State of California
AIR RESOURCES BOARD

CALIFORNIA PROCEDURES FOR EVALUATING ALTERNATIVE SPECIFICATIONS FOR GASOLINE USING VEHICLE EMISSIONS TESTING

Adopted: September 18, 1992
Amended: April 25, 2001

As amended April 25, 2001 (Corrected August 16, 2001)
Board Hearing: November 16, 2000

California Procedures for Evaluating Alternative Specifications for Gasoline Using Vehicle Emissions Testing

I. INTRODUCTION

A. Purpose and Applicability

1. The test procedures and analyses prescribed in this document ("test protocol") may be used to evaluate gasoline specifications proposed as alternatives to the Phase 2 California reformulated gasoline (CaRFG) flat limit specifications or the Phase 3 CaRFG flat limit specifications set forth in section 2262, title 13, California Code of Regulations (collectively referred to herein as the "CaRFG flat limit specifications").

2. Gasoline properties for which alternative specifications may be set by this protocol include all properties having CaRFG flat limit specifications, except Reid vapor pressure (RVP) and the Phase 3 CaRFG prohibition of MTBE. Any other properties not covered by the CaRFG flat limit specifications also may receive specifications by this protocol.

3. Limits on the values allowable for certain specifications are as follows, reflecting the cap limits in section 2262, title 13, California Code of Regulations:

For Alternatives to the Phase 2 CaRFG Flat Limit Specifications

benzene	--	not to exceed 1.20 volume percent
olefin (total)	--	not to exceed 10 volume percent
olefin (C3 to C5)	--	not to exceed 1 volume percent
sulfur	--	not to exceed 80 ppm
aromatic hydrocarbon	--	not to exceed 30 volume percent
oxygen	--	not to exceed 2.7 wt. percent
	--	minimum of 1.8 wt. percent during specified winter months in areas identified in section 2261(b)(1)(A), title 13, CCR.
distillation temp.		
T90	--	not to exceed 330 degrees F
T50	--	not to exceed 220 degrees F

benzene	--	not to exceed 1.10 volume percent
olefin (total)	--	not to exceed 10 volume percent
olefin (C3 to C5)	--	not to exceed 1 volume percent
sulfur	--	not to exceed 60 ppm (December 31, 2002 - December 30, 2004) not to exceed 30 ppm (starting December 31, 2004)
aromatic hydrocarbon	--	not to exceed 35 volume percent
oxygen	--	not to exceed 3.5 wt. percent[1]
	--	minimum of 1.8 wt. percent during specified winter months in areas identified in section 2262.5(b)(1)(A), title 13, CCR.
distillation temp.		
T90	--	not to exceed 330 degrees F
T50	--	not to exceed 220 degrees F

1 If the gasoline contains more than 3.5 percent by weight oxygen but no more than 10 volume percent ethanol, the maximum oxygen content is 3.7 percent by weight.

4. The pollutant measures addressed by this protocol are carbon monoxide emissions (CO, gm/mile), oxides of nitrogen emissions (NOx, gm/mile), exhaust emissions of non-methane organic gases (NMOG, gm/mile), the combined ozone forming potential of exhaust NMOG emissions (gm. ozone/mile), and the combined potency-weighted emissions of toxic air contaminants in exhaust (mg/mile).

B. Synopsis of Protocol

The difference in emissions between the test fuel and the reference fuel (test fuel emissions minus reference fuel emissions, in grams/mile) is computed for tests in each test vehicle and then averaged over all vehicles within each of several vehicle categories in a test fleet. These average differences by category are combined into a mileage-weighted mean that serves as an estimate of the difference in average emissions per mile between the test and reference fuels in the relevant on-road vehicle fleet. A statistical upper bound for this mileage-weighted estimate is computed. A mileage-weighted estimate of average emissions per mile from the reference fuel among the on-road vehicle fleet is also computed, using the same weights.

For each pollutant, the statistical upper bound for the average difference in emissions is compared to a specified "tolerance" fraction of the average emissions of that pollutant from the reference fuel. If the statistical upper bound is the greater of these two numbers for any pollutant, the candidate fuel cannot be approved.

C. Definitions

1. "Applicant" means that the party seeking approval of alternative gasoline specifications and responsible for the demonstration described in Section II.

