1, Section 11.1 and are unacceptable due to cyclonic flow.
		DEP Requirement	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 cyclonic flow tests and traverse and emission sampling tests.
(iv)	Alternative Methodology for Sampling Cyclonic Flow	EMC's Guideline Document 008 (GD-008)	One of the four possible alternatives from EMC's Guideline Document 008 (GD-008) for sampling in cyclonic flow must be implemented in sequential order, when conducting emission testing or flow determinations, if cyclonic or nonparallel flow patterns exist.
(v)	Recommended EPA M1 Observer Checklist	EMC's Guideline Document 054 (GD-054)	This observer checklist can be used to assist users of this document on selection of sampling ports and traverse points and performing cyclonic flow tests. Checklist for M1 is used to assist the on-site observer during a performance test. These checklists were developed with the expectation that the observer has a general working knowledge of the applicable test methods.

Table 7. EPA M2 or M2C (Volumetric Flowrate or VFR) Recommendation and Requirements

Item #	Topic	Citation	Description
(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. Measurements to determine the exhaust flowrate must be made at the same time as the measurement for NO_x, CO, formaldehyde, and VOC concentration". Also see, Table 2 to 40 CFR Part 60, Subpart JJJJ.
		DEP Requirement	During testing at each compressor station, M2 or M2C must be used in lieu of M19 when a permanent mounted or temporary installed fuel meter: (1) is not available for each source; or (2) does not meet the calibration requirements specified in Question 2 of FAQ of M19 and M2A.
(iii)	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 M2, 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.
(iv)	Recommended M2 Observer Checklist	EMC's Guideline Document 054 (GD-54)	This observer checklist can be used to assist users of this document on performing acceptable volumetric flowrate tests. Checklist for M2 is used to assist the on-site observer during a performance test. These checklists were developed with the expectation that the observer has a general working knowledge of the applicable test method(s).
(v)	Volumetric Flow Rate Requirement	25 PA Code and PA ST Test Manual (Rev. 3.3)	§ 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 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 A, Condition 21 of SP-005.

Table 8. EPA M3 (Stack Gas Molecular Weight) Recommendation and Requirements

Item #	Topic	Citation	Description
(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. Measurements to determine O_2 concentration must be made at the same time as the measurements for NO_x, CO, formaldehyde, and VOC concentration. Also see, Table 2 to 40 CFR Part 60, Subpart JJJJ.

(ii)	Recommended EPA M3 Observer Checklist	EMC's Guideline Document 054 (GD-54)	This observer checklist can be used to assist field testers and facility personnel on performing acceptable CO_2 and O_2 concentration tests. Checklist for M3 is used to assist the on-site observer during a performance test. These checklists were developed with the expectation that the observer has a general working knowledge of the applicable test method(s).

Table 9. EPA M3A (Stack Gas Molecular Weight) Recommendation and Requirements

Item #	Topic	Citation	Description
(i)	Applicability	§ 1.0 of M3A	"A procedure for measuring oxygen (O_2) and carbon dioxide (CO_2) stationary source emissions using a continuous instrumental analyzer Measurements to determine O_2 concentration must be made at the same time as the measurements for NO_x, CO, formaldehyde, and VOC concentration." Also see, Table 2 to 40 CFR Part 60, Subpart JJJJ.
(ii)	Stratification Requirements	§ 8.1 of M3A	See § 8.1.2 of M7E, Table 2 to 40 CFR Part 60, Subpart JJJJ, and below Table 9 for span definitions and requirements.
(iii)	EPA Traceability Protocol Gas Requirements	§ 2.12.1 of PA ST 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	O_2 and CO_2 span requirements are discussed in Section A, Condition 13 of SP-005 for each average run conc.
(v)	Method Performance	§ 13.0 of M3A	"The specifications for the applicable performance checks are the same as in Section 13.0 of M7E 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)	Recommended M3A Observer Checklist	EMC's Guideline Document 054 (GD-54)	This observer checklist can be used to assist users of this document on performing acceptable instrumental CO_2 and O_2 concentration tests. Checklist for M3A is used to assist the on-site observer during a performance test. These checklists were developed with the expectation that the observer has a general working knowledge of the applicable test methods.

Table 10. EPA M4 or 320 (Moisture) Recommendation and Requirements

Item #	Topic	Citation	Description
(i)	Applicability	§ 1.2 of M4	The method is applicable for the determination of the moisture content of stack gas. Measurements to determine moisture must be made at the same time as the measurement for NO_x, CO, formaldehyde, and VOC concentration. Also see, Table 2 to 40 CFR Part 60, Subpart JJJJ.
(ii)	Calibration and Standardization	§ 10.0 of M4	Post-test thermocouple calibration must meet all requirements specified in M4. Data from previous test projects will not be accepted and the associated emission data will be rejected.

(iii)	Recommended M4 Observer Checklist	EMC's Guideline Document 054 (GD-54)	This observer checklist can be used to assist users of this document on performing acceptable moisture tests. Checklist for M4 is used to assist the on-site observer during a performance 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 and Determination	§ 12.0 of M4	Average Moisture Content calculations must be performed per Section 12.0 of M4. These calculation formulas for moisture calculations are shown Section A, Condition 21 of SP-005.
		§ 16.3 of M4	"M320 is an acceptable alternative to M4 for determining moisture."

Table 11. EPA M7E (Nitrogen Oxides / NO_x) and 10 (Carbon Monoxide / CO) Recommendation and Requirements

Item #	Topic	Citation	Description
(i)	Applicability	§ 1.0 of M7E and M10	Method for measuring NO_x and CO stationary source emissions using a continuous instrumental analyzer. Quality assurance and quality control requirements are included to assure that you, the tester, collect data of known quality. Results of this test consist of the average of the three 1-hour or longer runs. See, Figure 7E-2 (Testing Flow Chart) of M7E and Table 2 to 40 CFR Part 60, Subpart JJJJ.
		DEP Requirement	A shepherd hook cannot be used to determine emission concentrations. To accurately determine emission concentrations, a sample or rake probe must be positioned inside the duct, stack, or flue.
(ii)	Calibration Span	§ 3.4 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."
		DEP Requirement	M7E and M10 average concentrations must be 20-100% of the span. A NO_x and CO outlet span of 10 ppm is required and must be used when the average concentration during any test run is <2. For more detail on span requirements, see Section A, Condition 13 of SP-005.
		DEP Rec.	To address high, one-minute concentration spikes or unknown emission concentration levels, introduce one or more extra calibration (zero-, low-, mid-, and/or high-level) or dilution gases during pretest calibrations according to the requirement of § 7.1 through 7.1.3 of M7E to select between more than span at the end of the run. This procedure is discussed below with examples in Section A, Condition 14 of SP-005
		DEP Requirement	For natural gas-fired sources, emission concentration results do not appreciative change from run-to-run or test project-to-test project. Historical and/or similar source stack test data can also be used to anticipate what the acceptable span will be for each run and corresponding source.
(iii)	Stratification Test	Table 2 to 40 CFR Part 60, Subpart JJJJ	"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 M1 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 M7E of 40 CFR Part 60, Appendix A."
		§ 8.1.2 of M7E	This section requires that this test is performed prior to sampling to determine: (1) if concentrations are uniform across axis of the sampling location; and (2) the appropriate number of sample traverse points.
			A stratification test is not required for small ducts, stacks, and flues that are less than 4 inches in diameter.
(iv)	Calibration Gas Verification	§ 8.2.1 of M7E	"Ensure that your calibration gas certifications have not expired". § 2.12.1 of DEP's ST Manual (Revision 3.3) states that, "Documentation from the gas supplier must be provided to verify that the certified concentration was valid at the time of testing. Tests conducted with any expired calibration gases must be voided. Alternatively, the expired gases may be reanalyzed, and the recertification value shall be used".
(v)	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-)."
		§ 13.3 of M7E	"For each run, the low-level and upscale drift must be less than or equal to 3.0 percent of the calibration span. The drift is also acceptable if the pre- and post-run bias (or the pre- and post-run system calibration error) responses do not differ by more than 0.5 ppmv at each gas concentration (i.e. | Cs post-run− Cs pre-run | ≤0.5 ppmv)."
(vi)	Calibration Error Test	§ 8.2.3 of M7E	"After you have assembled, prepared and calibrated your sampling system and analyzer, you must conduct a 3-point analyzer calibration error test (or a 3-point system calibration error test for dilution systems) before the first run and again after any failed system bias test (or 2-point system calibration error test for dilution systems) or failed drift test. Introduce the low-, mid-, and high-level calibration gases sequentially. For non-dilution-type measurement systems, introduce the gases in direct calibration mode. For dilution-type measurement systems, introduce the gases in system calibration mode."
(vii)	NO_2 to NO Conv. Eff. Test	§ 8.2.4 of M7E	M7E only. "Before or after each field test, you must conduct an NO_2 to NO conversion efficiency test if your system converts NO_2 to NO before analyzing for NO_x."
(viii)	System Bias	§ 3.16 of M7E	System Bias 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.
		§ 8.2.5 of M7E	Initial System Bias and System Calibration Error Checks. "Before sampling begins, determine whether the high-level or mid-level calibration gas best approximates the emissions and use it as the upscale gas." The initial system bias check (or pre and post 2-pt CE for dilution systems) within ±5.0% of calibration span or ≤0.5 ppmv absolute difference.
		§ 8.5 of M7E	Post-Run System Bias Check and Drift Assessment. "After each run, repeat the system bias check or 2-point system calibration error check (for dilution systems) to validate the run. Do not make adjustments to the measurement system (other than to maintain the target sampling rate or dilution ratio) between the end of the run and the completion of the post-run system bias or system calibration error check. Note that for all post-run system bias or 2-point system calibration error checks, you may inject the low-level gas first and the upscale gas last, or vice versa."

