



U.S. Department
of Transportation
Federal Highway
Administration

ANNUAL PROGRESS REPORT EXECUTIVE SUMMARY

FISCAL YEAR 1989

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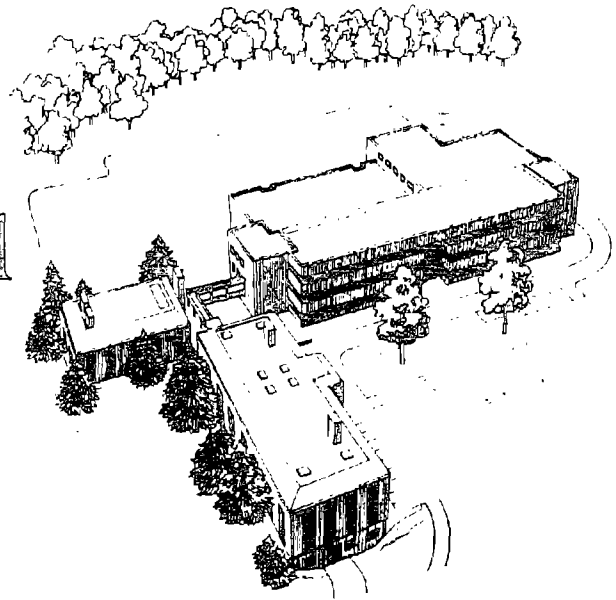
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OF HIGHWAY RESEARCH, DEVELOPMENT, AND TECHNOLOGY

Research, Development and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, Virginia 22101-2296

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FOREWORD

The Nationally Coordinated Program (NCP) of Highway Research, Development, and Technology, a management framework, has the following objectives: to ensure resource concentration on common problems, to minimize duplicated efforts among researchers, and to identify and highlight gaps in research. It also provides a list of all highway research activities. Along with the Highway Planning and Research (HP&R) program, the National Cooperative Highway Research Program (NCHRP), and the Federal Highway Administration (FHWA) staff and contract research programs, the NCP includes work under the Strategic Highway Research Program (SHRP), administered by the National Research Council; FHWA research on highway policy, planning, and motor carrier transportation; and, to the extent possible, research, development, and technology transfer activities funded by the States.

The NCP is organized into categories, programs, projects, and tasks. For each NCP program, there is a program manager within the FHWA Washington Headquarters who is responsible for coordinating the Federal staff and contract activities with the HP&R, NCHRP, and SHRP studies in the same area; these program managers are listed on each program description. The FHWA field office representatives assist the program managers in identifying States with a mutual interest in solving problems included under that program.

The Federal Highway Administration believes that plans for future highway research must address critical program areas -- High Priority National Program Areas (HPNPA's). These HPNPA's are focal points for research and given FHWA's long-term commitment. They are directly related to the NCP since the high priority programs fall under major categories of the NCP.

This progress report provides details about individual programs in the nine categories of the NCP for fiscal year 1989 and background information about the work under the programs since their inception.

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16. Abstract <p><i>THE</i> This executive summary gives an overview of progress being conducted under the Nationally Coordinated Program (NCP) of Highway Research, Development, and Technology during the period from October 1, 1988 through September 30, 1989.</p> <p><i>THE</i> This report covers technologies for highway design, construction, and operation including the specific categories of Highway Safety, Traffic Operations, Pavements, Structures, Materials and Operations, Policy and Planning, and Motor Carrier Transportation.</p>			
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NATIONALLY COORDINATED PROGRAM OF HIGHWAY
RESEARCH, DEVELOPMENT, AND TECHNOLOGY

ANNUAL PROGRESS REPORT
FISCAL YEAR 1990

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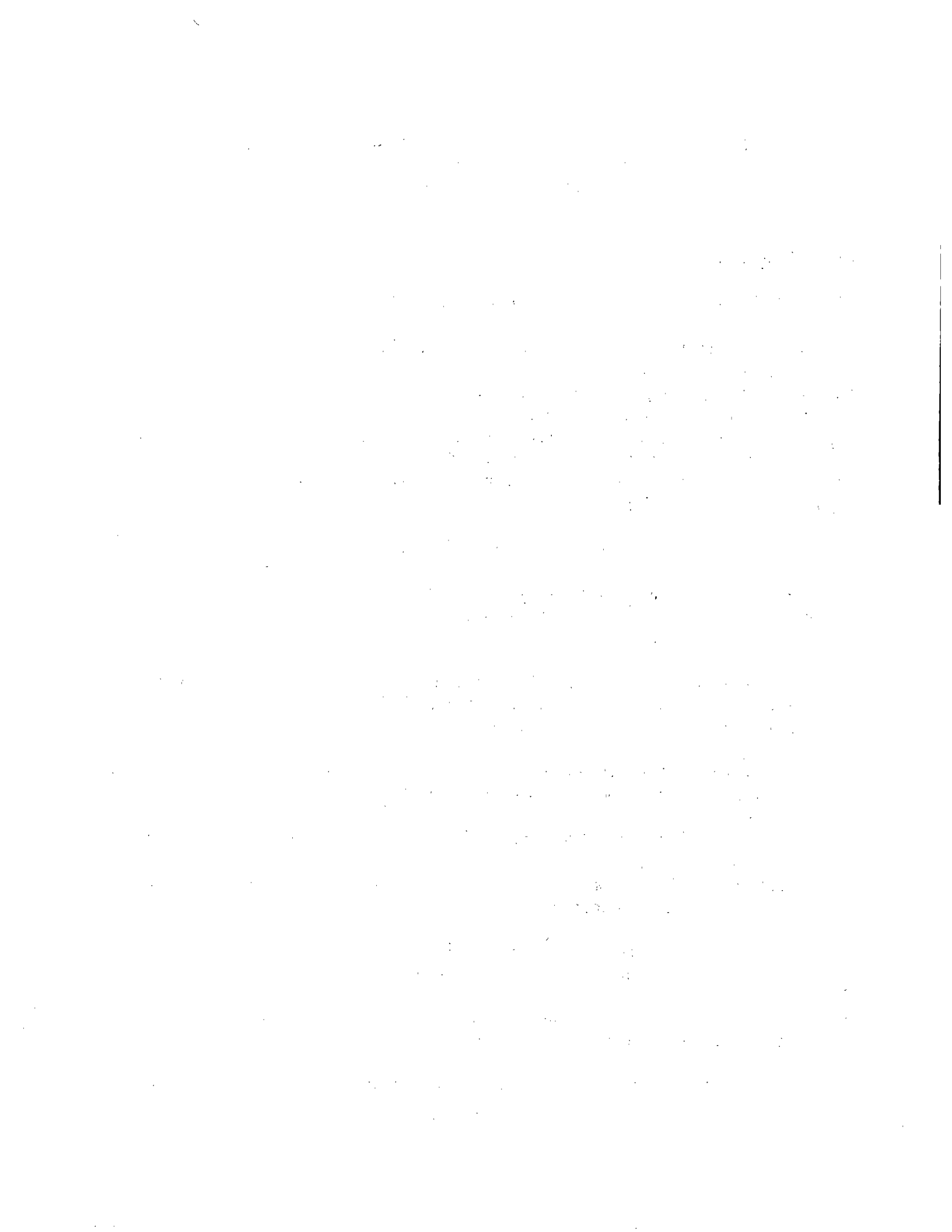
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NATIONALLY COORDINATED PROGRAM OF HIGHWAY RD&T
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PROGRAM NUMBER: A.1
PROGRAM TITLE: Traffic Control for Safety
PROGRAM MANAGER: Howard H. Bissell, P.E.

