LEONARD K. PETERS is professor of chemical engineering and Vice Chancellor for Research and Graduate Studies at the University of Kentucky. He has been at UK for 15 years, serving as Chairman of Chemical Engineering for five years. He has also worked as a research engineer at Alcoa Research Laboratories.

Dr. Peters received his BS, MS, and Ph.D. degrees in chemical engineering from the University of Pittsburgh.

Dr. Peters presided over the Forum’s General Session on Friday.

ROBERT HEMENWAY is serving as Chancellor of Lexington campus of the University of Kentucky. He came to UK from the University of Oklahoma, where he served as Dean of Arts and Sciences since 1986. Prior to that, he was at UK as Chairman of the Department of English and professor of English.

Dr. Hemenway earned degrees from the University of Nebraska at Omaha and a Ph.D. at Kentucky State University.

Dr. Hemenway presided over the Forum’s luncheon session on Friday.
David Phillips is Associate Administrator for Research, Development, and Technology for the Federal Highway Administration (FHWA). He has worked for FHWA in traffic operations and highway design since 1970.

Mr. Phillips has received several awards, including the Federal Highway Administrator's Award for Superior Achievement (1986), the Presidential Rank of Meritorious Executive Award (1984), Senior Executive Service Performance Award (1982, 1986, and 1988) and several Special Achievements Awards presented by the FHWA.

He has a BS in Civil Engineering from Rensselaer Polytechnic Institute and a Certificate in Traffic Engineering from Yale University.

MORNING SESSION
Friday, October 20, 1989

David K. Phillips, Associate Administrator for Research, Development and Technology
Federal Highway Administration

SAFETY RESEARCH—NEEDS AND FUNDING OPPORTUNITIES

U.S. Highway Safety

The highways in the United States are the safest in the world, but they are not without problems. The fatality rate is 2.4 per 100 million vehicle miles of travel; about 46,000 lives are lost annually. Total annual travel is increasing about four percent for passenger cars and nearly nine percent for trucks. By the year 2000 the projected number of highway fatalities will be 80,000 if the current fatality rate is not reduced. In economic terms and with today's dollar value, this would represent a loss of over $160 billion each year. The current fatality rate must be reduced.

The United States' highway system consists of a massive 3.8 million miles of roads. Ten percent of this mileage is for the major arterial highways including the interstate system; however, these arterials carry 70 percent of all annual highway travel. Even though research will emphasize these major arterials, the program cannot be limited to them. Safety solutions will be developed for problems found in all settings—rural, urban, freeway, interchange, intersection, roadside, and roadway situations.

To achieve the goal of a reduced fatality rate, new technology must be sought and used. Transportation strategies, developed 30 to 40 years ago, have become inappropriate for today's congestion and travel demands. Therefore, we must take advantage of new technology and apply it to today's problems. Highway, operational, and roadside safety problems will have to be better identified, and driver needs and limitations better understood.
Increase in noncompliance with traffic control devices and driver frustration with inefficient traffic laws are symptoms of problems created by too many vehicles, insufficient capacity, and large travel delays. New technology is available but its adaptation to today's highway systems has not kept pace with the increased demand for mobility.

Safety Goals for the 1990s

Even though the current federal-aid highway program ends in 1991, much safety work remains to be done during the 1990s. The questions are: What activities should be addressed for the 1992 budget and the years following? What should our national research goals be to reduce the level of fatalities and injuries? Reducing highway injuries is a national challenge; President Bush instructed the Secretary of Transportation to reduce the highway fatality rate to 2.2 by 1992. By the year 2000 the Highway Users' Federation would like to see a fatality rate reduced to 1.5 per 100 million vehicle miles. How can we best, and most economically, achieve these goals?

Transportation Research Board Safety Study

The Federal Highway Administration (FHWA) and the National Highway Traffic Safety Administration (NHTSA) are jointly funding a comprehensive assessment of highway safety research priorities. This assessment, which is being performed by the Transportation Research Board (TRB), will examine the current direction of highway safety research. This effort will determine if research priorities match the areas and topics that offer the greatest promise for future highway safety improvements. The approach is similar to the ongoing $150 million, five year Strategic Highway Research Program (SHRP) on pavement performance, asphalt, maintenance cost effectiveness, control of snow and ice, cement and concrete, and concrete bridge protection. The new safety study should aid the FHWA and the NHTSA in setting long-term research goals and priorities.

