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Regional and State Programs Division
Office of Mobile Sources
U.S. Environmental Protection Agency

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Guidelines for Retrofit Applicants

Purpose of this Document

This document is intended as a guideline for companies preparing applications to the U.S. Environmental Protection Agency (EPA) Retrofit/Rebuild Program. This document summarizes and adds to information found in the Retrofit/Rebuild Final Report also posted on this website.

What is the Retrofit/Rebuild Program?

The Retrofit/Rebuild Program was developed by a diverse group of state, federal, and industry personnel and is intended to reduce heavy-duty engine emissions by encouraging retrofit with emission control devices. The program provides states with methods to calculate SIP credits from retrofit projects. In addition, an independent third party verification system has been established to provide states with information on available retrofit products. During the verification process, an independent, voluntary review committee examines test data to verify emission reduction claims by emission control equipment manufacturers. Once a product has gone through the verification process successfully, information on the control technology will be posted on the Retrofit Website, maintained by EPA. This information can then be used by states, public agencies, and private groups who are interested in initiating retrofit projects.

Who should apply to the Retrofit/Rebuild Program?

Companies that manufacture emission control devices and who wish to have their products appear on the EPA Retrofit Website for use by states, agencies, and private organizations or companies.

What Information is Needed?

As outlined in the Retrofit/Rebuild Final Report found on this website, three types of data/information should be included in the application: 1) test data showing the emission reduction potential of the control equipment; 2) a description of the kinds of engines the control equipment can be retrofitted onto and a supporting engineering analysis; and 3) a proposed method for spot testing units in-use. The test data requirement for application to this program has been modeled after the requirements of the EPA Urban Bus Program. Sections I through VI detail the information and the manner in which it should be presented in the application packet.

Review Process

The review committee will make best efforts to review completed applications within 60 days from the date of submission.

I. Preliminary Testing Plan for Applicants

Those companies that have already gathered test data should skip to Section II. This form should be filled out by those applicants to the Voluntary Retrofit Program who have not yet initiated a testing program to gather data on a retrofit device.

The purpose of submitting a preliminary testing plan is to solicit input from the review committee on the applicability of the proposed testing plan. Review of this preliminary testing plan could reduce the costs of the testing program by focusing testing and eliminating any elements that are not necessary. It can also help to avoid additional testing to support product claims. Potential applicants should submit the information detailed below and submit the completed forms to the retrofit program coordinator before testing is begun. The review committee will comment on the proposed testing plan and respond to the submitting company.

Company name_____

Product name_____

Product type (ex. oxidation catalyst) _____

Application (ex. mobile heavy-duty)_____

Potential engines to be applied to (ex. all heavy-duty diesel on-highway)_____

Description of testing planned:

Example Description: A 1998 Cummins L10 diesel engine will be tested on an engine dynamometer at (insert testing lab name). The testing cycle will be the FTP for heavy-duty highway engines. Three FTP tests will be taken to establish a baseline and then the 200 cpsi oxidation catalyst will be installed on the engine. The catalyst will have been "de-greened" for a period of ten hours. The engine will then be tested on the FTP three times to determine post baseline emissions. Pollutants to be measured will include NOx, PM, HC, CO, and smoke. Continuous emissions data for NOx, HC, and CO will be submitted with the corresponding load, speed, and temperature conditions of the engine. Continuous backpressure measurements will be taken during testing and fuel consumption over the test cycle will be determined.

NOx emissions will be measured with a Horiba chemilumninescent analyzer, HC with a heated flame ionization detector, CO with an NDIR detector, and PM with filtration and gravimetric measurement in accordance with (for example) SAE recommended test procedures or EPA federal regulations.

II. Technology Description

In this section the type of technology that is being submitted to the review committee should be described. Applications should be submitted for complete emissions control reduction devices rather than individual components. Two examples are given below:

1) This application is for a Selective Catalytic Reduction system. The SCR system is designed to reduce NOx emissions. The system includes a vanadium-based SCR catalyst supported on a 200 cpsi ceramic substrate designed to handle a total flow of 1,500 acfm, manufactured by (insert company name), and a urea injection system manufactured by (insert company name). The system works by reducing NO and NO_2 emissions to N_2 and H_2O. The reduction of the nitrogen oxides takes place by injecting ammonia or a compound generating ammonia such as urea into the exhaust gas at a temperature of 320 – 420 degrees C and subsequently passing the ammonia/exhaust gas mixture through a catalyst, where the nitrogen oxides, which primarily consist of NO and NO_2 are converted .