OBJECTIVE: This program is to provide research and development for traffic control operations to meet the needs of the Office of Highway Safety, to establish and implement safety standards, and to meet the needs of the Office of Traffic Operations to improve traffic control devices for safe and efficient movement of motor vehicles on streets and highways. The research is to support the Manual on Uniform Traffic Control Devices (MUTCD).

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: Some 109 studies were completed and published during the prior 18 years under NCP Program A.1. The following are a few of the significant results from the past year.

- "Construction Costs and Safety Impacts of Work Zone Traffic Control Strategies" found the type of traffic control on four-lane divided highways depends on the type of construction and not on safety.
- "Guidelines for Converting Stop to Yield Control" suggested a Yield sign warrant based on volumes, accidents and sight distance.
- "Improving Work Zone Delineation on Limited Access Highways" indicates high intensity retroreflective panels should replace steady-burn lights on concrete barricades, and raised pavement markers should supplement pavement striping where road alignment changes.
- "Prevention of Wrong Way Accidents on Freeways" provided signing, marking, and design guides for freeway exit ramps to prevent wrong way movements.
- "Motorist Compliance with Standard Traffic Control Devices" found violations depend to some extent upon the "reasonableness" of the traffic control device.
- "Assessment of Current Speed Zoning Criteria" found that most speed limits on

the Nation's streets and highways (in urban, small-urban, and rural built-up areas) are set 8 to 12 mi/h below the prevailing speed of traffic, and 15 mi/h or more below the minimum safe speed.

- "Traffic Signal Installation and Safety" found no change in injury accidents, and a decrease in right-angle accidents was offset by an increase in rear-end and left-turn crashes.

Work Underway: There are 28 studies underway in NCP Program A.1. The following is a partial list of a few of these studies with interim results.

- "Variable Speed Limit System: System Design" has been successfully operating a pilot system on I-40 in Albuquerque, New Mexico, since March 1989.
- "Work Zones Standards and Practices" is enhancing Part VI of the MUTCD, including more typical drawings for the application of devices.
- "Fundamental Studies on Speed Zoning and Control" found changing speed limits on all types of roadways have little effect on speeds.

SHRP-Related Activities: "Maintenance Work Zone Safety," conducted a contest to select a number of innovative methods of traffic control for maintenance operations. Proposals were evaluated for a follow-on study, "Maintenance Work-Zone Safety Devices Development and Evaluation."

Plans for Next Year: There are a number of new planned starts for fiscal year 1990 including:

- "Procedure for Determining Work Zone Speed Limits" (NCHRP Project) will develop a standard procedure to use for both design and construction phases.
- An FHWA Staff Study will develop a sign for "Don't Drink and Drive."
- "Comparative Analysis of Leading and Lagging Left-Turns"(Arizona HP&R) will look at both the operational and safety effects.

Significant expected accomplishments include the publication of reports on:

- "Construction Costs and Safety Impacts of Work Zone Traffic Control Strategies."
- "Signal Display for Left-Turn Controls."
- "Assessment of Current Speed Zone Criteria."
- "Work Zone Delineation For Channelization."

- "Variable Speed Limit System for Freeways" along with software and hardware documentation.
- "Effect of Raising and Lowering Speed Limits on Speed and Accidents."

Program Status: The program manager's assessment of the status of each project in the program (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Signs and Markings	Continuing
b	Traffic Signals	Continuing
c	Highway Operations	Continuing
d	Speed Control	70 percent complete
e	Work Zone Control	97 percent complete
f	Railroad Grade Crossings	100 percent complete

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PROGRAM NUMBER: A.2
PROGRAM TITLE: Improving Driver Visibility of Roadway Environment
PROGRAM MANAGER: Richard N. Schwab

OBJECTIVE: To develop methods by which traffic operations personnel can determine whether the combination of lighting, signing, delineation, and signals are providing adequate visibility to meet the information needs for any specific driving environment. The primary emphasis is to improve the effectiveness of retroreflective traffic control devices by developing in service visibility performance requirements for inclusion in the Manual on Uniform Traffic Control Devices (MUTCD).

