

**APPENDIX C: VERIFICATION PROCEDURE**  
**Part 2**

Proposed Verification Procedures for Retrofit Emission Control Systems  
for Off-Road Industrial Engines



## **APPENDIX C, PART 2: VERIFICATION PROCEDURE DISCUSSION**

The Air Resources Board (ARB or Board) and equipment manufacturers share the responsibility to ensure that emission control systems for retrofit use on existing engines and equipment are functional and durable. This responsibility is greater yet when ARB's regulations directly require the systems end users to achieve emission reductions from the equipment and engines they own and operate as with the proposed LSI fleet requirements. ARB staff, based on significant input from industry and related trade groups, has developed a procedure to verify and ensure that control equipment is durable and effective in reducing emissions.

This document describes the verification procedure that the ARB will use to evaluate retrofit technologies and the claimed emission reductions of oxides of nitrogen (NO<sub>x</sub>) and hydrocarbons (HC) from off-road large spark-ignition LSI engines. The proposed Verification Procedure (Procedure) establishes a way for manufacturers to demonstrate to the ARB that their retrofit emission control system provides real and durable emission reductions while not increasing carbon monoxide (CO) above existing established levels. Resulting emissions benefits when using these retrofit systems will be used to meet SIP requirements or for calculating cost effectiveness for applicants to incentive programs.

The ARB's role is to ensure that the reduction claims for a given retrofit emissions control system are real, quantifiable, and durable. The ARB must also establish the emission reduction level, as well as verify that the equipment has passed rigorous field tests and investigate any secondary emissions of concern.

While developing the Procedure staff addressed important issues such as verifying the reduction claims, including durability, warranty, and in-use emissions. The durability and warranty requirements ensure that manufacturers are building retrofit emission control systems (RECS) with sufficient durability to meet the verified emission levels as the systems age. In-use compliance testing is a way to show ARB staff that the unit produced remains consistent with verified designs and continues to function as designed after it has left the manufacturing plant.

### **1. PROPOSED REGULATION**

Participation in the verification process is voluntary. The proposed Procedure outlines the requirements to which an applicant must fully comply: conduct emission tests, conduct durability and field demonstrations and submit the results to the ARB along with other information in the prescribed application format.

When the ARB completes the evaluation of a RECS, and is satisfied that the RECS reduces emissions, the Executive Officer will notify the applicant in writing and issue an Executive Order. The Executive Order states the verified emission reduction level and any conditions that are necessary to support or sustain that verification. The verification

also requires that the applicant provide a detailed warranty, conduct in-use compliance testing of the system after having sold or leased a specified number of units and report the results to the Executive Officer.

## **2. Applicability and Purpose**

The Verification Procedures apply to retrofit control systems, which through the use of sound, proven science and engineering will control emissions HC, NOx and CO from off-road LSI engines. The use of control systems verified in accordance with the proposed verification procedure may be a means of complying with other state board regulations applicable to LSI engines, to the extent provided for in those regulations.

## **3. APPLICATION PROCESS**

### **3.1 Letter of Intent – Proposed Verification Plan**

Prior to submitting a formal application for verification, the applicant must submit a letter of intent to apply for verification of their retrofit system. This will ensure that the applicant includes all information necessary for the ARB staff to conduct an initial evaluation. Providing such information will also ensure that the applicant understands the requirements and thus not spend extra time and resources conducting unnecessary testing. The letter should include:

- Identification of the contact persons, phone numbers, names and addresses of the responsible party proposing to submit an application
- A general description of the technical principles of the retrofit operation
- Plans for meeting the testing and other verification requirements or existing test data
- A percent emission reduction and/or brake-specific emission limit that the system is expected to achieve throughout the emission durability period
- Proposed emission control group and parameters
- Plans for meeting the testing and other verification requirements – including any existing test data
- Previous test data
- A brief statement that the applicant agrees to provide a warranty

### **3.2 Plan Review Timeframe**

During the initial review, ARB staff may be requesting more information and understanding of how the RECS functions on the target equipment. If the Executive Officer determines that the applicant has not made a satisfactory demonstration that the product designed to achieve the claimed emission reductions is based on sound principles of science and engineering, the Executive Officer shall notify the applicant in writing. The applicant has 60 days from the date of the notification letter to decide whether to submit additional materials and clarifications or discontinue their participation in the verification process.

