

APPENDIX A

**REVISED UTAH2000
EMISSION INSPECTION SYSTEM
SPECIFICATIONS**

December 2013

1.0 GENERAL

This appendix contains specifications for Emission Inspection System Contractors (hereafter, Contractors) to design Testing Equipment to be used in the Utah County Vehicle Emissions Inspection and Maintenance Program (hereafter, I/M Program). Testing Equipment to be used in the I/M Program must be capable of performing consistent Two-Speed Idle (TSI), and On-Board Diagnostics (OBD) emissions inspections.

1.1 Design Goals

Testing Equipment must be designed and constructed to provide reliable and accurate service in the automotive service environment and have a useful life of at least five years. The software must be designed for maximum operational simplicity and be capable of providing emissions readings or codes that can be used for vehicle diagnostics. A manual, non-test mode should be available to perform vehicle diagnostics. The software must prevent users from performing any actions that could change the results of an official emissions test. In addition, the Testing Equipment must include security measures that will prevent unauthorized modifications to the software or inspection data, record unauthorized entry, also known as tampering, and prevent subsequent inspections when tampering is detected.

These technical specifications contain the minimum requirements for Testing Equipment used to perform emissions inspections in the I/M Program. Contractors may include additional items with approval from the Utah County Health Department (hereafter, the Department).

1.1.1 Identification Data

A nameplate including the following information must be permanently affixed to the housing of the Testing Equipment:

- Name and address of manufacturer;
- Model description;
- Serial number; and
- Date of assembly.

In addition, the Contractor shall affix a label to the housing of the Testing Equipment that contains a toll-free telephone number for customer service. This telephone number must also be displayed on error messages that recommend the need for service by the manufacturer.

The Testing Equipment must also electronically display:

- Nameplate data;
- Testing Equipment number; and
- Propane Equivalency Factor (PEF).

1.2 Manuals

All Testing Equipment sold or leased by the Contractor must be provided with a current copy of a manual that contains, at a minimum, operating instructions, maintenance instructions, and initial startup instructions. The manual may be provided in an electronic format and should be accessible from the Testing Equipment.

1.3 Certification Requirements

The Contractor shall submit a letter to the Department stating that the Testing Equipment model sold or leased by the Contractor or its authorized representatives satisfies all design and performance criteria described in these specifications. Unless otherwise specified, a copy of the software documentation listed below must be submitted to the Department as part of the certification application. The documentation must include, at a minimum, the following:

- Complete program listing(s);
- Functional specifications;
- Functional flowcharts of the software;
- Example inputs and outputs from all processes;
- Detailed interface information on system components including the identification of protocol and output specifications; and
- File layouts.

To ensure proper maintenance of all Testing Equipment, a full description of the Contractor's service procedures and policies, sample contracts and warranty agreements must be provided as part of the certification application. The Contractor shall provide a training plan to the Department that will be used to conduct certification training of potential inspectors on the use of the Testing Equipment. The Contractor shall supply to the Department and maintain at least two pieces of Testing Equipment at no charge.

1.3.1 Performance Bond

As a prerequisite to certification, the Contractor shall furnish a performance bond to the Department. This bond must be in a form approved by the Department, executed as a surety by a bonding company authorized to do business in the State of Utah, and signed by a licensed resident agent. The performance bond must be for \$250,000 and must remain valid for the entire time period that the Contractor participates in the I/M Program. The performance bond must cover all Testing Equipment that is certified to conduct emissions inspections in the I/M Program.

