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Gray Davis
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November 1, 2001

Manufacturers Advisory Correspondence

MAC 2001-03

TO: ALL PASSENGER CAR MANUFACTURERS
ALL LIGHT-DUTY TRUCK MANUFACTURERS
ALL MEDIUM-DUTY VEHICLE MANUFACTURERS
ALL INTERESTED PARTIES

SUBJECT: Optional Test Procedure For Certifying Pre-2005 Model-Year Gasoline-Fueled Zero-Evaporative Vehicles And For Offsetting Evaporative And NMOG Emissions For Such Vehicles.

This letter notifies all interested parties that the Alliance of Automobile Manufacturers proposed test procedure for certifying gasoline-fueled zero evaporative vehicles has been approved, with modifications (see Attachment). Beginning with the 2005 model-year vehicles, however, manufacturers must provide additional supporting data, such as aging all fuel system components to full useful life, to continue using this procedure.

Also, included is the recommended exhaust NMOG/evaporative trading factors. The first factor, 0.1 g/test per 0.002 g/mi NMOG, is derived from the allowance in Section 1976(b)(1)(E) of Title 13, California Code of Regulations (13 CCR) for vehicles seeking a partial zero-emission vehicle (PZEV) credit and may be applied to reduce measured fuel evaporative emissions for certification and in-use testing provided that the vehicle's measured exhaust NMOG certification and in-use emissions are proportionately increased. The second factor, a 0.002 g/mi NMOG credit, is derived from the allowance in 13 CCR Section 1961(a)(11) and may be applied to reduce measured exhaust NMOG certification and in-use emissions for vehicles that are certified to the optional zero-fuel evaporative emission standard but do not seek PZEV credit.

If you have any additional questions, please contact Ms. Rhonda Runyon, Staff, On-Road Certification/Audit Section, at (626) 575-6653 or at rrunyon@arb.ca.gov.

Sincerely,

R. B. Summerfield, Chief /s/
Mobile Source Operations Division

Attachment

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, see our Website:
<http://www.arb.ca.gov>.

California Environmental Protection Agency

STATE OF CALIFORNIA
AIR RESOURCES BOARD

Manufacturer's Advisory Correspondence #MSO 2001-03

SUBJECT: Optional Test Procedure For Certifying Pre-2005 Model-Year Gasoline-Fueled Zero-Evaporative Vehicles And For Offsetting Evaporative And NMOG Emissions For Such Vehicles

APPLICABILITY: 2003 and 2004 model-year (MY) gasoline-fueled motor vehicles and gasoline-fueled hybrid-electric vehicles certified to the optional zero-fuel evaporative emission standards

REFERENCES:

1. Section 1976 of Title 13, California Code of Regulations (13 CCR), "Standards and Test Procedures for Motor Vehicle Fuel Evaporative Emissions."
2. "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles."
3. "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," Part II, A, 100.3.1.
4. 13 CCR Section 1961, "Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles."

BACKGROUND AND DISCUSSION:

13 CCR Section 1976 (b)(1)(E) establishes the optional zero-fuel evaporative emission standards for the three-day and two-day diurnal-plus-hot-soak tests, which are:

- "Whole vehicle" –
0.35 grams HC per test for passenger cars (PCs); 0.50 grams HC per test for light-duty trucks (LDTs) 6,000 pounds GVWR and under; and 0.75 grams HC per test for LDTs from 6,001 to 8,500 pounds GVWR, and
- "Fuel-only" –
zero (0.0) grams of fuel evaporative emissions per test.

In lieu of demonstrating compliance with the “fuel-only” zero (0.0) grams of fuel evaporative emissions per test over the three-day and two-day diurnal-plus-hot-soak tests, the manufacturer may submit, for advance Executive Officer approval, a test plan to demonstrate that the vehicle has zero (0.0) grams of fuel evaporative emissions throughout its useful life. The purpose of this Manufacturer’s Advisory Correspondence (MAC) is to provide manufacturers with guidance in developing a test protocol demonstrating compliance with the “fuel-only” zero evaporative requirements. Manufacturers have the option of submitting for approval an alternative test protocol demonstrating compliance with the zero evaporative emission requirements that is different from the one presented in this MAC. The test protocol developed in this MAC is approved for the 2003 and 2004 MY. Beginning with the 2005 and subsequent MY, manufacturers will investigate the following additional sources of emissions to support or modify their current test protocol:

- Fuel permeation stabilization of evaporative system components (determine temperature and duration to stabilize permeation rates)
- Hydrocarbon intake losses (develop measurement method)
- Hydrocarbon engine losses (measure engine gasket emissions)
- Durability of evaporative system components, including hoses and connectors (both liquid and vapor control systems)
- Rig tests conducted with components “aged” to useful life
- Ozone exposure to full useful life

Manufacturers will need to provide these data to continue using this test protocol for the 2005 and subsequent MY. In addition, the carry-over and carry-across of 2003 and 2004 MY data for 2005 and subsequent MY certification is conditional upon these supporting data.

Also, 13 CCR Section 1976 (b)(1)(E) provides manufacturers that are seeking PZEV credits the option of having the measured fuel evaporative emissions reduced (in 0.1 gram HC increments) in all certification and in-use testing, provided that the measured NMOG exhaust emissions for the vehicle are proportionately increased in all certification and in-use testing. Additionally, 13 CCR Section 1961(a)(11) allows an exhaust NMOG credit, to be applied against the measured NMOG emissions in certification and in-use testing, for vehicles that are certified to the zero-fuel evaporative standards but do not seek PZEV credit. By way of this MAC, the Executive Officer has approved staff’s method for calculating the exhaust/evaporative emission trading factor, including the factor of 0.1 g/test per 0.002 g/mi NMOG for purposes of 13 CCR Section 1976(b)(1)(E) and the factor of 0.002 g/mi NMOG for purposes of 13 CCR Section 1961(a)(11).

“WHOLE VEHICLE” EMISSIONS TEST PROCEDURE OVERVIEW

In order to demonstrate compliance with the “whole vehicle” emission standards, manufacturers shall conduct both the three-day and two-day diurnal-plus-hot-soak test sequence with either a vehicle which has been “aged” to the useful life or which accounts for aging to 15 years/ 150,000 miles useful life. Manufacturers may continue using their approved evaporative aging procedures or may propose alternatives, in which case the duration must be extended to account for the increased useful life of 15 years/ 150,000 miles.

If a manufacturer’s evaporative emission control system design includes an air induction system (AIS) carbon filter, the carbon element shall not be preconditioned nor shall it be removed from the vehicle during vehicle preconditioning prior to the 2-day and 3-day diurnal-plus-hot-soak tests.