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: The following are a few of the significant results from the past year:

- A series of laboratory and field studies of overhead guide sign visibility were reported which indicated how lighting and/or reflectorization of the backgrounds of these signs interact with the driver's ability to find their intended destination. The inherent value to the green color coding scheme was explored.
- A study investigating whether driver performance at partially lighted freeway interchanges could be improved by upgrading the delineation has found that even with substantially improved delineation, driver performance under partial illumination does not equal that of full interchange illumination.
- Twenty-five hundred copies of a handbook have been distributed to provide interim guidance on the selection, inspection, and maintenance of reflective signs. Additional copies of the report have recently been reprinted, and it is now available again.
- Initial voting has occurred within the Illuminating Engineering Society's Roadway Lighting Committee on a new Standard Practice for Roadway Lighting which will convert the basis for lighting design from the amount of light reaching the road surface to a system based on driver visibility. This new standard, if accepted, will be largely based on research sponsored by the Federal Highway Administration during the 1970's.

Work Underway: There are 28 studies underway in NCP Program A.2. The following is a partial list of these studies with interim results where appropriate.

- A contract to design and build a Photometric and Vision Laboratory is in the process of being awarded. The new laboratory will be used to evaluate both the retroreflective/luminance characteristics of traffic control devices and to study driver requirements for visual guidance and control information.
- Research has demonstrated the feasibility of developing a mobile retroreflectometer to measure in service pavement markings under daytime conditions. Prototype instruments have been built and limited field evaluation is being completed. These instruments can be used to monitor the current condition of existing marking, and to control the quality of newly applied markings. A prototype of a mobile system to measure the retroreflectivity of traffic signs is being built for field evaluation. Research is also underway to determine typical service life estimated for various signing and marking materials.
- A study to develop photogrammetric techniques for measuring entrance angles of highway signs from videodisc photologs has been initiated. This is part of an effort to improve the specification of sign materials and make them more responsive to typical highway viewing conditions.
- Research is underway to establish machine-measurable chromaticity coordinates for retroreflective materials that are equivalent to the ANSI safety surface colors (currently used for hazardous material placards). Consideration is being given to bring the standard highway sign colors into agreement with the ANSI colors.

Plans for Next Year: There are six studies planned as being new starts for FY 1990, including:

- "Relative Visibility of Increased Legend Size vs. Brighter Materials" (FHWA contract).
- "Revision of Roadway Delineation Handbook" (FHWA contract).
- "SRPM [Snowplowable Raised Pavement Markers] Wear and Improvement" (New Jersey HP&R).
- "Recognition of Sign Color Under Headlamp and Alternative HID" [High Intensity Discharge] Sources (Staff).

Significant expected accomplishments include:

- Publication of reports on "Minimum Visibility Requirements for Traffic Control Devices," "Trade-Off Between Delineation and Lighting on Freeway Interchanges," and "Handbook on Sign Maintenance, Fabrication, and Installation."
- Completion of studies to determine typical service life of retroreflective traffic control devices.

Program Status: The program manager's assessment of the status of each task is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Visibility of Traffic Control Devices	Continuing
b	Visual Guidance Needs	Continuing
c	Improving Utilization of Lighting Systems	Continuing

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PROGRAM NUMBER: A.3
PROGRAM TITLE: Highway Safety Analysis
PROGRAM MANAGER: John G. Viner

OBJECTIVE: The objectives are to develop a broad-based approach which will result in more cost-effective collection and use of accident, geometric, and traffic count data for highway safety analysis; develop methodologies for highway safety analysis; and provide supporting information such as countermeasure effectiveness, accident costs, and appropriate analysis procedures.

This program includes a High Priority National Program Area (HPNPA) titled "Information Resources." This HPNPA focuses on accident data systems and related files needed for highway safety analysis. It is concerned with the identification, collection and utilization of data needed for highway safety analysis; the reliability of existing data; and the use of modern technology and improved management to reduce the cost and burden of data collection and utilization.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: The following are a few of the significant results from the past year.

- A prototype highway safety analysis system, the "Highway Safety Information System" (HSIS) consisting of merged accident, roadway, and traffic files from six States, is nearing completion. This concept is a result of an earlier study which examined the capability of existing national data bases to meet highway safety analysis needs. The earlier study concluded that a system like the prototype HSIS could meet a broader range of highway safety analysis needs at less cost than any other single data system.
- A new safety analysis method was demonstrated. The method combines corrections for the statistical bias which results from choosing high hazard sites for safety treatment (Bayesian statistics) with classical statistics corrections for changes which occur over time.

Work Underway: There are 18 studies underway in NCP Program A.3. The following is a partial list of these studies with interim results where appropriate.

- A contract is being negotiated to develop and evaluate the prototype HSIS.
- New accident analysis methodologies are being developed to combine the results of several studies in order to have improved safety effectiveness estimates. A user friendly PC-based computer program is being developed for identifying high hazard sites, countermeasure evaluation, and combining results from separate studies.
- A study is examining the possible movement of accidents from improved to non-improved sites.
- A study is developing traffic accident costs based upon a sounder theoretical framework than the traditional human capital approach. The work has been closely coordinated with other organizations sharing interest in accident costs. Preliminary results have been received favorably by the academic community.

Plans for Next Year: The following major study is planned to commence in FY 1990:

- "Adaptation of Geographic Information Systems (GIS) for States and Local Jurisdictions" (NCHRP) will explore the state of the art in highway reference systems.

Significant expected accomplishments include:

- Publication of a report on accident costs.
- Completion of the prototype HSIS.
- Completion of a study on application of new accident analysis methodology.