The performance bond may be used by the Department at any time if the Contractor is in default of the requirements of these specifications, including but not limited, to the following "Events of Default":

- A. The Contractor fails to remedy a breach of covenant, representation, or warranty required by these specifications within thirty (30) days after written notice of such breach has been given to the Contractor by the Department;
- B. The Contractor makes a general assignment for the benefit of creditors, admits in writing its inability to pay debts as they mature, institutes proceedings to be adjudicated upon voluntary bankruptcy, consents to the filing of a bankruptcy proceeding against it, files a petition or answer or consent seeking reorganization, readjustment, arrangement, composition, or similar relief under federal bankruptcy or any other similar applicable law(s), consents to the filing of any such petition, consents to the appointment of a receiver, liquidator, trustee, or assignee in bankruptcy or insolvency of the manufacturer or a substantial part of its property, or takes action to further any of these purposes; or
- C. A court of competent jurisdiction enters a decree or order adjudging the Contractor as bankrupt or insolvent, or approving a properly filed petition seeking reorganization, readjustment, arrangement, composition, or similar relief for the Contractor under the federal bankruptcy or any other similar applicable law(s), and such decree or order is not discharged or stayed continuously for a period of sixty (60) days; or a decree or order of a court of competent jurisdiction for the appointment of a receiver, liquidator, trustee or assignee in bankruptcy or insolvency of the manufacturer or of a substantial part of its property, or for the liquidation of its affairs, is entered, and such decree or order is not discharged or stayed continuously for a period of sixty (60) days; or any substantial part of the property of the Contractor is sequestered or attached and is not returned to the Contractor or released from such attachment within sixty (60) days thereafter.

To require performance by the surety under the performance bond, the Department shall give written notice of the event of default to the Contractor, specifying the date upon which the surety performance must begin.

The Director or his designee shall release the performance bond once it is determined that the Contractor has satisfactorily completed its obligations in accordance with the terms of these specifications, or at an earlier date, if it is determined by the Director to be in the best interest of the Department.

1.4 Equipment Warranty Coverage

A written warranty coverage agreement, signed by an authorized representative of the Contractor and the I/M Program Station, which provides a complete description of coverage for all systems and components and all Contractor provided services listed below in Contractor Provided Services, must accompany the sale or lease of each unit of Testing Equipment.

The manufacturer's warranty must remain in force during the entire contract period including future contract extensions and shall be transferable to a new owner should the equipment be sold during the contract period.

The cost of equipment warranty shall be recovered through per-test fees paid to the contractor.

1.5 Contractor Provided Services

A Contractor-authorized repair technician is a Testing Equipment service technician that is authorized by the Contractor to perform service on their fleet of Testing Equipment. Only Contractor-authorized repair technicians may access the secure areas on the Testing Equipment.

The Contractor-authorized repair technician shall perform a gas calibration prior to returning an Analyzer to service whenever a component of the emissions measurement system is repaired or replaced. Similarly, the Contractor-authorized repair technician shall perform a leak check each time the Analyzer's sample line is broken and repaired. Contractor-authorized repair technicians shall have software driven menu options or other acceptable method that records the transfer of inspection station, inspector information, and other data from one unit of Testing Equipment to another without manual inputs or the transfer of previous data.

The Department may require the Contractor to conduct on-site or laboratory testing of the Testing Equipment in order to document continued compliance. The Contractor shall supply the I/M Program Station a temporary replacement unit of Testing Equipment that meets the I/M Program requirements if a unit of Testing Equipment is removed from the I/M Program Station for repair or testing. The Contractor shall be responsible for any costs incurred under this requirement.

The Contractor shall correct software features that do not meet these specifications to the satisfaction of the Department. The enhancement of operational software must be specified by the Department and be designed to update through the internet. Unless authorized by the Department, software enhancements must be available for beta testing within 120 days of commencement of a software update contract and receipt of an updated Testing Equipment specification. The Contractor shall not modify any existing Testing Equipment software without obtaining approval from the Department.

The Contractor shall be responsible for training Department officials responsible for oversight of the I/M Program, including but not be limited to, the instruction on all operational, maintenance, and quality control features of the Testing Equipment sampling system, full access to and use of inspection, audit, and calibration menus, and optional programs offered to inspectors. This training must be conducted at the Contractor's expense as a condition of certification, and upon written request by the Department.