“FUEL-ONLY” EMISSIONS TEST PLAN OVERVIEW

The “fuel only” emissions test plan includes the testing of two fuel system rigs, one of which is never exposed to any fuel (“dry” rig), and the other is exposed to fuel (“wet” rig). These rigs will undergo both three-day and two-day diurnal-plus-hot-soak tests (see Figure 1). Manufacturers, however, may provide an engineering evaluation in lieu of conducting the 2-day diurnal-plus-hot-soak test. If an engineering evaluation is conducted, the manufacturer must provide data showing that the carbon canister state, at the end of 2-day test drive cycle, will control two days worth of diurnal emissions.

The results of the “dry” rig testing are used to determine non-fuel (background) hydrocarbon emissions from rig components. These results are then subtracted from the “wet” rig results to determine total fuel-only evaporative emissions. The following procedures should be included in the design and preparation of the rigs:

A. Fuel System Rig Design

Two identical rigs are assembled from the same batch of components (see Figure 2). The manufacturer shall use good engineering judgment to ensure that the components included on a rig are those components that are exposed to liquid fuel or fuel vapor during the course of operation on a vehicle. Typically, these components include the fuel tank assembly (including the fill neck, fuel cap, fuel tank, and all tank fittings and valves), the fuel delivery system (including the fuel pump/sender, fuel filter, fuel lines, fuel rail assembly, and fuel injectors), the fuel vapor control system (including all fuel vapor tube assemblies, the purge control valve, and the carbon canister assembly), as well as the AIS assembly of the engine (including the intake manifold, the air “breathing” tube, air filter assembly, and any fuel vapor control device in the AIS). Any “holes” that may be

present in rig components that are a result of missing vehicle components (e.g. the "hole" in the intake manifold where the cylinder head was supposed to be) may be sealed before testing.

To make the rigs more easily transportable, each rig may be supported on a movable fixture (e.g. tube metal or a portion of the vehicle underbody). The lengths of metallic fuel lines may be reduced to allow the size of the rig to be more compact. However, the dimensions of all fuel-permeable components are to be production representative.

B. Rig Stabilization (Prior to Testing)

1. Fuel Injector Mechanical Operation:

For the "wet" rig only, the fuel injectors will be stabilized to a 4K-mile test condition. This stabilization may be achieved by installing the injectors on a representative vehicle and driving the vehicle for 4,000 miles (as an emission data vehicle would accumulate 4,000 miles), or by cycling the injectors to a 4K-stabilized condition, using a laboratory simulation based on good engineering judgment.

2. Carbon Canister Purge/Load Cycling:

For the "wet" rig only, the carbon canister will be stabilized to a 4K-mile test condition. This stabilization may be achieved by installing the canister on a representative vehicle and driving the vehicle for 4,000 miles (as an emission data vehicle would accumulate 4,000 miles); or by bench cycling the carbon canister to a 4K-stabilized condition, using a laboratory simulation based on good engineering judgment (e.g., by loading the canister no less than ten times to 2-gram breakthrough with a 50/50 mixture by volume of butane and nitrogen, at a rate of 15 grams butane per hour, with each loading preceded by canister purging with 300 canister bed volume exchanges at 0.8 cfm).

3. Evaporative System Fuel and Temperature Exposure:

Manufacturers will need to determine the necessary fuel exposure (temperature and duration) to stabilize permeable fuel system components. Staff understands that the data available on low permeable materials are not complete. Therefore, manufacturers may use the following temperature exposure ("bake") procedure prior to rig testing (see Figure 3):

a. Pre-Bake Events for the "Wet" Rig:

- 1) The 4K-stabilized fuel injectors will be installed onto the rig (note: any seals on the fuel injectors may be replaced with new seals to ensure the injectors can be properly installed onto the rig).
- 2) The fuel tank will be filled to a 40% nominal fill with California certification test fuel (as defined in Part II, A, 100.3.1 in "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium Duty Vehicles.")
- 3) The fuel pump will be operated to bleed air out of the fuel rail and to expose the injectors to fuel (note: the bleed air may escape, for example, through a special (non-production) service port on the fuel rail or through the fuel injectors).
- 4) The special fuel rail service port (if used) will be sealed and the fuel pump will be operated momentarily to pressurize the fuel rail.
- 5) The intake manifold may be flushed with fresh air. (This also may be conducted after baking, but before testing.)

b. Rig Bake (All Components):

All components on both the "wet" and "dry" rigs will be baked at 105°F (or at higher nominal temperatures) for no less than 336 hours (14 days) cumulative. This procedure is intended to accelerate the swelling of fuel-permeable "wet" rig components to more closely represent their stabilized swell state in use. Manufacturers have the option of removing both the carbon canisters and AIS components prior to this bake period.

c. Rig Bake (Engine-Compartment Components):

For both the "wet" and "dry" rigs, all engine-compartment rig components that contain fuel-permeable materials will be baked to represent 4000-mile vehicle aging ("engine-compartment temperature" bake). Typically, these components will include the flexible tubing located between the purge control valve and the engine intake manifold, as well as the flexible tubing that is designed to carry liquid fuel toward the fuel rail. AIS assembly components may be excluded from "engine-compartment temperature" baking since they are exposed to continuously flowing, ambient-temperature air, during engine operation. Also, "wet" rig fuel injectors that contain fuel-permeable materials may be excluded from "engine-compartment temperature" baking if they were installed on a vehicle for the 4K stabilization and included in the "wet" rig construction. Components that undergo the "engine-compartment temperature" bake procedure and undergo additional baking at 105°F for no less than 7 days have satisfied all rig-baking requirements.

The "engine-compartment temperature" bake may be achieved by one of the following methods:

- Baking these components (as installed on the rig or as transferred to a suitable environmental chamber) at an elevated temperature for no less than seven days (see Figure 3(A)). The elevated bake temperature may be based on maximum engine-compartment temperatures at the location of these components during fuel tank temperature profile determination or during a running loss test. However, if engine-compartment component temperature data are unavailable, then a constant bake temperature of 220°F may be used. The "wet" rig components will be exposed to a representative amount of fuel vapor or liquid fuel during baking.

OR

- Installing these components (e.g., rubber tubing) on a vehicle and driving the vehicle for 4,000 miles (on a test track or on a dynamometer). This option, however, is for "wet" rig components only (see Figure 3(B)).

The "engine-compartment temperature bake," however, may be excluded if the manufacturer submits data demonstrating that the difference between conducting and not conducting the "engine-compartment temperature bake" results in a negligible difference in emission measurements (see Figure 3(C)), based on good engineering judgment (e.g., a demonstration that fuel permeation from these components that have been "engine-compartment temperature" baked is less than 2 mg HC during a diurnal-plus-hot-soak test).

