Winter-Spring Report

Program for the Study
of Extremely-Low-Emission Vehicles:
Year 2 Activities

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Acknowledgments

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1. Executive Summary

This report discusses progress and results of research conducted in the winter and early spring of 2002. Major activities during the reporting period include further analysis of data collected from laboratory and field emissions measurements, further analysis of vehicle activity data, and reporting and dissemination. We also developed the program plan for year 3 of the program, commencing July 1, 2002; this was distributed for comment, and we soon will send out documents for extension of the agreements to fund these tasks. Specific accomplishments of the reporting period include the following:

- **Laboratory and On-road tasks:**
    - Completed testing of LEV vehicle in CE-CERT's Vehicle Emissions Research Laboratory.
    - Designed an improved sample conditioning system for the on-road measurement system.
    - Designed an improved cold-soak monitoring system.
    - Continued detailed analysis of discrepancies between laboratory and on-road emissions measurements to understand system biases, precision, and accuracy.
    - Commenced measurements of ammonia exhaust emissions (coordinated with Coordinating Research Council ammonia project).
    - Prepared presentations for the 12th Coordinating Research Council On-Road Vehicle Emissions Workshop.

- **Modeling tasks**
    - Continued the compilation and analysis by ZIP code of on-road vehicle activity data from the summer 2001 field study.
    - Compiled random sample of vehicles from the Department of Motor Vehicles registration database for comparison with the on-road vehicle fleet.
    - Processed DMV and on-road registration data to estimate vehicle fleet weights for the Comprehensive Modal Emissions Model (CMEM).
    - Continued integration of vehicle emissions models, air quality models, and data preprocessing system for integrated analysis.
    - Prepared presentations for the 12th Coordinating Research Council On-Road Vehicle Emissions Workshop.

In the April-June quarter, we expect to complete the following activities:

- Convert the CRC presentations into manuscripts for peer review and publication.

- Complete data analysis from the on-road and laboratory tasks.

- Construct and test the sample conditioning system and cold-soak monitoring system.

- Complete development and testing of a laboratory calibration system.

- Complete measurements of ammonia emissions from late-model automobiles and obtain data suitable for developing an ammonia model.

- Complete a vehicle testing matrix for year 3 of the program, addressing the number and types of vehicles to be measured for modeling purposes.

- Convene a meeting of program participants to determine the modeling scenarios to be investigated in year 3 of the program.

- Complete agreements for current sponsors to continue their support of year 3 of the program.

- Complete an agreement for the Manufacturers of Emission Controls Association (MECA) to become a member of the program.

- Recruit additional corporate supporters of the program.

2. Laboratory and On-Road Progress and Results

As indicated in the last quarterly report, the Laboratory and On-Road portions of the program are converging into a single Measurement effort. We are reporting those activities together in this report.

2.1 Analysis of Existing Data

We have collected information from a limited number of LEV through SULEV vehicles operating on the chassis dynamometer, operating on the road, and operating at Honda's test track. Results from this limited data set show some test-to-test variability and discrepancies between measurement methods. (See materials from the December 2001 program meeting and the February 2002 program report for examples.)

We have undertaken a systematic analysis of the data collected so far to understand the differences between measurement methods, the influences of factors such as cold-soak temperature, and the possible biases of different types of sampling and measurement instrumentation. This understanding will enable us to interpret the data already collected and data to be collected in the future. It also might point out improvements to measurement approaches that will provide benefits in the future.

2.2 On-Board Sample Collection

The weight of the on-board sample conditioning system effectively means that we are always testing a light-duty passenger car at or near its fully loaded weight. This is not typical of "real world" driving. Therefore, we have undertaken modifications to the sample conditioning system to reduce its weight. The sample conditioning system itself now is 50 pounds lighter than the original design, and the total weight of the new version will be 250 pounds less.