If the ARB staff determines that the retrofit system appears to be technologically sound and appropriate for the identified emission control group, the applicant will be notified of this finding. The applicant may then proceed with satisfying the remaining requirements for full verification of their RECS. Once the applicant and staff agree on the proposed verification plan any modifications to the prescribed test equipment and/or test procedures must be approved in advance by the Executive Officer and described later in the formal verification application.

### 3.3 Formal Application

When all prescribed verification testing is complete, the applicant may then submit a formal application. The test results along with other information should be submitted in the approved application format included in the proposed verification procedure. The ARB has 30 days to review this application for completeness and to determine whether additional information is required. Within 60 days after an application has been deemed complete, the staff will determine whether the RECS merits verification.

The Executive Officer shall notify the applicant of the decision in writing and issue an Executive Order specifying the Verification level and state absolute emissions or percentage reduction.

If the retrofit system passes the verification process, a performance classification level will be assigned by the Executive Officer. The level will be either the percentage reduction or the absolute emissions as shown in Table 1 below.

### 3.4 Data Submission

Any data submission must be in an electronic file that is column-delimited format or an alternative format approved by the Executive Officer. The appropriateness of allowing alternatives to the prescribed requirements will be taken into consideration at this time.

Emission tests used to support emission reduction claims must be reported in total hydrocarbons, oxides of nitrogen, and carbon monoxide. Emission test units must be reported in grams/brake horsepower-hour (g/bhp-hr.)

## **4. Classification of Retrofit Emission Control Levels**

Achieving large reductions in emissions with retrofit emissions control systems may not be a pragmatic proposal for all LSI engines and equipment. In recognition of this, and to facilitate the implementation of current emission control strategies, the ARB has proposed a procedure that would allow multiple levels of system verifications rather than a single level. The proposed levels are based on the performance of current LSI retrofit emission control system technology and input from industry. A multi-level approach gives a hierarchy for emission reduction technologies.

The multi-level verification classification consists of four HC + NOx reduction levels as shown in Table 1. The proposed levels should broaden both the spectrum of control technologies available and the number of applications that can be controlled. It should be noted that while staff is recommending a multi-level approach to verification, ARB is not deviating from the goal to realize the maximum reductions in HC + NOx emissions from LSI equipment that is economically and technologically feasible.

**Table 1. LSI Engine Retrofit System Verification Levels**

| <i>Classification</i>              | <i>Percentage Reduction (HC+NOx)</i> | <i>Absolute Emissions (HC+NOx)</i> |
|------------------------------------|--------------------------------------|------------------------------------|
| <b>LSI Level 1</b> <sup>(1)</sup>  | ≥ 25% <sup>(2)</sup>                 | Not Applicable                     |
| <b>LSI Level 2</b> <sup>(1)</sup>  | ≥ 75% <sup>(3)</sup>                 | 3.0 g/bhp-hr <sup>(3)</sup>        |
| <b>LSI Level 3a</b> <sup>(1)</sup> | ≥ 85% <sup>(4)</sup>                 | 0.5, 1.0, 1.5, 2.0, 2.5 g/bhp-hr   |
| <b>LSI Level 3b</b> <sup>(5)</sup> | Not Applicable                       | 0.5, 1.0, 1.5, 2.0 g/bhp-hr        |

<sup>(1)</sup> Applicable to uncontrolled engines only

<sup>(2)</sup> The allowed verified emission reduction is capped at 25% regardless of actual emission test values

<sup>(3)</sup> The allowed verified reduction for LSI Level 2 is capped at 75% or 3.0 g/bhp-hr regardless of actual emission test values

<sup>(4)</sup> Verified in 5% increments, applicable to LSI Level 3a classifications only

<sup>(5)</sup> Applicable to emission-controlled engines only

#### 4.1 Emission Control Groups

An emission control group is a set of LSI engines or applications that is determined by a group of common parameters that affect the performance of particular RECS. An after-market system would likely be flexible enough for use on a diverse group of engine models and equipment, including different engine makes, years, and fuel types. Categorizing the engine “universe” in this way is an effective method for reducing the amount of testing needed and allows ARB to evaluate diverse technologies with a single verification Procedure.

Significant parameters for the RECS of both the engine and application are considered in creating “emission control groups.” The exact parameters depend on the nature of the RECS and may include, but are not limited to, baseline or certification levels of engine emissions, displacement, horsepower rating, duty cycle, fuel delivery systems

and fuel. The emission control group may be comprised of several engine families, applications and engine manufacturers.