"FUEL-ONLY" EMISSIONS TEST PROCEDURES

The California test fuel and temperatures shall be used in all test procedures. The "dry" rig is tested first, followed by "wet" rig testing, followed by repeat "dry" rig testing. All hot soak tests for both rigs are to be conducted in the same SHED, and the SHED may not be used for any other testing purposes between rig tests. All diurnal tests for both rigs are to be conducted in the same SHED, and the SHED may not be used for any other testing purposes between rig tests. The provision to conduct tests in the same SHED may be waived if the manufacturer provides a compelling reason to do so. However, the manufacturer must provide data for advance Executive Officer approval demonstrating SHED-to-SHED correlation of emission results.

1. "Dry" Rig Test #1:

The stabilized "dry" rig will undergo the test procedures of the three-day and two-day (if required) diurnal-plus-hot-soak tests, including the required 6- to 36-hour soak between the hot soak and diurnal tests, with the following exceptions: 1) testing a rig instead of a vehicle, 2) eliminating all required vehicle procedures prior to the hot soak test (such as fuel fills,

preconditioning, exhaust and running loss tests, etc.), and 3) including only the first 24-hour diurnal period (end the test after 24 hours).

2. "Wet" Rig Test:

The carbon canister from the stabilized "wet" rig will be preconditioned to represent the state of the canister just prior to the hot soak test. This canister preconditioning may be achieved by installing the canister on a representative vehicle and preparing the vehicle for the hot soak test (including a vehicle preconditioning drive, 300-bed-volume canister purge, appropriate canister load, cold and hot start exhaust tests, and, for the 3-day test sequence, a 105°F running loss test). Alternatively, the carbon canister preconditioning may instead be achieved by conducting: 1) a 300-bed-volume canister purge, 2) appropriate canister load, and 3) a canister purge in a laboratory simulation, based on an engineering evaluation, to represent the net mass of butane desorbed from the canister during the drive cycle of the tests. This alternative method provides manufacturers flexibility for potential special cases in which canister removal is difficult.

The "wet" rig will be temperature soaked at the required test temperature for the last six hours preceding the hot soak test. The carbon canister may be disconnected from sources of fuel vapor during this temperature soak to maintain its preconditioned state; however, the canister is to be properly connected during the subsequent hot soak and diurnal tests. The fuel pump will be operated momentarily to pressurize the fuel rail prior to the hot soak test. The "wet" rig will undergo the procedures of the three-day and two-day (if required) diurnal-plus-hot-soak test, starting with the one-hour hot soak test and including the required 6- to 36-hour soak between the hot soak and diurnal tests. Manufacturers will conduct the remainder of the test by conducting one of the following test sequences (see Figure 4):

a. Simulate Engine-Compartment Temperature:

At the beginning of hot soak test, each fuel-permeable engine-compartment rig component will be heated to an elevated temperature (see Figure 4, option A). This elevated temperature used during this "pre-test heating" may be based on the engine-compartment temperature at the location of these components in a test vehicle at the beginning of the hot soak test. If these engine-compartment component temperature data are unavailable, then these components may instead be heated to 220°F.

b. Additive Temperature Correction Factor:

This "pre-test heating" may be excluded, however, if the manufacturer submits data, based on good engineering judgment, to quantify the difference

in hot soak test data between conducting the "pre-test heating" and not conducting the "pre-test heating" (see Figure 4, option B). This quantity would then be added to the hot soak test data in which "pre-test" heating was not conducted, and used toward demonstrating compliance to the 0.0 grams HC standard. One method to determine this quantity is to measure the difference in permeation of the fuel-permeable engine-compartment components (including their end connections) for one hour at two separate temperature conditions: 1) a constant temperature of 105°F and 2) a temperature-time profile based on the temperatures these components are exposed to in a test vehicle during the hot soak test.

c. Engineering Evaluation of Temperature Effect:

If the manufacturer has submitted data demonstrating that the difference between conducting and not conducting the "engine-compartment temperature" bake results in a negligible difference in emission measurements (that is, less than 2 mg during the hot soak test), then all fuel system components will be soaked at the test temperature (see Figure 4, option C).

3. "Dry" Rig Test #2:

(Repeat of "Dry" Rig Test #1) The stabilized "dry" rig will undergo the test procedures of the three-day and two-day (if required) diurnal-plus-hot-soak test, including the required 6- to 36-hour soak between the hot soak and diurnal tests, with the following exceptions: 1) testing a rig instead of a vehicle, 2) eliminating all required vehicle procedures prior to the hot soak test (such as fuel fills, preconditioning, exhaust and running loss tests, etc.), and 3) including only the first 24-hour diurnal period (end the test after 24 hours).

CALCULATIONS:

1. Standard calculations for hot-soak and diurnal tests apply.
2. Two separate "dry" rig tests will be conducted to address concerns with SHED background variability. The "dry" rig diurnal-plus-hot-soak HC evaporative emissions will be calculated based on the mean of the results between 1) the diurnal-plus-hot-soak test before the "wet" rig is tested and 2) the diurnal-plus-hot-soak test after the "wet" rig is tested. Diurnal-plus-hot-soak emission results are calculated based on the HC emission level of the one-hour hot soak test plus the 24-hour diurnal test HC emission level.
3. "Wet" rig diurnal-plus-hot-soak HC evaporative emissions will be calculated based the emission level of the one-hour hot soak test plus the highest 24-hour emission level during the diurnal test. If "pre-test heating" of engine-

compartment rig components is not conducted before the hot soak test, a factor (unless negligible) will be added to the hot soak test data to account for the increase in permeation that would occur had the components been pre-heated.

4. Total fuel evaporative emissions will be determined by subtracting the "dry" rig diurnal-plus-hot-soak HC evaporative emissions from the "wet" rig diurnal-plus-hot-soak HC evaporative emissions.
5. For rig testing, net enclosure volume is calculated by subtracting 5 cubic feet (or a manufacturer-determined rig volume with advance Executive Officer approval) from the enclosure volume.
6. The manufacturer may submit fuel evaporative emission calculations, for advance approval by the Executive Officer, if the test plan is expanded to include additional tests on the "dry" and "wet" rigs, as well as testing of more than one "dry" and "wet" rig.
7. Total fuel evaporative emissions less than or equal to 54 mg HC for both the three-day and two-day (if required) diurnal-plus-hot-soak tests demonstrate compliance with the optional zero-fuel evaporative emission standard.