Program Status: The program manager's assessment of the status of each project is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Information Resources	20 percent complete.
b	Analysis Methodology	20 percent complete
c	Safety Analysis	Continuing

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PROGRAM NUMBER: A.4
PROGRAM TITLE: Special Highway Users
PROGRAM MANAGER: Justin True

OBJECTIVE: This program is to provide research and development for a safe and efficient operating environment for special highway users such as large trucks, pedestrians, bicycles, mopeds, and motorcycles. The majority of existing geometric design and traffic operations criteria is based on the physical and operational characteristics of passenger cars. These criteria need to be reevaluated in terms of other highway users, including carriers of hazardous materials, and appropriate revision made.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: Approximately 37 studies were completed and published during prior years for activities now under NCP Program A.4. The following are a few of the significant results from the past year:

- "Safety Implications of Various Truck Configurations" employed a series of computer models to predict the safety consequences of future trucks that might be designed and operated under different size and weight regulations. A recommended set of factors was developed that should be included in truck size and weight regulations. The objective of these factors is to encourage the development of productive yet safe vehicles.
- "Present Practices of Highway Transportation of Hazardous Material" developed improved methods for estimating accident probabilities for use in routing hazardous materials. The study developed estimates of the probability of hazardous materials being released during an accident, and estimates of truck accident rates by area type and roadway type.
- "Examination of Truck Accidents on Urban Freeways" estimated the Nationwide annual cost of truck accidents on high volume urban freeways (ADT [Average Daily Traffic] of over 100,000) at 1.6 billion dollars. This cost includes accident costs, the cost of delay to other road users, vehicle operating costs, and accident clean up costs.

"Walk Alert" is a National program on pedestrian safety. It is sponsored by the FHWA and the National Highway Traffic Safety Administration (NHTSA), and is being conducted by the National Safety Council. NHTSA is a comprehensive program which includes engineering, educational, and law enforcement efforts to prevent pedestrian accidents. To date, 10 States and several cities are actively implementing the program and interest is continuing to grow.

Work Underway: There are eight studies underway in NCP Program A.4. The following is a partial list of these studies with interim results where appropriate.

- "Development of Truck Characteristics for Use in Highway Design and Operations" is assessing current highway criteria to determine their adequacy in accommodating large trucks. Sixteen geometric design and operational criteria have been evaluated. Appropriate changes to the existing criteria, based on a cost-effectiveness analysis, are being developed.
- "Ramp Signing for Trucks" is developing and evaluating active and passive signing systems for warning truck drivers of problem interchange ramps. The signs will be tested in both a laboratory and field setting. Guidelines as to proper sign location will also be developed.
- "The Effect of Bicycle Accommodations on Bicycle/Motor Vehicle Safety and Traffic Operations" is a pooled fund study which will develop a procedure for organizations to use in determining what type of bicycle facility should be implemented on a particular roadway, for example, marked bicycle lanes, wide curb lanes, and separate pathways.

Plans for Next Year: There are four studies planned as being new starts for fiscal year 1990, including:

- "Development of Countermeasures for Truck Accidents on Urban Freeways" (FHWA contract).
- "Development of Relationships Between Truck Accidents and Geometric Design" (FHWA contract).
- "Safety Impacts of Different Speed Limits for Cars and Trucks" (FHWA contract).
- "Study Design for Car/Truck Passing Sight Distance Requirements" (FHWA contract).

Significant expected accomplishments include the publication of these reports:

- "Truck Characteristics for Use in Highway Design and Operations."

- "Examination of Truck Accidents on Urban Freeways."

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Large Trucks	75 percent complete
b	Pedestrians	75 percent complete
c	Bicycles	45 percent complete
d	Mopeds and Motorcycles	0 percent complete

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PROGRAM NUMBER: A.5
PROGRAM TITLE: Design
PROGRAM MANAGER: Michael D. Freitas

OBJECTIVE: This project is to conduct and promote research to improve highway safety through the development and use of improved geometric design standards, safer roadside hardware and more skid resistant pavements.

EXECUTIVE SUMMARY AND PROJECT STATUS

Significant Results to Date: Approximately 80 studies were completed and published during the prior years under NCP Program A.5. The following are a few of the significant results from the past year.

- "Measurement of Heavy Vehicle Impact Forces and Inertial Properties" developed and tested an instrumented wall to measure the impact forces of heavy vehicles. The maximum impact forces measured from the instrumented wall were used to develop design forces for the bridge rail performance levels. These forces' levels are also used in designing new bridge rails by the States.
- "Improvements to HVOSM/Barrier VII Computer Programs" made improvements to existing barrier simulation programs to provide a terrain model, to improve the input and output formats, and to provide an easy method to interpret the results. Also the Numerical Analysis of Roadside Design (NARD) program has been installed in the PC environment.
- "Wet Weather Exposure Measures" resulted in the development of wet weather exposure maps by States and by geographic regions. These maps provide a better estimate of the percent of time highways are wet, based on local conditions. These estimates are expected to improve the planning for improvements in surface skid resistance.
- "Normalization of Pavement Friction for Operational, Seasonal, and Weather Effects" resulted in guidelines which will make the comparison between skid resistance data observed at different times and conditions more reliable.

Work Underway: There are 79 studies underway in NCP Program A.5. The following is a partial list of these studies with interim results where appropriate.

- "Guardrails on Curves, Curbs, and Slopes" has tested standard guardrail systems under a number of non-standard test conditions which represent the real world. These tests have demonstrated the performance of guardrail is sensitive to a number of site characteristics.
- "Warrants for Bridge Barriers on Low Volume Roads" developed and tested a direct transition from a three beam guardrail to a New Jersey shape bridge rail.
- "Aesthetic Bridge Rails" successfully tested a laminated wood bridge rail and an aesthetic concrete bridge rail based on a modified Kansas design.
- "Side Impact Test Criteria" has examined existing accident data bases to quantify and understand the side impact fixed object accident problem.