2. "Reference fuel" means a gasoline meeting the following specifications:

Phase 2 CaRFG Reference Fuel Specifications

Property	*Test Method*	*Specification*
Research Octane, min.	D2699	93
Sensitivity, min.		7.5
Lead (organic), max., g/US gal	D3237	0.050
Distillation Range		
10 pct. point, degrees F	D86-90	130-140
50 pct. point, degrees F	D86-90	190-210
90 pct. point, degrees F	D86-90	280-300
Sulfur, max. ppm wt.	D2622-87	40
Phosphorus, max., g/US gal		0.005
RVP, psi	D323-58 or 13 CCR sec. 2297	6.7-7.0
Olefins, maximum pct.	1319-89	6.0
Aromatics, maximum pct.	ARB MLD 116	25.0
Oxygen, wt. pct.	4815-89	1.8-2.2
Benzene, max. vol. pct.	3606-87	1.00

Phase 3 CaRFG Reference Fuel Specifications

Property	*Test Method*	*Specification*
Research Octane, min.	ASTM* D2699-99	93
Sensitivity, min.		7.5
Lead (organic), max., g/US gal	ASTM D3237-79(1984)$^{\varepsilon 1}$	0.050
Distillation Range		
10 pct. point, degrees F	ASTM D86-90	130-140
50 pct. point, degrees F	ASTM D86-90	190-213
90 pct. point, degrees F	ASTM D86-90	280-305
Sulfur, max. ppm wt.	ASTM D2622-87$^{\varepsilon 1}$	20
Phosphorus, max., g/US gal		0.005
RVP, psi	ASTM D323-58 or 13 CCR § 2297	6.7-7.0
Olefins, maximum pct.	ASTM D1319-89	6.0
Aromatics, maximum pct.	ARB MLD 116 (Nov. 1991)	25.0
Oxygen, wt. pct.	ASTM D4815-89	1.8-2.2
Benzene, max. vol. pct.	ASTM D3606-87	0.80

* American Society for Testing and Materials

3. "Candidate fuel" means any gasoline that would meet specifications proposed as alternatives to the specifications cited in I.A.1. All candidate fuels under a particular set of proposed specifications are represented in the emission demonstration by the test fuel.

4. "Duplicate test" means an emission test run on a particular vehicle and a particular fuel as a repetition of the preceding test on the same vehicle and fuel, without draining and re-filling the fuel tank and conducting pre-test dynamometer cycles, as described in VII.D., between the tests.

5. "LDV" means light-duty cycle. "MDV" means medium-duty vehicle. "TLEV" means transitional low-emission vehicle. "LEV" means low-emission vehicle. "ULEV" means ultra-low emission vehicle. "SULEV" means super ultra-low emission vehicle, all as defined in title 13, California Code of Regulations, section 1960.1. "Low-emission vehicle" includes LEVs, TLEVs, ULEVs, and SULEVs. For the purpose of this protocol, only vehicles capable of using gasoline are included among low-emission vehicles.

6. "Replicate test" means an emission test or a set of duplicate tests run on a particular vehicle and a particular fuel as a repetition of another test or set of tests on the same

vehicle and fuel, with draining and re-filling the fuel tank and the pre-test dynamometer cycles, as described in VII.D., between the tests or sets of tests.

7. "Test fuel" means the particular batch of gasoline representing candidate fuels in the emission demonstration required for approval of alternative gasoline specifications.

8. "Toxic air contaminants" means exhaust emissions of benzene, 1,3-butadiene, formaldehyde, and acetaldehyde.

II. DEMONSTRATION REQUIRED FOR CANDIDATE FUELS

The demonstration of approvability of alternative specifications shall consist of emission tests on a test fuel whose properties identified per the test plan in Section VI. have been accurately measured. The values of those properties shall correspond, as described in Section VI, with the proposed specifications. Comparisons of the results of these tests with the results of tests on the reference fuel must satisfy the criterion in section IV.

III. EMISSION TESTS AND COMPARISONS REQUIRED FOR CANDIDATE FUELS

A. Emission tests and comparisons shall be done on a fleet of on-road vehicleswhich exist at the time of the testing. The vehicle categories appropriate for inclusion in this fleet are defined in subsection V.A.