The Contractor shall provide the following services to the I/M Program Station as part of any sale, lease, or loan of Testing Equipment:

- Delivery, installation, calibration, and verification of the proper operating condition of the Testing Equipment;
- Two extra sample filters with each TSI Analyzer, and an additional printer cartridge or a certificate redeemable for a printer cartridge for all Testing Equipment;
- A minimum of two hours operation and maintenance training to the owners and operators for each unit of Testing Equipment purchased or leased.

The Contractor shall provide the following services to the I/M Program Station as part of the manufacturer's original warranty.

- Full systems support and repair, including temporary provision of units of equal quality and specification;
- Quarterly examination, calibration, and routine maintenance of Analyzer and sampling systems on the TSI Analyzers. Annual examination must be required on the OBD portion of the Testing Equipment.
- On-site service response by a Contractor-authorized repair technician within one business day (Saturday shall be considered a business day), excluding Sundays, national/state holidays (New Year's Day, Martin Luther King, Jr. Day, President's Day, Memorial Day, Independence Day, Pioneer Day, Labor Day, Veteran's Day, Thanksgiving, and Christmas), and other days the purchaser's business might be closed, of a request from the I/M Program Station. The names, toll free telephone number(s), and service facility addresses of the Contractor's representatives responsible for Equipment service must be provided to the I/M Program Station. All system repairs, component replacements, and/or Testing Equipment adjustments, including reset of quality control lockout systems, must be accomplished on-site within a minimum average response time of 8 business hours after a service request has been initiated. If the completion of this work is not possible within this time period, Testing Equipment of equal quality and specifications must be provided until the malfunctioning unit is properly repaired and returned to service.

1.6 Electronic Transmission Security

The Testing Equipment shall utilize a standard protocol encryption method for communications with the host incorporating error detection and not incorporating error correction. The Testing Equipment shall utilize bitsum checking for all messages.

1.7 Tamper Resistance

The controlled access design must be the responsibility of the Contractor, but all security measures must be submitted to the Department for approval. The Testing Equipment operators, Department personnel, and field representatives authorized by the Contractor shall be prevented from creating or changing any inspection results, programs, or data contained on the Testing Equipment. The Contractor shall use appropriate software and hardware provisions to protect I/M files and programs. The file and program protection may consist of mechanical

systems in combination with electronic and software systems. The protection features must prevent access to the secured portions of the hard disk containing I/M programs and inspection data. The control key or its functional equivalent, which gives access to the operating system (OS), must not be activated except through the use of a password on the audit menu. The password must be chosen by the Department at the time of certification testing. Other security or protection alternatives may be proposed by the Contractor for approval by the Department.

The Contractor shall, at a minimum, develop tamper resistant features to prevent unauthorized access through the Testing Equipment cabinet. Micro switches, keyed and software controlled locks, and software algorithms requiring the use of an access code must all be used where appropriate. Any unauthorized access to the secured areas of the Testing Equipment must be detected, even when the power is off. A software lockout algorithm must be activated should tampering occur, which would abort any existing inspection sequence and prevent further inspections until the lockout is cleared by a field representative authorized by the Department. The Contractor shall develop a system to allow Contractor-authorized repair technicians to clear tamper lockouts only during authorized service calls. The lockout system must be designed so that it can be activated from the audit menu by Department personnel. The Contractor may use keyed locks on the cabinet doors to secure the disk drives as long as the locks are built-in and can be changed by authorized personnel should a security problem be identified. A software controlled solenoid lock may also be used on the secured drive door of the Testing Equipment. The solenoid lock may be used instead of or in addition to any key or combination lock that may be provided. The Testing Equipment software must control the solenoid lock and unlatch the doors in response to authorized requests from the audit menu while maintaining the appropriate levels of security.

A tamper file must be created that includes the date, time, type, and location of the tamper lockout, date and time the lockout was cleared, and who cleared the lockout. The tamper lockout type and location must be accessible only through the lockout function of the Testing Equipment's audit menu.

Access to the compact disc drive (CD), if applicable, must be available to I/M Program Station personnel at all times. However, access to the BIOS, I/M related programs, and data must be secured separate from the CD and additional drives. The Contractor shall provide a security method approved by the Department for the CD drive(s) to prevent unauthorized reads, writes, and executable. However, the Contractor may offer Testing Equipment with additional disk drives that can run optional software application programs.