EXHAUST/EVAPORATIVE EMISSIONS TRADING FACTORS

1. Offset Under 13 CCR 1976(b)(1)(E):

The LEV II regulations provide manufacturers of vehicles seeking PZEV credit with additional flexibility in complying with the zero-fuel evaporative emission standards, such as the ability to offset a vehicle's measured HC fuel evaporative emissions by proportionately adding NMOG emissions to the vehicle's exhaust emissions test result. However, manufacturers electing to use this option must offset the fuel evaporative emissions in 0.1 grams HC increments. The ARB staff has developed the following equation to calculate the appropriate increase in a vehicle's measured NMOG exhaust emissions for a corresponding 0.1 grams HC per test reduction in the vehicle's measured fuel evaporative emissions:

$$E_{\text{exh}} [\text{g/mile}] = \frac{E_{\text{evap}} [\text{g/day}] \times F_{\text{adj}}}{D_{\text{ave}} [\text{mile/day}]}$$

Where:

E_{exh} is the amount of NMOG emissions (to be added to the exhaust test emissions).

E_{evap} is the amount of HC evaporative emissions (in 0.1 grams HC increments) (to be subtracted from the fuel evaporative emissions).

F_{adj} is 0.67, a factor used to adjust the certification evaporative temperature conditions to southcoast ozone planning temperature conditions (EMFAC 2000 model was used for calculating this adjustment factor).

D_{ave} is 36 miles per day, the average vehicle miles traveled per day in the South Coast Air Basin.

Example 1: Assume that a manufacturer is seeking to offset 0.1 grams HC per day of fuel evaporative emissions from a SULEV PC vehicle for which it is also seeking PZEV credit. Then the following amount of NMOG emissions would be added to the vehicle's exhaust test NMOG emissions:

$$E_{\text{exh}} [\text{g/mile}] = \frac{0.1 \times 0.67}{36} = 0.002 \text{ g/mile}$$

Example 2: Assume that a 2007 model-year SULEV PC (for purposes of this example, the in-use standard is the same as the certification standard) the vehicle in Example 1 above has the following 150,000-mile emissions before offsets: 0.006 g/mi NMOG and 0.067 g/test fuel evaporative HC during

certification, and, a few years later, 0.009 g/mi NMOG and 0.078 g/test fuel evaporative HC during in-use testing. Assume further that all other regulated pollutants from this vehicle comply with the SULEV PC emission standards during certification and in-use testing. Apply the 0.002 g/mi for 0.1 g/test offset. For certification purposes, this vehicle will be deemed as having certification levels of 0.008 g/mi NMOG ($0.006 + 0.002$) and 0.000 g/test fuel evaporative HC ($0.067 - 0.100 = -0.033$ reset to 0.000); the vehicle is qualified for and will be granted PZEV credit (if it is warranted to 150,000 miles, and if the OBD system is certified for 150,000 miles). However, this vehicle will be deemed as having in-use emissions of 0.011 g/mi NMOG ($0.009 + 0.002$) and 0.000 g/test fuel evaporative HC ($0.078 - 0.100 = -0.022$ reset to 0.000); the vehicle has exceeded its in-use NMOG standard and will be subject to corrective actions.

2. Offset Under 13 CCR 1961(a)(11):

The LEV II regulations provide an NMOG offset factor, to be determined by the Executive Officer, for non-PZEV vehicles that are certified to the optional zero-fuel evaporative emission standard. This reactivity-adjusted offset factor is used for subtracting from the measured NMOG emissions during certification and in-use testing. The ARB staff has developed an NMOG offset factor of 0.002 g/mi as follows.

The basic 0.002 g/mi NMOG per 0.1 g/test evaporative HC offset is the same as that developed for 13 CCR 1976(b)(E) above. The difference between the non-zero-fuel and optional zero-fuel evaporative standards is 0.15 g/test (e.g., 0.50 vs. 0.35 for PC, 0.65 vs. 0.50 for LDT under 6000 pounds GVWR, or 0.90 vs. 0.75 for LDT under 8500 pounds GVWR). The NMOG offset before reactivity adjustment is, therefore, 0.003 g/mi ($= 0.002 * 0.15 / 0.1$). Because evaporative HC emissions are less reactive than exhaust NMOG emissions, ARB staff has determined that the reactivity-adjusted NMOG offset of 0.002 g/mi is appropriate for non-PZEV vehicles certified to the optional zero-fuel evaporative emission standard.

Example 3: Assume a 2007 model-year PC vehicle has 50,000- and 120,000-mile NMOG certification emissions of 0.041 and 0.050 g/mi, respectively; all other emissions comply with the PC ULEV II standards. Furthermore, the manufacturer has elected to comply with the zero-fuel evaporative standards. Apply the 0.002 g/mi offset. The vehicle is then deemed as having 50,000- and 120,000-mile NMOG certification emissions of 0.039 ($= 0.041 - 0.002$) and 0.048 ($= 0.050 - 0.002$) g/mi, respectively, and is certified to the ULEV II emission standards as requested by the manufacturer.