Figure 2-1 shows a diagram of the new sample conditioning system, and Figures 2-2 through 2-4 show photographs. The system was built in early April 2002, and testing will continue in the current quarter.
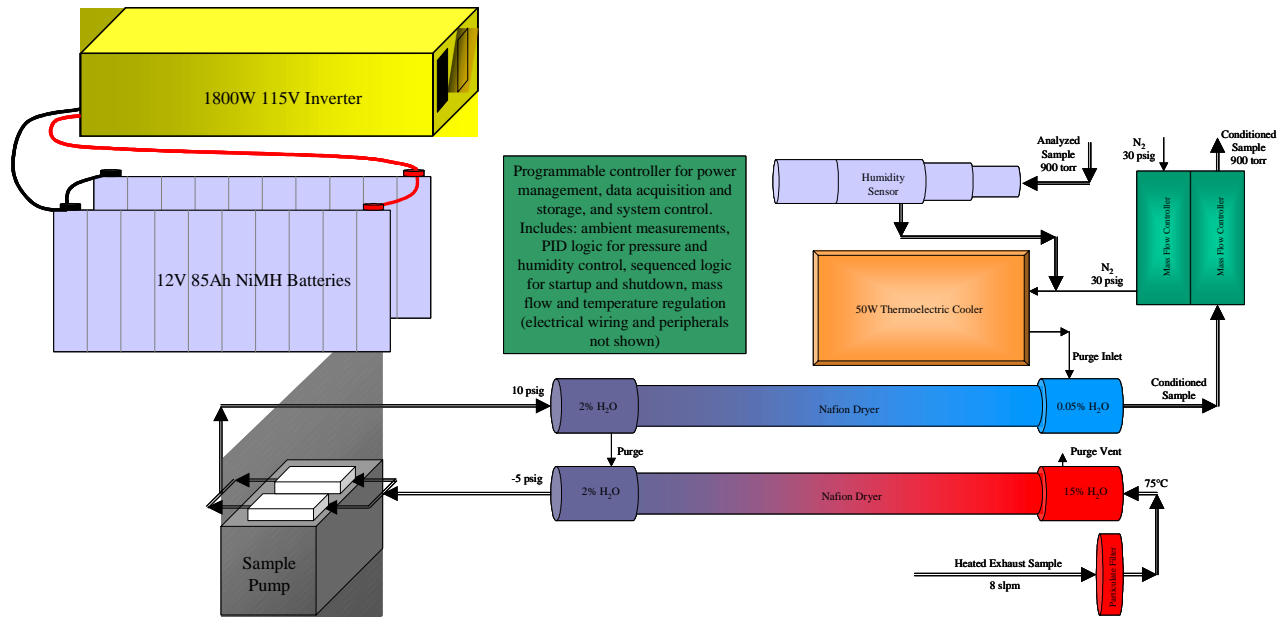
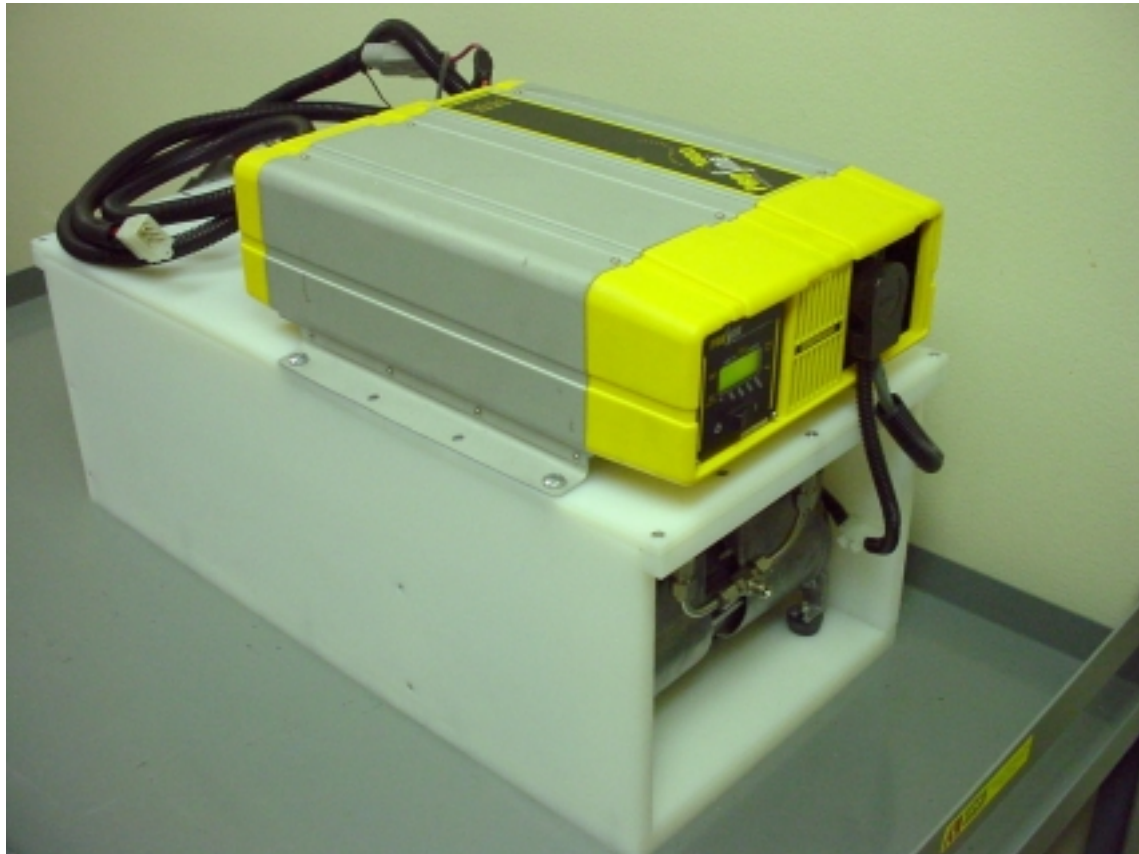**Figure 2-1.** Schematic diagram of redesigned sample conditioning system.
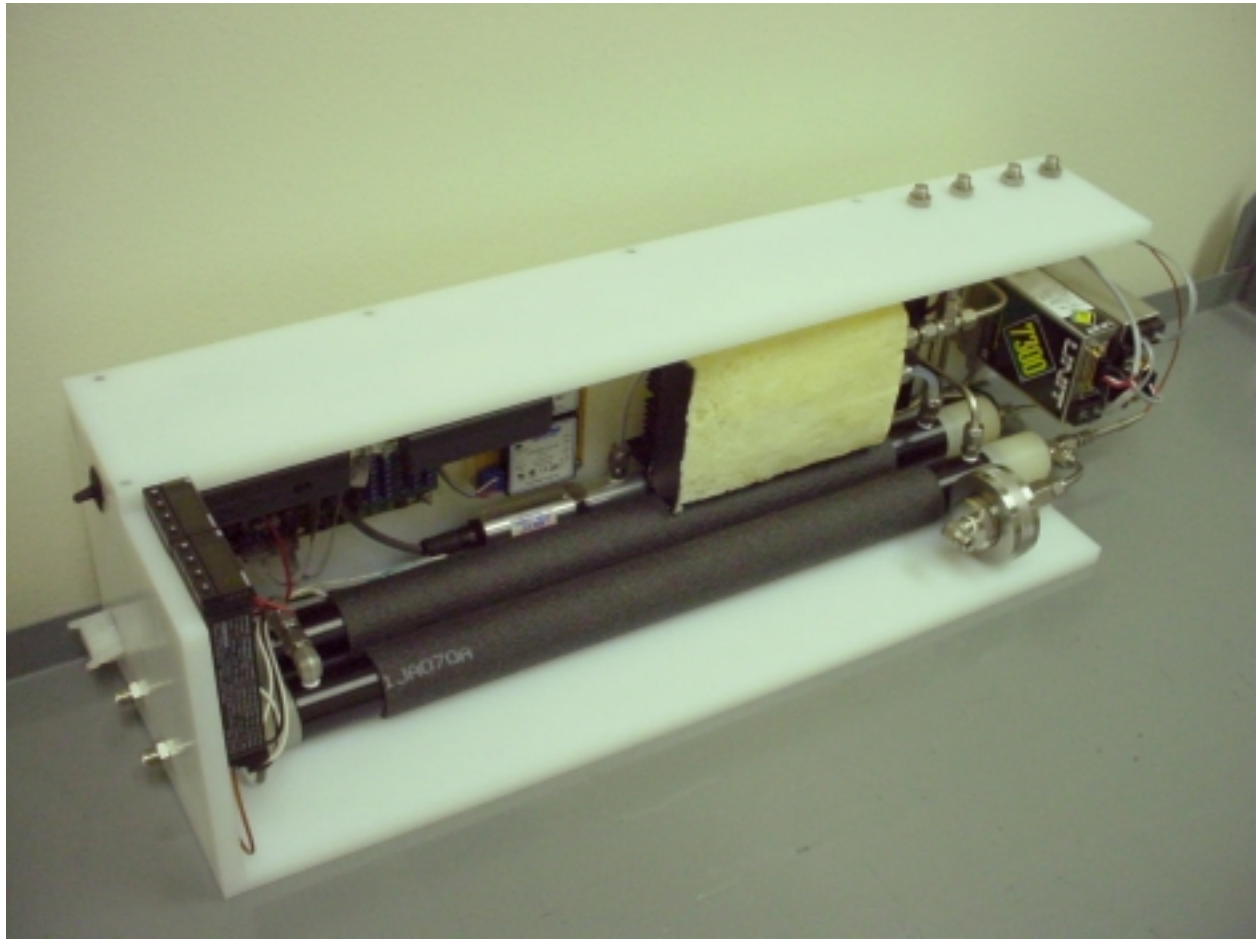

