FutureDrive

Volume 1, Number 2 **DOE/Industry Competitions Advancing Automotive Technology** Summer 1995

SAFETY FEATURE

Competition Safety Rules Meet Real-World Standards

The safety of the drivers, support crew, and spectators has always been a top priority at the automotive technology competitions sponsored by the U.S. Department of Energy. As the competitions have evolved to reflect the manufacturer's challenge by emphasizing the practical application of usable technology and overall market acceptability, so too, have the safety rules to parallel those with which industry must comply daily. Such regulations meet or exceed the Occupational Safety and Health Administration's standards, as well as many industry consensus standards set by the American National Standards Institute, the American Society for Testing and Materials, and the National Fire Protection Association.

A basic core of safety rules and requirements is in place for all competitions. Compliance is especially critical at the larger competitions, where there are greater numbers of attendees as well as more hazard exposure potentials.

The emphasis on safety and health requirements at these large competitions is evident through the presence of an onsite safety representative with sole responsibility for

safety compliance, the use of a ticket system to enforce rules for safety, and the regular inclusion of safety information in the monthly bulletin sent to all participants and organizers.

In every competition, a great deal of emphasis is put on added vehicle design elements that address the safety of the vehicle occupants. Rules and requirements for safe vehicle operation during the competitions help protect occupants and others who are on the track from exposure to collisions.

Examples of safety requirements that parallel those of industry include dress requirements, eye and face protection, control of hazardous energies, electrical safety, releases to the environment, material handling, incident reporting, and general safe work practices. To achieve full implementation of an industrial-style safety program, a compliance incentive in the form of enforcement and penalties for noncompliance also exists.

The 1995 Hybrid Electric Vehicle (HEV) Challenge being held June 5-13 in Auburn Hills, Michigan, incorporates many safety improvements. Rules and technical specifications have been clarified and include more detail. For instance, vehicle specifications clarify the type of high-voltage disconnect switches allowed and spell out ground fault detection procedures and specified limits, as well as provide greater detail on required battery tie-downs and high rpm shields.

Other improvements have been made at the HEV Challenge in incident reporting, safety stations, and safety awareness and compliance. Before the competition, teams receive a technical inspection checklist. Coordination takes place with local authorities on handling concept vehicles, and inspections are performed on all vehicles in the competition. A general safety meeting is also held for participants. (Also see "Competition Highlight" on p. 7.)

What benefits do competition participants reap from this real-world approach? Overall, a greater degree of safety, health, and environmental protection is achieved. Participants also gain a greater awareness of requirements for safe work practices, which can easily be transferred to tomorrow's jobs in industry. Finally, potential employers will view participants' acceptance of and compliance with safety standards, as well as their design creativity in these competitions, as a valuable asset when recruiting new employees.

Jeff McGhee
Competition Safety Coordinator
Argonne National Laboratory

IN THIS ISSUE

FUTUREDRIVE
Volume 1, Number 2, Summer 1995

Purpose
To inform past, present, and potential sponsors, participants, organizers, volunteers, and others interested in DOE-sponsored vehicle competitions about the plans for and results from the competitions.

We welcome submissions but reserve the right to edit them. Information in FutureDrive may be reproduced for publication with acknowledgment to FutureDrive, Argonne National Laboratory. Address correspondence, subscription requests, and changes of address to:

Cheryl Drugan
FutureDrive
Argonne National Laboratory
Energy Systems Division, Bldg. 362
9700 South Cass Avenue
Argonne, IL 60439
Phone: (708) 252-1877
Fax: (708) 252-7653

Contributors
Shelley Launey, Philip Patterson, Bob Larsen, Spencer Quong, Nicole LeBlanc, Jeff McGhee, Renee Nault, Jane Andrew, Cheryl Drugan, Erik Nelsen, David Holloway.

FutureDrive is published by the Energy Systems Division, Argonne National Laboratory, with publishing support services provided by Argonne's Information and Publishing Division.
Art Direction/Design by Daniel F. Sarro.

