

US EPA ARCHIVE DOCUMENT

**TEST/QA PLAN FOR THE VERIFICATION TESTING OF
ALTERNATIVE OR REFORMULATED LIQUID FUELS, FUEL ADDITIVES, FUEL
EMULSIONS, AND LUBRICANTS FOR
HIGHWAY AND NONROAD USE HEAVY DUTY DIESEL ENGINES AND LIGHT
DUTY GASOLINE ENGINES AND VEHICLES**

EPA Cooperative Agreement No. CR83191101



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List of Acronyms and Abbreviations

| | |
|-----------------|------------------------------------------------------|
| ADQ | audit of data quality |
| APCT Center | Air Pollution Control Technology Verification Center |
| CFR | Code of Federal Regulations |
| CO | carbon monoxide |
| CO ₂ | carbon dioxide |
| CVS | constant volume sampler |
| DER | Department of Emissions Research at SwRI |
| DQIG | data quality indicator goals |
| DQO | data quality objective |
| EPA | U.S. Environmental Protection Agency |
| ETV | Environmental Technology Verification |
| FID | flame ionization detector |
| FTP | federal test procedure |
| GVP | generic verification protocol |
| HC | hydrocarbon |
| HFID | heated flame ionization detector |
| ISO | International Standards Organization |
| NO _x | nitrogen oxides |
| OAE | Office of Automotive Engineering |
| PEA | performance evaluation audit |
| PM | particulate matter |
| QA | quality assurance |
| QC | quality control |
| QM | quality manager |
| QMP | quality management plan |
| QSM | Quality System Manual |
| RTI | Research Triangle Institute |
| SOP | standard operating procedure |
| SOW | statement of work |
| SwRI | Southwest Research Institute |
| TSA | technical systems audit |
| VR | verification report |

A3: Distribution List

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GROUP A: PROJECT MANAGEMENT

A4: Project/Task Organization

The U.S. Environmental Protection Agency (EPA) has overall responsibility for the Environmental Technology Verification (ETV) Program for the Air Pollution Control Technology Verification Center (APCT Center). Research Triangle Institute (RTI) is EPA's verification partner in this effort. Southwest Research Institute (SwRI) is the technology-specific testing organization for mobile sources within the APCT Center.

Management and testing of fuel and lubricant modifications for mobile sources within the APCT Center are performed in accordance with procedures and protocols defined by a series of quality management documents. The primary source for the APCT Center quality system is EPA's Policy and Program Requirements for the Mandatory Agency-wide Quality System, EPA Order 5360.1 A2 (May 2000). The quality system is in compliance with the following:

- *EPA Requirements for Quality Management Plans (EPA QA/R-2)*
- EPA's *Environmental Technology Verification Program, Quality Management Plan (EPA ETV QMP)*, for the overall ETV program
- APCT Center's *Verification Testing of Air Pollution Control Technology - Quality Management Plan (APCT Center QMP)*
- APCT Center's *Generic Verification Protocol (GVP) for Determination of Emissions Reductions Obtained by Use of Alternative or Reformulated Liquid Fuels, Fuel Additives, Fuel Emulsions, and Lubricants for Highway and Nonroad Use Diesel Engines and Light Duty Gasoline Engines and Vehicles*
- SwRI's Office of Automotive Engineering (OAE) Standard Operating Procedures (SOPs)
- SwRI's Department of Emissions Research (DER) SOPs
- This test/quality assurance (QA) plan.

Appendix A lists full citations for these documents. This test/QA plan is in conformance with *EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5)*, *EPA Guidance for Quality Assurance Project Plans (EPA QA/G-5)*, and the documents listed above.

As the APCT Center qualified testing organization, SwRI will verify the emissions reductions of alternative or reformulated liquid fuels, fuel additives, fuel emulsions, and lubricants intended for highway and nonroad use diesel engines and light duty gasoline engines and vehicles. SwRI will perform the testing, evaluate the data, and submit a report documenting the results to RTI. RTI will use the data to prepare the verification reports and the verification statements. The various QA and management responsibilities are divided among SwRI, RTI, and EPA key project personnel as defined below. The lines of authority among key personnel for this project are shown on the project organization chart in Figure 1.