(ix)	Recommended M7E and M10 Observer Checklist	EMC's Guideline Document 054 (GD-54)	This observer checklist can be used to assist users of this document on performing acceptable NO_x and CO emissions tests. These checklists were developed with the expectation that the observer has a general working knowledge of the applicable test method(s).
(x)	NO_x and CO Emissions Calculation	§ 12.0 of M7E	Average NO_x and CO emissions calculations must be performed per Section 12.0 of M7E. These calculation formulas for moisture calculations are shown in Section A, Condition 21 of SP-005.

Table 12. EPA M18 (Methane / CH_4 and Ethane / C_2H_6) Requirements

Item #	Topic	Citation	Description
(i)	Applicability	DEP Clarification	M18 may be used direct interface to determine the methane and ethane concentration. If GC backflush or methane cutter technologies are used, blended gases are used to demonstrate proper separation of methane and/or ethane to determine NMHC or NMEHC as specified in 40 CFR 1065.365. All calibrations and quality control checks must be through the entire sampling system.
		§ 1.2.1 of M18	"This method is designed to measure gaseous organics emitted from an industrial source. While designed for ppm level sources, some detectors are quite capable of detecting compounds at ambient levels, e.g., ECD, ELCD, and helium ionization detectors. Some other types of detectors are evolving such that the sensitivity and applicability may well be in the ppb range in only a few years." Also see, Table 2 to 40 CFR Part 60, Subpart JJJJ.
(ii)	Recovery Study for Bag Sampling	§ 8.4.2.1 of M18	"Follow the procedures for the bag sampling and analysis in Section 8.2.1. After analyzing all three bag samples, choose one of the bag samples and tag this bag as the spiked bag. Spike the chosen bag sample with a known mixture (gaseous or liquid) of all the target pollutants. The theoretical concentration, in ppm, of each spiked compound in the bag shall be 40 to 60 percent of the average concentration measured in the three bag samples. If a target compound was not detected in the bag samples, the concentration of that compound to be spiked shall be 5 times the limit of detection for that compound. Store the spiked bag for the same period of time as the bag samples collected in the field. After the appropriate storage time has passed, analyze the spiked bag three times. Calculate the average fraction recovered (R) of each spiked target compound with the equation in section 12.7".
		§ 8.4.2.2 of M18	"For the bag sampling technique to be considered valid for a compound, $0.70 \leq R \leq 1.30$. If the R value does not meet this criterion for a target compound, the sampling technique is not acceptable for that compound, and therefore another sampling technique shall be evaluated for acceptance (by repeating the recovery study with another sampling technique). Report the R value in the test report and correct all field measurements with the calculated R value for that compound by using the equation in Section 12.8".

Table 13. FAQs of EPA M19 (Volumetric Flowrate or VFR) Requirements

Item #	Topic	Citation	Description
(i)	Applicability	Question 1, FAQs of M19	This method is used to calculate exhaust flowrates for NO_x, CO, formaldehyde, and VOC (or NMHC or NMEHC) and conduct performance test for natural gas fired engines subject to 40 CFR 60, Subpart JJJJ requirements. Also see, Table 2 to 40 CFR Part 60, Subpart JJJJ.
(ii)	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 M19, for emission flow rate calculations".
(ii)	F-Factor(s) Calculation Determination		"The output of the fuel analyses is then used with Equation 19-13 or 19-15, in M19, Section 12.3.2.1, to calculate a test specific F_d or F_c 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. M19, 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 M19, 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 M2A, 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 M3A or M3B, concurrent with the pollutant measurements and fuel meter readings".
(vi)	Temporary Installed Fuel Meter Requirement		"A post test 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 exhaust flow rates (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 exhaust flow rate (Q_s) calculations are shown in Section A, Condition 21 of SP-005.
(ix)	Prohibited Use of Brake Horsepower and Fuel Consumption to Determine Volumetric Flow	Question 4, FAQs of M19	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 M19. EPA has determined this procedure to be unacceptable and M2, 2C, or 19 must be used during each test run.
			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 A, Condition 21 of SP-005.

Table 14. EPA M25A (Total Hydrocarbon) Recommendation and Requirements

Item #	Topic	Citation	Description
(i)	Applicability	§ 1.2 of M25A	"This method is applicable for the determination of total gaseous organic concentration of vapors consisting primarily of alkanes, alkenes, and/or arenes (aromatic hydrocarbons). The concentration is expressed in terms of propane." Also see, Table 2 to 40 CFR Part 60, Subpart JJJJ.
		DEP Requirement	A shepherd hook cannot be used to determine emission concentrations. To accurately determine emission concentrations, a sample or rake probe must be positioned inside the duct, stack, or flue.
(ii)	Calibration Span	§ 3.6 of M25A	"Means the upper limit of a gas conc. measurement range that is specified for affected source categories in the appl. part of the regulations. The span value is established in the applicable regulation and is usually 1.5 to 2.5 times the appl. emission limit. If no span value is provided, use a span value equivalent to 1.5 to 2.5 times the expected conc. For convenience, the span value should correspond to 100 percent of the recorder scale."
		DEP Reqd.	THC span requirements are discussed in Section A, Condition 13 of SP-005 for each average run conc.
		DEP Rec.	To address high, one-minute concentration spikes or unknown emission concentration levels, introduce one or more extra calibration (zero-, low-, mid-, and/or high-level) or dilution gases during pretest calibrations according to the requirement of § 7.1 through 7.1.5 of M25A to select between more than span at the end of the run. This procedure is discussed below with examples in Section A, Condition 14 of SP-005.
		DEP Requirement	For natural gas-fired sources, emission concentration results do not appreciative change from run-to-run or test project-to-test project. Historical and similar source stack test data can also be used to anticipate the acceptable span will be for each run and corresponding source.
(iii)	Calibration Gas Verification	§ 7.1 of M25A	"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."
		§ 2.12.1 of PA ST Manual (Rev. 3.3)	"Documentation from the gas supplier must be provided to verify that the certified concentration was valid at the time of testing. 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)	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."
		§ 3.7 of M25A	"Zero drift 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."
		§ 8.6.2 of M25A	"Immediately following the completion of the test period and hourly during the test period, reintroduce the zero and mid-level calibration gases, one at a time, to the measurement system at the calibration valve assembly. (Make no adjustments to the measurement system until both the zero and calibration drift checks are made.) Record the analyzer response. If the drift values exceed the specified limits, invalidate the test results preceding the check and repeat the test following corrections to the measurement system. Alternatively, recalibrate the test measurement system as in Section 8.4 and report the results using both sets of calibration data (i.e., data determined prior to the test period and data determined following the test period). Note: Note on the recording chart periods of process interruption or cyclic operation."
	Calibration Drift	§ 9.0 of M25A	"Zero and calibration drift tests. Ensures that bias introduced by drift in the measurement system output during the run is no greater than 3 percent of span."

(v)	Calibration Error Test	§ 3.2 of M25A	"Means the difference between the gas concentration indicated by the measurement system and the know concentration of the calibration gas."
		§ 8.4 of M25A	"Immediately prior to the test series (within 2 hours of the start of the test), introduce zero gas and high-level calibration gas at the calibration valve assembly. Adjust the analyzer output to the appropriate levels, if necessary. Calculate the predicted response for the low-level and mid-level gases based on a linear response line between the zero and high-level response. Then introduce 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. These differences must be less than 5 percent of the respective calibration gas value. If not, the measurement system is not acceptable and must be replaced or repaired prior to testing. No adjustments to the measurement system shall be conducted after the calibration and before the drift check (Section 8.6.2). If adjustments are necessary before the completion of the test series, perform the drift checks prior to the required adjustments and repeat the calibration following the adjustments. If multiple electronic ranges are to be used, each additional range must be checked with a mid-level calibration gas to verify the multiplication factor."
		§ 13.1.3 of M25A	"Less than ±5 percent of the calibration gas value."
(vi)	Predicted Response Determination	Email from Ned Shappley on September 13, 2024.	"For M25A, the zero response and the "high gas" response, should be equal to the cylinder response. The method assumes measured zero and span 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. When you run the low and the mid gas, you are comparing the expected response of the analyzer based on calibration curve against the "cylinder values". Since modern instrument now have a zero and span function, in most instances we would expect the zero and "high gas" to be very close to the cylinder values."
(vii)	Sampling System Temp. Heating Requirements	§ 6.1 of M25A	Section 6.1 of M25A states that "[a]ll sampling components leading to the analyzer shall be heated ≥ 110°C (220°F) throughout the sampling period."
		DEP Reqd.	If the boiling points (b.p.) of all VOCs at each sampling location are not known, the sampling system components must be heated above the highest b.p. to at least 350°F (or 375±25°F) to prevent condensation in the probe, sampling line, and analyzer. The sampling system components minimally consist of the probe, sample line, and analyzer must be recorded at least every 15-minutes during each run.
(viii)	Dilution Sampling Procedures (If Applicable)	DEP Rec. and Requirements	High moisture content in the sample gas can cause problems using M25A that may be resolved by using a dilution probe. Therefore, DEP recommends and requires the following sampling procedures on sampling ducts, stacks, or flues with low, mid, or high moisture conditions: (1) <10% moisture (dilution not needed); (2) 10-20% moisture (dilution is recommended); and (3) >20% moisture (dilution is required). In cases where high moisture is present and dilution will lead to non-detect THC results, DEP will need to be contacted. A condenser may never be used to remove moisture M25A or M320.
(ix)	Emissions Calculation	§ 12.0 of M25A	These calculation formulas for THC or VOC calculations are shown in Section A, Condition 21 of SP-005.