Printed on Recycled Paper

Collaboration: Trademark of New FutureCar Challenge

The goals are sky-high in an automotive technology competition debuting in 1996, but the potential rewards hold a strong allure for those driven to participate. The new FutureCar Challenge charges colleges and universities with the task of solving cutting edge technology challenges. The payoff? Universities will have the opportunity to make significant contributions to future automotive technology, and perhaps, shape the vehicle of the future.

FutureCar distinguishes itself from previous competitions in several ways. The FutureCar Challenge is a collaborative, rather than competitive effort. It is a union between the U.S. Department of Energy (DOE) and all three major U.S. automakers, a partnership that in itself is significant. Powerful and influential collaborations of this nature are relatively unusual and only occur when each party recognizes that the desired results and benefits cannot be achieved with any lesser participation.

FutureCar was conceived as an adjunct to the Partnership for a New Generation of Vehicles (PNGV). The PNGV is a unique liaison between seven federal agencies and the U.S. Consortium for Automotive Research to build a mid-size vehicle within the next 10 years that is capable of getting 80 miles per gallon, while still offering all the amenities that consumers expect. This means dramatic changes will have to be made in the powertrain, packaging, and materials used in current vehicles.

The FutureCar Challenge is a two-year competition requiring each team to convert a mid-size production vehicle from one of the "Big Three" automakers, with the goal of attaining up to *three* times its original fuel efficiency while maintaining the same levels of performance and function. In addition to the efficiency, utility, and performance goals of the competition, teams must consider the safety, recyclability, practicality, cost, and manufacturability of their vehicles.

While the initial FutureCar Challenge will be limited to 12-18 teams in 1996, we expect participation to increase in succeeding years. We would like to include a design review evaluation, conducted by PNGV government and industry participants, as well as a mid-distance road rally. The design review would provide extensive professional feedback to student teams on their technical approaches, while the rally will test energy efficiency and reliability and give much broader exposure to student teams.

Because of its unique demands, FutureCar is not the ideal competition for every school. With that in mind, DOE is offering other automotive technology competitions in 1996. Suggestions for new competitions—and sponsors—are always welcome. Please feel free to contact me with your ideas (Fax: 202/586-9815; E-mail: shelley.launey@hq.doe.gov). These ideas may be the vehicles that transport us from the present to the future in automotive technology.

Shelley Launey
Manager of Vehicle Competitions
DOE Office of Transportation Technologies

Solectria Sunrise Represents Dawn of New Era for Electric Vehicles

In the small space of two years, Solectria Corp. of Wilmington, Massachusetts, expects to achieve a big breakthrough in electric vehicle (EV) technology with its mass-producible Sunrise sedan. The vehicle overcomes two major market barriers for EVs: limited range and high price.

If all goes according to plan, the lightweight Sunrise will go more than 100 miles on a charge, but will cost an affordable $20,000, based on initial orders for 20,000 or more vehicles. (The few electric vehicles available today travel 80 miles or less and cost $100,000.) The company, one of the largest U.S. electric vehicle manufacturers, expects to make the all-composite electric vehicle available during model year 1997.

"The Sunrise represents an important development in the electric vehicle industry," says James Worden, Solectria's CEO. "Not only is it among the first ground-up EVs developed in the United States and the first to be sold for about $20,000, but it also incorporates technology that is ahead of most EVs on the market today."

Worden's been a trendsetter for many years. He "cut his teeth" on competitions for students as one of the first U.S. competitors. His first electric vehicle of note is what he calls his "tin box." Worden created the two-person purpose-built electric vehicle in high school, won a competition, used the vehicle to commute to the Massachusetts Institute of Technology (MIT), then entered the vehicle in the 1989 American Tour de Sol competition, along with a solar racing vehicle that he devised with the MIT solar racing club. Worden tapped into this knowledge and experience to start up Solectria. First through MIT, later with Solectria Corp., he has driven a variety of both electric conversions and purpose-built cars each year in the American Tour de Sol.