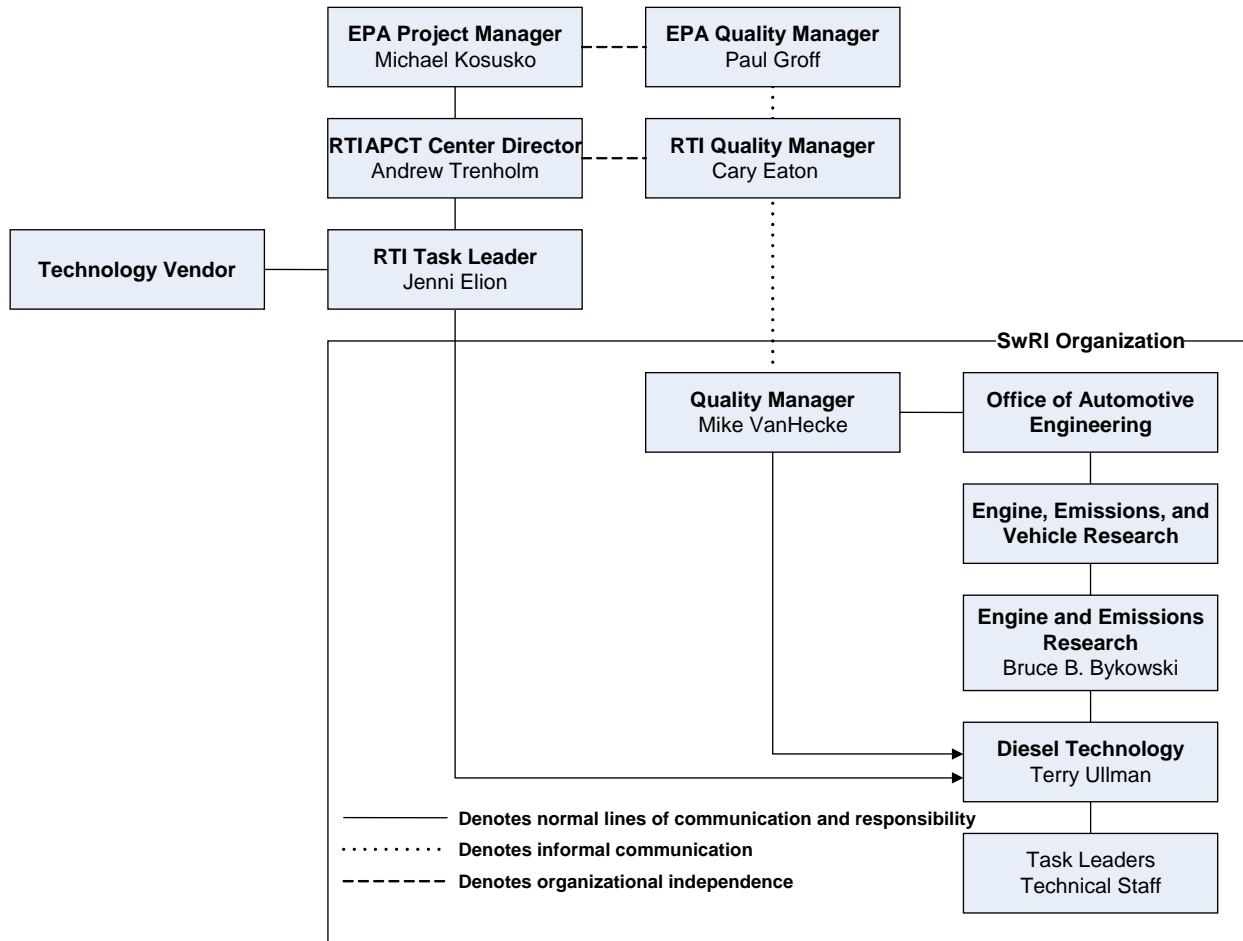


Figure 1. Organizational chart.

A4.1. Management Responsibilities

Project management responsibilities are divided among the SwRI, RTI, and EPA staff as described below.

A4.1.1. EPA Project Manager

The EPA project manager, Michael Kosusko, has overall technical responsibility for the program. He is responsible for granting final approval of GVPs, test/QA plans, and reports, and he recommends the resources necessary to meet project objectives and requirements.

A4.1.2. RTI APCT Center Director

The RTI APCT Center director is Andrew Trenholm. He has overall responsibility for liaison with the EPA project manager, technical and administrative oversight of the APCT Center, and the QA program in the APCT Center and in technology-specific verification tests. He will assign technology verification task leaders; oversee verifications; review technical panel

makeup; and review generic verification protocol and test-specific quality documents. These responsibilities are described in greater detail in Section 2 of the APCT Center's QMP.

A4.1.3. RTI Task Leader

The RTI task leader is Jenni Elion. She will:

- Define task objectives,
- Develop a detailed test scope,
- Work with vendors and stakeholders,
- Prepare test-specific addenda to this document,
- Review work progress to ensure that task budgets and schedules are met, and
- Prepare verification reports and verification statements.

Ms. Elion has overall responsibility for coordinating verification of technologies between applicants and the APCT Center qualified testing organization.

A4.1.4. SwRI Technical Leader

The SwRI technical leader is Terry Ullman. He will:

- Assist the RTI task leader with the test scope,
- Review/prepare operating procedures applicable to the testing,
- Review test apparatus and procedures prior to commencement of testing,
- Oversee testing of the fuel and lubricant modifications,
- Review test data/results for attainment of data quality objectives (DQOs) and reasonableness,
- Initiate corrective actions when needed,
- Review test results, and
- Submit test results to the RTI task leader.

Ullman has overall responsibility for technical and administrative activities, and exercises technical leadership to promote quality in project performance. He will also function as liaison for clients in specific technical areas and supervise the activities of project leaders.

A4.1.5. SwRI Task Leader

Task leaders assigned by the SwRI technical leader will:

- Review the statement of work,
- Develop specific instruction for test work,
- Interface between test operations and vendor, and
- Review and communicate results.

A4.2. Quality Assurance Responsibilities

QA responsibilities are divided among the EPA, RTI, and SwRI personnel as listed below.

A4.2.1. EPA Quality Manager

The EPA quality manager (EPA QM), Paul Groff, will conduct audits of RTI's QA system and of specific technical activities on the project. He will be available to resolve any QA issues relating to performance and EPA's QA requirements. Specific functions and duties of the EPA QM include approving the contents of this test/QA plan and subsequent revisions and reviewing QA reports prepared by RTI, including QA evaluations and audits. In addition, the EPA QM will:

- Communicate quality systems requirements, quality procedures, and quality issues to the EPA project manager and the RTI project manager,
- Review and approve APCT Center quality systems documents to verify conformance with the quality provisions of the ETV quality systems documents,
- Perform technical systems audits (TSAs) and performance evaluation audits (PEAs) of verification tests, as appropriate, and
- Provide assistance to APCT Center personnel in resolving QA issues.