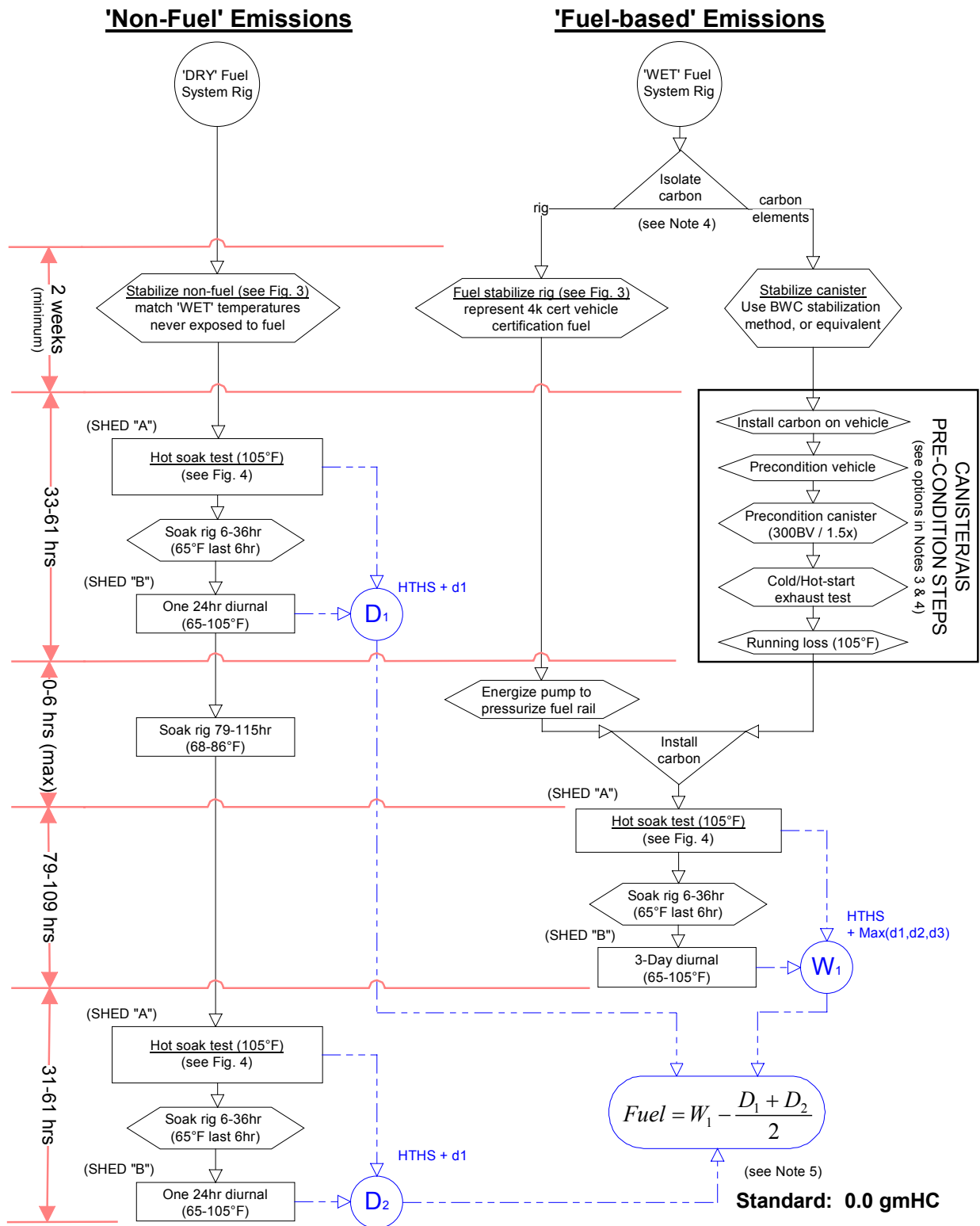


Figure 1: Test Rig 3-Day Evaporative Test Procedure¹

¹ This flow chart can be followed for the 2-day test except that vehicle preconditioning and testing must be consistent with the 2-day procedure.

NOTES

- 1) This is the California 3-Day diurnal measurement procedure with modifications to permit direct measurement of fuel-based hot-soak and diurnal evaporative emissions. (The California 2-Day diurnal measurement procedure (not shown) is similar to the 3-day.) The modifications are, in summary:
 - a) Measure the hot-soak and diurnal emissions of a fueled rig – a moveable fixture that holds together the vehicle fuel-handling (liquid and vapor) components.
 - b) Determine the background emissions of the SHED(s) and a second but identical un-fueled ('DRY') rig. This value is a correction factor (D) that is subtracted from the 'WET' rig measurement (W) to determine 'fuel-based' emissions ($Fuel$). The 'DRY' rig is treated identical to the fueled 'WET' rig with the exception it is never exposed to fuel and its components are never actuated. All measurements are conducted using the same SHED(s) – that is, SHED "A" and SHED "B" if separate units are used for hot-soak and diurnal measurements, or SHED "A" if a single SHED is used. Alternatively, different SHEDs may be used if the results of each SHED can be correlated with the others.
 - c) Pre-condition the 'WET' rig vapor storage carbon element(s) (i.e., evaporative canister, engine air-inlet element) by temporarily installing the carbon on-board a representative vehicle.
- 2) Two identical rigs assembled from the same component batches are required. The standard rig content includes, in summary (see Figure 1 for details):
 - a) Fuel cap, fillneck, and tank assembly
 - b) Liquid and vapor tube assemblies (tubing, valves, filters)
 - c) Vapor storage canister and purge valve assemblies
 - d) Engine fuel injection assembly plus air-inlet system (manifold, air "breathing" tube, air filter assembly)
 - e) A metallic fixture (tube metal or portion of vehicle underbody) to hold all tested components.
- 3) As an option, the exhaust and running-loss tests under "Canister/AIS Pre-Condition Steps" may be used to report measured emissions for the corresponding standards (with appropriate consideration given to component aging prior to test).
- 4) As an alternative to "Canister/AIS Pre-Condition Steps", a manufacturer may submit for advance agency approval a plan to pre-condition vapor storage devices (i.e., evaporative canister, engine air-inlet carbon element) using a laboratory simulation representative of vehicle operation. This provides manufacturers flexibility for potential special cases; for example, a vehicle design which integrates (permanently attaches) the evaporative canister with the fuel tank.
- 5) As an option, manufacturers may repeat 'non-fuel' or 'fuel-based' measurements. In this case, the mean (average) values of sample measurements (D , W) are used to determine "Total Fuel Emissions" ($Fuel$). This provides flexibility to address potential measurement uncertainty concerns.