B. Within the fleet in subsection III.A., comparisons using the criterion in section IV. shall be made between emissions measured in tests using a test fuel representing the candidate fuel and emissions measured in tests using reference fuel.

C. The criterion in section IV. shall be applied separately to CO emissions, NOx emissions, the exhaust NMOG emissions, the combined ozone-forming potential of exhaust NMOG emissions, and the combined potency-weighted emissions of toxic air contaminants. If the test fuel fails to meet the criterion in section IV. for any of these pollutants, the candidate fuel shall have failed the required demonstration.

IV. CRITERION FOR DEMONSTRATION OF ACCEPTABLE EMISSIONS

For each comparison required in section III., the upper confidence limit (UCL) for the estimated mean difference in emissions between fuels (test fuel vs. reference fuel) among all on-road vehicles in the tested categories, computed at the significance level 0.15 for the one-sided t-statistic, shall be less than or equal to a tolerance fraction (δ) of the average emissions (E_c, in grams/mile) estimated for those on-road vehicles using the reference fuel. The estimate of emission difference shall be based on the emission

measurements in the test fleet. In terms of parameters calculated per section IX., the criterion is expressed as:

$$UCL = D + t_{.15,\,nu} * S.E. \leq \delta * E_c$$

where D is the estimate of the mean difference in emissions between the fuels, and S.E. is the standard error for that estimate, calculated for nu degrees of freedom.

The tolerance fractions δ shall be as follows:

Pollutant Measure	δ
CO	.040
NOx	.020
NMOG	.030
Grams Ozone/mile	.040
Potency-Weighted Toxics	.040

V. TEST VEHICLES

A. Vehicle Categories for Testing

1. For the purpose of this protocol, categories of light-duty vehicles (passenger cars and trucks) are defined by the following model years, catalyst types, and/or emission standards. Only vehicles meeting all defining descriptors for a category are included in that category.

For Alternatives to the Phase 2 CaRFG Specifications

Model Year	*Catalyst Type*	*Emission Standard*
Pre-1975	No catalyst	
1975 – 1980	Open-loop oxidizing	
1981 – 1985	Closed-loop three-way	
1986 – 1990	Closed-loop three-way	
Post-1990	(any)	not low-emission
"	(any)	TLEV
"	(any)	LEV
"	(any)	ULEV

For Alternatives to the Phase 3 CaRFG Specifications

Model Year	*Catalyst Type*	*Emission Standard*
Pre-1975	No catalyst	
1975 – 1980	Open-loop oxidizing	
1981 – 1985	Closed-loop three-way	
1986 – 1990	Closed-loop three-way	
1991 – 1995	Closed-loop three-way	
Post-1995	(any)	not low-emission
"	(any)	TLEV
"	(any)	LEV
"	(any)	ULEV
"	(any)	SULEV

2. The executive officer shall maintain estimates of the total emissions from, and total annual miles traveled by, vehicles in the state in each of the categories listed above. These estimates shall be for the same time as, consistent with, and updated on the same schedule as the estimates of miles traveled that the executive officer uses to determine the required numbers of new retail outlets for clean fuels under section 2303(c), title 13, California Code of Regulations.

3. Over all vehicle categories in subsection V.A.1., the executive officer shall sum all exhaust NMOG emissions and all miles traveled in the state for the time corresponding to the estimates described in subsection V.A.2., assuming that all the vehicles receive the reference fuel all the time.

4. The test fleet required by subsection III.A.1. shall consist of each vehicle category contributing at least 3 percent of the sum of NMOG emissions (described in subsection V.A.3.) over all categories for the fleet or at least 5 percent of the sum of miles traveled over all categories.

B. Number, Descriptions, and Preparations of Vehicles

1. Within each vehicle category to be tested per subsection V.A.4., the emission comparisons described in subsection III. shall be conducted in at least five vehicles. Over all categories tested, the total number of vehicles shall be at least 20.

2. Except in the case described in subsection V.B.6., the group of vehicles within each test category shall meet these restrictions:

   (a) no two vehicles shall be the same model and model year.

   (b) not more than 20 percent shall have the same owner or the same manufacturer.