Table 15. EPA M205 (Verification of Gas Dilution Systems For Field Instrument Calibrations) Requirements

Item #	Topic	Citation	Description
(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., M3A, M6C, M7E, M10, and M25A - require on-site, multi-point calibration using gases of known concentrations. Also see, M205 of 40 CFR Part 51, Appendix M.
(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 pre-calibrated 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). 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 16. EPA M320 or ASTM D6348-03 (Vapor Phase Organic and Inorganic Emissions by Extractive FTIR) Requirements

Item #	Topic	Citation	Description
(i)	Applicability	Table 2 to 40 CFR Part 60, Subpart JJJJ	"Measure VOC at the exhaust of the stationary internal combustion engine. Results of this test consist of the average of the three 1-hour or longer runs."
		§ 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."
		40 CFR Part 60.17 of Subpart A	"To enforce any edition other than that specified in this section, the U.S. Environmental Protection Agency (EPA) must publish a document in the Federal Register, and the material must be available to the public." For more clarification, see Condition 12 of SP-005.
		EPA Clarification	On April 30, 2025, Kevin McGinn, Dave Nash, and Steffan M. Johnson of EPA further clarified that specific test method references listed in Subpart JJJJ such ASTM Method D6348-03 must be used. EPA also stated that, "at the direction of our Office of General Counsel, does NOT, by policy, automatically grant the use of the latest ASTM standards for compliance measurements". Users that insist that the latest ASTM method is better/cheaper/more repeatable/fewer interferences, etc., can consider adaptation of that ASTM standard thorough an Alternate Test Method request to incorporate them by reference for Subpart JJJJ.
(ii)	Total VOC Compounds Verification	DEP Requirement	There is no systematic approach to verify when "all" of VOC are measured to generate the total. However, based on correspondence with EPA and experience, DEP is requiring and recommending the measurement of the below VOC compounds during each run and test project.
(iii)	Required Nine VOC Compounds		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). Also see below Table 41, Appendix A, Condition 20 for specific listing of required VOC and sampling and reporting requirements.
(iv)	Rec. (or Additional) Five VOC Compounds		The measurement of the below five (5) additional VOC compounds 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 compounds. VOC results must be reported in terms of propane and exclude formaldehyde (HCHO). Also see below Table 42, Appendix A, Condition 20 for specific listing of recommended VOC and sampling and reporting.
(v)	Surrogate	§ 3.29 of M320	"Is a compound that is used in a QA spike procedure (section 8.6.2 of this method) to represent other compounds. The chemical and physical properties of a surrogate shall be similar to the compounds it is chosen to represent. Under given sampling conditions, usually a single sampling factor is of primary concern for measuring the target analytes: for example, the surrogate spike results can be representative for analytes that are more reactive, more soluble, have a lower absorptivity, or have a lower vapor pressure than the surrogate itself."
		DEP Clarification	Surrogate standards should be added to all samples when specified in the appropriate determinative method. However, because no recommended surrogates for the referenced compounds are listed in M320, laboratories are free to select surrogates that fall within the definition provided in Section 3.29 of M320.

		DEP Requirement	The use acetaldehyde as a surrogate is prohibited (or unacceptable) when the target analyte of NO_x, CO, and VOC surrogates are not commercially available.
			Formaldehyde (HCHO) surrogates must be used as the spike recovery gas for formaldehyde determination when they are commercially available. Any proposal to use acetaldehyde as a surrogate to measure the target analytic is prohibited (or unacceptable).
(vi)	Spike Procedures and Recovery Requirement	§ 2.2.2 of M320	"Analyte spiking is used for quality assurance (QA). In this procedure (Section 8.6.2 of this method) an analyte is spiked into the gas stream at the back end of the sample probe. Analyte concentrations in the spiked samples are compared to analyte concentrations in unspiked samples. Since the concentration of the spike is known, this procedure can be used to determine if the sampling system is removing the spiked analyte(s) from the sample stream."
		§ 9.2 of M320	"QA spiking (Section 8.6.2 of this method) is a calibration procedure used before testing. QA spiking involves following the spike procedure of sections 9.2.1 through 9.2.3 of this method to obtain at least three spiked samples."
		Email from Dave Nash on Jan. 5, 2024	Dave Nash of EPA stated that tested compounds (i.e., NO_x, CO, formaldehyde, and VOC) 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.
		Email Rec. from Dave Nash on Jan. 8, 2025	EPA stated that the best practice is to spike VOC compounds you are looking for with the same compounds. EPA also stated that it would be reasonable to minimally spike with the following recommended surrogates from the above targeted VOC compound lists. For instance, you can use surrogates of: (1) acrolein, benzene, methanol, and butane for targeted VOCs in the required list; and (2) formic acid, and 1,3-butadiene, octane for targeted VOCs in the recommended list.
		DEP Requirement	DEP requires that each tested compound or DEP approved surrogate must be spiked 3 times (three independent samples) during each run. An independent sample is defined in Section 3.22 of M320.
			As recommended by EPA, for VOC analyte (or compound) spiking: (1) you should ideally use the required and recommended VOC analyte(s) of interest; or (2) you can minimally use the VOC surrogate compounds of acrolein, benzene, methanol, and butane for targeted compounds in the required VOC list and formic acid, and 1,3-butadiene, octane for targeted compounds in the recommended VOC list.
(vii)	FTIR Quality Assurance Requirements	DEP Requirement	Each test report must provide a separate FTIR Quality Assurance (QA) Requirement Summary Table provides clarification of some NO_x, CO, HCHO, and VOC spiking and quality assurance requirements for each source and compressor station tested. An example FTIR QA table is shown in Section A, Condition 19 of SP-005 that denotes the preferred reporting format.
(viii)	Response Factors & Corrected VOC Concentrations	DEP Clarification	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.
		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 M18 of 40 CFR Part 60, Appendix A, or M320 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 M25A. The results from M18 and M320 can be corrected for response factor differences using Equations

	Response Factors & Corrected VOC Concentrations		4 and 5 of this section. The corrected VOC concentration can then be placed on a propane basis using Equation 6 of this section."
(ix)	Detection Limit Clarifications, Requirements, and Rec.	DEP Clarification	Conceptually, the "limit of detection" is the smallest amount of a substance that an analytical method can reliably distinguish from zero. For existing emission limits, sample or analytical results less than the analytical method detection limit or reporting limit can often be used to demonstrate compliance with the emission limit by using the method detection limit in the calculations. If the source would still comply when using the method detection limit in the emission calculations, the emission test demonstrates compliance.
		§ 2.2 of PA ST Manual (Rev. 3.3)	"A reasonable attempt must be made to obtain results that are greater than the method detection limit. There are several ways to potentially increase the pollutant concentration above the detection limit, including (1) increasing the sample volume, (2) concentrating the sample, and (3) using high-sensitivity analytical techniques. If appropriate steps are not taken, the results that are below the detection limit could be considered unacceptable. If the result for a sample is less than the analytical detection limit, despite reasonable efforts to obtain detectable results, the detection limit shall be utilized in the source emission calculations."
		DEP Requirement and Rec.	Method detection limit (MDL) must be reported that are used rather than using zero values or some other arbitrary values to calculate results as defined in Section 2.2 of the Source Testing Manual (Revision 3.3). The use of the less than sign (<) is permitted to be used with the detection limit results since the actual results are somewhere between zero and the detection limit. All 1-minute average results "as recorded" by the data acquisition system (DAS) must be included in the test report (i.e., -20 ppm). DEP will review negative results to determine if improper sampling, calibrations, or technology caused this problem. If any of these causes are proven, DEP may invalidate the test results and recommend that the analyst reprocess the results.
(x)	Sample Calculations	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 A, Condition 21 of SP-005 of this Standard Protocol.
		EPA Clarification	DEP is awaiting clarification from EPA for how to determine (or calculate) total VOC emissions concentration. When received, DEP will provide this clarification on each field test project.
		Email from Dave Nash on May 1, 2024.	EPA stated that negative SF6 native concentrations cannot be subtracted from SF6 spikes.

Table 17. ALT-096 (Non-Methane Hydrocarbon or NMHC) Requirements

Item #	Topic	Citation	Description
(i)	Applicability	EPA's approval per 80 FR 11175; Feb. 15, 2013, to use ALT-096	This approved alternative test method is applicable for Spark Ignition (SI) Reciprocating Internal Combustion Engines (RICE) subject to 40 CFR Part 60, Subpart JJJJ. This method uses Thermo-Electron Model 55I (TECO-55I) to measure methane and low concentration VOC (or NMOC) measurements directly. TECO-55I uses gas chromatography (GC) to separate and measure methane from the NMOC in the emissions gas stream, and FID to measure separately from NMOC.
		Pg. 1 of ALT-096	"You must follow the relevant requirements in M25A when you use the TECO-55I for measurements under 40 CFR 60, Subpart JJJJ."
		DEP Clarification	Methane is separated and measured by the FID, followed a backflush of the chromatographic column to measure NMEHC from four channels (THC, CH_4, and NMEHC) of the analyzer.
		DEP Requirement	A shepherd hook cannot be used to determine emission concentrations. To accurately determine emission concentrations, a sample or rake probe must be positioned inside the duct, stack, or flue.
(ii)	Calibration Error and Drift	Pg. 1 of ALT-096	"You must also follow the appropriate procedures in Sections 8, 9, and 10 of M25A to ensure that linearity, calibration drift error, and drift are within the M25A limits."
(iii)	Calibration Procedures	DEP Requirement	You are required to measure and report methane and NMOC, you must calibrate the instrument with a mixture of methane and propane (or the required NMOC hydrocarbon in M25A or the applicable rule if it is different from propane). The methane in this calibration gas is necessary to generate quantitative concentrations for these components, as well as to confirm the separation of methane from other NMOC while not retaining additional NMOC, which would bias the NMOC results low. If you are required to report all two components independently, you must check linearity, calibration error, and calibration drift using methane and the required NMOC hydrocarbon.
(iv)	Cal. Span	DEP Requirement	THC span requirements are discussed in Section A, Condition 13 of SP-005 for each avg. run conc.
(v)	Minimum Number of Required Sample Points Per Run	Email from Ned Shappley on March 4, 2025.	A sample is normally collected every 2-3 minutes and sent to a column where the methane elutes off the column, then the gas is backflushed off the column to an FID. The process usually takes 2-3 minutes where the instrument (or backflush analyzer) will provide a result of the most recent sample collected and analyzed.
		DEP Requirement	The field tester must collect the measured data according to the procedures in ALT-096 and must ensure that a min. of one stack test data measurement is collected and recorded every four minutes.
(vi)	Sampling System Heating Requirements	Pg. 1 of ALT-096	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 M25A).
		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.
(vii)	Emissions Calculation	§ 12.0 of EPA M25A	These calculation formulas for average THC and NMEHC emissions calculations are shown in Section A, Condition 21 of SP-005.