The Testing Equipment must prevent Contractor-authorized repair technicians from performing the following, except in a manner approved by the Department:

- Clearing a state lockout;
- Clearing a lockout for a failed three-day gas calibration or leak check;
- Adding, deleting, or modifying test data;

- Adding, deleting, or modifying I/M Program Station information or an Certified Emissions Inspector's license number; and
- Altering the calibration gas bottle values.

1.8 Automated Inspection Process Software and Displays

The inspection process, data collection, and quality control features of the Testing Equipment must be automated as much as possible. The software must automatically select the emission standards for the vehicle from an internal reference table. Vehicle identification information must be derived from a database accessed over a real time data system to the Testing Equipment. Access to the Vehicle Identification Database (VID) shall be accomplished by entry of the vehicle identification number (VIN) in its entirety. Provisions must be made for manual entry of data for vehicles not in the reference files of the Testing Equipment. The Contractor in consultation with the Department shall customize how the emission testing results are displayed on the Testing Equipment and on the approved paperwork provided to the owner of the vehicle.

2.0 HARDWARE REQUIREMENTS

2.1 Overview

The hardware requirements for the Analyzer must meet or exceed specifications as published by the California Bureau of Automotive Repair (BAR) and contained in the "BAR-97 EMISSIONS INSPECTION SYSTEM SPECIFICATIONS" (BAR-97), dated May 1996, except where reference is made to ASM testing and NOx gas measurement requirements. The Analyzer may include all amendments made to the BAR-97 hardware specifications to present date. Each Analyzer shall be equipped with Bar Code Scanner and Engine Revolutions per Minute Detection System.

2.2 Accessing the OBD System

The Testing Equipment must include hardware and software necessary to access the on-board computer systems on all model-year 1996 and newer gasoline and natural gas powered vehicles. The Testing Equipment must also be able to access the on-board computer system on all model years 1998 and newer diesel powered vehicles. The equipment design and operation of the Testing Equipment must meet the federal requirements contained in Title 40 of the Code of Federal Regulations (CFR), Chapters 85.2207-2231 and the recommended practices regarding OBD inspections contained in the J1962, J1978 and J1979 published by the Society of Automotive Engineers (SAE). The Testing Equipment must be able to connect to the vehicle's OBD connector and access, at a minimum, the following OBD data:

- Service modes: \$01, \$03, \$06, \$07, \$09, \$0A

At a minimum, the Testing Equipment must also be capable of communicating with all OBD vehicles that use the following communications protocols:

- International Organization for Standardization (ISO) 9141;

- Variable pulse width (VPW) as defined in the SAE's J1850;
- Pulse width modulation (PWM) as defined in the SAE's J1850;
- Keyword protocol 2000 (KWP); and
- Controller area network (CAN) as defined in the ISO 15765-4.3:2001.

The OBD interrogation process must be fully integrated into the Testing Equipment, automated, and require no inspector intervention to collect and record the OBD data retrieved via the OBD connector link. No separate interface may be used.

2.3 OBD Inspection Equipment

The OBD inspection Equipment apply only to the OBD communication components, which must meet all federal requirements contained in 40 CFR §§85.2207 - 85.2231 and recommended practices contained in the J1962, J1978, and J1979 published by the SAE. The Equipment must meet criteria contained in the EPA's guidance document, "Performing Onboard Diagnostic System Checks as Part of a Vehicle Inspection and Maintenance Program" (EPA, 2001) or EPA's applicable update to this document.

2.4 Bar Code Scanner

The bar code scanner must be able to read a one-dimensional (1-D) and a two-dimensional (2-D) bar code through a windshield and use visible laser diode technology or an equivalent approved by the Department. The bar code scanner must not be able to read Universal Product Code (UPC) 1-D bar codes. The bar code scanner must be able to withstand multiple drops to concrete covering a distance of at least 4 feet and be environmentally sealed to withstand the normal operating conditions of an automotive service environment.