3. Except as provided in subsection V.B.6., within each vehicle category, the test vehicles shall have distributions of engine displacement, types of fuel/air metering, catalyst technology, emission control system, and California vs. U.S. (49-state) certification that the executive officer deems are sufficiently representative of California's on-road fleet to make significant bias of the overall test results unlikely.

4. Except as provided in subsection V.B.6, each vehicle used under this protocol shall have accumulated at least the following miles traveled:

Age of vehicle, as determined by model year	*Minimum miles traveled*
0 to 1	4,000
2 to 5	18,000
6 to 10	41,000
11 to 15	61,000
>15	76,000

5. Each vehicle shall be tested in its as-received condition; except, any routine maintenance scheduled to occur per the manufacturer's recommendation may be performed.

6. If the applicant demonstrates to the executive officer that the requirements in subsection V.B. are unreasonably difficult to meet for a vehicle category and unnecessary to provide a group of vehicles that reasonably represents the vehicle category, the executive officer may relax the requirements for that vehicle category.

7. Instead of following paragraphs 2 through 5 of this subsection B., the applicant may compose each category of test vehicles required by subsection V.A.4. through random sampling of on-road vehicles. This option may be followed only after approval by the executive officer of the proposed sampling method as part of the plan described in section VI.

VI. TEST PLAN

A. The applicant shall submit to the executive officer a test plan including the following information:

1. identification of properties of the fuel that affect exhaust emissions and would require specification in commercially available fuel; these shall include (but are not limited to) all properties with adopted gasoline specifications.

2. identification of the appropriate form of specification for each property identified in VI.A.1.; each specification shall be one of the following forms, as necessary to ensure that all candidate fuels made to the specification would not cause greater emissions of the pollutants addressed by the protocol than would the test gasoline:

(a) allowable value of property < [specified value]
(b) allowable value of property > [specified value]
(c) [specified value] < property < [specified value]

3. the engine families, model years, California or U.S. certification, and sources of vehicles with which the applicant proposes to satisfy subsection V.B. (if the option in subsection V.B.7 is not exercised);

4. if the option in subsection V.B.7 is exercised, the method by which random sampling will be accomplished;

5. the identities of any contractors who will conduct emission tests or analyses of samples;

6. quality control provisions consistent with good laboratory procedures in testing for the emission levels expected to be encountered in the tests,

7. the number of emission tests (duplicates and replicates) to be run on each vehicle within each vehicle category,

8. an approximate description of the test fuel, including all properties described in subsection VI.A.1.,

9. a test procedure for determining the value of each property described in VI.A.1 that does not have an adopted gasoline specification, and

10. a description of any statistical test by which the applicant would analyze individual test data to identify and discard statistical outliers.

B. Items 1. and 2. below apply to each proposed specification that would alter an adopted gasoline specification or that pertains to a gasoline property that does not have an adopted gasoline specification.

1. If a specification is of the kind in subsection VI.A.2.(a) or (b), the value of [specified value] shall be the value measured for that property in the test fuel, as described in subsection VI.E.

2. If a specification is of the kind in subsection VI.A.2.(c), the values of [specified value] shall be stated in the test plan.

C. For each adopted gasoline specification that would not be changed by the proposed alternative specifications, the value of the associated property in the test fuel shall satisfy that specification and be typical of values in current retail gasoline.

D. Unless the option in subsection V.B.7 is exercised, after the executive officer's approval of the plan, the applicant shall specify to the executive officer the vehicle identification numbers of the vehicles to be tested. These numbers shall become part of the approved plan.

E. After the executive officer's approval of the plan, the applicant shall supply measurements of the properties of the test fuel, including all properties described in subsection VI.A.1.

F. No datum shall be considered valid for the purpose of a demonstration controlled by this protocol unless that datum has been produced according to a plan approved by the executive officer before the datum has been taken.

G. Except as provided by section VIII., no demonstration shall be valid unless all data corresponding to an approved plan have been taken and included in the calculations prescribed in section IX.

H. Except as provided by section VIII., deviations from an approved plan shall not be permitted except by the prior permission of the executive officer.

I. No more than 20 days after receiving a proposed test plan, the executive officer shall either inform the applicant that the plan is complete or advise the applicant of necessary additions or changes. No more than 15 working days after receiving requested additions or changes, the executive officer shall advise the applicant that the amended plan is complete or further advise the applicant of necessary additions or changes. No more than 20 working days after advising the applicant that a plan is complete, the executive officer shall either approve or reject the plan. A rejection shall be accompanied by specifications of deficiencies.