Table 18. ALT-106 (Non-Methane/Ethane Hydrocarbon or NMEHC) Requirements

Item #	Topic	Citation	Description
(i)	Applicability	Section B, Condition C4(b)(iv)(C) of GP-5 / GP5A	This permit is applicable for Stationary Natural Gas-Fired Spark Ignition (SI) Internal Combustion Engines (ICE). The VOC (or NMNEHC) concentration, as propane, excluding formaldehyde of the exhaust gas using ALT-106 is measured directly.
		EPA's approval per 80 FR 9457, 9459; Feb. 23, 2015, to use ALT-106	This is approved alternative test method is applicable for Spark Ignition Internal Combustion Engines subject to 40 CFR Part 60, Subpart JJJJ. "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." This alternative test method uses a semi-continuous measurement by Backflush GC and can also determine NMOC directly.
		DEP Clarification	Methane and ethane are separated and measured by the flame ionization detector (FID), followed a backflush of the chromatographic column to measure NMEHC. The analyzer has four channels (THC, CH_4, C_2H_6, and NMEHC).
			Except as noted below, users must follow the relevant requirements in M25A when you use this alternative VOC test method under 40 CFR 60, Subpart JJJJ.
		DEP Requirement	A shepherd hook cannot be used to determine emission concentrations. To accurately determine emission concentrations, a sample or rake probe must be positioned inside the duct, stack, or flue.
(ii)	Sample Collection, QC, and Calibration	Pg. 2 of ALT-106	"You must also follow the appropriate procedures in Sections 8, 9, and 10 of M25A to ensure that linearity, calibration drift error, and drift are within the M25A limits."
(iii)	Calibration Procedures	Pg. 2 of ALT-106	"You must calibrate the instrument with a mixture of ethane, propane and the required NMEOC hydrocarbon in M25A 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 M25A."
			"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 M25A 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.

(iv)	Cal. Span	DEP Requirement	THC span requirements are discussed in Section A, Condition 13 of SP-005 for each avg. run conc.
(v)	Minimum Sample Points Required Per Run	Email from Ned Shappley on March 4, 2025.	A sample is normally collected every 2-3 minutes and sent to a column where the methane and/or ethane elutes off the column, then the gas is backflushed off the column to an FID. The process usually takes 2-3 minutes where the instrument (or backflush analyzer) will provide a result of the most recent sample collected and analyzed.
		Pg. 2 of ALT-106	"You must collect the measured data required in the bullets above for each test run at a minimum of one measurement every 15 minutes".
		DEP Requirement	The field tester must collect the measured data according to the procedures in ALT-096, except that a minimum of one stack test data measurement must be collected and recorded every four minutes.
(vi)	Methane and Ethane Separation Recording Requirement	Pg. 2 of ALT-106	"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."
(vii)	Sampling System Heating Requirements	Pg. 2 of ALT-106	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 M25A).
		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.
(viii)	Emissions Calculation	§ 12.0 of EPA M25A	These calculation formulas for average THC and NMEHC emissions calculations are shown in Section A, Condition 21 of SP-005.

12. Calibration Span Requirements

This section includes tables that summarizes DEP and EPA span requirements and acceptance criteria according to M7E, M10, M25A, ALT-096, and ALT-106. All span data must be documented and included in the test report. For instance:

(a) *NO_x and CO Span Requirements using M7E and M10* – For each test run:

(i) EPA recommends that, per §3.4 of M7E, the measured emission concentrations should be between 20 to 100 percent of the selected calibration span [i.e., Span = Expected Concentration / (20% to 100%)].,

(ii) EPA has granted delegated authority to DEP (or state agencies) to require that the NOx and Co span must be equivalent to 20 to 100 percent of the expected concentration.

(ii) DEP determines if an acceptable span was used by calculating the lowest and highest average emission run concentrations for the selected span [i.e., Range of Acceptable Avg. Run Emission Concentrations = Span * (20% to 100%) = Span * (0.2 to 1.0)].

(iii) DEP determines that a span of 10 ppm must be used when the avg. run emission conc. is below 2 ppm [i.e., Lowest Avg. Run Emission Conc. = 10 ppm * 20% (or 0.2) = 2 ppm].

Table 19. NO_x and CO Outlet Spans Summary

Test Run Number	1	2	3
	Uncorrected Avg. Conc., (ppmwv)		
Acceptable Conc. Ranges for NO_x or CO Span of 10 ppm[1]	0-10	0-10	0-10
Acceptable Conc. Ranges for NO_x or CO Span of 20 ppm[2]	4-20	4-20	4-20
Acceptable Conc. Ranges for NO_x or CO Span of 30 ppm[3]	6-30	6-30	6-30
Acceptable Conc. Ranges for NO_x or CO Span of 40 ppm[4]	8-40	8-40	8-40
Acceptable Conc. Ranges for NO_x or CO Span of 50 ppm[5]	10-50	10-50	10-50
Acceptable Conc. Ranges for NO_x or CO Span of 100 ppm[6]	20-100	20-100	20-100
Acceptable Conc. Ranges for NO_x or CO Span of 150 ppm[7]	30-150	30-150	30-150
Acceptable Conc. Ranges for NO_x or CO Span of 200 ppm[8]	40-200	40-200	40-200

1 Acceptable Conc. Ranges = Span of '10 ppm must be used when avg. run conc. is <2 ppm.
2 Acceptable Conc. Ranges = Span of 20 ppm x 0.2 (or 20%) and 1.0 (100%) = 4-20 ppmwv.
3 Acceptable Conc. Ranges = Span of 30 ppm x 0.2 (or 20%) and 1.0 (100%) = 6-30 ppmwv.
4 Acceptable Conc. Ranges = Span of 40 ppm x 0.2 (or 20%) and 1.0 (100%) = 8-30 ppmwv.
5 Acceptable Conc. Ranges = Span of 50 ppm x 0.2 (or 20%) and 1.0 (100%) = 10-50 ppmwv.
6 Acceptable Conc. Ranges = Span of 100 ppm x 0.2 (or 20%) and 1.0 (100%) = 20-100 ppmwv.
7 Acceptable Conc. Ranges = Span of 150 ppm x 0.2 (or 20%) and 1.0 (100%) = 30-150 ppmwv.
8 Acceptable Conc. Ranges = Span of 200 ppm x 0.2 (or 20%) and 1.0 (100%) = 40-200 ppmwv.

(b) *THC Span Requirements using M25A, ALT-096, and ALT-106* – For each test run:

(i) EPA recommends that, per §3.6 of M25A, the selected span value is equivalent to 1.5 to 2.5 times the applicable limit **or** expected concentration.

(iii) EPA has granted delegated authority to DEP (or state agencies) of whether to determine the THC span using the emission limit (or standard) or the expected concentration.

(iv) DEP has determined that utilizing the expected concentration rather than the applicable limit is the most accurate procedure to determine the span during each test run.

(v) DEP has increased the acceptable range of emission concentration for each selected span by expanding the recommended span equivalent concentration range in §3.6 of M25A.

(vi) Per §3.6 of M25A, the recommended span value equivalent is 1.5 to 2.5 times the expected concentration or 40% to 66.7% of the expected concentration. For instance: (1) Span = (1.5 to 2.5) * Expected Concentration; or (2) Span = Expected Concentration / (40% to 66.7%).

(vii) For purposes of SP-005, the required (or selected) span value equivalent is 1.25 (and not 1.5) to 2.5 times the expected concentration or 40% to 80% of the expected concentration. For instance: (1) Span = (1.25 to 2.5) * Expected Concentration; or (2) Span = Expected Concentration / (40% to 80%).

(viii) Dividing the span by a factor of 1.25 or multiplying the span by 80% increases the high expected average run concentration. This procedure is consistent with §7.1.5 of M25A that requires a high-level cal. gas of 80-90% of span must be introduced during pretest calibrations.

(ix) To determine if an acceptable span is used, you must calculate the low and high average emission run concentration for the selected span. For instance: (1) Range of Acceptable Emission Conc.'s = Span / (2.5 to 1.25)]; or (2) Range of Acceptable Emission Conc.'s = Span * (40% to 80%).

(x) DEP determines that a span of 10 ppm must be used when the avg. run emission conc. is below 5 ppm [i.e., Lowest Avg. Run Emission Conc. = 10 ppm / 2.5 = 4 ppm].

