State of California
AIR RESOURCES BOARD

EXECUTIVE ORDER D-605U

Relating to Exemptions under
Sections 38390 and 38391 of the Vehicle Code

Emissions Technology, Inc.
Combustion Catalyst System

Pursuant to the authority vested in the Air Resources Board by Part 5, Division 26 of the Health and Safety Code and Sections 38390, 38391, and 38395 of the Vehicle Code; and

Pursuant to the authority vested in the undersigned by Sections 39515 and 39516 of the Health and Safety Code and Executive Order G-02-003;

IT IS ORDERED AND RESOLVED: That installation of the Combustion Catalyst System, manufactured by Emissions Technology, Inc. of 3620 East Wier Avenue, Phoenix, Arizona 85040, has been found not to reduce the effectiveness of the applicable engine emission control system, and therefore, the Combustion Catalyst System is exempt from the prohibitions in Sections 38390 and 38391 of the Vehicle Code for installation on 1996-2006 model-year off-road compression-ignition engines.

Combustion Catalyst System part numbers 80160, 80162, 80165, and 80174 are exempted under this Executive Order.

This Executive Order is based on emission testing Emissions Technology, Inc. conducted with the Combustion Catalyst System. Testing showed that the Combustion Catalyst System does not increase engine emissions.

If evidence provides the Air Resources Board with reasons to suspect that the Combustion Catalyst System will affect emissions with prolonged use, Emissions Technology, Inc. shall be required to submit additional emission data to show that the Combustion Catalyst System does not increase emissions of regulated pollutants or any other pollutants that might contribute to formation of toxic air contaminants.

This Executive Order is valid provided that installation instructions for the Combustion Catalyst System do not recommend tuning the engines to specifications different from those of the engine manufacturer.

Changes made to the design or operating conditions of the Combustion Catalyst System, as exempt by the Air Resources Board, which adversely affect the performance of the engine's pollution control system, shall invalidate this Executive Order.

Marketing of the Combustion Catalyst System using identification other than that shown in this Executive Order or for an application other than that listed in this Executive Order shall be prohibited unless prior approval is obtained from the Air Resources Board.

This Executive Order shall not apply to any Combustion Catalyst System advertised, offered for sale, sold with, or installed on an off-road engine, vehicle, or equipment prior to or concurrent with transfer to an ultimate purchaser.

This Executive Order does not constitute any opinion as to the effect the use of the Combustion Catalyst System may have on any warranty either expressed or implied by the engine manufacturer.

No claim of any kind, such as "Approved by the Air Resources Board," may be made with respect to the action taken herein in any advertising or other oral or written communication.

In addition to the foregoing, the Air Resources Board reserves the right in the future to review this Executive Order and the exemption provided herein to assure that the exempted add-on or modified part continues to meet the standards and procedures of California Code of Regulations, Title 13, Section 2474, et seq.

THIS EXECUTIVE ORDER DOES NOT CONSTITUTE A CERTIFICATION, ACCREDITATION, APPROVAL, OR ANY OTHER TYPE OF ENDORSEMENT BY THE AIR RESOURCES BOARD OF ANY CLAIMS OF THE APPLICANT CONCERNING ANTI-POLLUTION BENEFITS OR ANY ALLEGED BENEFITS OF EMISSIONS TECHNOLOGY, INC.'S COMBUSTION CATALYST SYSTEM.

Violation of any of the above conditions shall be grounds for revocation of this Executive Order. The Executive Order may be revoked only after a ten-day written notice of intention to revoke the Executive Order, in which period the holder of the Executive Order may request in writing a hearing to contest the proposed revocation. If a hearing is requested, it shall be held within ten days of receipt of the request, and the Executive Order may not be revoked until a determination is made after a hearing that grounds for revocation exist.

Executed at El Monte, California, this 29TH day of March 2006.

Allen Lyons, Chief
Mobile Source Operations Division

EVALUATION SUMMARY

Manufacturer Name: Emissions Technology, Inc.

Name of Device: Combustion Catalyst System

Background:

Emissions Technology, Inc. (ETI) of 3620 East Wier Avenue, Phoenix, Arizona 85040 has requested exemption of its Combustion Catalyst System (CCS) from the prohibitions in Section 38391 of the California Vehicle Code (VC). The engine application includes 1996 through 2006 model-year off-road compression-ignition engines.

Recommendation:

Grant exemption to ETI as requested and issue Executive Order D-605U. The exemption covers CCS part numbers 80160, 80162, 80165, and 80174.