J. The executive officer shall not approve a test plan unless he or she finds that it would produce a valid emission demonstration, as required by section II, by the procedures described in this protocol.

K. If requested by the executive officer, the applicant shall supply a sample of the test fuel to the ARB.

VII. EMISSION TEST PROCEDURES

A. All emission tests shall be done according to "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," incorporated by reference in title 13, California Code of Regulations, section 1961(d).

B. Within any vehicle category, the same number of replicate tests and the same number of duplicate tests within each replicate test shall be run on each test vehicle on both the

reference fuel and the test fuel. The number of replicate tests and the number of duplicate tests shall be determined by the applicant (subject to approval as part of the test plan) and may vary among the vehicle categories.

C. The first fuel to be tested in any vehicle shall be chosen randomly.

D. Whenever the fuel to be tested in a vehicle differs from the existing fuel in the vehicle, and whenever a replicate test is to be run, the test vehicle's fuel tank and fuel delivery system shall be drained of fuel to the extent that is practicable. The fuel tank shall then receive a 40 percent fill of the fuel to be tested. The vehicle shall then be run through one Highway Fuel Economy Driving Cycle (HFEDC) (40 Code of Federal Regulations, Part 600, Subpart B). The fuel tank and fuel delivery system shall again be drained, and the tank shall receive a 40 percent fill of the test fuel. Finally, the vehicle shall undergo another HFEDC and two consecutive LA4 cycles. The test vehicle shall not be operated again before the tests required in A. above.

E. Pre-testing procedures alternative to subsection VII.D. may be used if they are part of the approved plan described in section VI. Such alternatives may be approved only if found to be equivalent or superior in achieving a valid test of the fuel under test.

F. In each FTP test run, the NMOG emissions shall be speciated for determining the ozone-forming potential of the vehicle's exhaust. Species in the NMOG emissions shall be identified and quantified by the procedures in the "California Non-Methane Organic Gas Test Procedures". Exhaust emissions of benzene, 1-3 butadiene, formaldehyde, and acetaldehyde shall be identified and quantified using the procedures in the same document.

VIII. EXCLUSION OF DATA OR VEHICLES

A. Any datum from an individual test run may be excluded as an outlier relative to its duplicate data (or to its replicate data if replicates do not contain duplicate tests) if so indicated by a statistical test approved by the executive officer as part of the test plan. If an analysis is used to exclude one or more datum for a pollutant, the same analysis shall be applied to all data for that pollutant.

B. Any vehicle may be excluded from the test program if it cannot be tested safely. In such a case, a similar vehicle shall be tested.

C. No datum shall be used in an emission demonstration under this protocol if:

1. test procedures during the generation of the datum differed from the procedures required by VII.A., or

2. the datum was taken without adherence to the quality control requirements in the test plan, or

3. the vehicle used to generate the datum can be shown to have operated in a way different from the way it operated during other tests, and such a difference can reasonably be expected to affect emissions, or

4. either the testing equipment or the chemical analytical equipment can be shown to have functioned differently during the generation of the datum than during other tests, and such difference in function can reasonably be expected to affect emissions.

D. A datum deleted according to one of the disqualifying conditions in VIII.C. shall be replaced by a new test unless the vehicle used to generate the datum is no longer in the possession of the applicant or the applicant's contractor or unless the vehicle has been used in ordinary service since testing was completed. However, if the original vehicle cannot be tested and the deletion of a datum leaves no data for a particular vehicle/fuel combination, a similar vehicle shall be obtained and all tests on the original vehicle shall be repeated with the replacement vehicle.

IX. CALCULATIONS

A. Summary and Explanation of Calculations

This procedure calculates a statistical upper bound on the difference in average emissions per mile from the test fuel and from the reference fuel for the relevant on-road vehicle fleet. The emissions of all the pollutants measured during testing are expressed in units of mass per mile. The calculation procedure is the same for all pollutants.

From the data on each vehicle, the difference in average emissions per mile is calculated as:

average emissions per mile from the test fuel
minus
average emissions per mile from the reference fuel

where the average is over all data, whether duplicate test data or replicate test data.