Table 20. THC Span Requirements

Test Run Number	1	2	3
	Uncorrected Avg. Conc., (ppmwv)		
Acceptable Conc. Ranges for THC Span of 10 ppm[1]	0-10	0-10	0-10
Acceptable Conc. Ranges for THC Span of 16.7 ppm[2]	6.7-13	6.7-13	6.7-13
Acceptable Conc. Ranges for THC Span of 20 ppm[3]	8-16	8-16	8-16
Acceptable Conc. Ranges for THC Span of 30 ppm[4]	12-24	12-24	12-24
Acceptable Conc. Ranges for THC Span of 40 ppm[5]	16-32	16-32	16-32
Acceptable Conc. Ranges for THC Span of 50 ppm[6]	20-40	20-40	20-40
Acceptable Conc. Ranges for THC Span of 100 ppm[7]	40-80	40-80	40-80

1 Acceptable Conc. Ranges = Span of 10 ppm must be used when avg. run conc**.** is <4 ppmwv.
2 Acceptable Conc. Ranges = Span of 16.7 ppm / 2.5 and 16.7 ppm / 1.25 = 6.7-13 ppmwv.
3 Acceptable Conc. Ranges = Span of 20 ppm / 2.5 and 20 ppm / 1.25 = 8-16 ppmwv.
4 Acceptable Conc. Ranges = Span of 30 ppm / 2.5 and 30 ppm / 1.25 = 12-24 ppmwv.
5 Acceptable Conc. Ranges = Span of 40 ppm / 2.5 and 40 ppm / 1.25 = 16-32 ppmwv.
6 Acceptable Conc. Ranges = Span of 50 ppm / 2.5 and 50 ppm / 1.25 = 20-50 ppmwv.
7 Acceptable Conc. Ranges = Span of 100 ppm / 2.5 and 100 ppm / 1.25 = 40-80 ppmwv.

13. Recommended Calibration Procedures to Increase Span Options

This section discusses recommended pretest calibration procedures that should be used when the average run emission concentration results are unknown. These procedures involve introducing one or more extra certified calibration (zero-, low-, mid-, and/or high-level), blended, or dilution gases during pretest calibrations that meets the calibration gas requirement specified in M7E, M10, M25A ALT-096, and/or ALT-106 to:

(a) Appreciably increase the range of acceptable average run concentrations (i.e., from 0-10 ppm to 0-200 ppm or greater); and

(b) Increase the number of span options at the end of each test run by one for each certified calibration, blended, or dilution gas that is used during pretest calibrations.

Below Tables 21, 21a, and 21b illustrate how these pretest calibration procedures can help ensure that an acceptable span is used/selected at the end of each NO_x and CO test run.

Table 21. Pre-Test Cal. Procedures to Choose Between Three NO_x and CO Spans @ End of Run[1,2]

Cal. Gas	Cal. Gas Requirements	Selected Span A (ppm) Cert. Cal. Gas Conc.	Higher Span B (ppm) Cert. Cal. Gas Conc.	Higher Span C (ppm) Cert. Cal. Gas Conc.
Zero (or Low)	<20% of Span	<20% x Span (A)	<20% x Span (A)	<20% x Span (A)
Mid	40-60% of Span	(40-60%) x Span (B)	Equal to Span (C)	Equal to Span (D)
High	Equal to Span	Equal to Span (C)	Additional Cert. Gas[3] Equal to Span (D)	Additional Cert. Gas[4] Equal to Span (E)

1 Recommended pre-test calibration procedure to introduce additional gas or gases to select between more than one THC span at the end of each test run.

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.

3,4 One additional high cal. gas recommended to be used during pretest analyzer calibration error (ACE) checks to, based on average run concentration (ppm), choose between three spans at end of test run.

Table 21a. Example Cal. Procedures to Choose Between Three NO_x and CO Spans @ End of Run[1]

Cal. Gas	Cal. Gas Reqd.	Selected Span = 10 ppm Cert. Cal. Gas Conc.	Add'l Span = 20 ppm Cert. Cal. Gas Conc.	Add'l Span = 50 ppm Cert. Cal. Gas Conc.
Zero (or Low)	<20% of Span	0.0 ppm (must be <2 ppm)	0.0 ppm (must be <4 ppm)	0.0 ppm (must be <10 ppm)
Mid	40-60% of Span	5 ppm (must be 4-6 ppm)	10 ppm (must be 8-12 ppm)	20 ppm (must be 20-30 ppm)
High	Equal to Span	10 ppm (must be 10 ppm)	20 ppm[1] (must be 20 ppm)	50 ppm[2] (must be 50 ppm)

1 An additional high cal. gas of 20 ppm is recommended to be used during pretest cal. error and bias checks.

2 An additional high cal. gas of 50 ppm is recommended to be used during pretest cal. error and bias checks.

Table 21b. Example Cal. Procedures to Choose Between Three NO_x and CO Spans @ End of Run[1]

Cal. Gas	Cal. Gas Reqd.	Sel. Span = 100 ppm Cert. Cal. Gas Conc.	Add'l Span = 150 ppm Cert. Cal. Gas Conc.	Add'l Span = 200 ppm Cert. Cal. Gas Conc.
Zero (or Low)	<20% of Span	0.0 ppm (must be <20 ppm)	0.0 ppm (must be <30 ppm)	0.0 ppm (must be <40 ppm)
Mid	40-60% of Span	60 ppm (must be 40-60 ppm)	60 ppm (must be 60-90 ppm)	100 ppm (must be 80-120 ppm)
High	Equal to Span	100 ppm (must be 100 ppm)	150 ppm[1] (must be 150 ppm)	200 ppm[2] (must be 200 ppm)

1 Introducing an additional high cal. gas of 150 ppm is recommended to be used during pretest cal. error and bias checks.

2 Introducing an additional high cal. gas of 200 ppm is recommended to be used during pretest cal. error and bias checks.

Below Tables 2, 22a, and 22b illustrate how these pretest calibration procedures can help ensure that an acceptable span is used/selected at the end of each THC test run.

Table 22. Pre-Test Calibration Procedure to Choose Between Three THC Spans @ End of Run[1,2]

Cal. Gas	Cal. Gas Requirements	Selected Span A (ppm) Cert. Cal. Gas Conc.	Higher Span B (ppm) Cert. Cal. Gas Conc.	Higher Span C (ppm) Cert. Cal. Gas Conc.
Zero	<0.1% of Span	<0.1% x Span (A)	<0.1% x Span (A)	<0.1% x Span (A)
Low	25-35% of Span	(25-35%) x Span (B)	(45-55%) x Span (C)	(80-90%) x Span (D)
Mid	45-55% of Span	(45-55%) x Span (C)	(80-90%) x Span (D)	(80-90%) x Higher Span (E)
High	80-90% of Span	(80-90%) x Span (D)	Add'l Certified Gas (80-90%) x Higher Span (E)[3]	Add'l Certified Gas (80-90%) x Higher Span (F)[4]

1 Recommended pre-test calibration procedure to introduce additional gas or gases to select between more than one THC span at the end of each test run.

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.

3,4 One 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 22a. Example Calibration Procedure to Choose Between Three THC Spans @ End of Run[1,2]

Cal. Gas	Cal. Gas Reqd.	Sel. Span = 10 ppm Cert. Cal. Gas Conc.	Add'l Span = 20 ppm Cert. Cal. Gas Conc.	Add'l Span = 30 ppm Cert. Cal. Gas Conc.
Zero	<0.1% of Span	0.0 ppm (must be <1 ppm)	0.0 ppm (must be <2 ppm)	0.0 ppm (must be <5 ppm)
Low	25-35% of Span	3 ppm (must be 2.5-3.5 ppm)	5 ppm (must be 5.0-7.0 ppm)	9 ppm (must be 7.5-11 ppm)
Mid	45-55% of Span	5 ppm (must be 4.5-5.5 ppm)	9 ppm (must be 9.0-11 ppm)	16 ppm (must be 14-17 ppm)
High	80-90% of Span	9 ppm (must be 8-9 ppm)	16 ppm[1] (must be 16-18 ppm)	25 ppm[2] (must be 24-27 ppm)

1 Introducing an additional high cal. gas of 16 ppm is recommended to be used during pretest cal. error and bias checks.

2 Introducing an additional high cal. gas of 25 ppm is recommended to be used during pretest cal. error and bias checks.

Table 22b. Example Calibration Procedure to Choose Between Three THC Spans @ End of Run[1,2]

Cal. Gas	Cal. Gas Reqd.	Sel. Span = 40 ppm Cert. Cal. Gas Conc.	Add'l Span = 50 ppm Cert. Cal. Gas Conc.	Add'l Span = 100 ppm Cert. Cal. Gas Conc.
Zero	<0.1% of Span	0.0 ppm (must be <4 ppm)	0.0 ppm (must be <5 ppm)	0.0 ppm (must be <10 ppm)
Low	25-35% of Span	14 ppm (must be 10-14 ppm)	14 ppm (must be 13-18 ppm)	34 ppm (must be 25-35 ppm)
Mid	45-55% of Span	18 ppm (must be 18-22 ppm)	25 ppm[1] (must be 23-28 ppm)	45 ppm (must be 45-55 ppm)
High	80-90% of Span	34 ppm (must be 32-36 ppm)	45 ppm[2] (must be 40-45 ppm)	85 ppm[3] (must be 80-90 ppm)

1,2 Introducing additional mid cal. gases of 25 ppm and high cal. gas of 45 ppm are recommended to be used during pretest cal. error and bias checks.

3 Introducing an additional high cal. gas of 85 ppm is recommended to be used during pretest cal. error and bias checks.

14. THC Sampling System Temperature Heating Requirements

This section includes tables that summarizes the sampling system temperature heating requirements and acceptance criteria. All sampling system temperature data, along with the sample run data, must be documented and included in the test report.

Table 23. THC Sampling System Temperature Heating Requirements for M25A 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 (or above 350°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.

15. Gas Dilution Requirements

This section includes tables that summarizes required procedures associated with M205 that allows dilution of known high-level calibration gases during testing. All dilution system data, along with the sample run data, must be documented and included in the test report.

Table 24. Analyzer Information Per M205

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 25. Dilution System Verification Per M205

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 26. Dilution System Results Per M205

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

Table 27. Mid-Level Supply Gas Calibration Direct to Analyzer Results Per M205

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%)

16. Bias and Drift Checks Requirements

This section includes tables that summarizes bias and drift checks requirements for SP-005. Theses checks consist of applicable pretest calibration error and pre-and-post test system bias, and drift for M3A, M7E, M10, M25A, ALT-096, and ALT-106 for each test run. All bias and drift check data must be included in the final test report.