The Sunrise sedan, powered by Solectria's AC induction drive system, uses an inductive charge port and an onboard 1.5 kW inductive charger developed by Hughes Power Control Systems. The drive system features a brushless motor that utilizes energy at a much higher efficiency rate than the DC motors presently found in most EVs on the market. Whenever possible, the materials used for the Sunrise's composite body will be chosen based on their recyclability.

A pre-production prototype of the Solectria Sunrise competed in this year's American Tour de Sol, an eight-day national road rally championship that ran from Waterbury, Connecticut, to Portland, Maine, on May 20-27. Electric, hybrid-electric, and solar-electric vehicles participate in the annual event, coordinated by the Northeast Sustainable Energy Association (NESEA) of Greenfield, Massachusetts, and sponsored by the U.S. Department of Energy through Argonne National Laboratory, among others.

Solectria's development of the Sunrise is an ongoing regional effort coordinated by the Northeast Alternative Vehicle Consortium with funding provided by the Advanced Research Projects Agency and the Boston Edison Co. Boston Edison holds the marketing rights to the Sunrise in the nine Northeast states and all markets foreign to the United States.

For more information on the Solectria Sunrise, contact Deborah Goldsmith, Solectria Corp., 68 Industrial Way, Wilmington, MA 01887. Phone: (508) 658-2231; Fax: (508) 658-3224. For further information on the American Tour de Sol, contact NESEA, 50 Miles St., Greenfield, MA 01301. Phone: (413) 774-6051; Fax: (413) 774-6053.

Sunrise Specifications

SOLECTRIA

- **System Power** ..... 42kW Nominal/50kW Peak AC Induction Direct Drive with Regenerative Braking
- **Gradability** 20%
- **Curb Weight** ..... 770 kg (1,694 lbs)
- **Payload** ..... 310 kg (682 lbs)
- **Gross Vehicle weight** ..... 1,080 kg (2,376 lbs)
- **Passengers** 4
- **Airbags** 2
- **Doors** 2
- **Heat/Defrost** Maintains 20° to 25°C (68° to 77°F) at -10° to 35°C (14° to 95°F) Ambient Temperature
- **Wheelbase** ..... 277 cm (109 inches)
- **Track F/R** ..... 152 cm (60 inches)/132 cm (52 inches)
- **Length** ..... 467 cm (184 inches)
- **Width** ..... 188 cm (74 inches)
- **Ground Clearance** ..... 18 cm (7 inches)
- **Cabin Height** ..... 112 cm (44 inches)
- **Brakes** ..... Front and Rear Hydraulic Disk Brakes
- **Tires** ..... Low Rolling Resistance
- **Range at 85 km/hr (53 mph) with:**
  - Sealed Lead Acid Batteries ..... 200 km (120 miles)
  - Ovonic Nickel Metal Hydride Batteries .. 330 km (200 miles)
- **Acceleration**
  - 0-48 km/hr (0-30 mph) ..... 6 seconds
  - 0-97 km/hr (0-60 mph) ..... 17 seconds

Chrysler Powers Up for 1995 Hybrid Electric Vehicle Challenge

CHRYSLER CORPORATION

Chrysler Corp. is preparing for an onslaught: the approximately 600 engineering students from 32 university teams who will descend in June on the Chrysler Technology Center in Auburn Hills, Michigan, for the 1995 Hybrid Electric Vehicle (HEV) Challenge. In this competition, each student team must convert an existing vehicle platform (Chrysler Neon, Ford Escort wagon, or Saturn SL2 sedan) to run on both an electric motor powered by batteries and a combustion engine powered by compressed natural gas (Neons only), methanol, ethanol, or reformulated gasoline. The converted cars will be tested for efficiency; emissions; heating and air-conditioning system performance (Neons only); and road performance (range, acceleration, and vehicle handling).

Making the event run smoothly will be some 100 Chrysler volunteers, ranging from engineers and technicians to program management, sales, and marketing staff. And in addition to being the host and primary sponsor of the competition, Chrysler contributed twelve 1995 Neons and gave $5,000 to all of the U.S. teams in each class.