Within each vehicle category, the difference in emissions between the two fuels is the mean value of the difference values among vehicles. Within each vehicle category, the standard deviation of the difference among vehicles is also calculated.

The expectation value of the relevant on-road vehicle fleet's average difference in emissions per mile is the weighted average of the differences in emissions among the vehicle categories. The weights used in the averaging are the estimates of total miles traveled by vehicles in the various categories.

Estimates of the standard error and degrees of freedom corresponding to the fleet-average difference in emissions are calculated from the weights, the numbers of test vehicles in the categories, and the standard deviations within categories.

The upper bound on the average difference in emissions for the on-road fleet is calculated from the expectation value, the standard error, and the one-sided student-t value for the 0.15 significance level and the calculated degrees of freedom.

The tolerance value for the upper bound is a tolerance fraction times the weighted average value of the average emissions measured within vehicle categories on the reference fuel.

The type of statistical upper bound computed by this procedure is called an "upper confidence limit" in the statistical literature. Upper confidence limits for a statistical result have a high probability of exceeding the unknown true value of the quantity being measured. The probability is approximately 85 percent that the (unknown) true value of the mileage-weighted average difference of emissions per mile is less than its corresponding upper confidence limit. Consequently, if the true value of the difference in average emissions per mile is greater than the tolerance value, approximately 85 percent, or more, of all possible upper confidence limits will exceed this true value and therefore exceed the tolerance value. It follows that a candidate fuel with a true difference of emissions of a certain pollutant greater than the tolerance value will satisfy the criterion, and be accepted (with respect to that pollutant, only) as causing no increase in emissions, only about 15 percent of the time.

The upper confidence limits computed by this procedure are 85 percent one-sided upper confidence limits for a weighted average of normally distributed random variables. They are based on an approximate t-distribution. The degrees-of-freedom parameter of this distribution is calculated by Welch's approximation.

B. Test Run Results

1. Emission rates of CO, NOx, and NMOG, expressed as "g/mile", and the emission rate of each toxic pollutant, expressed as "mg/mile", shall be determined in each test by the procedure described in the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," incorporated by reference in title 13, California Code of Regulations, section 1961(d).

2. Values of ozone-forming potential, in "g ozone per mile", shall be determined for exhaust emissions in each test according to Part II, Section D. of the Standards and Test Procedures referred to in subsection IX.B.1.

3. In each test, the emission rate of each toxic pollutant shall be multiplied by its relative potency, as shown in the following table, and the four products shall be summed.

	Relative Potency
1,3-butadiene	1.0
benzene	.17
formaldehyde	.035
acetaldehyde	.016

C. Upper Confidence Limit for Inferred Mean Emission Difference

1. The procedures in this section shall be followed for the test fleet required by subsection VII.A. The procedures shall be followed separately by CO, NOx, NMOG, the combined ozone-forming potential of exhaust NMOG, and the combined potency-weighted toxic emissions.

2. For each vehicle, the results, (g/mile for CO, NOx, and NMOG, g ozone/mile, or mg/mile for combined potency-weighted toxic emissions) from all tests (whether duplicates or replicates) on the test fuel shall be averaged, as shall the results from all tests on the reference fuel. The average result when the vehicle is tested on the reference fuel shall be subtracted from the average when the vehicle is tested on the test fuel. The result of the subtraction is a difference value for the vehicle, d_v for the pollutant measure.

3. Within each vehicle category, the mean value and squared standard deviation of mean difference values shall be calculated over all vehicles:

   $m_{d,i}$ = mean value of d_v over all (n_i) vehicles in category i

   $s^2_{d,i}$ = square of standard deviation corresponding to $m_{d,i}$

   = sum over vehicles of $\{(d_v - m_{d,i})^2 / (n_i-1)\}$

4. The population-weighted mean value of m_d shall be calculated over all tested vehicle categories:

   D = Sum over all categories (i) of $\{m_{d,i} * p_i\}$

   where p_i is total miles traveled by on-road vehicles in vehicle category i divided by the sum of total miles traveled by on-road vehicles in all categories that have been tested within the fleet. The values of "p" shall be determined for the same time as the sums of NMOG emissions and the sums of miles traveled described in subsections V.A.3.