2) This application is being submitted for an oxidation catalyst. The oxidation catalyst reduces the soluble organic fraction of PM, gaseous HC, CO, and toxic emissions. The catalyst is installed either as a replacement muffler or as an add-on device to be inserted into the exhaust system. The catalyst supplied contains Pt/Pd at a metal ratio of 6:1 and a total loading of 20 g/ft^3 supported on a 200 cpsi metallic substrate designed to handle a total flow of 1,500 acfm. The oxidation of PM, HC, CO, and toxic emissions takes place when the exhaust gas passes through the catalyst and is oxidized by the precious metal coating. PM, HC, CO, and toxics are oxidized to H_2O and CO_2.

Where information is sensitive and confidential, please divulge as much information as possible.

III. Engine Application

In this section, a brief, specific description of the type of application the technology/product will be retrofitted onto. Two examples are listed below.

1) The SCR system is intended for two uses:
   - diesel generators;
   - marine vessel engines

2) The oxidation catalyst is intended for use in:
   - all highway and nonroad diesel engines

IV. Testing Information and Percent Reduction

In this section, requirements for testing data are described. Subsections A to E detail the specific data requirements.

A. Engine(s) model, make, and year the product was tested on;
B. Test cycles (a description of appropriate test cycles is given below)

Default Test Cycles

As with the federal urban bus retrofit program the accepted test method will be the Federal Test Procedure (FTP). The applicant should follow the data generation requirements as outlined in part 85.1406 of the Federal Register. If it is not appropriate to use the FTP cycle or if a technology developer wants to generate data using a test cycle that is different from the FTP, then the manufacturer should use: 1) test methods recommended by EPA, such as the 8-mode cycle for verification of a technology with nonroad engines; 2) test methods recommended by CARB; 3) the Central Business District cycle (CBD) or the New York Bus Composite Cycle (NYBCC) for chassis dynamometer testing.

Possible Alternative Testing Cycles

If a technology developer has already generated data using a cycle that is not included as a default testing method then the cycle will need to be reviewed by the administrative group and the review committee. Such cycles could include, for example, the R49. In such a case the 60 day review period limit will not be valid.

Testing cycles should reflect the in-use duty cycle. For example, if an SCR system is intended for marine vessel applications, then a cycle with some transient operation should be used since marine engines typically go through periods of transient operation.

C. Test Data

The test data requirements for all technology verifications will be equivalent to that which is specified for the federal Urban Bus Retrofit/Rebuild program as described in CFR part 85.1406. Part 85.1406 calls for three FTP tests to establish baseline emissions and three post-baseline FTP tests to establish post-baseline emissions. The emission control device should be "de-greened" for a period of ten hours before post-baseline testing. Data to be provided for both baseline and post-baseline tests include:

Continuous emissions data for NOx, HC, and CO (bag CO data should also be acceptable) should be submitted with the corresponding load, rpm, and temperature

conditions of the engine. Continuous backpressure measurements should be taken during testing. Specific detail on test procedures by mode should be included.

Other information may be important. For example, in an SCR application, information on urea consumption and urea slip during testing should be included.

D. Emissions Percent Reduction

The control equipment manufacturer should calculate the percent of PM, NOx, HC, CO (where applicable) reduced by the control technology as established during engine/chassis testing. The percent reduction levels should be established by calculating the difference between baseline or engine out emissions and post-baseline (or post retrofit) emissions. For example, post-baseline PM emissions in gr/bhp-hr of .2 would be divided by baseline PM emissions of .3. This figure would then be subtracted from one and multiplied by 100 to arrive at the percent reduction.

E. Testing Laboratory and Equipment

The testing laboratory that conducted emissions testing should be identified as well as the sampling devices used. For example, NOx emissions were measured with a Horiba chemilumninescent analyzer, HC with a heated flame ionization detector, CO with an NDIR detector, and PM with filtration and gravimetric measurement in accordance with EPA federal regulations.