Staff expects that the procedure will be used for a wide range of technologies, each with its own nature, strengths and weaknesses. Because the applicant is most acquainted with the engines and equipment the RECS will work on, ARB staff recognizes the importance of applicant input in the early stages of the application process when the emission control group is identified for verification.

The applicant should submit its proposed emission control group and parameters for the RECS with their proposed verification plan. A RECS system that employs two or more individual sub-systems or components would be tested and submitted for evaluation as one system. This coordination with staff will also help identify appropriate use of any existing data and potentially reduce the amount of testing that would be required under an emission control group system.

Emission control groups are fully integrated into the procedure for both initial verifications and extensions of existing verifications. For the initial verification of a RECS, the applicant must restrict its application to a single emission control group. By restricting the scope of the first application, staff is better able to conduct a thorough review of the retrofit emission control system.

#### 4.2 Extensions of a Verification

After the RECS has been successfully verified for one emission control group, the applicant may extend the verification by submitting data showing that the retrofit emission control system would be effective on other engines or equipment. Any information deemed necessary by the Executive Officer to address differences between the emission control group already verified and the additional emission control group(s) or engines could be required for the extension.

If the applicant has design modifications of the RECS in the original verification, an extension of the original Executive Order or issuance of an additional Executive Order can be made through this same verification procedure. The applicant may use additional test data, engineering analysis or justification, and any other information deemed essential by staff. Processing time periods are consistent with initial verification.

### **5. Verification Requirements**

#### 5.1 Emissions Reductions Testing

The applicant's proposed plan and the formal application must focus on testing the retrofit emission control system on engines representing a single identified emission control group. Some manufacturers of RECS have been conducting testing and evaluation of their emissions control systems for a number of years. That test

information has mainly been used to assist their customers in controlling exposure of individuals to CO emissions while operating power equipment in confined space environments. ARB staff anticipates that some applicants may request to use the existing test data for verification purposes. The applicant is encouraged to submit with their verification plan any existing test data or their plans for meeting the emission testing, durability testing, field compatibility and the later in-use compliance testing requirements of the procedure. Based on this information and discussions, staff will determine whether testing requirements are already partially or fully satisfied.

The primary aim of emission testing is to ensure that retrofit emission control systems give real emission reductions while minimizing any generation of harmful secondary emissions by presenting test results for representative engines/equipment from the chosen emissions control group. Engine family name when available, make, model designation (e.g. name or number) and model year should be used for the test engine identification.

Baseline emission test data must be collected for HC and NOx as well as the emission test data after the RECS is installed. If this verification is for a retrofit to be used on a certified engine, the certification emission standards can be used as the baseline emission test data. Baseline emissions data for CO is required to insure that the RECS does not cause the CO emissions to exceed the allowed limits.

The appropriate test cycles to use in the testing are shown in Table 2 below.

**Table 2. Test Cycles for Emission Reduction Testing**

| Test Type | LSI Retrofit System Verification Date | Off-Road (including portable engines)  | Off-Road (constant-speed operation)  |
|-----------|---------------------------------------|--|--|
| Engine    | Pre-2007                              | Steady-state test cycle from ARB off-road regulations<br>or<br>U.S. EPA transient test | Steady-state test cycle from ARB off-road regulations<br>or<br>U.S. EPA transient test |
| Engine    | 2007 and later                        | U.S. EPA transient test  | U.S. EPA transient test  |

## 5.2 Test Engine Selection

The applicant will identify the engine/s that best represent the chosen emission control group for testing. Appropriate identification of test engines would be the make, model, model year, HC, NOx, and CO baseline emission test levels for uncontrolled equipment, or HC, NOx, and CO certification standards and engine family name for engines subject to emission regulations.



The applicant must also describe the equipment applications on which the RECS is intended to be used, by giving examples of in-use equipment, characterizing typical duty cycles, indicating any fuel requirements, and/or providing other application-related information.

### 5.3 Test Fuel

The testing fuel used shall be consistent with the fuel specifications as outlined in the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," as referenced in Title 13, California Code of Regulations, section 1961 (d). If testing will be done using U.S. EPA fuel, as outlined in title 40, Code of Federal Regulations (CFR), part 1065, the manufacturer shall demonstrate that the emission results are consistent with the above ARB test procedures. Manufacturers may, however use "commercially available fuels" to accumulate service hours.

During all engine tests, the engine shall employ lubricating oil consistent with the engine manufacturer's specifications for that particular engine. These specifications shall be recorded and declared in the verification application.