Figure 2-2. On-board power supply unit.

Figure 2-3. Sample conditioning system, opened to reveal detail.

Figure 2-4. Conditioning system installed in cargo area of UCR test vehicle.

2.3 Laboratory Calibration

Little development was done on the laboratory calibration system in the reporting quarter. We will complete development of the calibration system and apply it to the lab and on-road measurements in the coming quarter. A computerized user interface recently has been developed.

The engineer who began working on this system recently left CE-CERT to take another job before completing this project. This might result in delays in completing and validating the system.

2.4 Ammonia Emissions from Late-Model Vehicles

A portion of the U.S. EPA's funds in the current year are directed toward measurement of ammonia emissions from extremely-low-emission vehicles. This activity is complementary to a separate ammonia measurement project sponsored by the Coordinating Research Council (projects E-60 and E-61).

Laboratory ammonia emissions measurements in the reporting quarter were all conducted under the CRC program. In the coming quarter, we will complete the CRC-funded testing and integrate the EPA emissions measurement activity to maximize value to both programs. CE-CERT will make ammonia measurements over the Hot 505 cycle, the CE-CERT NCHRP modal cycle, and the New York City Cycle. We will measure catalyst efficiency and obtain data that can be used for creating an ammonia database. It also will be possible to add ammonia emissions calculations to the Comprehensive Modal Emission Model (CMEM) framework's capabilities.

In the course of the CRC project, we have obtained modal emissions data from several late-model vehicles certified as ULEVs and SULEVs. These data will be used in developing the CMEM modules for low-emitting vehicles.

2.5 Vehicle Testing Matrix

At this time, except for the ammonia project, emissions testing has been limited to a Honda Accord ULEV that CE-CERT procured and to other vehicles made available by the sponsors. When the emissions measurement program gains momentum in year 3, it will be necessary to have a testing matrix representative of the range of ULEV and SULEV technologies in the in-use fleet. Therefore, in the final quarter of year 2 and the very early stages of year 3, we must obtain agreement among the sponsors with regard to what vehicles should be studied. The needs of the vehicle emissions modeling program will drive this decision-making process to a significant extent. Based on those needs and the comments we receive from sponsors, we will distribute a testing plan that addresses:

- The balance between high-mileage and low-mileage ULEVs and SULEVs.

- Whether to test natural gas-powered vehicles. These vehicles are likely to have different emissions profiles than gasoline-powered vehicles, but they are likely to constitute a very small portion of the in-use fleet.