V. Applicable Engines

The manufacturer should provide a recommendation as to the engine families the control technology can be used with. This recommendation should be in the form of an engineering analysis conducted either in-house or by an outside group. The analysis should use sound engineering judgment to determine what engine families the retrofit/rebuild equipment can be used in. Particulate matter composition (soluble organic fraction estimates), exhaust temperature, space velocity, duty cycle and other operating conditions should be considered in the engineering analysis. The manufacturer and the review committee will use best judgement in applicability to non tested engines. Relational data may be used with sound engineering assumptions. The committee will review the engineering analysis to determine which engine families the control equipment can be used with. In reviewing the submission, the review committee will use good engineering and scientific judgment and analyze all submitted data on a given product to make its determination. The review committee will document each decision and submit records to the administrator so that the analysis can be justified if EPA chooses to review the committee decision.

Following is an example of considerations that need to be taken into account in the engineering analysis.

1) This SCR system is limited to a temperature window of 320-420 degrees C. The SCR system can be used in (include information on engine families) based on manufacturer specifications for exhaust temperature under rated speed and load conditions. If maximum emission reduction percentages are to be used, the application should be limited to engines in which operations result in exhaust temperatures within the temperature window indicated. Alternatively, expected NOx reductions should be adjusted based on expected exhaust temperature profiles. For example, if under typical conditions, exhaust temperatures are below 320 degrees for 30 percent of the time, the expected emission reduction percent should be adjusted from 70 percent to 49 percent (70% NOx reduction for 70% of operating time).

Note: In the future, an example of an engineering analysis will be added to this document to assist applicants.

VI. In-Field Testing Method

The applicant should submit a proposed "field testing" plan to the review committee. The manufacturer is required to test a number of units in the field (this number can be as low as four and as high as 10 or 15). The testing is meant to be a cost effective means of determining whether or not an emissions control unit is reducing emissions as expected. The field testing plan describes how units in the field will be tested for performance. As an example, a truck retrofitted with an oxidation catalyst could be tested (upstream and downstream of the catalyst) using a five gas analyzer to check for CO emissions. Estimated percent reductions must be met during field testing. For some applications such as fuel additives and rebuild kits, field test methods will be more difficult to develop. In these cases, manufacturers might choose to designate two fleet vehicles of similar make and model year, one retrofitted with the control technology and one without. The vehicle without the control technology could act as a "control" vehicle for field testing purposes.

The field testing should be taken while the engine operates under typical conditions based upon operator’s input on best and worst case conditions.

In addition to a field method such as using an electrochemical portable analyzer, a more comprehensive testing method needs to be developed by the product manufacturer in the case of dynamometer testing. For example if an oxidation catalyst fails field tests and must then be tested in dynamometer tests, then a potential testing method would be to remove the catalyst and attach it to a "slave" engine in a testing lab. Another possibility could be to test on a mobile chassis dynamometer. As in the case of verification testing, the third party verifier will automatically approve of a method that uses either the FTP or other EPA approved test cycles, CARB approved test cycles, the CBD, and the NYBC cycles. Alternative cycles may be used, but must first be approved of by the review committee. A pass rate of 67% must be established or credit will be revoked. The manufacturer may conduct as many tests as are necessary to achieve this percent pass rate.

Backpressure Measurement

In addition to emissions testing, backpressure measurements will be taken during field testing to ensure that retrofit equipment is not increasing backpressure beyond manufacturer acceptable limits in retrofitted engines.

Application to the Voluntary Retrofit/Rebuild Program

Applicants should complete the following form for the Voluntary Retrofit/Rebuild Program:

1) Company name _____

2) Contact information

- contact person_____
- telephone number_____
- e-mail address_____
- mailing address_____

5) Type of product to be verified_____
(if a system is required, submit information on all components)

6) Name of product to be verified_____

7) Application_____
(ex. mobile heavy-duty diesel on-highway and marine engines)

6) Applicable engines (please see guideline document for a description)

8) Attach testing data including:
(please see guideline document for a description of testing data requirement)

- Preliminary testing plan if completed
- Engine(s) product tested on
- Method (ex. chassis dynamometer, engine dynamometer)
- Space velocity (for aftertreatment devices)
- Description of catalyst type (in case of catalytic aftertreatment)
- RPM, exhaust temp, backpressure data taken during testing
- Detail on test results by mode and test cycle for baseline and post-baseline
- Identify lab where testing was done
- Identify testing equipment

8) Attach engineering analysis (please see guideline document for a description)

9) Attach spot test method proposal (please see guideline document for a description)