For each technology tested under this test/QA plan, the EPA QM (or his designee) will perform the following specific activities associated with the verification tests:

- Review and approve the GVP for this technology,
- Review and approve this SwRI-specific test/QA plan and each test-specific addendum,
- Review and approve each verification report and each verification statement, and
- Perform a PEA of the verification test of SwRI's ETV testing operations.

A4.2.2. RTI Quality Manager

The RTI APCT Center quality manager (RTI QM), Cary Eaton, is organizationally independent of the RTI APCT Center director and is responsible for ensuring that QA/quality control (QC) procedures described in this test/QA plan are followed. In addition, Eaton will:

- Maintain regular communication with the EPA QM and APCT Center staff regarding QA issues,
- Report on the adequacy, status, and effectiveness of the QA program on a regular basis to the task leader and the APCT Center director,
- Conduct audits of lab activities as necessary and prepare audit reports,
- Ensure that corrective action, if necessary, is properly implemented and documented,
- Review and approve GVPs, test/QA plans, test/QA plan addenda, and SOPs,
- Review the audit of data quality (ADQ) report of the SwRI quality manager (SwRI QM),
- Review and approve test (including QC) reports, and
- Prepare the QA section of each verification statement and verification report.

A4.2.3. SwRI Quality Manager

The SwRI QM, Mike Van Hecke, plays a central role in the introduction, implementation, and consistent application of continuous quality improvement at SwRI's DER. He fulfills the role as quality management representative for the department and conducts audits of all pertinent quality standards to ensure compliance. He is organizationally independent of the unit generating the data. He will:

- maintain the official, approved version of this document,
- review and approve test-specific addenda to this document, and
- reconcile test results with DQOs via data quality indicator goals (DQIG) attainment.

The SwRI QM will document the test-specific ADQ as described in Element C1.2.

A5: Problem Definition/Background

This ETV test/QA plan for heavy-duty diesel engine testing at the SwRI's DER describes how the Federal Test Procedure (FTP), as listed in 40 CFR Part 86 for highway engines and 40 CFR Part 89 for nonroad engines, will be specifically implemented for this testing program. The phrase "without deviation" is used when the FTP is followed exactly. When the FTP allows flexibility (e.g., "alternate methods ... may be used"), the specific implementation will be described if such flexibility is used.

A6: Project/Task Description

A6.1. Description

This ETV test/QA plan describes the test and QA procedures that will satisfy the specifications of the *Generic Verification Protocol (GVP) for Determination of Emissions Reductions Obtained by Use of Alternative or Reformulated Liquid Fuels, Fuel Additives, Fuel Emulsions, and Lubricants for Highway and Nonroad Use Diesel Engines and Light Duty Gasoline Engines and Vehicles* developed under the authority of the APCT Center at RTI. This document is written to conform to all specifications of *EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5*, the EPA ETV QMP, and the APCT Center QMP. It describes the quality system of SwRI and the procedures applicable to meeting EPA quality requirements that are common to all ETV tests. Test-specific addenda, noted below, will be reviewed and approved by EPA prior to testing.

This testing, based on the FTP, is to quantify the effectiveness of "commercially ready" fuel and lubricant modifications for oxides of nitrogen (NO_x), hydrocarbons (HCs), particulate matter (PM), and carbon monoxide (CO) that are intended for use on diesel and light duty gasoline engines considered mobile sources of air pollution. For a specific technology, the number and type of FTP tests may differ (see *GVP, Section 5.1*) from certification requirements in order to satisfy the DQOs (see *GVP, Section 2.4*).

A description of a specific technology, engine to be tested, and test-specific details will be documented as a test-specific addendum to this document that will be prepared by the RTI task leader and submitted for EPA review and approval prior to the start of testing. The test-specific addendum will provide additional information needed to conform to required elements A5 (Problem Definition/Background) and A6 (Project/Task Description) of EPA QA/R-5.

A6.2. Schedule

Figure 2 shows an example schedule for completion of a first draft verification report and statement. The test-specific schedule is expected to vary from technology to technology based on the scheduling needs of the applicant, SwRI, and the APCT Center.

| | M | O | N | T | H |
|---------------------------------------------------------------------|---|---|---|---|---|
| TASK | 1 | 2 | 3 | 4 | 5 |
| APCT Center develops Statement of Work (SOW) | ◆ | | | | |
| Applicant accepts SOW, signs Terms & Conditions | ◆ | | | | |
| EPA approves applicant-specific test/QA plan addendum | | ◆ | | | |
| SwRI receives test items from applicant | | ◆ | | | |
| SwRI conducts testing | | | ■ | | |
| SwRI delivers test report to APCT Center | | | | ◆ | |
| APCT Center completes first draft verification report and statement | | | | | ◆ |

Figure 2. Example of schedule.

A7: Quality Objectives and Criteria

The DQOs of this testing focus on the measurements of NO_x, HC, PM, and CO. Test requirements are those found in 40 CFR 86 and 40 CFR 89 FTP test methods, with the number of tests being determined by:

1. A minimum of three tests,
2. Additional tests indicated (see *GVP, Section 5*), and
3. Additional tests desired by the applicant.