Plans for Next Year: There are 6 studies planned as being new starts for fiscal year 1990, including:

- "Critical Reviews on Specific Roadside Safety Issues" (FHWA contract).
- "Evaluation of Vehicle and Barrier Simulation Models" (FHWA contract).
- "Development of Roadside Accident Data Collection and Analysis Plan (FHWA contract).
- "Development of Preliminary Severity Indices for Roadside Benefit/Cost Model" (FHWA contract).
- "Feasibility of Using Composite Materials in the Construction of Roadside Safety Hardware Systems" (FHWA contract).

Significant expected accomplishments include:

- A compendium critically assessing and documenting the relationships identified in the literature between accidents and various geometric design elements. "Gaps" in the literature will be identified and research plans will be prepared to fill these "gaps."
- Five "White Papers" which provide detailed reviews of specific roadside safety topics. These papers will detail the existing body of knowledge on a particular issue such as crash cushion design and performance.
- A detailed plan for the collection and analysis of roadside accident data necessary to address key roadside safety issues.
- Severity indices for various roadside features to be used in benefit/cost analyses of roadside treatments.
- An assessment of potential uses of composite materials in the development of

- An assessment of potential uses of composite materials in the development of lower cost higher performance roadside hardware.

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Geometric Design	Continuing
b	Guardrails and Median Barriers	Continuing
c	Bridge Rails	60 percent complete
d	Rail Ends and Transitions	75 percent complete
e	Frangible Structures	90 percent complete
f	Advanced Testing Methods	Continuing
g	Roadway Surface Properties	Continuing

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PROGRAM NUMBER: A.9

PROGRAM TITLE: Technology Transfer for Highway Safety

PROGRAM COORDINATORS: Guenther W. Lerch--Implementation
David M. Burk--Experimental Projects
Charles R. Stockfisch--Demonstration
Projects
Larry Jones--National Highway Institute
Harry H. Hersey--Rural Technical
Assistance Program

OBJECTIVES: The objectives of this program are to assess the usefulness of newly completed research, new materials, products and procedures, and to promote the adoption of safe and cost-effective technology in the area of highway safety; to provide technical assistance to the users of such new technology and to develop technology transfer products such as guidelines, computer programs, technical manuals, audiovisual products, demonstration projects and training courses in the highway safety area for use by Federal, State and local highway agencies.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

This program is intended to accelerate the adoption of new technology in subjects related to the roadway and roadside safety. The Office of Implementation, the National Highway Institute (NHI), and Demonstrations Projects Division jointly carry out this function. The Office of Implementation develops useful application aids and training materials from completed research. The National Highway Institute follows through with presentations of the training course developed. The Demonstration Projects Division promotes the adoption of selected items through field presentations and pilot installations, and administers the Experimental Projects program for evaluation of new technology. Studies, demonstrations, and training are primarily generated from problem statements submitted by Federal, State, and local agencies, as well as the private sector.

Major accomplishments and activities carried out in fiscal year 1989 include:

IMPLEMENTATION

- Development of a work zone traffic management synthesis that examined five

critical areas of work zone traffic control and its safety implications. The topics included cover the following subjects: delineation practices for concrete barriers, application and operation of flashing arrow panels, protection of pedestrians in work zones, vertical anchorage of concrete barriers, and design and use of rumble strips. Five individual synthesis reports identify and analyze current standards and present practice, and offer recommendations for revised National standards to be incorporated into the Manual on Uniform Traffic Control Devices (MUTCD).

- Completion of a handbook entitled, "Planning Design and Maintenance of Pedestrian Facilities." The handbook consolidates the current state of the art of pedestrian facilities. It provides in a single document information needed for planning and designing pedestrian facilities.
- Implementation of a National pedestrian safety program, "Walk Alert," in 12 States and one city. The program was developed by the National Safety Council for the Federal Highway Administration and the National Highway Transportation Safety Administration. "Walk Alert" is a grass roots program aimed at pedestrians of various ages and emphasizes the 3Es--engineering, education, and enforcement.
- Verification of minimum warning time for railroad-highway grade crossing signals. The current 20-second minimum advance warning time given in MUTCD is the time specified for crossings with active warning systems. The study also developed a suggested guideline for determining the maximum advance warning time for crossings with active warning devices which may result in a modification to the MUTCD.
- Development of a 9-minute videotape on pedestrian safety, "Pedestrian Safety--What You Can Do." The video illustrates common urban and rural pedestrian safety problems and identifies appropriate countermeasures for each. It identifies what can be done to improve pedestrian safety for various age groups, and also identifies relevant material on pedestrian safety available from the Federal Highway Administration.
- Completed a study with the Pennsylvania Department of Transportation to determine the feasibility of establishing regional test centers for pavement-marking materials.
- Development of a Users Manual and a self-instructional computer program on a grade severity rating system (GSRS). Use of the GSRS should reduce the probability of large truck runaways on severe downgrades. The computer program can help safety engineers determine the maximum safe speed for large trucks to descend steep grades. The maximum safe speed is based on truck weight and brake temperature.

- Development of two brochures on pedestrian safety. One brochure provides guidance to counties, cities, and towns for implementing the "Uniform Federal Accessibility Standards" in the city street environment. The other brochure describes pedestrian safety publications developed by FHWA.
- Development of a videotape "Mailboxes May Be Hazardous to Your Health," which highlights the hazards of nonyielding mailbox supports, and provides guidance on how to erect safe mailbox structures. The videotape should be of interest to a wide audience including postal officials, State and local highway officials, and community groups.