Device Description:

The Combustion Catalyst System is designed to inject aerosol catalysts into the intake air stream of diesel engines. The aerosol catalysts are claimed to enhance combustion and reduce exhaust emissions. The system consists of a bottle containing an aqueous solution of catalytic salts, an electric pump, and a connection hose. Using engine vacuum and pump, vacuum is pulled on the bottle. An air hole at the top of the bottle feeds air to the bottom of the aqueous solution. As vacuum is pulled from the top and through the bottle, air bubbles form at the bottom of the solution and travel up through the solution, picking up the catalysts. The catalysts in the bubbles are then introduced into the intake air stream. The system is designed to introduce 3 to 6 millimeter diameter bubbles at a rate of 3 to 4 bubbles per second. The bottle measures approximately 7" H x 5" L x 2.5" D and contains 700 milliliter of catalytic solution. For a typical application, one bottle is designed to last approximately 400 hours. The system includes a timer which records the elapsed time since system installation and since the last bottle replacement. At the end of 400 hours, a warning light alerts the user, indicating the time for bottle replacement.

ETI offers four different catalyst formulations. The formulations vary in catalytic metals, their amounts, and types and amounts of carriers and stabilizing agents. The base solution is either de-ionized water or propylene glycol. The final catalyst solution is manufactured to ETI specifications by Heraeus Metal Processing, Inc. in Santa Fe Springs, California. The formulations are identified by part numbers 80160, 80162, 80165, and 80174. Any one of the formulations can be offered in one of the four following CCS models:

1. DC-100 designed for engines with fuel consumption rate less than 15 gallons per hour (GPH) (one catalyst bottle)
2. DC-101 is DC-100 with different packaging
3. DC-100M is DC-100 without the protective box (for applications with space constraints)
4. DC-200 designed for engines with fuel consumption rate less than 30 GPH (two catalyst bottles)

Multiple units are used on engines with fuel consumption rate greater than 30 GPH and on engines with more than one air intake duct.

ETI recommends installing the system as close to the engine or turbocharger as possible but away from exhaust or extreme heat.

Discussion/Basis for the Recommendation:

ETI was required to conduct testing to demonstrate no adverse impact on emissions. Testing requirements were twofold: (1) test the CCS on a representative engine and compare the exhaust emissions to new engine certification standards and (2) analyze the particulate matter (PM) sampled from the certification test for chlorine/chloride and compare the levels with and without the CCS. Testing was performed on a 2005 MY Cummins, Inc. QSM11-C engine certified to Tier 3 emission standards (engine family 5CEXL0661AAF; 10.8 liter; 400 horsepower). The engine was tested using the new engine certification test (8-mode test cycle

for variable speed engines). ETI was required to run duplicate tests in each configuration (e.g. two baseline tests, two CCS tests) to minimize test-to-test variability. ETI performed three tests in each configuration. Tests were conducted at California Environmental Engineering (CEE) located in Santa Ana, California. Data are presented below:

	8-mode Test Cycle Emissions (g/kW-hr)				
Test	NMHC	CO	NOx	NMHC+NOx	PM
Baseline 1	0.2579	1.3933	3.7516	4.0095	0.1281
Baseline 2	0.2722	1.4322	3.7507	4.0229	0.1227
Baseline 3	0.2607	1.4244	3.6924	3.9532	0.1231
Avg. Baseline	0.2636	1.4167	3.7316	3.9952	0.1246
Formulation A1	0.2404	1.3711	3.5662	3.8066	0.1302
Formulation A2	0.2718	1.4305	3.6398	3.9116	0.1308
Formulation A3	0.2685	1.4177	3.6068	3.8753	0.1256
Avg. A	0.2602	1.4064	3.6043	3.8645	0.1289
% Difference	-1.3	-0.7	-3.4	-3.3	+3.4
Formulation B1	0.2596	1.3959	3.5593	3.8190	0.1283
Formulation B2	0.2623	1.4329	3.5685	3.8308	0.1249
Formulation B3	0.2568	1.4396	3.5886	3.8454	0.1251
Avg. B	0.2596	1.4228	3.5721	3.8317	0.1261
% Difference	-1.5	+0.4	-4.3	-4.1	+1.2
Formulation C1	0.2579	1.3947	3.6020	3.8599	0.1283
Formulation C2	0.2457	1.4150	3.6491	3.8949	0.1310
Formulation C3	0.2602	1.4365	3.6363	3.8965	0.1274
Avg. C	0.2546	1.4154	3.6291	3.8837	0.1289
% Difference	-3.4	-0.1	-2.7	-2.8	+3.4
Formulation D1	0.2638	1.3473	3.5335	3.7971	0.1280
Formulation D2	0.2678	1.3766	3.5793	3.8473	0.1305
Formulation D3	0.2713	1.3948	3.5890	3.8603	0.1306
Avg. D	0.2676	1.3729	3.5673	3.8349	0.1297
% Difference	+1.5	-3.1	-4.4	-4.0	+4.1
Standards	n/a	3.5	n/a	4.0	0.20

Notes:

1 Engine break-in period was approximately 135 hours. All tests were performed immediately following break-in.
2 Tests were conducted using California ultra low sulfur diesel (sulfur content < 15 ppmw).
3 Particulate matter was sampled over the entire test cycle using a single filter.
4 CEE reported the emissions in grams per brake horsepower-hour. Emissions were converted to grams per kilowatt-hour.
5 Formulation A = 80160; Formulation B = 80162; Formulation C = 80174; Formulation D = 80165.
6 Original equipment manufacturer deterioration factors were zero for all pollutants.