- Whether to test hybrid-electric vehicles. Again, these vehicles cannot be modeled based on our measurements from conventional-powertrain gasoline-powered vehicles, but they do not constitute a large segment of the in-use fleet now, and it is unclear that studying one or two types of hybrids will represent the diverse types that are coming to market.

3. Modeling Progress and Results

3.1 Vehicle Activity

The field project to collect vehicle activity data in the summer of 2001 produced an enormous amount of data. In the reporting quarter, we continued to process the data on in-use vehicle types and vehicle driving patterns as a function of time of day and type of roadway.

As of early April, we had completed approximately 70% of the license plate data (383 of 540 tapes) and Autoscope data sets (374 of 540).

3.2 Air Quality Modeling

Work continued on the development of the emissions pre-processor for air quality modeling. The modeling framework and processes will be in place in time to support the air quality modeling portion of the program.

In the coming quarter, we will arrange a meeting or teleconference to discuss the modeling scenarios that should be modeled. We will contact key representatives of all sponsoring organizations in early May and arrange a time between mid-May and mid-June. From this meeting, we will prepare a set of scenarios to be evaluated using the air quality models linked with advanced vehicle emissions models.

4. Issues and Next Steps

4.1 Sponsor Funding

Because of State of California budget cuts, the Air Resources Board reduced its support to the SELEV program during the current fiscal year. The EPA will reduce its support in the upcoming fiscal year.

The Manufacturers of Emission Controls Association (MECA) became aware of our program through the efforts of a CE-CERT Board of Advisors member, Tim Johnson of Corning. MECA has agreed to join the program, but is able to invest only $20,000 at this time. One of MECA's objectives is to learn about measurement approaches and to work with industry and government to establish emission measurement strategies. Therefore, although MECA's financial commitment is quite limited, its potential role in disseminating results from this program and integrating SELEV into the wider community can be substantial.

We also have met with Toyota and Nissan about the possibility of sponsorship. Further meetings will take place in May 2002, and we are optimistic about securing commitments from both companies. We also met with Phillips Petroleum, but it is difficult at this time to gauge the level of interest there. We will continue to follow up with Phillips.

4.2 Next Steps

In the April-June quarter, we expect to complete the following activities:

- Convert the presentations from the April, 2002, Coordinating Research Council workshop into manuscripts for peer review and publication.

- Complete data analysis from the on-road and laboratory tasks.

- Construct and test the sample conditioning system and cold-soak monitoring system.

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- Convene a meeting of program participants to determine the modeling scenarios to be investigated in year 3 of the program.

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- Recruit additional corporate supporters of the program.

5. Reporting

The Coordinating Research Council accepted several papers and presentations from the SELEV program for its 12th On-Road Vehicle Emissions Workshop in April, 2002:

- Barth, M. "Developing Link Emission Factors in the South Coast Air Basin."

- Malcolm, C. "Understanding Real-World Vehicle Activity Patterns and Vehicle Fleet Distributions in the South Coast Air Basin."

- Qin, Y. "Comparison of On-Road Ozone Model Predictions with Ambient and On-Road Ozone Measurements."

- Shepherd, P. "Development and Evaluation of a System for On-Board Measurement of Tailpipe Mass Emission Rates" (parking lot demonstration).

- Wilson, R. "Comparison of Mass Emissions in a Dynamometer Laboratory with Mass Emissions at a Test Track for a New Technology Vehicle over Standard Driving Cycles."

- Younglove, T. "Observed On-Road Vehicle Fleet Differences and Their Effects on Emissions" (poster).

Our objective in the near term is to convert as many of these workshop papers and presentations as possible into manuscripts for peer review and journal publications.

On May 17, 2002, CE-CERT will make a brief presentation in Washington, DC, describing our research program. CE-CERT has received allocations from the EPA via the Congressional

budgeting process for the past three years. The purpose of this presentation is (a) to describe what we have used that funding for and (b) to explain how those activities fit into a larger vision of our research program's role in contributing to cleaner air and improved energy efficiency. A portion of this EPA support has been used for the SELEV program. Invitees to this presentation will include aides to members of Congress, staffers of the Congressional committees, and staffers of Federal agencies with interests in environmental quality and energy.