DEMONSTRATION AND EXPERIMENTAL PROJECTS

- The State of Iowa has a contract underway for a video imagery system. The system allows video logging data containing road geometry and inventory data and roadway imagery to be recorded directly to a laser disk. The State will use the data on a future demonstration project, geographic information systems, and video imagery applications.
- The State of Wisconsin has a work order to evaluate the integration of a second-generation photologging system with a geographical information system (GIS) using graphics-based utility software and multiple-work systems. The State plans to set up a GIS and will use the Iowa data collection equipment.
- During fiscal year 1989, safety experimental projects were redefined and prioritized. Priority areas include a continuation of terminal end treatments and an evaluation of safety treatments of culvert openings.

NATIONAL HIGHWAY INSTITUTE

- The safety-related National Highway Institute courses generating the most interest in FY 1989 were:
 - Design and Operation of Work Zone Traffic Controls
 - Railroad-Highway Grade Crossing Improvement Program
 - Highway Safety Engineering Studies
 - AASHTO Roadside Design Guide
 - Functional Requirements of Highway Safety Features

RURAL TECHNICAL ASSISTANCE PROGRAM

- **Developing a videotape on tort liability that will be distributed to the Technology Transfer Centers.**
- **Developing a videotape on work zone safety to be distributed to all Technology Transfer Centers.**

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PROGRAM NUMBER: B.1

PROGRAM TITLE: Traffic Management Systems

PROGRAM MANAGER: Frank J. Mammano

OBJECTIVE: This program addresses the highway congestion problem by enhancing existing and developing new traffic management techniques and control systems. Examples of candidate activities include integrated urban traffic management; improved traffic signal control strategies; more extensive freeway control with emphasis on areawide traffic flow optimizations through more positive control of metering, including mainline metering; and incident management for both freeway and urban networks.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: Approximately 55 studies were completed and published during prior years under NCP Program B.1. The following are a few of the significant results from the past year.

- As part of a contract research study, a real time, multilane Wide Area Detection System (WADS), using video detection technology, was developed, installed, tested and evaluated under field conditions. As a follow-on activity, two additional WADS systems will be installed on I-35W in Minneapolis as part of a Minnesota DOT/FHWA project. As a proposed follow-on activity funded by Minnesota DOT, incident detection software will be developed and implemented using 20-25 WADS systems on Interstate 394 in the Twin Cities by 1991.
- A new traffic signal strategy for the control of isolated intersections, OPAC, was field tested at three intersections in Tuscon, Arizona and Arlington, Virginia. The results of these field tests indicated that use of the OPAC strategy resulted in reductions in vehicle delay of up to 25 percent when compared to full actuated control of the same intersections. The exact amount of delay reduction was dependent on traffic volumes and the number of signal phases.
- A prototype digital inductive loop detector tester was developed by a Small Business Innovative Research (SBIR) contract. The hand-held instrument will significantly improve the accuracy of loop detector acceptance tests and maintenance measurements of loop detector electrical parameters.

Work Underway: There are 28 studies underway in NCP Program B.1. The following is a partial list of these studies with interim results where appropriate:

- "Integrated Motorist Information System (IMIS) Evaluation" has collected a set of "before" and the first two of five sets of "after" traffic data in the IMIS corridor on Long Island, New York. The remaining "after" data will be collected during fiscal year 1990.
- "Analysis of Complex Congested Corridor Locations" is performing case study analyses of six complex congested freeway corridors (in New York, Seattle, Minneapolis, Milwaukee, San Francisco, and Columbus), using a variety of computerized analysis tools, in order to evaluate the potential effectiveness of a wide range of alternative solutions.
- "Coordinated Operation of Ramp Metering and Adjacent Traffic Signal Control Systems" is developing, testing, and evaluating strategies to coordinate the operation of ramp metering and traffic signal control systems in areas where the systems geographically overlap.
- Five cost sharing studies were initiated in fiscal year 1989 to aid in developing a university, State, and Federal technology base for intelligent vehicle/highway system (IVHS) projects.
- "Demand Estimation, Benefit Assessment, and Evaluation of HOV Lanes," is developing a computerized procedure, based on the latest microcomputer version of the FREQ model, which will quantify the impacts of potential high occupancy vehicle (HOV) facilities.
- An investigation of vehicle detectors is being conducted by Ohio University under an HP&R study. The best detector for vehicle turning movements at intersections is being determined.

Plans for Next Year: There are two studies planned as new starts for fiscal year 1990:

- "Integrated Freeway/Arterial Control System" (Washington HP&R).
- "Priority Lane Treatments" (NCHRP Synthesis).

Significant expected accomplishments include:

- A comprehensive evaluation of the Integrated Motorist Information System will be completed.
- A computerized procedure for assessing the impacts of potential HOV facilities will be developed.

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Control Systems	50 percent complete
b	System Hardware	70 percent complete
c	Demand Reduction Techniques	80 percent complete
d	Advanced Systems	20 percent complete
e	Signalization Strategies	40 percent complete

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PROGRAM NUMBER: B.2

PROGRAM TITLE: Traffic Analysis and Operational Design Aids

PROGRAM MANAGER: Alberto J. Santiago

OBJECTIVE: To develop computerized tools comprising traffic control strategies which optimize traffic performance, models for testing and evaluating traffic control strategies and geometric improvements, and procedures to accurately assess the capacity of all types of surface street and freeway facilities.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: Approximately 42 studies were completed and published in prior years under NCP Program B.2. The following are a few of the significant results from the past year.