The rationale for the number of FTP test cycles will be included in the test-specific addenda to this document, which will conform to required element B1 of EPA QA/R-5.

The DQIG for individual measurements will conform to those specified in relevant sections of the FTP, as shown in Table 1. Test-specific DQIG will be documented in the test-specific addenda to this document.

Table 1: Data Quality Indicator Goals (DQIG)

| Param | DER SOP | 40 CFR | Acceptance Criteria |
|----------|----------------|------------------|-----------------------------------------------------------------------------------|
| NOx | 06-002 | 86.1323-84(a)(4) | NO ₂ content ≤ 5% of NO concentration |
| NOx | 06-002 | 86.1323-84(a)(7) | Converter efficiency ≥90% (SwRI: 95%) |
| | 06-003 | | Gas divider linearity: known - observed ≤ 2.0% |
| | 06-003 | | Gas divider linearity, full-scale: known - observed ≤ 0.5% |
| NOx | 06-025 | | Analyzer initial zero = 0.0 ± 0.5 meter division |
| NOx | 06-025 | | Analyzer initial span: known - observed ≤ 0.5 meter division |
| NOx | 06-025 | | Analyzer post-check zero and span: drift ≤ 1.0 meter division |
| NOx | 06-041 | | Carbon dioxide (CO ₂) quench, pre-test zero: 0.0 ± 0.5% full scale |
| NOx | 06-041 | | CO ₂ quench, pre-test span: known - observed ≤ 0.5% full-scale meter |
| NOx | 06-041 | | CO ₂ quench, post-test zero and span: drift ≤ 2% full-scale meter |
| NOx | 06-041 | | CO ₂ quench: ≤ 3% full scale meter |
| Sampling | 07-003 | | 20 °C ≤ CVS (constant volume sampler) dilution air temp ≤ 30 °C |
| Sampling | 07-009, 07-038 | | Background of CVS and tunnel: ≤ 10 ppmC (carbon) |
| Sampling | 07-009, 07-038 | | Background: CVS tunnel - bag ≤ 2 ppmC |
| Sampling | 07-009 | | NOx post-test zero and span drift ≤ 2% full scale meter |
| Sampling | 07-009 | | HC post-test zero and span drift ≤ 3% full scale meter |
| Weighing | 07-020 | | Chamber: 19 °C < temperature ≤ 25 °C |
| Weighing | 07-020 | | Chamber: 37% ≤ relative humidity ≤ 53% |
| Weighing | 07-020 | | Reference filter weight change ≤ 20 micrograms |
| Weighing | 07-020 | | Reference mass weight change ≤ 10 micrograms |
| Bag Cart | 07-023, 07-038 | | Pre-test zero: 0.0 ± 0.5% full-scale meter |
| Bag Cart | 07-023, 07-038 | | Pre-test span: known - observed ≤ 0.5% full-scale meter |
| Bag Cart | 07-023, 07-038 | | Pre-test zero and span check: known - observed ≤ 1% full-scale meter |
| Bag Cart | 07-023 | | Post-test zero and span: drift ≤ 2% full scale |
| Testing | 07-028 | | Gas meter #2 (secondary flow) counts ≥ 373 counts/min |

A8: Special Training/Certification

The DER is certified to International Organization for Standardization (ISO) 9001:2000 “Model for Quality Management Systems.” This independently-assessed quality system provides the basis for quality procedures that are applied to every project conducted in the DER.

DER is accredited to ISO/IEC 17025 “General Requirements for the Competency of Calibration and Testing Laboratories.” Under American Association for Laboratory Accreditation Certificate Number 0702-01, DER has been accredited to perform evaluations of automotive fluids, fuels emissions, automotive components, engine and power-train performance and durability using stationary engine dynamometer test stands (light-duty, nonroad, and heavy duty) and vehicle dynamometer facilities, and automotive fleets (see <http://www.a2la2.net/scopepdf/0702-01.pdf>). The certificate accredits DER to use specific standards and procedures, including dynamometer procedures for HCs, CO, NOx, and PM.

DER has also achieved and has maintained Ford Tier 1 status for providing engineering services, received the Ford Q1 Quality Award and the Ford Customer-Driven Quality Award, and maintains its status as a Caterpillar-Certified Supplier.

All SwRI personnel supporting the project will be qualified as prescribed by OAE SOP 4.18 (Training).

A9: Documents and Records

Test-specific documentation and records will be processed as specified in OAE SOP 4.5 (Document Control), OAE SOP 4.16 (Quality Records), and OAE SOP 4.10.2 (Test Conduct and Recording of Test and Calibration Data). See Element B10 for details of test data acquisition and management.

In accordance with Part A, Sections 5.1 and 5.3 of EPA's QMP, SwRI will retain all test-specific documentation and records for seven years after the final payment of the agreement between SwRI and the APCT Center. RTI will retain all verification reports and statements for seven years after final payment of the agreement between RTI and EPA.

GROUP B: DATA GENERATION AND ACQUISITION

B1: Sampling Process Design (Experimental Design)

The test design follows the FTP, with the number of separate FTP tests for a specific technology determined by the algorithm specified in Section 5.1 of the GVP. The rationale for the number of FTP test cycles will be included in the test-specific addenda to this document, which will conform to required element B1 of EPA QA/R-5.

B2: Sampling Methods

The sampling system is comprised primarily of the exhaust sampling system to which continuous measurement devices and particulate filters are attached, as depicted in Figure 3.