### 5.4 Test Cycle

The test used for the verification should follow the test cycles specified in the Table 2 or with an alternative cycle(s) approved by the Executive Officer. For off-road engines used in constant-speed operation, the applicant must use the D-2 steady state test cycle or another appropriate off-road test cycle representing the operating conditions of the application, with approval from the Executive officer, or the U.S. EPA transient test.

The applicant may request the Executive Officer approve an alternative test cycle or method in place of a required test cycle or method if the need arises. Some of the criteria staff will use in evaluating a proposed alternative are:

- Similarity of characteristics to the specified test cycle or method and in-use duty cycle
- Existing test data generated using the alternative test cycle or method
- Technological necessity
- Technical ability to conduct the required test

### 5.5 Testing and Emissions Analysis

A minimum of three hot start tests for the test cycle selected must be run for both the baseline configuration without emissions controls and with the implemented RECS configuration. For all test runs used to support emission reduction claims, the applicant must report emissions of total HC, NOx, and CO in grams per brake horsepower-hour.

Test data must be submitted in electronic file in comma-delimited columns or another format approved by the Executive Officer.

The Executive Officer may require the applicant to perform additional analyses if there is reason to believe that the use of the RECS may result in the increase of toxic air contaminants, or other harmful compounds. In the determination, the Executive Officer may consider all relevant data, including but not limited to the following:

- The nature of any substance added to the fuel, intake air, or exhaust stream
- Whether a catalytic reaction is known or reasonably suspected to increase toxic air contaminants or ozone precursors
- Results from scientific literature
- Field experience

#### 5.6 Durability Demonstration

The previous section on emission testing described the process ARB would use to evaluate the emission reductions for the RECS and to determine if the reductions are real. This section focuses on the process for verifying that the RECS emission reductions are durable. Testing conducted in the durability demonstration provides a picture of how the performance of the RECS may change over time. Testing gives further certainty that the emissions control system is durable and physically functional.

The durability demonstration consists of operating the system in the field or in a laboratory for 2,500 hours. Emissions testing must be performed both at the beginning and end of the demonstration period. If the applicant chooses to conduct all the durability accumulation services in the laboratory, an in-field compatibility demonstration report would be required.

If the applicant has demonstrated durability for an identical system in a prior verification or has demonstrated durability through field experience, the applicant may request ARB to accept the previous demonstration. In evaluating such a request, staff will consider relevant information including, but not limited to:

- Similarity of baseline emissions and application duty cycles
- The relationship between the emission control group used in previous testing and the current emission control group
- Number of engines tested
- Evidence of successful operation and user acceptance
- Published reports

If the RECS fails to maintain the initial verified percent emission reduction or absolute emission level during the durability demonstration period, ARB will either deny the verification or downgrade the system to the verification level corresponding to the appropriate lower performance level.

If the RECS fails to maintain at least a 25% reduction, it cannot be verified. The applicant must submit a report explaining the circumstances of the failure. ARB will then determine if the applicant should continue the durability demonstration after fixing the failed system or begin a new durability demonstration.

#### 5.7 Test Engine Selection

The applicant may choose the engine and application to be used in the durability demonstration subject to ARB approval. The selected engine need not be the same engine used for emission reduction testing, but if the applicant does use the same engine, the emission reduction testing results can also be used for the zero hour durability test requirement.

#### 5.8 Service Accumulation

Durability demonstration consists of an extended service accumulation period in combination with emission reduction testing before and after the service accumulation. Service accumulation begins at the zero hour and concludes at 2,500 hours. The applicant could choose to satisfy the durability demonstration by complying with the requirements for a shorter durability period. The minimum durability demonstration period would be 1,000 hours if it can be correlated with or demonstrated to be equivalent to 2,500-hour in-use.

The applicant must provide sufficient documentation to justify the request for a shorter durability demonstration period. The applicant may propose a sampling scheme for approval by the Executive Officer. The sampling scheme may include, but is not limited to, logging only significant changes in a parameter, averages or changes above some threshold value. Data must be submitted in an electronic file in comma-delimited columns or another format that is approved by the Executive Officer.

#### 5.9 Required Emission Testing for Durability Demonstration

The ARB staff proposes that emissions testing be conducted as part of the durability demonstration. The tests are intended to provide a picture of any change in performance of RECS over time.