- The development of the TRAF-NETSIM surface-street simulation model was completed and released to the public through the software distribution centers. This model enables the user to test traffic control strategies and/or proposed geometric improvements prior to their field implementation.
- The development of the GTRAF graphics package was completed and released to the public through the software distribution centers. GTRAF is a graphics post-processor for TRAF-NETSIM which assists the user in interpreting the model's results by providing pictorials of the simulation results using static and animated displays.
- Completed the development of the RFLO simulation model for freeway operations. This model, currently under testing, is particularly useful in analyzing the impact of freeway incidents.
- Completed the assessment of the operational requirements for traffic assignment models to be used in routing drivers with in-vehicle guidance systems.

Work Underway: There are 42 studies underway in NCP Program B.2. The following is a partial list of these studies with interim results where appropriate:

- "Freeway Simulation Model Enhancement and Integration" has developed a prototype microscopic freeway simulation model which interfaces with other surface-street models and allows for the analysis of control strategies, geometric designs, and incident management of traffic corridors.
- "Application of Artificial Intelligence to Urban Congestion Problems" has determined the practical application of this technology for management of traffic in urban corridors. Accomplishments to date include the development of functional specifications for a system that integrates computerized traffic analysis models, computerized traffic control, and expert systems for the control of urban networks.
- "Graphics Displays for Network-Wide Traffic Analysis" and "Simulation of Intersection and Urban Interchange Operations" are two recently initiated studies to assist users in using models in developing control strategies for corridors taking into account overall network performance.
- Several studies are underway to develop training courses, on-line tutorials, and other technology transfer activities for several traffic models including TRAF-NETSIM and FRESIM.

Plans for Next Year: There are four studies planned as being new starts for fiscal year 1990, including:

- "Traffic Modeling to Support Advanced Driver Information Systems" (FHWA contract).
- "Application of Parallel Processing for Traffic Analysis" (FHWA contract).
- "Introduction to Traffic Models -- Training Course" (FHWA contract).

Significant expected accomplishments include:

- Public release of the CORFLO simulation models for traffic operations in corridors.
- Completion of an integrated pre-processor for computerized traffic simulation models.
- Final release of the Integrated Traffic Data System (ITDS)
- Completion of the FRESIM freeway microscopic simulation model.

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Development of Optimization Procedures for Traffic Control	65 percent complete
b	Development of Improved Traffic Analysis Tools	75 percent complete
c	Development of Capacity Procedures	80 percent complete

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PROGRAM NUMBER: B.3
PROGRAM TITLE: Motorist-Highway System Interactions
PROGRAM MANAGER: Truman M. Mast

OBJECTIVE: This program area will address the problems of highway design related to features and operations that involve direct driver interaction. For example, there are numerous geometric design and traffic control device standards that explicitly consider quantifiable driver characteristics, such as perception-reaction time or visual acuity. Motorist information systems will receive major emphasis because of their critical role in the motorist-highway interaction process. Research will be conducted to improve existing fixed roadway signs and markings, where compatibility with driver characteristics is at issue, as well as to develop and evaluate the technology for modern vehicle-based information systems.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: Approximately 19 studies were completed and published during prior years under projects now contained in NCP B.3. The following are a few of the significant results from the past year:

- "Improved Safety and Mobility for Older People" was a study performed by an expert committee assembled by the Transportation Research Board to comprehensively evaluate available data and research on the safety and mobility of aged highway users.
- "Improved Safety and Mobility for Older People" evaluated the available data on highway and vehicle design, driver and pedestrian performance, crash protection, vision screening, license renewal, training, education, and other issues. The central finding of the study committee was that age alone is a poor predictor of the performance of any individual, and thus it should not be the basis for restricting or withholding drivers' licenses.
- "Improved Safety and Mobility for Older People" also recommended that highway safety should be improved by adjusting the design of highway and road signs to accommodate older users and by adapting license screening tests to better identify people of all ages who have impairments that affect their driving.

Work Underway: There are 10 studies underway in NCP Program B.3. The following is a partial list of these studies with interim results where appropriate:

- "Traffic Control Design Elements for Accommodating Drivers with Diminished Capability" has identified specific driving situations and traffic control device configurations which are problematic for the older driver. Underlying psychomotor, perceptual and cognitive bases for these difficulties have been identified, and possible countermeasures are being evaluated.
- "Cooperative Field Evaluation of an Experimental In-Vehicle Urban Freeway Navigation and Information System (Pathfinder)" is an experimental field study designed to test the feasibility of using the latest technological devices to aid the motorist in avoiding adverse traffic conditions and improve urban traffic congestion. It is a cooperative effort among FHWA, the California Department of Transportation (Caltrans), and General Motors.
- "Laboratory Assessment of the Potential Traffic Operation Benefits of In-Vehicle Navigation Systems" reviewed the literature on in-vehicle navigation systems as they relate to driver route choice behavior and the benefits accruing from the reduction of traffic congestion.
- "Assessment of the Effects of In-Vehicle Display Systems on Driver Performance"
- "Traffic Maneuver Problems of Drivers with Diminished Capacity"

Plans for Next Year: There are four studies planned as being new starts for fiscal year 1990, including:

- "In-Vehicle Highway Hazard Warning Systems" (FHWA contract).
- "Pavement Markings and Delineation for Older Drivers" (FHWA contract).
- "Older Driver Perception-Reaction Time for Intersection Sight Distance and Object Detection" (FHWA contract).
- "Relative Visibility of Increased Legend Size Versus Brighter Materials" (FHWA contract).

Significant expected accomplishments include:

- Developing a functional system design as part of a cooperative effort among Federal, State, and private industry to assess the feasibility and utility of a real-time in-vehicular highway navigation and motorist information system, which can assist motorists encountering traffic congestion and aid traffic engineers responsible for managing the system.

- Completion of a study to determine how drivers with diminished capability are being adequately accommodated by the current generation of traffic control devices.