Challenging Tomorrow's Engineers

Chrysler sees its sponsorship of this competition as an investment in the future of the industry. "With the considerable challenges facing the auto industry in terms of vehicle engineering and development, this program provides Chrysler with an excellent opportunity to develop the quality of engineering students coming into the job market," says Francois J. Castaing, Chrysler Vice President of Vehicle Engineering.

The competition gives the students a new perspective on real-world engineering problems. Chrysler engineers visited the Neon teams for an initial inspection, identifying problems and offering advice. "That really opened up my eyes," notes Enrico Cacanindin, a junior at the University of Michigan at Ann Arbor and group leader for his school's Neon team. "He [the engineer] was able to give us some points to consider, but he didn't tell us what to do. He just said, 'Think about what would happen if...' "

Creating Tomorrow's Cars at the HEV Challenge

The Chrysler Technology Center, which opened in 1991, was specifically designed as an advanced, integrated environment for vehicle engineering. At the heart of the "Tech Center" is the Scientific Test Facility, a one-stop boot camp for cars-to-be. There, the student engineers will find out how vehicles get their stripes as Chrysler personnel subject the student-converted cars to demanding, state-of-the-art tests. At the end of the competition, students will get a look at the working environment of "real" engineers during a tour of the facilities.

Welcoming Neon

The Neon Conversion Class is making its debut this year, joining Saturns and Ford Escorts. The Neon teams are also pioneers in two areas new to this Challenge: their cars must have working heating and air-conditioning systems (in anticipation of consumer demands), and they must use compressed natural gas.

"Chrysler has made a significant investment in natural gas vehicle technology over the last several years," comments Ken Mack, Chrysler's Executive Engineer for advanced research programs and lead coordinator at Chrysler for the competition, "so it seemed a 'natural' for us to select it as the fuel for this year's Challenge."

Other cosponsors of the event, along with Chrysler, are the U.S. Department of Energy (through Argonne National Laboratory and the National Renewable Energy Laboratory) and Natural Resources of Canada.

Jane Andrew
Technical Editor
Argonne National Laboratory

SPONSOR BENEFITS

HEV Sponsorship Options

The students who participate in the HEV Challenges come up with some fantastic solutions, but they need a lot of help along the way. Organizations can support student innovation in these events in two ways:

- As Associate Sponsors, who provide resources that benefit all teams in one or more classes, or
- As Local Sponsors, who provide resources to one or two local college teams.

These events attract national attention and provide excellent visibility. For more information on HEV sponsorship arrangements, please call or write: Nicole LeBlanc, Argonne National Laboratory, 9700 South Cass Avenue, ESD/C264-A, Argonne, IL 60439-4815. Phone: (708) 252-6594.
Lori Campbell, National Renewable Energy Laboratory, 1617 Cole Blvd., Golden, CO 80401. Phone: (303) 384-7413.

Sponsor a Vehicle Competition and Lead Technology Development

When a company sponsors a vehicle competition, many benefits flow to the sponsor as well as to the competition. While the competitions obtain needed funding, equipment, or services, sponsoring organizations receive high visibility by publicly demonstrating corporate commitment to the future of education, the U.S. economy, and the environment.

Sponsors also gain a competitive edge. They have immediate access to new ideas and technological innovations and the opportunity to test and evaluate advanced automotive products. They can recruit gifted students with unique practical experience who will become outstanding employees.

Another advantage: Sponsorship increases corporate visibility in the auto industry and the public. The sponsor's company logo appears on competition vehicles, the company name in widely distributed press releases and printed materials. Company products are displayed at the competitions. Local and national TV and broadcast media cover the events.

Among many other prominent companies, **Chrysler Corp., Ford Motor Co., General Motors, Saturn Corp., Detroit Edison, Goodyear, and Electronic Data Systems** have all sponsored vehicle competitions.