The RECS must be tested for baseline and control emissions once at the beginning and once at the end of the durability demonstration period. The applicant may elect to test for baseline emissions only once, either at the beginning of the durability demonstration period or at the end of the durability demonstration period. However, if this is the case, the applicant must use the same baseline test result for calculating emissions reductions for both the beginning and the end of the demonstration period. As an alternative to testing a single unit before and after the service accumulation period, the applicant may request that the Executive Officer consider the testing of two identical units, one that has been preconditioned and another that has completed the service accumulation period.

For service accumulation in the laboratory the duty cycle must be the same test cycle(s) as for the initial emissions reductions testing and a minimum of three hot-start tests is required. The applicant may request ARB to accept existing field demonstration data or waive the initial emission tests if there is substantial test data from previous demonstrations.

#### 5.10 Maintenance

Except for emergency engine repairs, only scheduled maintenance on the engine and RECS may be performed during the durability demonstration. If normal maintenance includes replacement of any component of the engine emission control system, the time (years, or hours) between component change must be included with the results of the demonstration.

If emergency repair was conducted on an engine equipped with the RECS within the durability demonstration period, the applicant must report to the Executive Officer, within 30 days of the repair, on what repair was performed and what components were involved, and provide an explanation on the possible cause(s) for the engines and/or the RECS malfunction. Based on the information provided by the applicant, the Executive Officer will decide whether to allow that engine to continue to be used in the durability demonstration program, or to start a new durability demonstration period.

#### 5.11 Performance Requirements

Throughout the durability demonstration period, the RECS must meet the following requirements:

- (1) If the applicant claims a percent emission reduction, the percent emission reduction must exceed the minimum percent emission reduction associated with the LSI Level for which the applicant was seeking verification.
- (2) If the applicant claims a lower emission level, the emission level test results must not exceed the emission level associated with the LSI Level for which the applicant was seeking verification.
- (3) The RECS must maintain physical integrity. Its physical structure and all of its components not specified for regular replacement during the durability demonstration period must remain intact and fully functional.
- (4) The RECS must not cause any damage to the engine, vehicle, or equipment.
- (5) No maintenance of the RECS beyond that specified in its owner's manual will be allowed without prior ARB approval.

#### 5.12 Performance Failures in Durability Demonstration Period

If the retrofit emission control system does not maintain its initial emission reduction percent or emission reduction level over the durability period for any reason, the Executive Officer may downgrade the system to the verification level corresponding to the lowest degraded performance observed in the durability demonstration period. If

the RECS fails to maintain the emission reduction performance pursuant to the performance requirements described above during the demonstration period, the RECS will not be verified. If the system fails, and the applicant desires to proceed with the verification, the applicant must submit a report explaining the circumstances of the failure within 90 days of the event. ARB will then determine if the applicant should continue the current durability demonstration after fixing the failed system or begin a new durability demonstration.

### 5.13 Field Demonstration Requirements

The applicant must demonstrate successful operation and compatibility of the retrofit emission control system in the field with at least one vehicle or engine belonging to the emission control group chosen for verification. The field demonstration test period is a minimum of 200 hours. ARB will consider existing field experience and engineering justification to determine whether additional emission control groups require separate field demonstrations.

Field demonstrations are not required for the purpose of determining in-field emission reductions and have no emission-testing component. Instead, the purpose is to see if the RECS is compatible with the emission control group selected and how it withstands real-world conditions. Compatibility here incorporates many aspects. It is important to determine, for instance, if the operator notes any unusual effects, how the system handles real-world vibrations, jolts, and variable exhaust flows, and what maintenance issues may turn up. The field demonstration, therefore, would verify that the applicant's system is technologically mature and ready for real-world application.

Compatibility is determined by the Executive Officer based on a third-party statement (described below) and any other data submitted. A control system will be considered compatible with the chosen application if it does not:

- cause engine damage or engine malfunction or
- hinder or detract from the vehicle or equipment's ability to perform its normal functions.

The RECS would be deemed to fail the field demonstration requirements if it could not comply with the above-specified criteria during the demonstration period.

Field demonstration is required if all durability was conducted in the laboratory. If the durability demonstration selected is an in-field test, it may be used to satisfy the field demonstration requirement for that emission control group. In this case the field demonstration requirements need only be a written statement from an ARB-approved third party such as the owner or operator of the vehicle or equipment.

The statement must describe overall performance, maintenance required, problems encountered, the results of a visual inspection and any other relevant comments. The results of a visual inspection conducted by the third party at the end of the

demonstration period must also be described. This should comment on whether the RECS is physically intact, securely mounted, or leaking any fluids and should include any other evaluative observations. If the RECS fails in the course of the field demonstration, the applicant must notify ARB within 15 days of the failure and then submit a report explaining the circumstances of the failure within 90 days of the failure. ARB may then determine whether to deny verification or allow the applicant to correct the failed RECS and either continue the field demonstration or begin a new field demonstration.