As shown, emissions for each of the CCS formulations were below the new engine certification standards. They were also comparable to baseline emissions. Similar results are expected when any of the four CCS formulations is used on any of the engines included in the Executive Order.

The catalysts used in CCS contain metals and chlorinated compounds. Though they are not listed in the Air Resources Board's Toxic Air Contaminant (TAC) list, the large amounts of chlorine used in the catalyst solutions pose the potential for emissions of chlorinated dioxins and chlorinated dibenzofurans (collectively known as "dioxins"), which are listed as TACs possessing extremely high carcinogenic potency. As a result, ETI was required to quantify the organic chlorine and inorganic chlorides emitted during the certification test and show that the chlorine/chloride levels with the CCS are not significantly higher than the levels without the CCS. The limit was set at four times the baseline levels (without CCS). The PM filters were shipped from CEE to Southwest Research Institute (SwRI) in San Antonio, Texas for analyses.

The PM filters were analyzed for inorganic chloride and total chlorine. The method required halving each filter, using one-half for inorganic chloride analysis and the other half for total chlorine analysis. One-half of each filter was dissolved in de-ionized water (25 mL) to extract the inorganic chloride. The other half of the filter was fused with sodium carbonate then dissolved in de-ionized water (50 mL) for total chlorine determination. The sample solutions were analyzed using ion chromatography. The instrument reporting limit was 0.1mg/L or 0.1ug/mL. This corresponds to limits of detection (LOD) of 5 ug/filter and 10 ug/filter for inorganic chloride and total chlorine, respectively. Organic chlorine was determined by calculating the difference between the total chlorine and the inorganic chloride, and the LOD was established at 10 ug/filter. Sodium carbonate (99.999% Na_2CO_3) used for the fusion contained a small amount of chlorine. This amount was determined by dissolving the sodium carbonate amount used in the fusion (2 grams per fusion) in 50 mL of de-ionized water and analyzing it for chlorine content. Two measurements were made. The average concentration, approximately 10 ug/filter, was subtracted from the sample results to correct for the additional chlorine introduced by the sodium carbonate. Results are presented below:

	Chlorine/Chloride (ug/filter)		
	Total Chlorine	Inorganic Chloride	Organic Chlorine
Baseline 1	117	99.0	18.0
Duplicate Baseline 1	109	103	<10
Baseline 2	126	81.4	44.6
Formulation A1	80.2	86.7	<10
Formulation A2	98.4	79.2	19.2
Formulation B1	127	87.7	39.3
Formulation B2	106	86.3	19.7
Formulation C1	75.1	61.2	13.9
Formulation C2	78.1	79.0	<10
Formulation D1	91.6	90.0	<10
Formulation D2	56.2	72.3	<10
Blank 1	110	101	<10
Blank 2	120	108	12.0
Blank 3	92.6	102	<10

Notes:

1 Limit of detection (LOD) for total chlorine was 10 ug/filter. LOD for inorganic chloride was 5 ug/filter. LOD for organic chlorine was 10 ug/filter.
2 To minimize chlorine input, High Efficiency Particulate Air (HEPA) filter was installed in the intake air line. Lube oil, oil filter, and fuel filter were changed before baseline tests and again before testing each of the CCS formulations. HEPA filter was changed before testing each of the CCS formulations.
3 Same batches of test fuel and lube oil were used for all the tests.
4 Glass fiber filters were used for PM sampling.

The chlorine levels varied widely from filter to filter. Compared to the levels found on baseline filters, data did not show significant increases with the CCS, as might be expected based on the large amounts of chlorine used in the CCS. However, the levels found on many CCS filters were also lower than the levels found on blank filters. As presented, the chlorine/chloride data are inconclusive, primarily due to the high levels of chlorine found on the blank filters. Minimal or no increase in chlorine levels with the CCS might indicate that no significant catalytic reaction is taking place. This is supported by the emission data, which showed no significant emission reduction.

As noted earlier, ETI ran triplicate tests. The filters from the third tests were analyzed by SwRI for metals content (ICP and ICP-MS analyses). Many of the active catalysts were below detection limits, further suggesting the absence of any catalytic reaction (see application file for results).

Based on the above, staff expects no adverse emissions impact when any of the four CCS formulations is used on the engines for which ETI is requesting exemption. Staff concludes that ETI's four CCSs meet the requirements for a conditional VC 38395 exemption for the engines listed in the Executive Order. If in the future, staff is provided with evidence which suggests that the CCS might affect emissions with prolonged use, ETI will be required to submit additional emission data to show that the CCS does not increase emissions of regulated pollutants or any other pollutants that might contribute to formation of toxic air contaminants.