ZERO EVAPORATIVE EMISSIONS TEST RIG

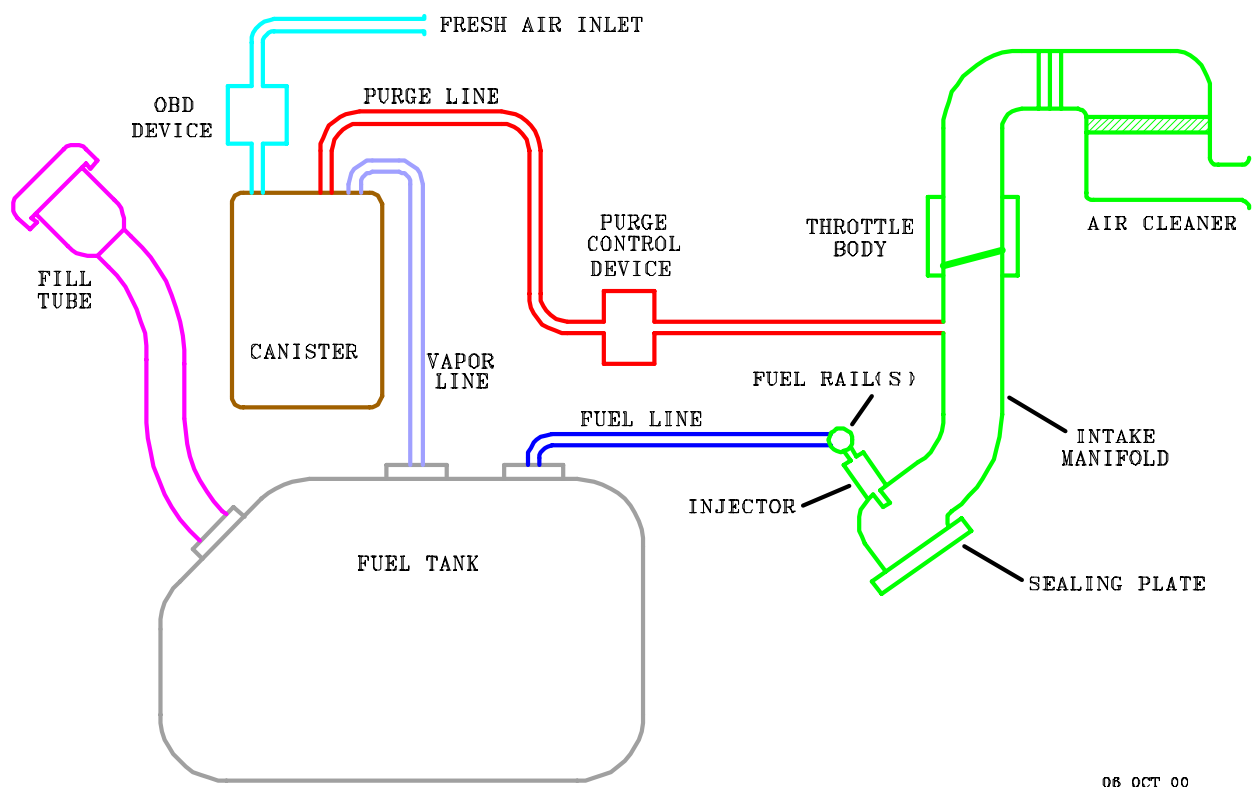


Figure 2: Schematic of a typical fuel system rig ('WET' and 'DRY').