#### 5.14 Other Requirements

In addition to the emission testing, durability testing and field demonstration, the applicant must meet a number of other requirements and provide additional information, much of which depends on the nature of the retrofit emission control system. This type of information would be explored with ARB staff and the applicant in the proposed verification plan.

#### 5.15 Fuel and Oil Requirements

The applicant must specify the fuel and lubricating oil requirements necessary for proper functioning of the RECS in the owner's manual. The applicant must also specify any consequences that will be caused by failure to comply with these requirements, as well as methods for reversing any negative consequences.

#### 5.16 Maintenance Requirements

The applicant must identify all normal maintenance requirements for the RECS. The applicant must specify the recommended intervals for cleaning and/or replacing components. Any components to be replaced within the defects warranty period must be included with the original RECS package or provided free of charge including freight and handling fees, to the customer at the appropriate maintenance intervals.

Any normal maintenance items that the applicant does not intend to provide free of charge must be approved by the Executive Officer (the applicant is not required to submit cost information for these items). In addition, if applicable, the applicant must specify procedures for proper handling of spent components and/or materials removed from the RECS. If any materials are hazardous, the applicant must identify them as such in the owner's manual.

#### 5.17 System Labeling

Certain emissions-critical or emissions-related parts and/or engines must be properly identified for the end users. This will enable users to determine their compliance with any regulations. Also, the label will assist the applicants to identify a representative sample of retrofit emission control systems for in-use compliance testing. By using LSI emission control group names, ARB will be able to clearly identify given RECS and

distinguish significant differences in design from superficial changes that are, for instance, employed by the applicant for marketing purposes.

The applicant must provide legible and durable labels to be affixed on both the RECS and the engine on which the RECS is installed except as noted in below. The required labels must identify the verification level as well as the percent reduction or absolute emission level. The label must also include name, address, and phone number of the manufacturer, the LSI retrofit emission control group name. A unique identification comprising the serial number for the RECS and the month and year of manufacture are also required for this label. The month and year of manufacture are not required on the label if this information can be readily obtained from the applicant by reference to the serial number. A scale drawing of a sample label must be submitted with the verification application. Unless an alternative is approved by the Executive Officer, the label information must be in the following format:

**Name, Address, and Phone Number of Manufacturer**  
**LSI Retrofit Emission Control Group Name**  
**Product Serial Number**  
**ZZ-ZZ** (Month and Year of manufacture, e.g., 11-05)

(2) LSI Retrofit Emission Control Group Name. Each RECS shall be assigned a name defined as below:

**CAV/MMM/LL##/NHP## or NHL##/APP/XXXXX**

Where:

- CA: Designates a RECS verified in California
- V: Year of verification
- LL##: Verified LSI Level (e.g., LL2 means the retrofit system was verified to the "LSI Level 2", LL3a means the retrofit system was verified to "LSI Level 3a).
- NHP##: Verified HC + NOx reduction percent (e.g., NH75 means HC + NOx reduction of 75 percent).
- NHL##: Verified HC + NOx absolute emissions in units of g/bhp-hr, (e.g., NH3.0 means verified HC + NOx emission level of 3.0 g/bhp-hr).
- APP: Verified application includes a combination of Off-road (OF), or Stationary (ST)
- XXXXX: Five alphanumeric character code issued by the Executive Officer

The applicant may request that the Executive Officer approve an alternative label format to the RECS or engine as described in this section. In reviewing this request, the Executive Officer may consider all relevant information including, but not limited to, the informational content of an alternative label as proposed by the applicant.

### 5.18 Noise Level Control

Applicants must ensure that the RECS is in compliance with all applicable noise limits for which the RECS is intended. All RECS must be in compliance with applicable local government requirements for noise control.

### 5.19 Limits on CO

In order for the RECS to be verified, it must comply with the following limits on CO:

- (1) If installed on engines not emission-certified, the system must not cause the CO emissions to exceed the greater of:
  - (a) 37 g/bhp-hr or
  - (b) ten percent above the engine's baseline CO emission level.
- (2) If installed on an emission-certified engine, the system must not cause the CO emission to exceed the CO emission standard applicable to the engine at the time of the engine's certification

### 5.20 Emission Sampling Ports

To facilitate in-field emission measurements, the applicant may design the RECS to have two sampling ports where emissions measurements can be made.