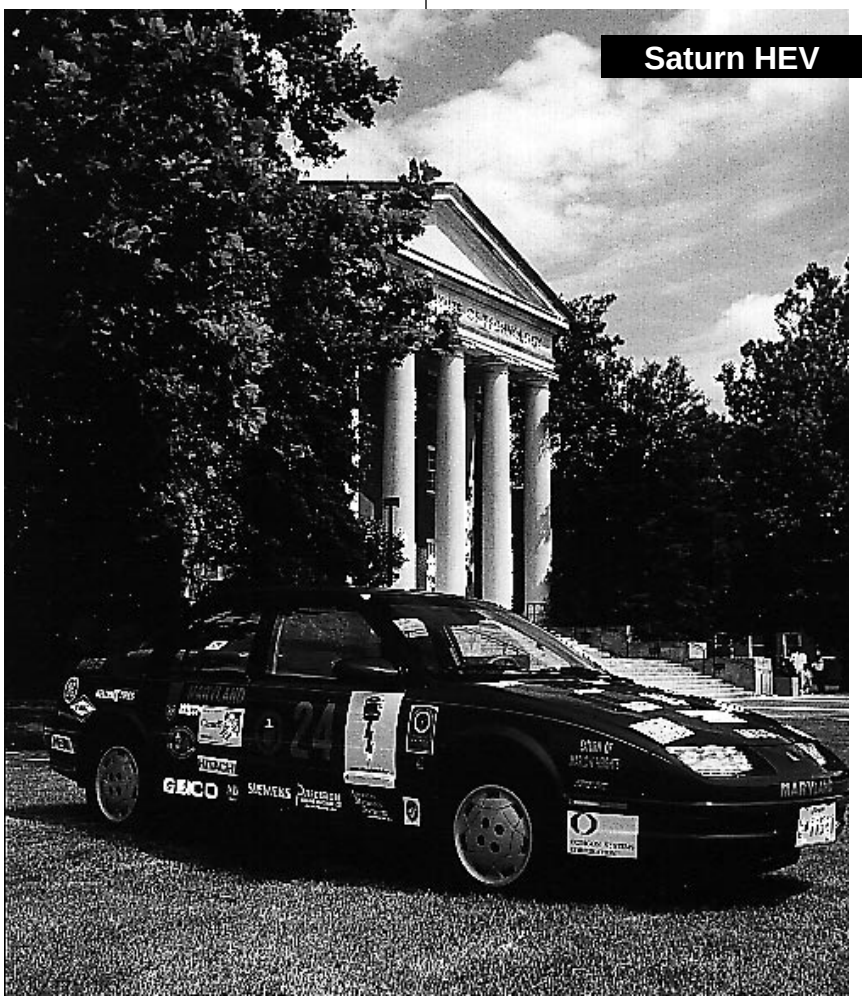
"We sponsor the competitions to let students and the general public know that we support advanced transportation technologies," remarks John Olsen, Detroit Edison's Electric Vehicle Program Manager. "We also have an interest in improving air quality and demonstrating that our company is environmentally friendly." Detroit Edison has sponsored DOE's HEV Challenge for three years (1993-95). The utility also cosponsored the 2nd Annual Micro-Electric Vehicle Competition on April 3 with Ford and the Society of Automotive Engineers. High school students designed and built miniature, battery-powered vehicles that raced up a fixed incline while pulling a weighted trailer in the event.

University of Maryland Team Is Pacesetter in Vehicle Design, Safety Standards

The University of Maryland's Society of Automotive Engineers (SAE) team has participated in almost every vehicle competition sponsored by the U.S. Department of Energy (DOE) and generally set the standard in vehicle design and safety by winning the respective awards at nearly all of the events. Currently, two projects at the university utilize innovative technology: the solar car and the Saturn hybrid-electric vehicle (HEV).

"The Pride of Maryland II.I" is a solar car designed and built entirely by undergraduate students in the mechanical, electrical, computer science, chemical, and aerospace engineering departments. To the students working on the car, it is more than just a solar car, it is more than just another project, and it is definitely more than just a three-credit class. "The Pride of Maryland II.I" is equipped with two state-of-the-art Unique Mobility permanent magnet motors. The use of the two motors allows the car to keep the motor efficiency above 90% when the speed of the car for the race day is slow due to poor weather conditions. The motor mounts are designed so the motors can be easily and quickly changed for each day of the race, depending on the strategy for that race day.