The TRB has established a Strategic Transportation Research Study (STRS) for Safety Committee which held its first meeting on August 9, 1989. Dr. A. Ray Chamberlain, executive director of the Colorado Department of Highways, chairs the 17-person committee. This 18-month study will be completed in October 1990. The TRB staff is now in the process of assembling a list of high priority safety research areas.

FHWA Safety Program for the 1990s

The FHWA Office of Safety and Traffic Operations Research and Development outlined the principal areas for the 1990s:

- Highway Safety Information Management
- Driver Behavior Research for Highway Safety
- New Highway Simulator
Highway information is essential for isolating safety problems and developing sound policies to address them. Currently, neither the FHWA nor the states have economical and timely access to the data necessary to identify highway safety problems, effectively direct needed highway safety research, or accurately determine the effectiveness of safety programs. States and local jurisdictions spend in excess of $500 million annually on traffic accident reporting alone. This does not include additional funds that are spent to collect highway inventory and traffic count data. By contrast, very little effort is devoted to using this data to analyze safety problems.

To improve safety to the highway system, a systematic approach for cost-effectively collecting and using this data must be developed. This approach would include:

- Evaluation of a multi-state Highway Safety Information System (HSIS) containing accident, geometric, and traffic data. The HSIS will be used as an information tool to: provide quick answers to specific questions, isolate and identify highway safety problems, and guide future research efforts. Currently, the development of FHWA's HSIS is nearly complete and in January 1990 it will begin to answer major safety questions.

- Use of emerging technology to improve the quality and economics of field data collection. This includes the use of geographic information systems for combining accident, geometric, and traffic data, the development of portable computerized data input devices to improve the speed and accuracy of accident reporting, and the integration of videodisc photologs for collection of roadway information.

- Improvement in data uniformity at the federal and state levels. Restructuring accident data collection can decrease the cost of data collection by eliminating unused data and, at the same time, improve its overall ability to assess safety trends.

- Development of better analysis techniques. These techniques are needed to improve field safety assessments and to develop simulation models for assessing highway safety risk.

- Development of a standardized safety assessment program. This program will combine the information available in the HSIS, new
computerized data collection tools, and improved analysis techniques to provide a systematic approach for analyzing highway safety problems.

Driver Behavior Research

Studies have shown driver error is involved in as much as 80 percent of highway accidents. However, to put all the blame on the driver in these accidents is a mistake. In fact, in many of these accidents the failure occurs at the point of interaction between the driver and the roadway. The driver is not always at fault; rather, accidents usually occur when there is some mismatch between the driver and the roadway. When the design of the roadway fails to account adequately for drivers' limitations and capabilities, accidents are often the tragic result. A good example of this occurs where the cause of the accident is cited as "improper driver lookout." Actually, many of these types of accidents involve inadequate sight distance and other aspects of poor highway design. Many mismatches between the highway and the driver are not known at this time and known ones are not fully understood.

Most of the research proposed on driver behavior is aimed at identifying and understanding the situations where there is a mismatch between the driver's capabilities and highway design. Once understood, development efforts can begin to correct these problems with countermeasures that are both practical and within the resource limitations of our society. Advances in research methodology for investigating driver behavior problems warrants a renewed and substantial effort. New highway simulation technology, for example, now makes it possible to investigate driver behavior questions that have, until recently, been impossible to address.

In driver behavior research, special emphasis will be given to drivers aged 65 or older. Today about 12 percent of our population is in this age group and by the year 2030 about 20 percent, over 50 million people, will be aged 65 or older. In general, older people experience visual and hearing deterioration, decreased cognitive capabilities, movement limitations, medication side effects, and other problems that may limit driving attentiveness and capabilities. We must know what the problems are and how to safely deal with them in our highway and traffic operational solutions.

In general, driver behavior research and development will emphasize these major areas: driver risk perception, age-specific driver problems, driver fatigue, and the development of a driver performance model. The driver behavior research program also will address: accident evasion skills, behavior adaption, adverse weather and reduced visibility problems, attention and alertness, information overload, driver expectancy, perception of maneuver response time, and public education concerning the driver behavior aspects of highway safety.