2.5 Engine Revolutions per Minute Detection

Testing Equipment must be equipped with a tachometer, or equivalent software and hardware necessary to detect engine RPM from the original equipment manufacturer (OEM) ignition technologies in use at the time of certification. Possible updates may be required to enable future ignition systems to be monitored for engine RPM. A software "HELP" screen must be available to help the Certified Emissions Inspector locate an RPM signal. The cable-type connection must be at least 25 feet long (measured from the front of the Testing Equipment).

Based on the vehicle identification information available to the Certified Emissions Inspector, the Testing Equipment must display messages indicating when the vehicle under inspection requires a specific type or method of the tachometer pick-up connection. A digital display tachometer must be displayed to measure engine speed. For TSI Analyzers, RPM readings must be recorded on a second-by-second basis for the 10 second or 5 second period that is used to determine the pass or fail status of the TSI emissions inspection, respectively. The tachometer operation must use one of the following means:

- Radio frequency-type transmitter/receiver that requires no direct vehicle connection and can detect engine RPM on vehicles using distributorless ignition systems (DIS);
- Cable-type connection capable of detecting engine RPM of current OEM ignition technology;
- Battery/accessory power connection; or
- Cable-type connection capable of detecting engine RPM via the OBD port.

During the official inspection process the Testing Equipment must prompt the Certified Emissions Inspector to shut the engine off while connecting the cable-type RPM connection.

The Certified Emissions Inspector may use the previously listed methods for 1996 and newer model-year vehicles if the OBD port is unable to detect engine RPM. Tachometer performance must be no less than a 0.5 second RPM response time with an accuracy of +/-3 percent of actual RPM.

2.6 Real-Time Inspection Testing Monitoring System

If required by the Department, an I/M Program Station shall be equipped with real time video capturing equipment. If a required I/M Program Station does not properly maintained an installed video capturing system and If video equipment is not fully operational, the I/M Program Station must immediately contact the Department and discontinue testing until video images of the test lanes are available for viewing by the Department.

2.7 Inspection Restrictions Based on Current Calibrations

The Analyzer must:

- prevent TSI emissions inspections if the leak check has not passed in the last 24 hours;
- prevent TSI emissions inspections if the gas calibration has not passed in the last 72 hours;

The Testing Equipment must display appropriate error messages that indicate when a leak check or other calibration is needed to allow TSI inspections to be performed.

2.8 Running Changes and Other Hardware Modifications

Changes to design characteristics, component specifications, or any other modifications to the Testing Equipment hardware must be approved by the Department. The Contractor is responsible for confirming that such changes will have no detrimental effect on performance of the Testing Equipment. The Department may require testing at approved beta test sites prior to the release of the modifications.

All proposed hardware modifications must be thoroughly tested by a third-party before being submitted to the Department, and be accompanied by a cover letter containing the following information:

- Description of all of the proposed modifications to be performed, a parts list, and the installation instructions for the Contractor-authorized repair technician;

- Test data and an engineering evaluation regarding the effects of the proposed modification(s) on the performance and reliability of the Testing Equipment for any modifications to the bench or sample system;
- Timeline showing timeframe in which the modifications are expected to occur and the number of existing units of Testing Equipment that will be updated;
- Description of any special procedures that are needed to perform the hardware modifications; and
- Documentation for any software update that would be required for the proposed hardware modifications.

2.9 Exhaust Gas Analysis Equipment Specifications

This section defines the requirements for the components needed to determine the concentrations of the exhaust gases during the TSI inspections.

2.9.1 Measured Gases

The Analyzer must measure hydrocarbons (HC) as hexane in parts per million (ppm), carbon monoxide (CO), carbon dioxide (CO₂), and oxygen (O₂) in percent. The Analyzer must have a digital display for vehicle engine speed and exhaust concentrations of HC, CO, CO₂, and O₂ and must be capable of measuring exhaust concentrations of HC, CO, CO₂, and O₂ at a minimum sample rate of twice per second.