B2.1. Exhaust Gas Sampling System

The exhaust gas sampling system conforms to 40 CFR 86.1310-90 and 40 CFR 89.419. The system that will be used at SwRI is depicted in Figure 3.

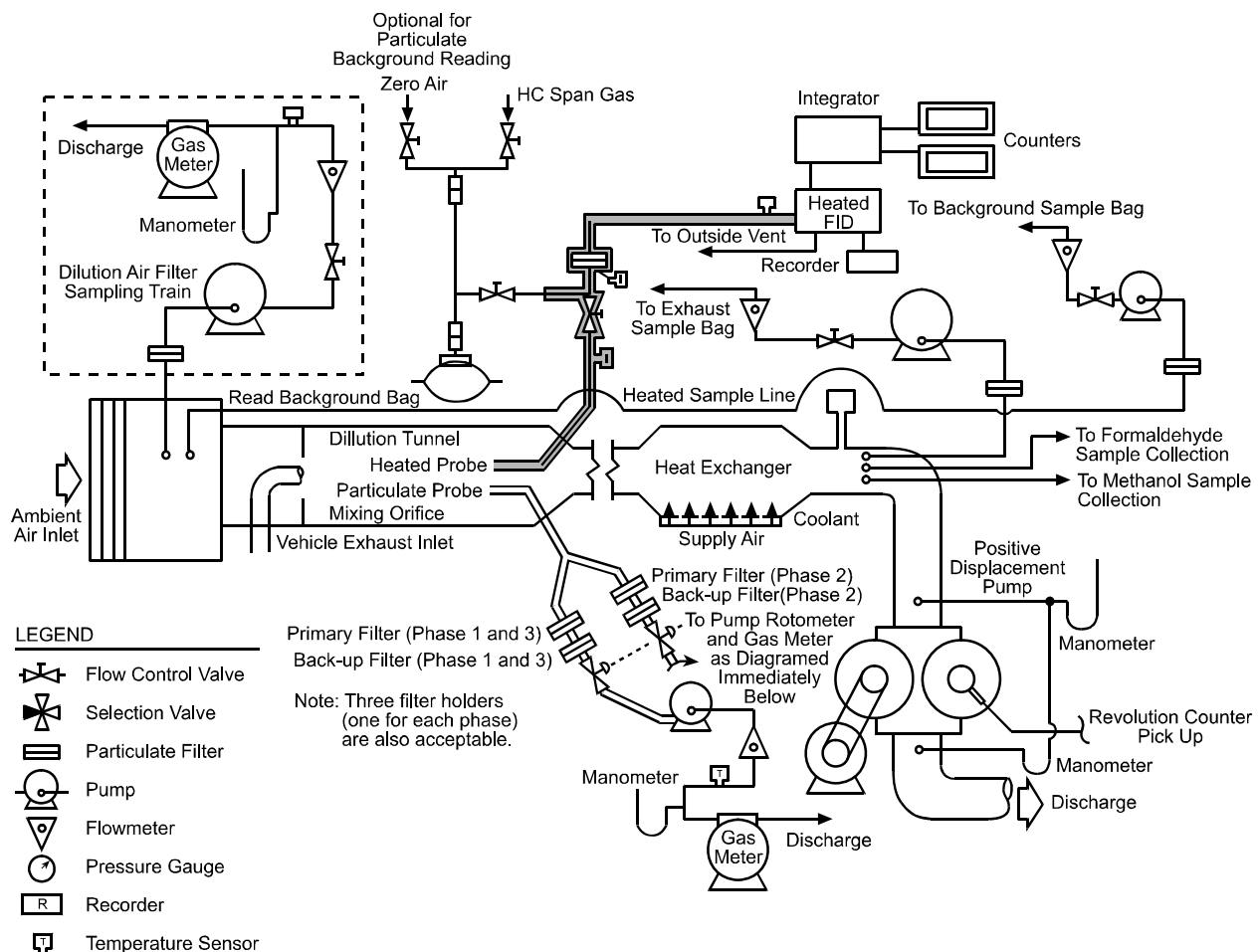


Figure 3. Gaseous and particulate emissions sampling system.

B4: Analytical Methods

B4.1 Exhaust Gas Measurement System

The exhaust gas measurement system conforms to 40 CFR 86.1310-90, 40 CFR 89.419, and 40 CFR 89.421. The configuration that is used at SwRI is shown in Figure 4.

B4.2. Filter Weighing

Particulate filters are stored, conditioned, and weighed in a room at SwRI that conforms to 40 CFR 86.1312-88 according to DER SOP 07-020 (Particulate Filter Conditioning and Weighing).

The weighing process conforms to 40 CFR 86.1339-90. The balances that will be used are listed in the SwRI DER "Recall Database."

The chamber in which the PM filters are conditioned and weighed conforms to 40 CFR 86.1312-88 without deviation.

B4.3. Gaseous Analyzers

Gaseous analyzers depicted in Figure 4 conform to 40 CFR 89.309, 40 CFR 86.1310-90, and 40 CFR 86.1311-94 without deviation. The specific instruments to be used in this test will be selected from those listed in the master list of calibration equipment maintained in the SwRI DER "Recall Database." Their operation is specified in DER SOP 07-009 (Emissions Testing During Heavy-Duty Diesel Engine Transient Cycle), which conforms to required elements B4 (Analytical Methods), B5 (Quality Control), and B6 (Instrument/Equipment Testing, Inspection, and Maintenance) of EPA QA/R-5.