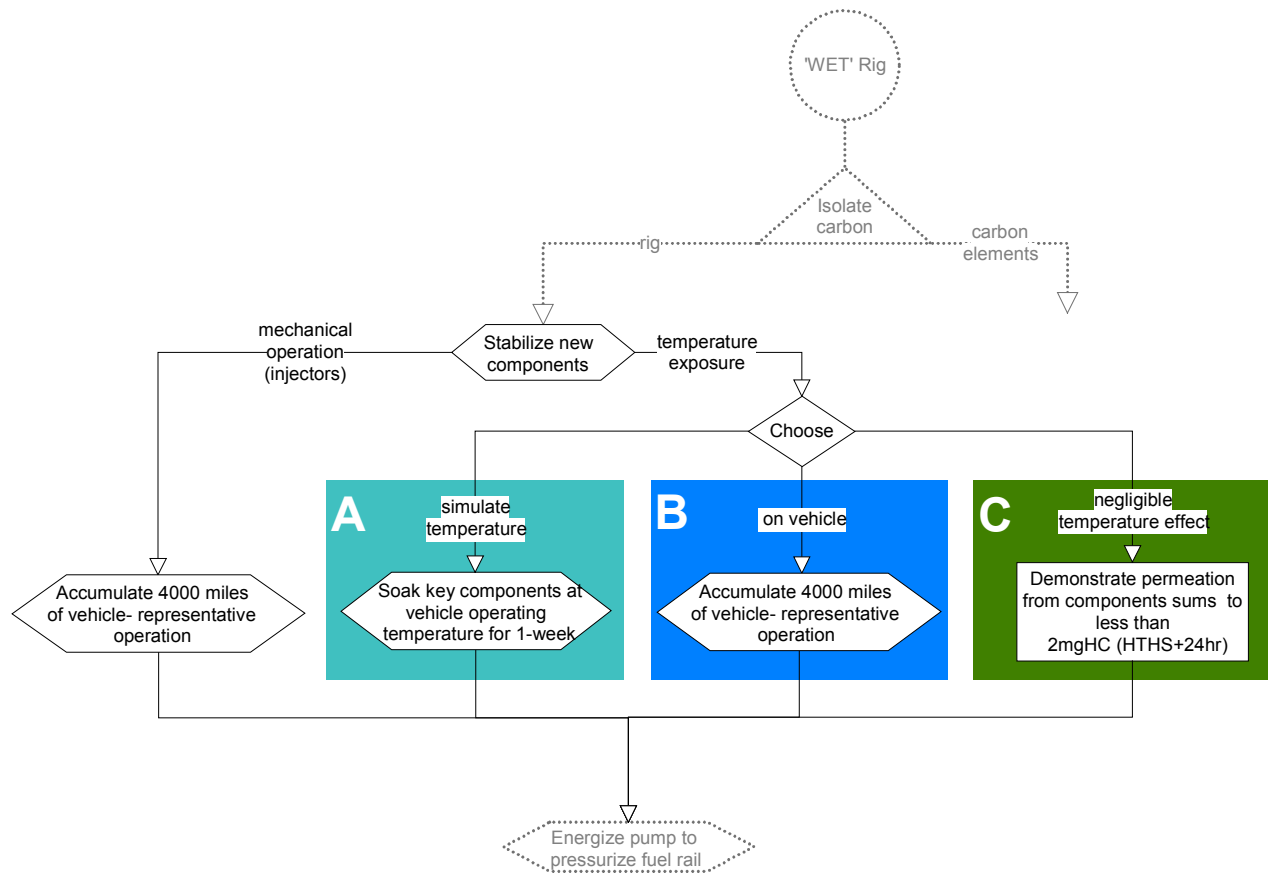


Figure 3: Fuel Rig Stabilization Options

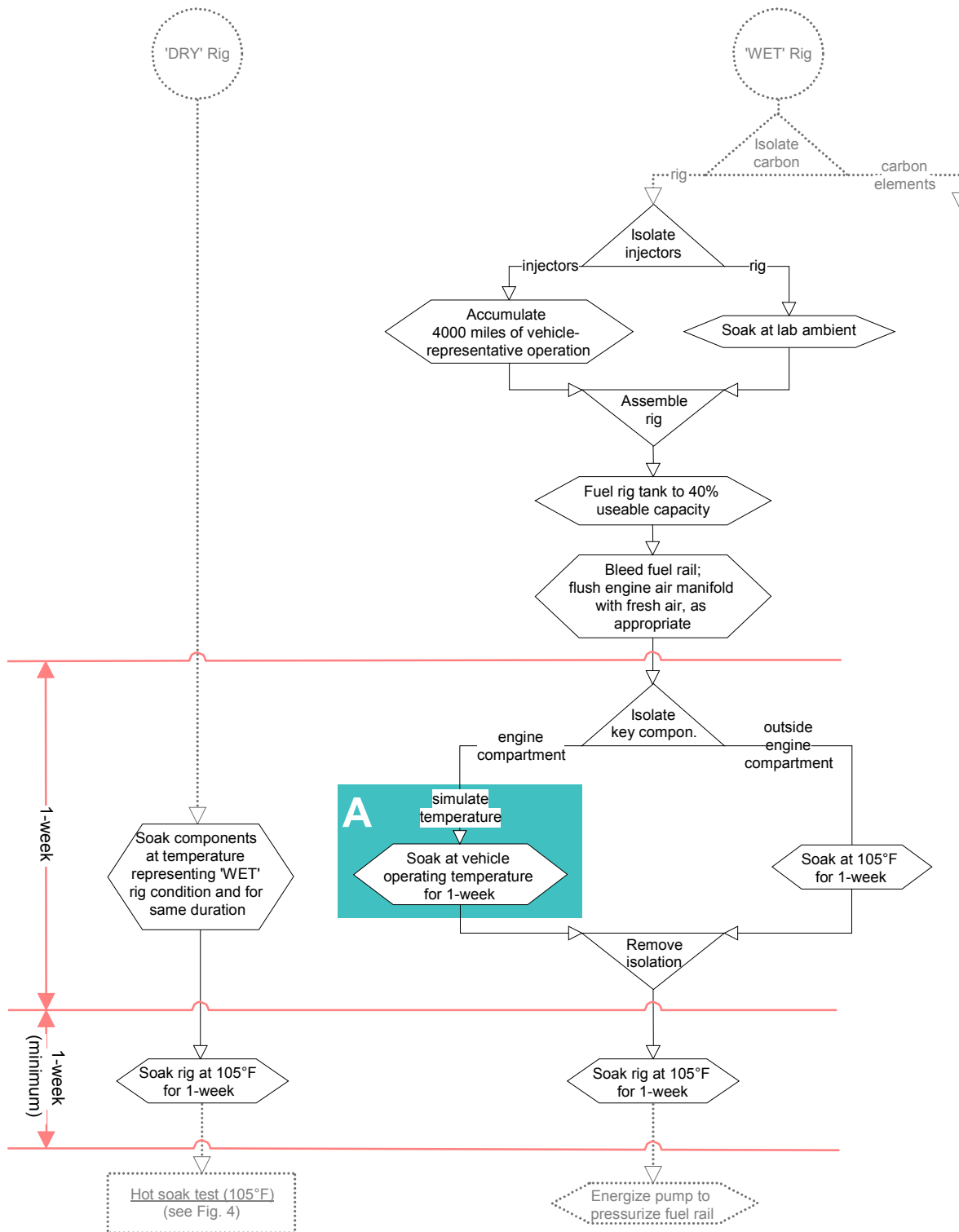


Figure 3(A): Fuel system stabilization accomplished by simulating engine compartment temperatures.

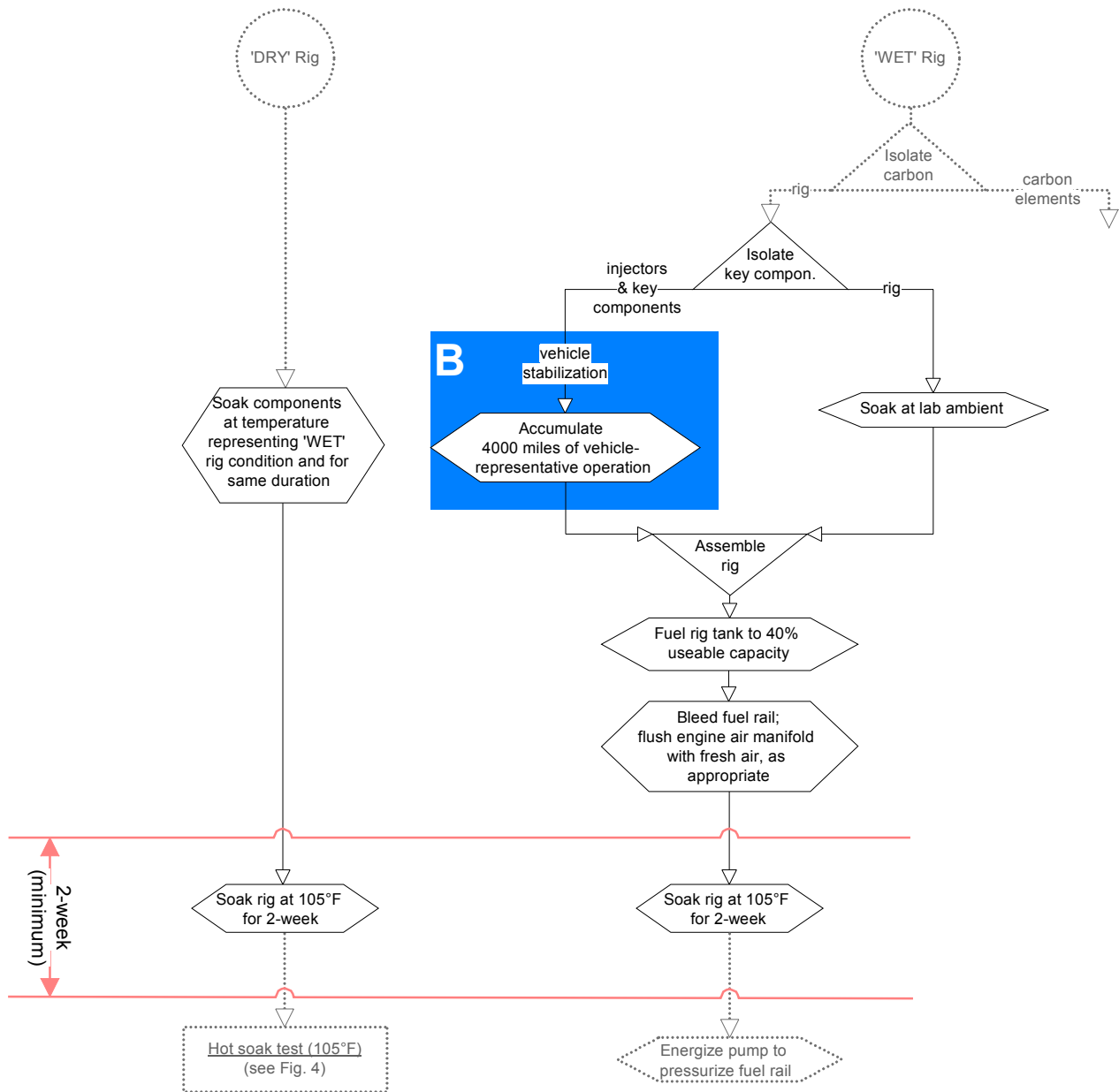


Figure 3(B): Fuel system stabilization accomplished by transferring key components to a vehicle and accumulate 4000 miles of operation.