2.9.2 Warm-up Conditions

The Analyzer must reach stability within 30 minutes from startup at 35 degrees Fahrenheit (°F). The Analyzer must be considered warmed-up when the internal verifications are complete and the zero and span readings for HC, CO, CO₂, and O₂ have stabilized within the allowable accuracy values for five minutes without adjustment. If stabilization has not been reached within an allotted time frame, then the Analyzer must prevent TSI inspection sequences and display a message instructing the Certified Emissions Inspector to call for service. Functional operation of the gas sampling system must remain disabled through an internal lockout until the instrument meets stability and warm-up requirements.

2.9.3 Sampling System Components

A) General:

The sampling system must extract exhaust gas from a subject vehicle, remove particulate matter and aerosols from the sampled gas, drain the condensed water from the sample if necessary, and deliver the resultant gas sample to the Analyzer's sensors for analysis. The sampling system must, at a minimum, consist of a tailpipe probe, flexible sample line, continuously draining water removal system, particulate trap, sample pump, and flow control components. Provisions must be made for the

introduction of zero air and calibration gases. Materials that are in contact with the gases sampled must not contaminate or change the composition of the gases to be analyzed, including gases from vehicles not fueled by gasoline. The system must be designed to be corrosion-resistant and to withstand vehicle exhaust.

B) Sample Probe and Hose Criteria:

Sample hose must be 25 feet in length with a tolerance of +/- 0.5 feet when measured from the front of the Analyzer cabinet. The hose must be composed of non-kinking material that will not be affected by or react to the exhaust gases.

Sample hose and probe provided with each Analyzer must withstand exhaust gas temperatures at the probe tip of up to 1,100°F for 10 minutes. Use of dissimilar metals with thermal expansion factors of more than 5 percent must not be used in either the construction of probes or connectors.

A positive means of retention must be incorporated to prevent the probe from slipping out of the tailpipe when in use.

A thermally insulated securely attached hand grip must be provided on the probe to ensure easy probe insertion using one hand.

The probe must be designed so that the tip extends 16 inches into the tailpipe and at least 10 inches into the vehicle's exhaust.

The probe tip must be shielded to avoid inadvertent debris collection and sealed to prevent any sample dilution when it is inserted into the tailpipe. Use of a tailpipe extension is permitted as long as the extension does not change the exhaust back pressure by more than +/- 1 inch of water pressure.

A straight probe tip must be provided that is bent less than 15 degrees, made of stainless steel solid-wall tubing with a 3/16 inch outside diameter, and designed so the connector between the removable probe tip and the rigid portion of tubing is up inside the tailpipe at least three inches to reduce the effects of any leak that might occur.

A probe tip cap suitable for performing a leak check must be provided if the vacuum decay method for performing a leak check is used. Otherwise, all hoses and connectors that are necessary to perform a leak check must be provided.

The sample system must include equipment necessary to inspect vehicles equipped with dual exhaust pipes. The flow in each leg of the dual exhaust probe sample system must be equal.

C) Particulate Filter and Water Trap:

- The particulate filter must be capable of trapping 97 percent of all particulates and aerosols five microns or larger;
- The filter must not absorb or adsorb HC;
- The filter housing must be transparent to allow the operator to observe the filter's condition without removing the housing. The filter must be removable and reliably seal after replacement;
- The water trap must be sized to remove exhaust sample water from vehicles fueled with, or a combination of gasoline, propane, compressed natural gas (CNG), oxygenated fuels, and alternative fuels. The filter bowl, filter, and housing must not react to these fuels or the vehicle's exhaust gases. The condensed water must be continuously and sufficiently drained from the water trap's bowl to prevent condensation in the sample system or in the optical bench's sample cell; and
- Incorporate a back-purge system.

D) Low Flow Indicator:

The Analyzer must lockout official TSI inspections when the sample flow is below the acceptable level. The Analyzer's sample system must be equipped with a flow meter or equivalent device that detects sample flow degradation. The Analyzer must display a low flow condition message when flow rate causes the measurement error for any gas to exceed 3 percent of the gas value used for calibration or audit or causes the analyzer response time to exceed 13 seconds to 90 percent of a step change in input, whichever is less. The sample vacuum may be continuously monitored to detect a low flow condition as an alternative.