New Highway Simulator

A new highway simulator (HYSIM) that meets the diverse driver behavior and vehicle dynamics research and development needs of the 1990s and beyond will be needed to replace the simulator now being used at the
FHWA’s Turner-Fairbanks Highway Research Center. The HYSIM requires a high fidelity state-of-the-art simulator that is motion-based, provides realistic dynamics, a wide field of view, high-resolution graphics, low-response lag time; and is capable of simulating interactive traffic. The simulator must be capable of providing a variety of highway geometrics and highway environments such as vertical curves, complex city intersections, tunnels containing freeway interchanges, and the adverse visibility conditions of rain and fog.

The NHTSA also seeks a simulator that permits the study of a variety of vehicle characteristics and dynamics. Therefore, the FHWA and the NHTSA are working together to obtain a highway simulator that can be used for driver behavior research studies. To start this effort both the FHWA and the NHTSA are requesting $5 million in fiscal year 1991. The agencies seek technical and financial contributions from the private sector.

Driver Behavior Research Vehicle

Not all driver behavior studies can be conducted from a laboratory simulator, instead, some studies must be conducted in real-world highway and traffic conditions. The driver behavior research program requires a research vehicle consisting of a full-sized sedan equipped with modular instrumentation packages. As a minimum, it must be equipped with instrumentation systems that will measure and record: continuous vehicle lateral placement on the roadway, vehicle speed, distance traversed, headway between a lead vehicle, driver inputs to steering, brake, and accelerator, driver eye movements, and driver psychophysiological states such as galvanic skin response. It also must be equipped with a mockup dashboard that facilitates installation of experimental displays and controls. In addition, it must be designed to accommodate special experimental subsystems such as heads-up displays and auditory and visual in-vehicle sign simulation systems. A communications package also is necessary so the vehicle can receive and transmit congestion data for on-board navigation devices as well as receive signals from roadside warning devices.

Highway Design Problems

While the U.S. highway system is massive, a large number of severe accidents involve a limited group of highway features. Although many safety solutions are known, highway fatalities continue to rise. The following facts illustrate the problem’s diversity:

• While the Interstate and other federal-aid primary highways comprise only eight percent of the roadway miles in this country, they account for 58 percent of all fatalities. Non-federal-aid highways, on the other hand, make up 78 percent and only account for 24 percent of the fatalities.

• More than half of all fatal accidents involved only one vehicle. Most (48 percent) involved collisions with a fixed object. Collisions with guardrails account for over 1,100 deaths annually. Each year, over
5,000 deaths are a result of collisions with trees and utility poles. Another 4,000 fatalities result from non-collisions—primarily rollovers.

- For multi-vehicle accidents, 6,000 head-on fatalities occur each year. Another 9,000 fatalities occur at intersections and interchanges, over 3,000 of these at rural intersections.

Highway Design Management

In efforts to reduce fatalities, planned research in highway design management includes the following activities:

- Analyze highway accidents to determine if the causes relate to vehicle maneuvers and/or roadway design characteristics.

- Determine the economics of highway safety improvements to determine the costs and the effects of various proposed highway design changes.

- Develop design techniques for minimizing accidents at locations known to have high accident potential for all highway classifications.

- Integrate improved highway safety strategies in the design process to optimize safety.

- Study the overall performance capabilities of roadside safety systems and develop selection criteria for placement.

Improving Pedestrian Safety

Each year about 7,000 pedestrians are killed as a result of collisions with motor vehicles. This is nearly 20 percent of all highway fatalities and represents the largest single category fatality statistics.

Sixty percent of these fatalities occur on federal-aid highways. Three-quarters of all fatal pedestrian accidents occur in urban areas. Reports indicate 80,000 pedestrians are injured each year and many more are not reported to any record-keeping authority. Both the very young and the elderly are overly represented in pedestrian accidents. Given this information, the annual costs to society of these accidents are significant.

Pedestrian safety is a joint responsibility of the FHWA and the NHTSA. The FHWA is responsible for engineering improvements—crosswalks, sidewalks, traffic signals—and the NHTSA is responsible for education, training, and law enforcement. Close coordination between the two agencies is essential to reduce pedestrian fatalities and injuries since pedestrians and motorists must understand and use traffic safety improvements. Training opportunities will be identified and implemented with the assistance of the NHTSA.
To improve pedestrian safety, a systematic approach to analyze accident data and to apply known human factors principles to proposed safety countermeasures will be employed. This approach will include these activities:

- Accident data on pedestrian accidents will be analyzed to classify them into commonly occurring "accident types." Where required, additional accident data will be gathered.