### 5.21 Owner's Manual

The applicant must provide a copy of the owner's manual for the retrofit emission control system. At a minimum, the following information must be clearly specified.

- Warranty statement including the warranty period over which the applicant is liable for any defects
- Installation procedure and maintenance requirements for the RECS
- Any fuel consumption improvement or penalty
- Any fuel requirements
- Requirements for lubrication oil quality and maximum consumption rate
- Contact information for replacement components and cleaning agents

### 5.22 Determination of Emissions Reduction

The ARB verification of the emission reductions from the RECS will be based on the average of the entire valid baseline and control emission and durability test results (i.e., before and after the installation of the RECS). For applicants that are verifying to absolute emission levels, an average of the control test results will be used.

For durability testing: if the applicant chooses to perform either the zero hour or the 2500 hour baseline test, but not both, then those results must be used in the calculation of the reductions for the zero hour and the 2500 hour control tests.



## **6. Post-Verification Responsibilities**

After a control system has been verified for use with an emission control group, it may be sold in California as such, participate in incentive programs in which verification is required, or be used to satisfy the requirements of ARB in-use control regulations. After verification, applicants have the responsibility to perform in-use compliance testing and to honor the warranty.

## **7. Warranty Requirements**

The applicant must provide a minimum defects and emissions performance and product warranty with a minimum coverage of 2,500 hours or three years, whichever comes first. Because the emissions benefits must be real and durable for a specified length of time, an installation warranty will also be required, ensuring that nothing has been compromised by an incorrect installation. The applicant must also include a copy of this warranty statement in the owner's manual.

### **7.1 Product Warranty**

The applicant must provide a transferable warranty to all owners, for ownership within the warranty period, and lessees, within the lease contract warranty period. The warranty should state that the verified RECS is free from defects in design, materials, workmanship, or operation of the RECS which would cause the RECS to fail to conform to at least 90 percent of the lower bound of all the test values used to determine percentage verification levels or 90 percent of the upper bound of all test values used to determine absolute verification levels.

The minimum warranty period should be three years or 2,500 hours, provided the operation of and conditions of use for the equipment, engine, and RECS conform with the operation and conditions specified in the ARB's Executive Order and stated in the owner's manual.

The warranty must cover the full repair or full replacement costs of the RECS, including parts and labor. The warranty must also cover the full repair or replacement cost of returning the engine components to the condition they were in prior to the failure, including parts and labor, for damage to the engine proximately caused by the verified RECS. Repair or replacement of any warranted part, including the engine, must be performed at no charge to the equipment or engine owner. This includes only those relevant diagnostic expenses in the case in which a warranty claim is valid. The applicant may, at its option, instead pay the fair market value of the engine prior to the time the failure occurs.

The repair or replacement of any warranted part otherwise eligible for warranty coverage may be excluded from the warranty if the RECS or engine has been abused, neglected, or improperly maintained. If such abuse, neglect, or improper maintenance

was the direct cause of the need for the repair or replacement of the part it's repair or replacement would be excluded from the warranty. Failure of the equipment or engine owner to ensure scheduled maintenance or to keep maintenance records for the equipment, engine, or RECS may, but shall not, per se, be grounds for disallowing a warranty claim.

## 7.2 Installation Warranty

A person or company who installs a verified RECS must warrant that the installation is free from defects in workmanship or any materials which cause the RECS to fail to conform to the emission control performance level it was verified to for three years or 2,500 hours, whichever occurs first.

The extent of the warranty coverage provided by installers must be the same as the warranty provided by the applicant as established by the Product Warranty section (discussed above) and the same exclusions must apply.

## 7.3 Product Warranty Statement

The applicant must furnish a copy of the warranty statement in the owner's manual. The applicant may include descriptions of circumstances that may result in a denial of warranty coverage, but these descriptions shall not limit warranty coverage in any way.