E) Analyzer lockout:

The Analyzer must lockout official TSI inspections when the sample flow is below the acceptable level. The Analyzer's sample system must be equipped with a flow meter or equivalent device that must indicate when sample flow degradation for any gas other than NO causes:

- The measurement error to exceed 3 percent of the gas value used for checking; or
- The Analyzer response time to exceed 13 seconds for a 90 percent step change in input.

The sample vacuum may be continuously monitored to detect a low flow condition as an alternative.

3.0 Analyzer Requirements

3.1 Gas Calibration

A) General:

The Analyzer must automatically require and successfully pass a leak check and a gas calibration for HC, CO, CO₂, and O₂ by a method that is approved by the Department. The Analyzer must not allow an error of more than 2 percent of the readings using the high and low range span gases for TSI inspections. The Analyzer must automatically prohibit the performance of the tailpipe portion of the vehicle emissions inspection when readings exceed the 2 percent error tolerance. The Analyzer channels must be adjusted to the center of the allowable tolerance range as a result of the gas calibration procedure.

The standard gases to be used to calibrate and audit the Analyzer must meet the requirements in the Federal Clean Air Act, §207(b) and described in Subpart W of Part 85 of Chapter I, Title 40 of the CFR. All standard gases purchased by the I/M Program Station for use in the Analyzer must conform to the requirements established by the BAR for emissions inspection analyzer calibration gases and the National Institute of Standards and Technology (NIST).

B) Gas Calibration Procedure:

- The Analyzer must maintain accuracy between gas calibrations taking into account all errors, including noise, repeatability, drift, linearity, temperature, and barometric pressure;
- The Analyzer must automatically require a zero gas calibration and a high and low range gas calibration for HC, CO, CO₂, and O₂, where applicable. The Analyzer must record the gas reading data prior to the adjustment and other data pertinent to control charting Analyzer performance;
- The gas calibration must be accomplished by the following method: Calibration gases that meet the requirements of Section 3.1: Calibration Gases for TSI Analyzers must be introduced into the calibration port of the Analyzer. The pressure in the sample cell must be the same with the calibration gas flowing as with the sample flowing during an inspection. Once the pressure is the same, the Analyzer must perform a zero gas calibration and a leak check. The leak check must ensure that the entire sample system does not leak.

3.2 Calibration Gases for TSI Analyzers

The following gases must be used for the two-point calibration and audit.

A) Low Range Calibration Gas

HC = 200 ppm propane

CO = 0.5 percent

CO₂ = 6.0 percent

O₂ = Zero Air

N₂ = Balance 99.99 percent pure

B) High Range Calibration Gas

HC = 3200 ppm propane

CO = 8.0 percent

CO₂ = 12.0 percent

O₂ = Zero Air

N₂ = Balance 99.99 percent pure

3.3 Dilution

The flow rate of the Analyzer must not cause more than 10 percent dilution during sampling of vehicle exhaust gases from a 1.6 liter engine at normal idle. Ten percent dilution is defined as a sample of 90 percent exhaust and 10 percent ambient air.

3.4 Calibration Prompts and Gas Usage

The Analyzer must display prompts to guide the inspector through the gas calibration procedure in a manner that minimizes the amount of gas used. The Analyzer must be designed to keep the loss of calibration gas to less than 0.5 liter in 24 hours when the valve on the calibration gas bottle is left open.

3.5 Propane Equivalency Factor

The value of the PEF must range from 0.490 to 0.540 and be displayed in a manner acceptable to the Department for each gas audit and gas calibration point. If an optical bench must be replaced in the field, then the Contractor-authorized repair technician must change any external labels to correspond to the PEF of the new bench. The Analyzer must incorporate an algorithm relating PEF to HC concentration. Corrections to the PEF must be made automatically and the corrected PEF value must range from 0.470 to 0.560.