5. The standard error of the weighted mean emission difference shall be calculated from the standard deviations within emission categories:

   $S.E.^2$ = Sum over all categories (i) of $\{p^2_i * s^2_{d,i} / n_i\}$

where n_i is the number of test vehicles in category i.

6. The number of degrees of freedom associated with D shall be calculated as:

$$nu = \frac{(S.E.^2)^2}{\text{Sum over all categories of } \{p_i^4 * s_{d,i}^4 / [n_i^2 * (n_i - 1)]\}}$$

7. The upper confidence limit for the population mean emission difference shall be calculated as:

$$UCL = D + t_{.15,\,nu} * S.E.$$

where t is the one-tailed "student's t" value for significance level (alpha) = .15 and degrees of freedom nu.

8. "t" shall be calculated as:

$$t_{.15,\,nu} = U + (U^3 + U)/(4 * nu) + (5 * U^5 + 16 * U^3 + 3 * U)/(96 * nu)$$

where U = 1.036

D. Emissions from the Use of Reference Fuel

1. Within each test vehicle category, the average of all emission results (mass/mile) when the reference fuel is used, as described in IX.B.2, shall be averaged over all vehicles. The result, $e_{c,i}$, is the emission rate for category i.

2. The estimate of the on-road fleet emissions from the use reference fuel shall be the weighted sum over categories of $e_{c,i}$ using the same weights, p_i, as in the calculation of D.

$$E_c = \text{sum over all categories (i) of } \{p_i * e_{c,i}\}$$

X. SUBMISSION OF RESULTS

By means agreed upon by the executive officer and the applicant, the applicant shall submit documentation of adherence to the plan described in section VI. and to the procedures specified in section VII., the calculations required in section IX., any outlier analyses conducted per paragraph VIII.A., the output from all FTP runs and all specifications of NMOG.

XI. CERTIFICATION OF CANDIDATE FUELS

A. No more than 20 working days after receiving the information described in section X., the executive officer shall either inform the applicant that the information is complete or advise the applicant of necessary additions or changes. No more than 15 working days after receiving requested additions or changes, the executive officer shall advise the applicant that the amended information is complete or further advise the applicant of necessary additions or changes. No more than 20 working days after advising the applicant that the information is complete, the executive officer shall deem the demonstration required by section II., concerning emission comparisons, to be either accomplished or not accomplished. A rejection shall be accompanied by specifications of deficiencies.

B. If the executive officer determines that an applicant has accomplished the demonstration concerning emission comparisons in section II., the executive officer shall certify the candidate fuel as a Phase 2 CaRFG or Phase 3 CaRFG3 certified alternative gasoline formulation. The executive officer shall include in the certification order specifications for properties of the certified fuel in accordance with subsections VI.A.I., VI.B., and VI.C. The executive officer shall notify interested parties of the certification order within 10 days of issuance.

C. A certification shall be in force for five years, at which time the reapproval process in section XII. shall be followed.

XII. PERIODIC REAPPROVAL

A. Every five years after the initial certification of alternative specifications, test data shall be provided for any vehicle category previously exempted from testing pursuant to section V.A.4. if the exempting criteria (less than 3 percent of emissions and less than 5 percent of miles traveled) are no longer met. Test data shall also be provided for any previously tested vehicle category for which the executive officer determines that the vehicles tested no longer provide a reasonable representation of the on-road vehicles in that category.

B. Every five years, the upper confidence limit specified in subsection IX.C. and the emissions from the use of reference fuel specified in subsection IX.D. shall be re-calculated for the test fleets identified in subsection V.A.4. The calculations shall use the original test data, any new test data provided pursuant to subsection XII.A. or XIII.A., and the current statistical weights (p) as described in subsection IX.C.4. If the upper confidence level exceeds the criterion in section IV. for any pollutant, the certification of the fuel shall be rescinded, effective two years following the date of the order rescinding the certification.

XIII. AUGMENTATION OF ORIGINAL TEST DATA

A. An applicant who made the petition that led to the approval may augment any portion of the information in the original test plan or the submission required in section X. All new information shall be developed according to this test protocol.

B. If new information or proposed changes are submitted, the executive officer shall evaluate and either accept or reject them by standards consistent with the requirements in this procedure for the original approval.