Table 28. Oxygen (O_2), Carbon Dioxide (CO_2), Nitrogen Oxides (NO_x), and Carbon Monoxide (CO) Calibration Error, System Bias, and Drift Per M3A, M7E, and M10

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

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 29. THC or VOC (NMHC or NMEHC) Calibration Error Per M25A, ALT-096, and ALT-106[1]

Run # (Must be performed for THC, NMHC, or NMEHC)	Calibration Gas Level	Manufacturer Certified Cylinder Concentration (C_v, ppmdv)	Analyzer Response or Meter Output (ppmdv)[2]	Predicted Response (C_p, ppmdv)[3]	Analyzer Response or Meter Output (C, ppmdv)[4]	Analyzer Calibration Error (ACE, % 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						
Allowable Error	----	----	----	----	----	≤5%	----

1 Conduct before (within 2 hours) the first test run.

2 Introduce zero gas and high-level calibration gas at the calibration valve assembly. Adjust the analyzer output to the appropriate levels.

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.

4 Introduce the low-level and mid-level calibration gases successively to the measurement system. Calculate the differences between the measurement system responses and the predicted responses.

5 Do not make any adjustments to the measurement system until a drift check is made. If adjustments are necessary before the completion of the test series, perform drift check first, then make required adjustments and repeat the calibration.

Table 30. THC or VOC (NMOC or NMEHC) Response Time Test Per M25A, ALT-096, & 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 31. THC or VOC (NMOC or NMEHC) Drift Per M25A, ALT-096, or ALT-106

Run # / Span (Must be performed for THC, NMHC, or MNEHC)	Calibration Gas Level	Manufacturer Certified Cylinder Value (C_v, ppmvd)	Analyzer System Response (C, ppmvd)[1,2]		Difference, (%)[3]	Drift (D, % 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						
Allowable Error	----	----	----	----	----	≤3%	----

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 (mid) drift must be less than ± 3 percent of the span value.

17. Spiking Requirements

This section discusses and includes tables that summarizes spiking requirements for SP-005. These spiking requirements are applicable for M18 and M320 for each test run. All spiking data must be included in the final test report.

(a) *Spiking Procedure (Formaldehyde and VOC Compounds)*.
The below spike results must be recorded in the test report:

(i) Spike gas introduced directly to the FTIR, and should be taken until a stable reading is achieved. The direct spike gas concentration is to be recorded (see Table 33). Alternatively, the certified gas concentrations listed in Table 32 maybe be used.

(i) Introduce stack gas to the FTIR through the sampling system and take the reading when a stable reading is achieved. The native concentration of the surrogate spiking analyte is to be recorded (see Table 34).

(ii) Introduce a spike gas to the sampling system at a constant flow rate ≤ 10% of the total sample flow rate and calculate the dilution ratio as well as the system response time (Table 35).

(iii) Matrix spike recovery spectra is to be recorded and be within the 70% to 130% of the calculated value of the spike concentration that the method requires. During pre-test calibrations, the QA spike must be conducted prior to the beginning of the test run according § 8.6.2 of M320. CTS (Certified Transfer Standard) procedures must be performed according § 8.6.1, 8.10, and 8.11.3. The corresponding values is to be recorded (see Table 36).

(iv) Matrix spiking must be performed on the sampling system prior to the sampling runs. EPA M320 specifies the performance of "surrogate" spiking at each sampling location. All M320 spiking at the sampling locations will be performed using a certified cylinder of formaldehyde with a balance of nitrogen.

Table 32. Spiking Cylinder Information for Source #

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

Table 33. Direct Spike Values

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

Table 34. Native Values

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

Table 35. Spike Values

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

Table 36. Summary of Spikes

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

18. FTIR Quality Assurance Requirements

This section includes a FTIR Quality Assurance (QA) Requirement Summary Table for M320 and ASTM D6348-03 that must be included in each test report that provides clarification of NO_x, CO, HCHO, and VOC

spiking and quality assurance requirements for each source and compressor station tested. The below example table denotes the preferred reporting format.

Table 37. Summary of FTIR Information

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 engine type and target analyte			AI within 20%	
(2 points for each target analyte)				
FTIR data collected an analysis performed by -			name:	
FTIR data validated by			name:	

19. Reporting Requirements

This section includes the reporting requirements for SP-005:

(a) *Facility and Testing Firm Contact Information*

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

Table 38. Facility and Testing Firm Contact Information Summary

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

(b) *Source Information for Each Compressor Station*

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.

Table 39. Facility and Source Information Summary

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) *Test Method Option(s) for Each Pollutant*

This section of the Standard Protocol specifies the test method options for each pollutant outlined in SP-005. The test method for each pollutant must be clarified in the test notification letter to use SP-005 and included in the final test report.

Table 40. Pollutant and Test Method Options for Each Pollutant

Pollutant(s)	Required Test Method Options
Sample / Velocity Traverses	M1 or 1A
Volumetric Flow Rate (VFR)	M2 or 2C
Oxygen and Carbon Dioxide Concentration	M3 or 3A
Volumetric Flow Rate (VFR)	M19
Volumetric Flow Rate (VFR)	Engine Horsepower / BSFC[1]
Moisture	M4 or M320
Gas Dilution Calibrations	M205
Nitrogen Oxides (NO_x)	M7E, ASTM D6348-03, or M320
Carbon Monoxide (CO)	M10, ASTM D6348-03, or M320
Formaldehyde (HCHO)	M320[2]
Volatile Organic Compound (VOC/NMHC/NMEHC)	M18, 25A w18/320, ASTM D6348-03, M320, ALT-096, or ALT-106

[1] Any proposal to determine VFR using Modified EPA M19 (Engine Horsepower / BSFC) is denied (see discussion in Table 7 of Section A in SP-005).

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

(d) *Required and Recommended VOC Compounds Reporting*

When FTIR M320 and ASTM D6348-03 is used, the concentration of each individual organic component (Cj) in the gas stream must be recorded during each run and included in the test report. If the results of the individual emission compounds on the required target list does not total at least 95% of the total VOCs emissions from the referenced engine sources, the results of additional compounds detected (or identified) by the FTIR must be added to achieve this requirement. The below required and recommended (if reported) emissions summary tables list stack test data parameters that must be included in each test report.

(i) The below nine (9) required speciated FTIR VOC compounds from each natural gas-fired stationary internal combustion engine must be sampled during the reporting period and results included in the final test report. Also, see below VOC emission summary in Section A, Condition 19 of SP-005.

Table 41. Required Nine VOC Compounds Information Summary

Nine Required VOC Compounds and Chemical Formulas	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

(ii) If performed, the below five (5) recommended speciated FTIR VOC compounds from each natural gas-fired stationary internal combustion engine must be sampled during the reporting period and results included in the final test report.

Table 42. Five Recommended VOC Compounds Information Summary

Five Recommended VOC Compounds and Chemical Formulas	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

(e) *General Reporting Requirements*

(i) 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 and (2) this Standard Protocol.

(ii) For test report submittals, refer to the current information in the Source Testing FAQs.

(iii) The test report must contain all data collected from each test project relating to the performance testing at each compressor station, such as pre-compliance, preliminary, and informational testing in preparation of the performance test.

(iv) 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).

(v) 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.

(vi) Confidential information submittals must follow the procedures in 2.1 of DEP's Source Test Manual (Revision 3.3).

(vii) 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).

(viii) 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.

(ix) The submittal of false information will cause associated emission results to be rejected and will likely lead to enforcement action by DEP's Regional Office.

(f) *Summary of Emissions Test Results Data*

The information in the below emissions summary tables for M1, M2, M2C, M3, M3A, or M3B, M4, M18, M19, M25A, M205, M320, ASTM D6348-03, ALT-096, and ALT-096, ALT-106 must be included in the final test report.

Table 43. NO_x and CO Test Results Summary (TRS) Per M7E and M10
Source Name / ID No. [1] / Stack/ ID Name / No.[1]

Test Date				**Average**
Test Run Number	1	2	3	N/A
Sampling/Stack Data Summary				
Oxygen, (%)				
Volumetric Flowrate, (dscfm by M19)[2]				
Volumetric Flowrate, (dscfm by M2/2C)[2]				
NO_x (as NO_2) Emission Results Summary				
Span Used During Testing, (ppm)				
Is Run Average concentration <2 ppm?				
Is Run Average Conc. 20-100% of the Span?				
NO_x Emission Concentration, (ppmdv)				
NO_x Emission Concentration, (ppmdv @ 15% O_2)				
GP5 / GP-5A NO_x Emission Conc. Limit, (ppmdv @ 15% O_2)	N/A	N/A	N/A	
NO_x Emission Rate, (lb/hr)				
NO_x Emission Factor, (g/BHP-hr)				
GP5 / GP-5A NO_x Emission Rate Limit, (g/BHP-hr)	N/A	N/A	N/A	
Subpart JJJJ / ZZZZ NO_x Emission Rate Limit, (g/BHP-hr)	N/A	N/A	N/A	
CO Emission Results Summary				
Span Used During Testing, (ppm)				
Is Run Average concentration <2 ppm?				
Is Run Average Conc. 20-100% of the Span?				
CO Emission Concentration, (ppmdv)				
CO Emission Concentration, (ppmdv @ 15% O_2)				
GP5 / GP-5A CO Emission Concentration Limit, (ppmdv @ 15% O_2)	N/A	N/A	N/A	
CO Emission Rate, (lb/hr)				
CO Emission Factor, (g/BHP-hr)				
GP5 / GP-5A CO Emission Rate Limit, (g/BHP-hr)	N/A	N/A	N/A	
Subpart JJJJ / ZZZZ CO Emission Rate Limit, (g/BHP-hr)	N/A	N/A	N/A	