## 7.4 Retrofit Emission Control System Warranty Reports

### 7.4.1 Annual Warranty Claims Reports

The applicant must submit an annual warranty report to the Executive Officer by February 1 of each calendar year including the following information:

- Annual and cumulative sales, and annual and cumulative leases of equipment installed with RECS in California.
- Annual and cumulative production of RECS is required for California only.
- Annual summary of warranty claims in California only must include:
  - A description of the nature of the claims and of the warranty replacements or repairs. The applicant must categorize warranty claims for each LSI retrofit emission control group by the component(s) part number(s) replaced or repaired.
  - The number and percentage of RECS of each model for which a warranty replacement or repair was identified.
  - A short description of the RECS component that was replaced or repaired under warranty and the most likely reason for its failure.
- Date the warranty claims were filed and the engine family and application in which the RECS were used.
- Delineate the reason(s) for any instances in which warranty service is not provided to end-users that file warranty claims. The applicant may also report instances where the applicant chose to make repairs for the user even though the applicant

has determined that those warranty claims were unsubstantiated or that they were not required under Section 2757 of the Verification Procedure.

#### 7.4.2 Periodic Warranty Claims Reports

The applicant is required to submit a periodic warranty report within 30 calendar days if there are three or more warranty claims for the same component or same part number that is repaired or replaced; or, if there are four or more total warranty claims, or four percent of the cumulative number of RECS subject to these warranty provisions, whichever is greater. Throughout the year the applicant must continue to comply with the periodic warranty reporting as more warranty claims were made. The periodic warranty report must include the following information:

- Description of the nature of the claims and of the warranty replacements or repairs. The applicant must categorize warranty claims for each LSI retrofit emission control group by the component(s) part number(s) replaced or repaired.
- The number and percentage of RECS of each model for which a warranty replacement or repair was identified.
- A short description of the RECS component that was replaced or repaired under warranty and the most likely reason for the component failure.
- Date the warranty claims were filed and the engine family and application that were installed with the RECS.
- The reason(s) for any instances in which warranty service is not provided to end-users that file warranty claims. The applicant may also want to report instances where the applicant chose to make repairs for the user even though it determined that those warranty claims were unsubstantiated or that they were not required.

#### 7.5 In-Use Compliance

An in-use compliance test requirement was included to ensure that RECS sold to end-users are as effective during normal operation as those tested for the initial verification. The in-use compliance testing is required when at least 50 units of a specific RECS group have been sold in the California market.

For each RECS control group, the Executive Officer will identify a representative sample of engines or equipment fitted with RECS for the in-use compliance testing from each emission control group. As with any in-use emission testing, all properly maintained engines would be expected to sustain the verified emission levels. Good maintenance records for the engines or equipment with the selected RECS installed will be an important part of the compliance information. Accumulated hours of usage, maintenance records (to the extent practicable), operating conditions and a description of any unscheduled maintenance that may affect the emission results would be important to present.

Applicants must obtain and test a minimum of four RECS that have operated between 1,500 and 2,000 hours or between 22 and 29 months. This testing would allow ARB to

identify and assist in resolving any problems associated with the RECS before having widespread application of those systems in the market. A tune-up or regular maintenance prior to testing is allowed.

An applicant is required to follow the same testing procedure as used for initial emission testing, including the same test cycle(s). Doing so would eliminate any variations in emission reduction performance that occur with different test cycles. ARB could then make a more meaningful comparison of the emission reductions between the in-use RECS and those that were originally verified. After all testing is completed, the applicant must submit an in-use compliance report that summarizes the results of in-use testing.

#### 7.5.1 In-Use Compliance Report

The applicant must submit an in-use compliance report to the Executive Officer within three months of completing each phase of testing. These reports are important so that ARB may be brought in early if there are problems that would need to be addressed that affect the verification of the RECS. The following information must be reported for each of the minimum of four RECS tested:

- Parties involved in conducting the in-use compliance tests.
- Quality control and quality assurance information for the test equipment.
- RECS group name and manufacture date.
- Equipment and type of engine the RECS was applied (engine family name, make, model year, model, displacement, etc.)
- Estimated hours that the RECS were used.
- Results of all emission testing.
- Summary of maintenance, modifications, and repairs performed on the RECS.

#### REFERENCES

ARB, 2002. "Staff Report: Initial Statement of Reasons, Proposed Regulation for the Verification Procedure for In-use Strategies to Control Emission From Diesel Engines," California Air Resources Board, March 29, 2002.

ARB, 1998a. "Public Hearing to Consider Adoption of Emission Standards and Test Procedures for New 2001 and Later Off-Road Large Spark-Ignition Engines," California Air Resources Board, September 4, 1998.

EPA, 2001. "Evaluation of Emissions Durability of Off-road LPG Engines Equipped With Three-way Catalyst," United States Environmental Protection Agency, September, 1998.

EPA, 2005. "Test Procedures for Highway and Nonroad Engines and Omnibus Technical Amendments," United States Environmental Protection Agency, June, 2005.