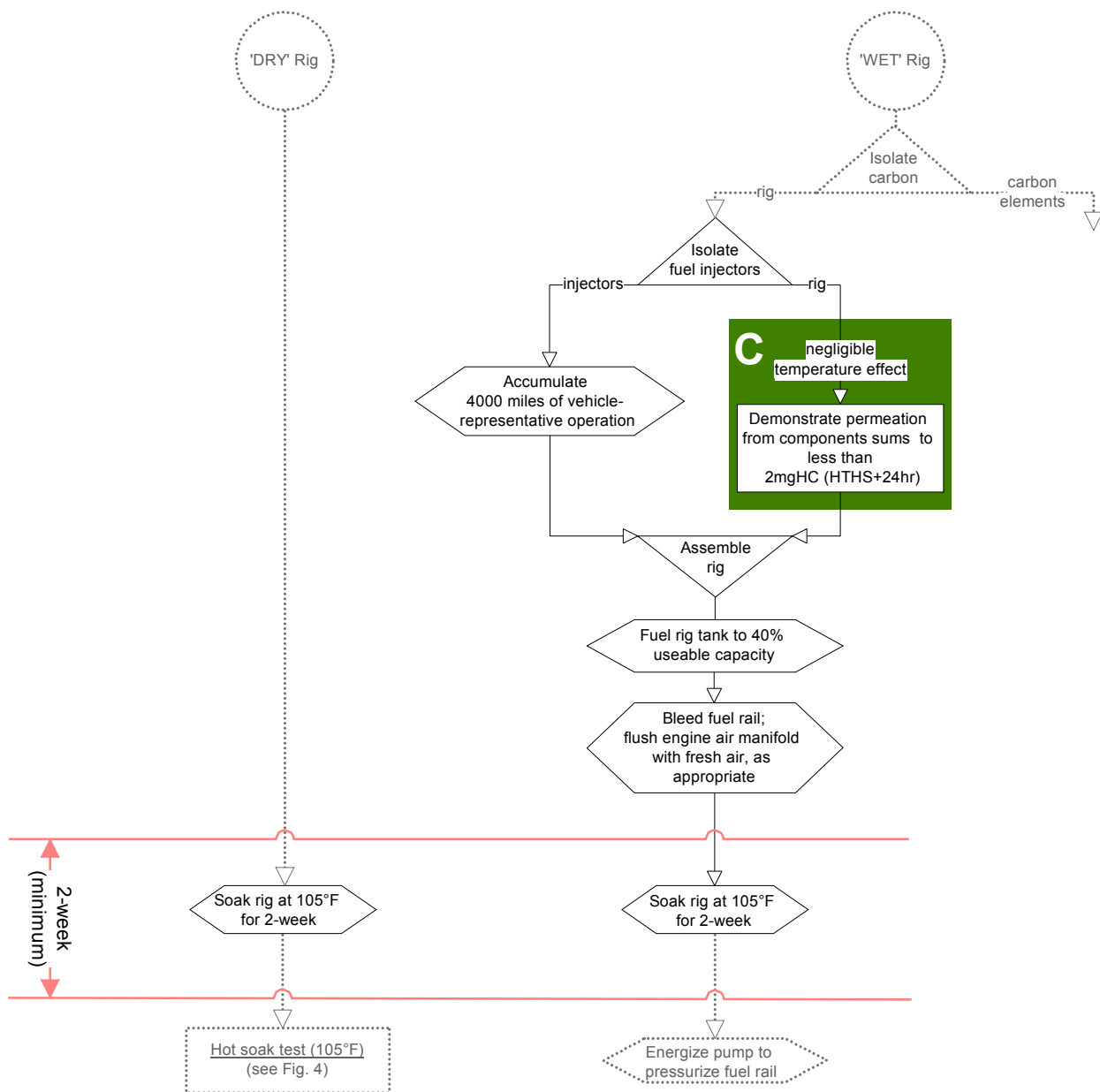


Figure 3(C): Fuel system stabilization accomplished when permeation at elevated temperatures is determined to be negligible.

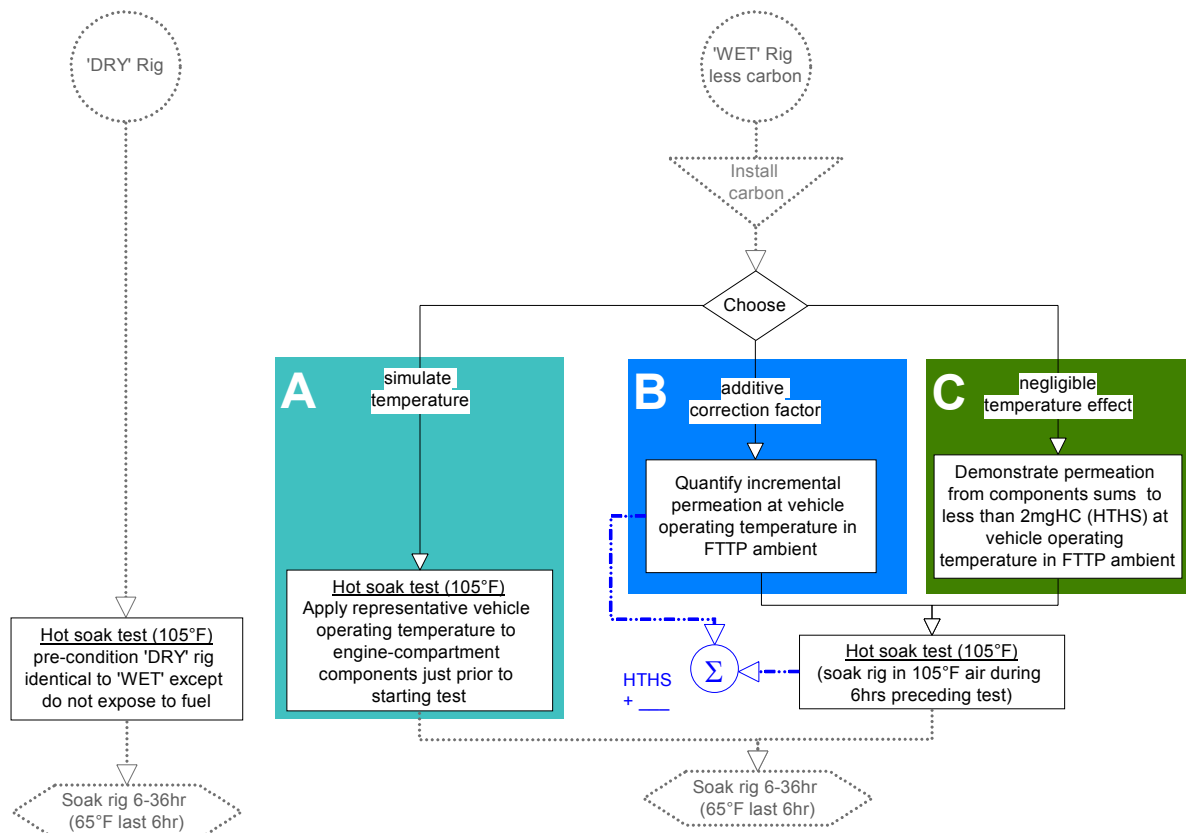


Figure 4: Fuel Rig Hot Soak Testing Options