1 Per public eFACTS.
2 Volumetric flowrates, (dscfm) can be determined by M2, M2C, or M19.

Table 44. THC or VOC (NMOC or NMEHC) Test Results Summary (TRS) Per M25A w 18, 320 Source Name / ID No. [1] / Stack/ ID Name / No.[1]

Test Date				**Average**
Test Run Number	1	2	3	N/A
Sampling/Stack Data Summary				
Oxygen, (%)				
Volumetric Flowrate, (dscfm by M19)[2]				
Volumetric Flowrate, (dscfm by M2/2C)[2]				
THC Emissions (as Propane/C_3H_8) Emission Results Per M25A[1]				
Span Used During Testing, (ppm)				
Is Run Average concentration <4 ppm?				
Is Run Average Conc. 1.25 to 2.5 of the Span?				
Uncorrected THC Emission Concentration, (ppmwv)				
THC Emission Concentration, (ppmvd)				
THC Emission Concentration, (ppmdv @ 15% O_2)				
Subpart JJJJ / ZZZZ VOC Emission Conc. Limit, (ppmdv @ 15% O_2)	N/A	N/A	N/A	
THC Emission Rate, (lb/hr)				
THC Emission Rate, (g/BHP-hr)				
GP5 / GP-5A VOC Emiss. Rate Limit, (g/BHP-hr)	N/A	N/A	N/A	
Subpart JJJJ / ZZZZ VOC Emission Rate Limit, (g/BHP-hr)	N/A	N/A	N/A	
VOC (NMHC or NMEHC) as Propane/C_3H_8 Emission Results				
Span Used During Testing, (ppm)				
Is Run Average concentration <4 ppm?				
Is Run Average Conc. 1.25 to 2.5 of the Span?				
Uncorrected THC Emission Concentration, (ppmwv)				
THC Emission Concentration, (ppmvd)				
Methane Emission Conc., (ppmvd by M18 or M320)				
Ethane Emission Conc., (ppmvd by M18 or M320)				
NMHC or NMEHC Emission Conc., (ppmvd)				
NMHC or NMEHC Emission Concentration, (ppmdv @ 15% O_2)				
Subpart JJJJ / ZZZZ VOC Emission Conc. Limit, (ppmdv @ 15% O_2)	N/A	N/A	N/A	
NMHC or NMEHC Emission Rate, (lb/hr)				
NMHC or NMEHC Emission Rate, (g/BHP-hr)				
GP5 / GP-5A VOC Emiss. Rate Limit, (g/BHP-hr)	N/A	N/A	N/A	
Subpart JJJJ / ZZZZ VOC Emission Rate Limit, (g/BHP-hr)	N/A	N/A	N/A	

1 Per public eFACTS.

2 Volumetric flowrate, (dscfm) can be determined by M2, M2C, or M19.

Table 45. VOC (NMOC or NMEHC) Test Results Summary (TRS) Per ALT-096 or ALT-106
Source Name / ID No. [1] / Stack/ ID Name / No.[1]

Test Date				**Average**
Test Run Number	1	2	3	N/A
Sampling/Stack Data Summary				
Oxygen, (%)				
Volumetric Flowrate, (dscfm by M19)[2]				
Volumetric Flowrate, (dscfm by M2/2C)[2]				
VOC (NMHC or NMEHC) as Propane/C_3H_8 Emission Results				
Span Used During Testing, (ppm)				
Is Run Average concentration <4 ppm?				
Is Run Average Conc. 1.25 to 2.5 of the Span?				
NMHC or NMEHC Emission Conc., (ppmvd)				
NMHC or NMEHC Emission Concentration, (ppmdv @ 15% O_2)				
Subpart JJJJ / ZZZZ VOC Emission Conc. Limit, (ppmdv @ 15% O_2)	N/A	N/A	N/A	
NMHC or NMEHC Emission Rate, (lb/hr)				
NMHC or NMEHC Emission Rate, (g/BHP-hr)				
GP5 / GP-5A VOC Emiss. Rate Limit, (g/BHP-hr)	N/A	N/A	N/A	
Subpart JJJJ / ZZZZ VOC Emiss. Rate Limit, (g/BHP-hr)	N/A	N/A	N/A	

[1] Per public eFACTS.

[2] Volumetric flowrate, (dscfm) can be determined by M2, M2C, or M19.

Table 46. VOC Test Results Summary (TRS) Per M320 or ASTM D6348-03
Source Name / ID No. [1] / Stack/ ID Name / No.[1]

Test Date				**Average**
Test Run Number	1	2	3	
Sampling/Stack Data Summary				
Oxygen, (%)				
Volumetric Flowrate, (dscfm by M19)[2]				
Volumetric Flowrate, (dscfm by M2/2C)[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.
[2] Volumetric flowrate, (dscfm) can be determined by M2, M2C, or M19.

Table 46a. VOC Test Results Summary (TRS) Per M320 or ASTM D6348-03
Source Name / ID No.[1] / Stack/ ID Name / No.[1]

Test Date				Average
Test Run Number	1	2	3	
Sampling/Stack Data Summary				
Oxygen, (%)				
Volumetric Flowrate, (dscfm by M19)[2]				
Volumetric Flowrate, (dscfm by M2/2C)[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)				
Emission Conc., (ppmvd)				
Total VOC (as C_3H_8) Emission Results				
Emission Concentration, (ppmdv)				
Emission Conc., (ppmdv @ 15% O_2)				
Subpart JJJJ / ZZZZ VOC Emission Conc. Limit**,** (ppmdv @ 15% O_2)	N/A	N/A	N/A	
Emission Rate, (lb/hr)				
Emission Rate, (g/BHP-hr)				
GP5 / GP-5A VOC Emiss. Rate Limit, (g/BHP-hr)	N/A	N/A	N/A	
Subpart JJJJ / ZZZZ VOC Emiss. Rate Limit, (g/BHP-hr)	N/A	N/A	N/A	

1 Per public eFACTS.
2 Volumetric flowrate, (dscfm) can be determined by M2, M2C, or M19.

Table 47. Formaldehyde Test Results Summary (TRS) Per M320 or ASTM D6348-03
Source Name / ID No. [1] / Stack/ ID Name / No.[1]

Test Date				**Average**
Test Run Number	1	2	3	
Sampling/Stack Data Summary				
Oxygen, (%)				
Volumetric Flowrate, (dscfm by M19)[2]				
Volumetric Flowrate, (dscfm by M2/2C)[2]				
Formaldehyde Emission Results				
Emission Conc., (ppmvd)				
Emission Conc., (ppmdv @ 15% O_2)				
GP5 / GP-5A Emission Conc. Limit, (ppmdv @ 15% O_2)	N/A	N/A	N/A	
Emission Rate, (lb/hr)				
Emission Rate, (g/BHP-hr)				
Emission Rate Limit, (g/BHP-hr)	N/A	N/A	N/A	
Percent Reduction, (%)				
GP5 / GP-5A Percent Reduction, (%)	N/A	N/A	N/A	

1 Per public eFACTS.
2 Volumetric flowrate, (dscfm) can be determined by M2, M2C, or M19.

Table 48. NO_x and CO Test Results Summary (TRS) Per M320 / ASTM D6348-03
Source Name / ID No. [1] / Stack/ ID Name / No.[1]

Test Date				**Average**
Test Run Number	1	2	3	
Sampling/Stack Data Summary				
Oxygen, (%)				
Volumetric Flowrate, (dscfm by M19)[2]				
Volumetric Flowrate, (dscfm by M2/2C)[2]				
NO_x (as NO_2) Emission Results				
Emission Conc., (ppmvd)				
Emission Concentration, (ppmdv @ 15% O_2)				
GP5 / GP-5A Emission Conc. Limit, (ppmdv @ 15% O_2)	N/A	N/A	N/A	
Emission Rate, (lb/hr)				
Emission Rate, (g/BHP-hr)				
GP5 / GP-5A Emission Rate Limit, (g/BHP-hr)				
Subpart JJJJ / ZZZZ Emission Rate Limit, (g/BHP-hr)				
CO Emission Results				
Emission Conc., (ppmvd)				
Emission Concentration, (ppmdv @ 15% O_2)				
GP5 / GP-5A Emission Conc. Limit, (ppmdv @ 15% O_2)	N/A	N/A	N/A	
Emission Rate, (lb/hr)				
Emission Rate, (g/BHP-hr)				
GP5 / GP-5A Emission Rate Limit, (g/BHP-hr)				
Subpart JJJJ / ZZZZ Emission Rate Limit, (g/BHP-hr)				

1 Per DEP's website.
2 Volumetric flowrate, (dscfm) can be determined by M2, M2C, or M19.

20. Sample Calculations

This section includes example calibration and emissions calculations for SP-005:

(a) Calculate the Certified Calibration Gas Per M3A as follows:

Table 49. Certified Calibration Gas (ppm) Calculations

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 ALT-106 as follows:

Table 50. Certified, Blended, and Diluted Calibration Gas (ppm) Calculations

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 M3A, M7E and M10, ACE (%) as follows:

Table 51. Analyzer Calibration Error (%) Calculation for M3A, M7E, and M10

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

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

(d) Calculate the Slope, (m) for Predicted Response as follows:

Table 52. Slope Calc. to Determine Predicted Responses for M25A, ALT-096, and ALT-106

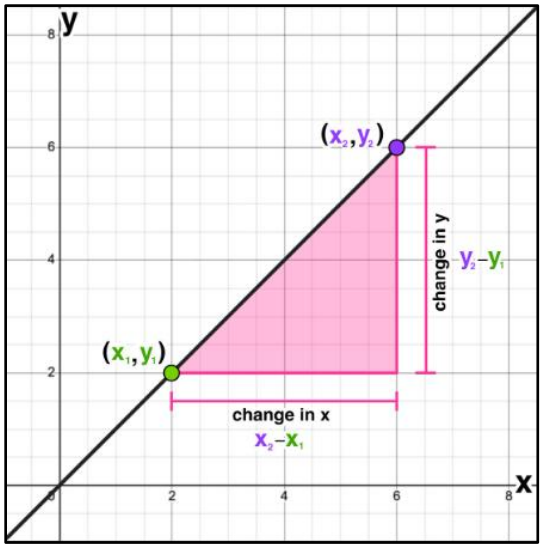
Slope (m) = Rise / Run
or
m = [Δy / Δx] = [(y2-y1) / (x2-x1)]

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)
y1 (or Rise) = The zero-level analyzer system responses, (ppm)
y2 (or Rise) = The 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)
x1 (or Run) = The zero-level manufacturer certified cylinder concentrations, (ppm)
x2 (or Run) = The high-level manufacturer certified cylinder concentrations, (ppm)

Example Diagram of Slope of a Line with Rise and Run
Calibration data, obtained by conducting measurements on a series of standards containing known concentrations of the compound, are plotted which results in a calibration curve.