B5: Quality Control

Activities are specified in OAE SOP 4.15.2 (Data Control and Reporting) for assessing the quality of data from each test event. These SOPs conform to required elements B5 (Quality Control) and D3 (Reconciliation with User Requirements) of EPA QA/R-5.

B6: Instrument/Equipment Testing, Inspection, and Maintenance

Gaseous analyzers depicted in Figure 4 conform to 40 CFR 89.309, 40 CFR 86.1310-90, and 40 CFR 86.1311-94 without deviation. DER SOP 07-009 (Emissions Testing During Heavy-Duty Diesel Engine Transient Cycle) includes and conforms to required element B6 (Instrument/Equipment Testing, Inspection, and Maintenance) of EPA QA/R-5.

B7: Instrument/Equipment Calibration and Frequency

Calibration and frequency of instruments and equipment are specified in OAE SOP 4.11.1 (Calibration and Maintenance) and OAE SOP 4.11.2 (Calibration Recall), which conform to required element B7 (Instrument/Equipment Calibration and Frequency) of EPA QA/R-5.

B7.1. Gas Meter Calibrations

As specified in DER SOP 06-003 (Linearity Verification of Gas Dividers), all gas meters, selected from the list of routinely used instruments listed in the DER Recall Database, are calibrated to conform to 40 CFR 86.1320-90 and 40 CFR 89.319. Any necessary correction is made by mechanically adjusting the meter and recalibrating.

B7.2. Gaseous Analyzer Calibrations

B7.2.1. Hydrocarbon Analyzers

The hydrocarbon analyzers used in this testing program, listed in the DER Recall Database, are calibrated in conformance with 40 CFR 86.1321 and 40 CFR 89.319, using the procedures specified by the applicable flame ionization detector [FID/heated flame ionization detector (HFID)] manufacturer. Their operation is specified by DER SOPs 06-012 (Monthly Calibration of Analyzers for Continuous Dilute Gaseous Exhaust), 06-021 (FID Response for Methane), 06-024 (Hydrocarbon Analyzer and Systems Response Checks), and 06-044 (Hydrocarbon Analyzer Optimization), which conform to required element B7 (Instrument/Equipment Calibration and Frequency) of EPA QA/R-5.

B7.2.2. Carbon Monoxide Analyzers

The CO analyzers used in this testing program, listed in the DER Recall Database, are calibrated in conformance with 40 CFR 86.1322 and 40 CFR 89.320, using zero-grade air. Their operation is specified by DER SOPs 06-016 (Wet CO₂ Interference Check for CO Analyzers) and 06-023 (Calibration of Analyzers Using Digital Readout), which conform to required element B7 (Instrument/Equipment Calibration and Frequency) of EPA QA/R-5.

B7.2.3. Oxides of Nitrogen Analyzers

The NO_x analyzers used in this testing program, listed in the DER Recall Database, are calibrated in conformance with 40 CFR 86.1323 and 40 CFR 89.321, using zero-grade air. Their operation is specified by DER SOPs 06-002 (NO_x Converter Efficiency Determination), 06-012 (Monthly Calibration of Analyzers for Continuous Dilute Gaseous Exhaust), 06-025 (NO_x Analyzer and System Response Checks), and 06-041 (NO_x Analyzer CO₂ Quench Check), which conform to required element B7 (Instrument/Equipment Calibration and Frequency) of EPA QA/R-5.

B7.2.4. Carbon Dioxide Analyzers

The carbon dioxide (CO₂) analyzers used in this testing program, listed in the DER Recall Database, are calibrated in conformance with 40 CFR 86.1324 and 40 CFR 89.322, using zero-grade air. Their operation is specified by DER SOP 06-023 (Calibration of Analyzers Using Digital Readout), which conforms to required element B7 (Instrument/Equipment Calibration and Frequency) of EPA QA/R-5. These measurements are ancillary for this testing program.

B7.2.5. Methane Analyzers

The methane analyzers used in this testing program, listed in the DER Recall Database, are calibrated in conformance with 40 CFR 86.1325 and 40 CFR 89.324, without deviation. These measurements are ancillary for this testing program.

B7.3. Analyzer Calibration Gases

The gases used for instrument calibration conform to 40 CFR 86.1314-94 and 40 CFR 89.312 without deviation.

B8: Inspection/Acceptance of Supplies and Consumables

Inspection and acceptance criteria for client-supplied or SwRI purchased materials and equipment are coordinated by the SwRI task leader. This process is conducted in accordance with OAE SOP 4.10.1 (Receiving Inspection). Upon receipt and processing by SwRI shipping and receiving, the shipment is delivered to the test facility. The inventory clerk of the test facility checks the shipment against the packing slip and notifies the appropriate task leader or supervisor, who then inventories and inspects the items received.

B9: Non-direct Measurements

All data used in this project will be generated by this project. No non-measurement sources, such as computer databases, programs, literature files, and historical databases, will be used.

B10: Data Management

B10.1 Data Acquisition and Management

Data acquisition and data management are performed according to OAE SOP 4.10.2 (Test Conduct and Recording of Test and Calibration Data) and OAE SOP 4.15.2 (Data Control and Reporting), which conform to required element B10 (Data Management) of EPA QA/R-5. The planned data streams, with responsibilities of the SwRI technical leader and SwRI QM, are depicted in Figure 5. The SwRI technical leader is operationally responsible for all aspects of a test. The SwRI QM is operationally responsible for all data quality aspects of a test, with primary focus, but not exclusive focus, on the areas indicated in the figure.