The solar cells used on the solar array are 14.6% efficient at ideal conditions. To ensure that the array is operating most efficiently, peak power trackers from Australian Energy Research Laboratories have been installed. These trackers monitor the voltage and current from the solar array and vary the load on the array to maximize the power output. The array is supported by a Kevlar, Nomex, and Carbon Graphite composite structure designed to reduce the weight of the 1993 Sunrayce array from 85 to 45 lbs. This will retain the same strength and decrease the weight, which in turn, increases the strength-to-weight ratio of the solar array and raises the overall vehicle efficiency.



Saturn HEV

The Saturn hybrid-electric vehicle is a second-generation design that improves and completes the first year's design. The vehicle conversion is designed not only to increase fuel economy but to reduce the emissions of the original Saturn as well. To accomplish these goals, a new engine is programmed to operate at the lowest brake-specific fuel-consumption point, and an electrically heated catalyst allows for a shorter catalyst light-off time, therefore significantly reducing start-up emissions.

Along with drivetrain control refinements and the new engine, several innovative components have been added to boost the efficiency and consumer acceptability of the prototype. For those who don't like cold winter mornings, a Schatz heat battery stores energy through an isolated phase-change material. It also allows for nearly instant heat through the defroster and warms the engine block to operating condition faster than conventional means. A Sanden R134 air-conditioning compressor with a four-horsepower DC brushless motor supplies ample cooling for hot summer days. To enhance the ergonomics of the total vehicle, an AM/FM/cassette player has been retained and enough trunk space for groceries or golf clubs has been preserved.

David Holloway
Professor
University of Maryland

Safety at Sunrayce Ensures Its Success

Racing a few dozen solar-powered cars across the country seems like an easy enough project. But, assuring the success of each Sunrayce competition depends on ensuring the safety of the competitors and spectators involved. Sunrayce 95 regulations incorporate specific and stringent safety systems. The National Renewable Energy Laboratory (NREL), which coordinates the competition, emphasizes safety in the racing format, race route, and communications and vehicle tracking systems. For instance, the race route has been moved from a south-to-north course to an east-to-west one. NREL avoids large metropolitan centers, high traffic areas, and interstate highways in designing the route.

Several mechanical specifications have been added to Sunrayce 95 regulations as well, from clearer requirements for helmets and safety harnesses to rollover protection. These rules require teams to build vehicles that are not only safer for the driver but other traffic and pedestrians, too. Other safety improvements included shortening daily legs and injecting a day of rest into what proved to be an exhausting competition schedule.

The ability to promptly communicate and track vehicles is also key to maintaining safety. NREL organizes the complex communication network used throughout the event. A new location and communication system was developed by Electronic Data Systems, Hughes Network Systems, and Delco Electronics to ensure that race officials are kept up to date on each competing team's location and status throughout Sunrayce 95. In the event of an accident, a crisis management team has been assembled to assist as needed.

Forty solar-powered cars, another 200 or so support vehicles, and some 1,000 people will move across the country in this year's competition. The Sunrayce 95 organizers must take every measure possible to ensure the safety of the drivers, support crew, and spectators.

For more information about Sunrayce 95 or upcoming competitions, contact Sunrayce Headquarters at (303) 384-6735.

Erik Nelsen
Communications Coordinator
National Renewable
Energy Laboratory

COMPETITION UPDATES

APS Electrics
The *APS Electrics*, held March 3-5 in Phoenix, Arizona, allowed students to implement infrastructure and vehicle design innovations. The Horizon battery made its debut at this year's competition, and the zinc flow battery from Powercell won in its class. The Norvik fast charger demonstrated that it can serve multiple vehicles.

DOE Clean Air Road Rally (DOECARR)
In the *DOE Clean Air Road Rally*, a variety of 50 alternative-fuel vehicles traveled through 31 towns—from Burbank to Long Beach, California—on March 31-April 1. Besides awards given in each class, two design awards were presented. WE'RE IT, an electric vehicle built by a women's team from Texas, received an award for Best Electrical Design. The car has an unusual energy management system; each battery is treated individually rather than treating the entire pack as a single unit. The Best Alternative Design award placed emphasis on mechanical design and was given to the University of California, Davis, for its hybrid-electric vehicle. The car was built from scratch after a great deal of theoretical design and wind tunnel testing.