- Measures of exposure to hazards for pedestrians will be investigated. Particular exposure measures—number of trips, length of time, counts of pedestrians and vehicles—will be critically evaluated. This information will be used to develop accident rates for pedestrians.

- Accident countermeasures will be developed for the most commonly occurring pedestrian accident types. The countermeasures will be field-tested to determine not only their effectiveness in reducing pedestrian accidents, but also on other roadway users.

- Human factors analyses of pedestrian safety measures will be conducted to fine tune them to meet most effectively the needs of various pedestrian groups.

- Awareness of pedestrian accidents and their costs will be widely publicized and cost-effective countermeasures will be promoted.

- Pedestrian training needs will be identified. Pilot training courses will be developed and, in conjunction with the NHTSA, training programs on pedestrian safety will be implemented.

- Procedures will be developed so that consideration of the safety and operational needs of pedestrians will prove more cost effective than addressing them in retrospect.

New Traffic Control Methods

On existing highways, warning and control information is provided through a system of signs, signals, and markings known as traffic control devices. Most of the signs and markings are "static," meaning the message never changes. Some also lack adequate visibility. However, warning and control device information needs to be recognized, understood, timely, and credible based on roadway, traffic, and environmental conditions to properly assist the driver. If signs and markings are designed for the ideal situation, they do not properly warn or control for wet or icy pavements, heavy traffic, reduced visibility conditions, or accidents and incidents on the roadway. If the signs and markings are designed for less than ideal conditions, they lose their credibility to the motorist under normal conditions because they are too restrictive. Research has found that drivers violate traffic controls when they
think the devices are defective or not appropriate. For example, drivers learn to ignore signs saying, "Bridge Freezes Before Roadway," because most of the time it does not apply. Therefore, traffic control methods and devices should be developed to provide useful, up-to-date, and meaningful warning and control information depending on roadway, traffic, and environmental conditions measured.

To provide safety advisory and warnings through "roadside" and "in-vehicle" devices, the "Intelligent Vehicle Highway System" is being proposed with a component know as the "Advanced Driver Information System." The system will depend upon the development of smart, roadside traffic, and environmental information that can be used by either roadside or in-vehicle receivers. While this development is primarily intended for major arterial type roadways and their intersections, freeway applications also are included. Features of the proposed system will include:

- Roadside changeable-message sign development and other appropriate aids that provide driver control and warning assistance.

- Improved sign content, sign symbols, and visibility to aid driver detection and comprehension.

- Improved understanding of driver visibility requirements and the effects of roadway lighting and signalling.

- Improved methods to collect roadway environmental data.

- Computerized algorithms to analyze the roadway, traffic, and environmental data collected by the sensors and to provide commands to the roadside displays.

- Intersection controls to assign more appropriately the right-of-way to crossing traffic and to warn motorists of impending problems based on traffic, roadway, and environmental measures.

- Credible controls in work zones based on the work activities and roadway conditions.

- Lane/edge-of-road information to supplement existing markings that will be visible under all roadway conditions including rain, snow, and fog.

Conclusion

Descriptions of current research plans for improving highway safety in the United States has been presented. It is an ambitious program designed to use today's technology. The work will be undertaken jointly with other public and private organizations to improve highway safety. These organizations would include, but not be limited to, states, NHTSA, National Safety Council,
American Trucking Association, International Association of Chiefs of Police, National Governors' Association, American Association of State Highway and Transportation Officials, Institute of Transportation Engineers, and others.

Cooperative program funding will be sought from National Highway Traffic Safety Administration, Nationally Coordinated Highway Research Program, states, and highway planning and research sources. Categorical federal-aid program, private industry, and state/local funding will be the resource for eventual system deployment.

Obviously, one of our major concerns deals with obtaining funds commensurate with the task at hand. In 1977 the federal level had $9 million available for researching safety problems. In fiscal year 1989 we had $6 million. This level of safety funding is about 0.01 percent of the total $66 billion invested annually in our highway transportation system. The estimated cost of this research program is $35 million per year or $350 million spread over 10 years. With the national economic cost of fatalities estimated at $160 billion per year, this modest safety investment is equivalent to about 0.02 percent of the annual loss.

Since the current highway authorization expires September 30, 1991, Congress will begin to review the highway transportation needs as preparation for developing a highway bill for the twenty-first century. Hopefully, the bill will provide the necessary authorization to permit a major research effort focused on reducing fatalities and injuries.