Qualitative data regarding the technology to be tested, per 40 CFR 86.1344 and 40 CFR 89.405, are manually recorded on the data sheets specified in DER SOP 07-003 (Transient Test for Heavy-Duty Diesel Engines). Operating and emissions data are captured by the data management system, described schematically in Figure 5.

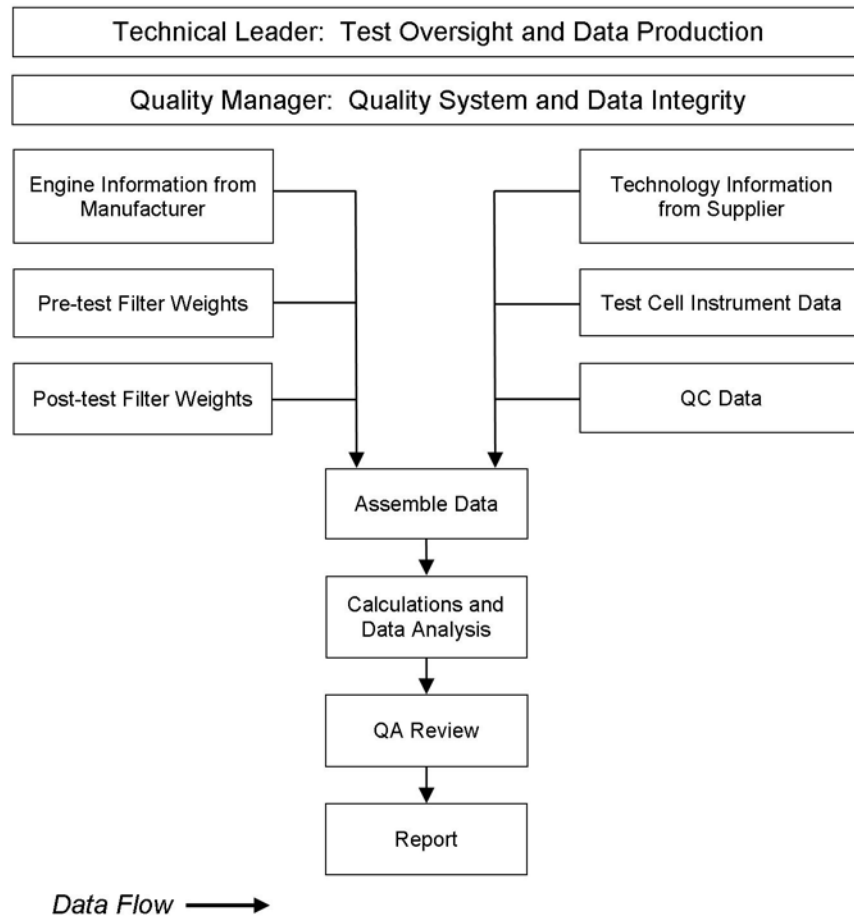


Figure 5. ETV data management system.

B10.2 Reporting

The test report must be sufficiently detailed with background information to allow complete description of the verification testing in the verification report (VR). Each of the elements identified in the *GVP*, section 6.1 must be addressed in the test report. OAE SOP 4.15.2 (Data Control and Reporting) conforms to these requirements.

The VR, which will be prepared by the APCT Center, includes the verification statement and a detailed discussion of the verification testing. An outline of the VR is provided in the *GVP*, section 6.1, and the VR includes each of the elements listed. The description of the verification testing will be based on the test report. The APCT Center will conduct the data analysis and verification based on the equations in the *GVP*, section 5.1.

GROUP C: ASSESSMENTS AND OVERSIGHT ELEMENTS

C1: Assessments and Response Actions

C1.1. Internal Audits

Internal audits by SwRI are conducted as specified in OAE SOP 4.17 (Internal Quality Audits), which conforms to required element C1 (Assessments and Response Actions) and C2 (Reports to Management) of EPA QA/R-5.

C1.2. Audits of Data Quality

In accordance with Table 9.1 of the EPA ETV QMP, the SwRI QM will conduct an ADQ of at least 10 percent of all of the verification data. The ADQ will be conducted in accordance with EPA's *Guidance on Technical Audits and Related Assessments for Environmental Data Operations, EPA QA/G-7*, including:

- a written report detailing the results of custody tracing,
- a study of data transfer and intermediate calculations,
- a review of QA and QC data, including reconciliation to user requirements (e.g., DQOs and DQIGs), and
- a study of project incidents that resulted in lost data, and a review of study statistics.

The ADQ report ends with conclusions about the quality of the data from the project and their fitness for their intended use.

C1.3. External Audits

SwRI will cooperate with any external assessments by the EPA or the APCT Center. RTI or EPA will conduct a single mandatory quality and technical systems assessment of DER before the start of the first test at DER. They may conduct optional assessments during the first test or any subsequent test. The external assessments will be conducted as described in EPA QA/G-7.

C1.4. Corrective Action

Corrective action that results from any audit or assessment is performed according to OAE SOP 4.13 (Nonconformance, Preventive and Corrective Action, Customer Complaints), which conforms to required elements B5 (Quality Control) and C1 (Assessments and Response Actions) of EPA QA/R-5.