DOE Advanced Student Hybrid (DASH) Challenge
The Ground-Up class of Hybrid-Electric Vehicles from the 1994 HEV Challenge joined the DOECARR in its road competition. The *DOE Advanced Student Hybrid (DASH) Challenge* encouraged students to use the most advanced technologies and to build vehicles not envisioned a few years ago. At DASH, the hybrids were judged and awarded points for energy efficiency, low-emissions output, vehicle range, acceleration, autocross, consumer acceptability, and a technical report.

EV Grand Prix
Hosted by Virginia Power, this high school electric vehicle competition was held at the Richmond International Raceway in Richmond, Virginia, on May 5-6. Nineteen teams competed in 6 events, while 8 university Formula Lightning electric vehicles competed in the competition.

Electra Challenge
Five teams participated in the *Electra Challenge*, a high school electric vehicle competition hosted by Duke Power. Held April 6-9, the competition was conducted as part of the Champion Spark Plug Auto Fair, which drew about

130,000 people to the Charlotte Motor Speedway in Charlotte, North Carolina. Five events were conducted at *Electra Challenge:* oral presentation, design, efficiency, acceleration, and handling.

Formula SAE
The *Formula SAE* was held May 18-21 at the Pontiac Silverdome in Michigan. Formula-style racing cars were judged in three different categories: static inspection and engineering design, solo performance trials, and high-performance track endurance. At this competition, the DOE, through Argonne National Laboratory, sponsored several awards for the top M-85 finishers, Best M-85 Fuel Economy, Best M-85 Design/Conversion, and Outstanding Teamwork.

American Tour de Sol
The seventh annual *American Tour de Sol,* a road rally event involving electric, hybrid-electric, and solar-electric vehicles, covered 50-70 miles daily from May 20-27 through New England states on public secondary roads. After crossing the finish line on May 26, vehicles were placed on public display the following day at the Maine Solar Blast festival. Awards were based on energy efficiency and driving range.

HEV Challenge
Opening ceremonies at the *1995 HEV Challenge* on June 6 begin with a bang, as DOE and Chrysler officials recognize the achievements of this three-year competition. Afterwards, the teams get down to business with the Zero Emission Vehicle Range Verification, Electromagnetic Compatibility testing, and the Heating, Ventilation, and Air Conditioning event (Neons only) taking place from June 6-9. The remaining four days of the competition are packed with events, including Acceleration, Consumer Acceptability, Emissions, Fuel Economy, Engineering Design Review, Range Event, and Vehicle Handling. The awards ceremony for top HEV in each class is scheduled for June 13.

West Coast Supermileage
The *West Coast Supermileage* takes place June 10-11 in Sacramento, California. Categories include the ISO-octane and Alcohol fuel classes. DOE presents an award in the Alcohol fuel class.

Sunrayce 95
On June 20, U.S. Secretary of Energy Hazel O'Leary will wave the flag to start *Sunrayce 95* from Monument Circle in Indianapolis, Indiana. She will also join participants the night before the competition for awards presentations to the top solar car qualifiers and the winners of the Solar BikeRayce USA. (Also see article on p. 7.)

Cleveland Electric Formula Classic
The *Cleveland Electric Formula Classic* will be held July 21-22 in Cleveland, Ohio. Last year, drive systems from the DOE, Centerior Energy, Hughes, AC Delco, Westinghouse, General Electric, Solectria, and Motorola were present.

Complete results from each competition will be published in the upcoming Fall 1995 issue of *FutureDrive.*

Please keep us informed of any changes in names or addresses for the FutureDrive mailing list so we can ensure each issue arrives in a timely manner to the right person.

FutureDrive
DOE/Industry Competitions
Advancing Automotive Technology

Non-Profit Organization
U.S. Postage Paid
Lemont, IL
Permit No. 87