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

Table 53. Predicted Response Calculations for M25A, ALT-096, and ALT-106

Predicted Response for Low-Level Cert. Gas Conc. Per M25A and ALT-106 $C_{p\ (low)} = mx_{low} + b = (slope)x_{low} + (Y\text{-intercept})$ Where: $C_{p\ (low)}$ = Predicted Response (C_p, ppm for Low-Level Cert. Gas Conc.) m = slope (dimensionless quantity) x_{low} = The low-level manufacturer certified cylinder concentrations, (ppm) b = Y-intercept = The zero-level analyzer system responses, (ppm)
Predicted Response for Mid-Level Cert. Gas Conc. Per M25A and ALT-106 $C_{p\ (mid)} = m\ x_{mid} + b = (slope)\ x_{mid} + (Y\text{-intercept})$ Where: $C_{p\ (mid)}$ = Predicted Response (C_p, ppm for Mid-Level Cert. Gas Conc.) m = slope (dimensionless quantity) x_{mid} = The mid-level manufacturer certified cylinder concentrations, (ppm) b = Y-intercept = The zero-level analyzer system responses, (ppm)

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

Table 54. Analyzer Calibration Error (%) Calculation for M25A, ALT-096, and 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 M3A, SB (%) as follows:

Table 55. System Bias (%) Calculation for M3A and M7E

$SB = [(C_s – C_{Dir}) / CS] * 100$ 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 M3A, D (%) as follows:

Table 56. Drift (%) Calculation for M3A, M7E, and M10

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

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

Table 57. Drift (%) Calculation for M25A, ALT-096, and ALT-106

$D = \lvert SB_{final} - SB_{intial} \rvert / CS$ 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:

Table 58. Response Factor Calculation for M320 and ASTM D6348-03

Formula used to calculate Optional Response Factor of compound i when measured with M25A. $RF^i = C_{Mi} / C_{Ai}$ (Eq. 4) Where: RF^i = Response factor of compound i when measured with M25A. 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:

Table 59. Concentration of Compound (ppmv as C) Calculation for M320 and ASTM D6348-03

Formula to calculate concentration of compound i corrected to the value that would have been measured by M25A, 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 M25A, ppmv as carbon. C^{imeas} = Concentration of compound i measured by M320, 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:

Table 60. RF Concentration of Compound (mg) Calculation concentration of compound

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 M4, $V_{m(std)}$ (dscf) as follows:

Table 61. Standard Volume Meter (dscf) Calculation for M2 and M2C

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

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

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 M4, B_{ws} (%)) as follows:

Table 62. Moisture of Stack Gas (%) Calculation for M2 and M2C

1. H_2O collected in impingers in standard cubic feet

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

2. H_2O collected in silica gel in standard cubic feet

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

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 M3, M_d (lb-lb-mole) as follows:

Table 63. Molecular Weight (lb/lb-mole) of Stack Gas Calculation for M3

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 M2 or M2C, V_s (ft/sec) as follows:

Table 64. Average Stack Velocity (dscf/sec) Calculation for M2 and M2C

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

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

Where: V_s = Stack Flow Rate, [Ft/Sec]
K_p = Velocity Equation constant = 85.49 (ft/sec) [(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 (in $H_2O)^{0.5}$

(q) Calculate the Stack Gas Flow Rate Qs (dscf/hr) using M2 or M2C, Q_s (dscf/hr) as follows:

Table 65. Average Stack Gas Flow Rate (dscf/hr) Calculation for M2 and M2C

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

Qs = (3600 sec/hr) * (ft/sec) * (ft^2) * (1-___) * (17.647) * (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

Table 66. Unacceptable Average Stack Gas Flow Rate (dscf/hr) Calculation for BSFC

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

Where: Q_s = Stack Flow Rate, [dscf/hr]
F_d = Fuel F factor, dry basis, from M19 [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:

Table 67. Average Stack Gas Flow Rate (dscf/min) Calculation using Fd-Factors

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

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

Where: Q_s = Stack Flow Rate, [dscf/hr]
F_d = Fuel-specific oxygen-based F factor, dry basis, from M19, [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:

Table 68. Average Stack Gas Flow Rate (dscf/hr) Calculation using Fc-Factors

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

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

Where: Q_s = Stack Flow Rate, [dscf/hr]
Fc = Fuel-specific carbon dioxide-based F factor, dry basis, from M19, [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:

Table 69. Emission Conc. (ppmvd) Calc. for M7E, M10, M25A, ALT-096, and ALT-106

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:

Table 70. Emission Conc. @ 15% O_2 Calc. for M7E, M10, M25A, ALT-096, and ALT-106

C (ppm @ 15% O_2) = [(C) (ppmvd) * [(20.9 – O_{2d}, corrected) / (20.9 - %O_{2d}, 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:

Table 71. Emission Rate (lb/hr) Calculations for M7E, M10, M25A, and ALT-106

E (lb/hr) = [(C) (ppmvd) / 1,000,000)] * Q_s (std ft^3/hr) * [MW / 385] (lb/ft^3) 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:

Table 72. Emission Rate (g/HP-hr) Calc. for M7E, M10, M25A, ALT-096, and ALT-106

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:

Table 73. Heat Input Calculation

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)

21. Appendix A (Example Test Notification Letter to Use SP-005)

To facilitate the submittal of test notification letters to use SP-005 from the owner or operator for each test project, DEP has included the below example test notification letter in below Appendix A. This test notification letter details required information that must be minimally included in each notification letter that is emailed to DEP at least 30 days prior to testing. For more detail, see Section A, Condition 7 of SP-005.

Appendix A: Example Test Notification Letter to use SP-005

Submittal Date

[DEP Regional Office Manger Full Name]
Air Quality Environmental Program Manager
PADEP - Bureau of Air Quality Control
[Applicable Regional Office]
[Regional Office Address]

Dear Mr. or Ms. [DEP Regional Office Manger Last Name]:

[Name of Facility] is notifying the Department of Environmental Protection's (DEP's) Natural Gas Industry Testing Section (NGITS) that pre-approved, standard protocol 005 (SP-005) will be used without deviation for referenced emission testing at engine source(s) and compressor station(s) listed in below table(s). The proposed date(s) for each source is listed in below tables. Please note that due to the multiple test method options for each pollutant, the specific test method to be used during each run must be identified in below Table 3. As required by SP-005, this testing notification letter to use SP-005 has been submitted at least 30-day prior to testing via email to Bureau of Air Quality's (BAQ's) PSIMS' resource email account (ra-epstacktesting@pa.gov) and to the applicable DEP's regional office resource account.

Table 1: Source, Control Device, and Stack Information

Compressor Station Name / PFID No. / Tentative Test Date(s)								
Permit No. and Federal Subpart(s)	Location (Township & County)	Source Name, Source ID No., and Proposed Test Date(s)	Control Device and Source ID No.	Stack Name and Source ID No.	Install Date	Mfg. Date	Rated Engine Speed	Baseline Emissions or Compliance?

Table 2: Source, Control Device, and Stack Information

Compressor Station Name / PFID No. / Tentative Test Date(s)								
Permit No. and Federal Subpart(s)	Location (Township & County)	Source Name, Source ID No., and Proposed Test Date(s)	Control Device and Source ID No.	Stack Name and Source ID No.	Install Date	Mfg. Date	Rated Engine Speed	Baseline Emissions or Compliance?

Table 3: Test Method Identification for Each Pollutant for Tables 1 and 2

Test Option	Pollutant(s)	Proposed Test Methodology
Pollutant(s) and Proposed Test Methodology	Volumetric Flow Rate (VFR)	M2 or M2C or M19?
	Moisture	M4 or M320?
	Nitrogen Oxides (NO_x as NO_2)	M7E, ASTM D6348-03, or M320?
	Carbon Monoxide (CO)	M10, ASTM D6348-03, or M320?
	Formaldehyde (HCHO)	M320?
	Total Hydrocarbon (THC)	M25A?
	Methane (CH_4) Compound	M18, M320, ALT-096, or ALT-106?
	Ethane (C_2H_6) Compound	M18, M320, or ALT-106?
	Volatile Organic Compounds (VOCs/NMHC/NMEHC)	M25A wM18/M320, ASTM D6348-03, 320, ALT-096, or ALT-106?

Sincerely,

Facility Contact's Person Full Name
Facility Contact's Person Job Title
Name of Facility
Mailing Address
Contact Number
Email Address

cc: Mr. Bryon M. Richwine
Natural Gas Industry Testing Section - Chief
PADEP - Source Testing and Monitoring Division
400 Market Street
Harrisburg, PA 17105-2063
(717) 787-7723
RA-EPstacktesting@pa.gov

Consultant's Contact's Person Name
Consultant's Contact's Person Job Title
Name of Testing Firm
Mailing Address
Contact Number
Email Address