C2: Reports to Management

Internal assessment reports will be reviewed by the SwRI QM, who will respond as noted in element C1. The written report of the ADQ will be submitted to the APCT Center for review as noted in Element C1.2.

GROUP D: DATA VALIDATION AND USABILITY ELEMENTS

D1: Data Review, Verification, and Validation

Activities are specified in OAE SOP 4.10.2 (Test Conduct and Recording of Test and Calibration Data) and OAE SOP 4.15.2 (Data Control and Reporting), which conform to required element D1 (Data Review, Verification, and Validation) of EPA QA/R-5.

D2: Verification and Validation Methods

Activities are specified in OAE SOP 4.15.2 (Data Control and Reporting), which conforms to required element D2 (Verification and Validation Methods) of EPA QA/R-5.

D3: Reconciliation with User Requirements

Activities are specified in OAE SOP 4.10.2 (Test Conduct and Recording of Test and Calibration Data) and OAE SOP 4.15.2 (Data Control and Reporting), which conform to required element D3 (Reconciliation with User Requirements) of EPA QA/R-5. (See element C1.2)

APPENDIX A: APPLICABLE DOCUMENTS AND PROCEDURES

1. EPA Documents

EPA. Policy and Program Requirements for the Mandatory Agency-wide Quality System. EPA Order 5360.1 A2. U.S. Environmental Protection Agency. May 2000.

EPA. *EPA Requirements for Quality Management Plans. EPA QA/R-2*, EPA Publication No. EPA/240/B-01/002. U.S. Environmental Protection Agency, Office of Environmental Information. Washington, DC. March 2001.

EPA. *Environmental Technology Verification Program, Quality Management Plan*. EPA Publication No. EPA/600/R-03/021. Office of Research and Development, U.S. Environmental Protection Agency. Cincinnati, OH. December 2002.

EPA. *EPA Requirements for Quality Assurance Project Plans. EPA QA/R-5*, EPA Publication No. EPA/240/B-01/003. Office of Environmental Information, U.S. Environmental Protection Agency. March 2001.

EPA. *Guidance for Quality Assurance Project Plans. EPA QA/G-5*, EPA Publication No. EPA/600/R-98/018. Office of Environmental Information, U.S. Environmental Protection Agency. February 1998.

EPA. *Guidance on Technical Audits and Related Assessments for Environmental Data Operations. EPA QA/G-7*, EPA Publication No. EPA/600/R-99/080. Office of Environmental Information, U.S. Environmental Protection Agency. January 2000.

2. APCT Center Documents

APCT Center. *Verification Testing of Air Pollution Control Technology - Quality Management Plan*. Research Triangle Institute. Research Triangle Park, NC. October 1998.

APCT Center. *Generic Verification Protocol (GVP) for Determination of Emissions Reductions Obtained by Use of Alternative or Reformulated Liquid Fuels, Fuel Additives, Fuel Emulsions, and Lubricants for Highway and Nonroad Use Diesel Engines and Light Duty Gasoline Engines and Vehicles*. Research Triangle Institute, Research Triangle Park, NC. September 2003.

3. SwRI OAE Standard Operating Procedures

These documents are proprietary but will be made available to APCT Center and EPA staff during on-site assessments.

| | |
|----------------|-----------------------------------------------------------------------|
| QSM | QUALITY SYSTEM MANUAL – April 2001 |
| OAE SOP 4.5 | Document Control |
| OAE SOP 4.10.1 | Receiving Inspection |
| OAE SOP 4.10.2 | Test Conduct and Recording of Test and Calibration Data |
| OAE SOP 4.11.1 | Calibration and Maintenance |
| OAE SOP 4.11.2 | Calibration Recall |
| OAE SOP 4.13 | Nonconformance, Preventive and Corrective Action, Customer Complaints |
| OAE SOP 4.15.2 | Data Control and Reporting |
| OAE SOP 4.16 | Quality Records |
| OAE SOP 4.17 | Internal Quality Audits |
| OAE SOP 4.18 | Training |

4. SwRI DER Standard Operating Procedures

These documents are proprietary but will be made available to APCT Center and EPA staff during on-site assessments.

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|------------|------------------------------------------------------------------------|
| SOP-06-002 | NO _x Converter Efficiency Determination |
| SOP-06-003 | Linearity Verification of Gas Dividers |
| SOP-06-012 | Monthly Calibration of Analyzers for Continuous Dilute Gaseous Exhaust |
| SOP-06-016 | Wet CO ₂ Interference Check for CO Analyzers |
| SOP-06-021 | FID Response for Methane |
| SOP-06-023 | Calibration of Analyzers Using Digital Readout |
| SOP-06-024 | Hydrocarbon Analyzer and Systems Response Checks |
| SOP-06-025 | NO _x Analyzer and System Response Checks |
| SOP-06-041 | NO _x Analyzer CO ₂ Quench Check |
| SOP-06-044 | Hydrocarbon Analyzer Optimization |
| SOP-07-003 | Transient Test for Heavy-Duty Diesel Engines |
| SOP-07-009 | Emissions Testing During Heavy-Duty Diesel Engine Transient Cycle |
| SOP-07-020 | Particulate Filter Conditioning and Weighing |
| SOP-07-023 | Operation of Bag Cart |
| SOP-07-028 | Dilute Steady-State Engine Emissions Test |
| SOP-07-038 | Steady-State Emissions Testing of Heavy-Duty Engines |