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Motorist Characteristics	Continuing
b	Vehicle-Based Motorist Information System	Continuing
c	Motorist-Highway Interface	Continuing

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PROGRAM NUMBER: B.9

PROGRAM TITLE: Technology Transfer for Traffic Operations

PROGRAM COORDINATORS: Roger L. Dean--Implementation
Charles R. Stockfisch--Demonstration
Projects
Barry Nunemaker--National Highway
Institute
Ray Griffith--National Highway Institute.

OBJECTIVES: The objectives of this program are to assess the usefulness of new systems, products and procedures, and promote the adoption of cost-effective technology in the use of both freeway and traffic signal control systems; promote the use of state-of-the-art traffic analysis tools, optimization procedures, and capacity procedures to reduce highway congestion and enhance safety; promote the best current practices related to highway design features and operations that involve driver perception-reaction and visual acuity; provide technical assistance to the users of the new technology; and develop technology transfer (T²) products such as guidelines, computer programs, technical manuals, audiovisual products, demonstration projects and training courses in the traffic engineering area for use by Federal, State, and local highway agencies.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

This program is intended to accelerate the implementation of new technology related to evaluation and promotion of traffic management systems and traffic analysis and operational design aids. The Office of Implementation typically translates research and development items into products that can be directly implemented by the traffic engineering community. Where direct face-to-face promotion of new technology is required, the Demonstration Projects Division carries out presentations at field locations on a Nationwide basis, and administers the Experimental Projects Program for the evaluation of new technology. When the technology transfer product is a training course, the National Highway Institute conducts presentations in the States and local agencies based on demand. Studies, demonstrations, and training are primarily generated from problem statements submitted by Federal, State, and local highway agencies and the private sector.

Major accomplishments and activities carried out in fiscal year 1989 include:

IMPLEMENTATION

- Initiated, developed and designed a 1990 wall calendar in cooperation with the National Highway Institute, the Demonstration Projects Division, and the Publications and Visual Aids Branch. The calendar will feature products and services available through the FHWA T² offices, and will provide other information sources and telephone numbers.
- Updated last year's informational brochure using desktop publishing techniques. The new brochure is more generic in nature, and provides sources for FHWA-sponsored publications, software, and audiovisual materials. The brochure will be distributed at National conventions, and to Divisions and States on a request basis.
- Initiated the creation of the Traffic Software User Group (TSUG). The purpose of this group is to bring traffic model users together by providing them with a source of help and information. In addition, TSUG will help identify the target audience for the models we develop and will serve as a source for test users as new models are distributed.
- Implementation staff began shipping display materials to local or regional meetings where the exhibit is assembled and staffed by FHWA field personnel in order to more widely promote T² products and services. For example, with support from the Office of Highway Safety, the Office of Traffic Operations, the Office of Safety and Traffic Operations Research and Development, and the respective Region Office staffs, an exhibit was provided at each of the three Tri-Regional Traffic and Safety Conferences held in Atlanta, Baltimore, and Seattle.
- Initiated contracts for "Development of a GTRAF Demonstration Program," "Development of a FRESIM User Package," "TRAF-Netsim Training Course," "Update of Arterial Analysis Package," and "Laboratory Testing of Self-Powered Vehicle Detector (SPVD)."

DEMONSTRATION PROJECTS

- Demonstration Project No. 974 - "Relieving Urban and Suburban Traffic Congestion through Incident Management," is under development, and workshops are expected to begin in mid-1990.
- A new Demonstration Project for "Traffic Control Equipment and Software" has been initiated, and demonstrations are expected to begin in late 1990.

EXPERIMENTAL PROJECTS

No major activities occurred in this category.

NATIONAL HIGHWAY INSTITUTE

- Twenty-nine presentations of courses on Traffic Operations related subjects were made during the year. The courses receiving the most interest in FY 1989 were for the "Arterial Analysis Package (AAP)" and the "National Electric Manufacturers Association Traffic Signal Controller System."

RURAL TECHNICAL ASSISTANCE PROGRAM

- A conference on microcomputers was conducted, and the proceedings were published as "Highway Applications of Microcomputers."
- Presentations of the "Traffic Operations Training Course for Local, Rural, and Small Urban Area Personnel" were begun. The course covers traffic signal design, application of traffic control devices, and human factors.

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PROGRAM NUMBER: C.1
PROGRAM TITLE: Evaluation of Rigid Pavements
PROGRAM MANAGER: Roger M. Larson

OBJECTIVE: This program is to improve guidance on the design and rehabilitation of rigid pavements. It includes evaluation of performance, cost effectiveness of design features, procedures to estimate total service life, remaining service life, prediction models for critical distress mode, and the most cost-effective maintenance, rehabilitation or reconstruction strategy.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: Approximately 85 studies were completed and published since FY 83 under NCP Program Area C.1 and related FCP Project 4B. The following are a few significant results from the past year:

- "Rehabilitation of Concrete Pavements: Volumes I to IV" (FHWA-RD-88-071 to 074) have been published and document the research studies on full depth repair, partial depth repair, grinding, load transfer restoration, edge support, bonded concrete overlays, unbonded concrete overlays, crack and seat and Asphaltic Concrete (AC) overlay, and a prototype advisory system to determine the most appropriate rehabilitation strategy for Jointed Reinforced Concrete Pavement (JRCP), Jointed Plain Concrete Pavement (JPCP) and Continuously Reinforced Concrete Pavement (CRCP).
- "Rigid Pavement Analysis and Design" (FHWA-RD-88-068) has been published. This study evaluated available rigid pavement analysis models and design methods and recommended some rigid pavement design sections for experimental evaluation. Guidelines were developed for joint load transfer design, including a faulting model for doweled and undoweled pavements, and joint spacing.
- The Fourth International Conference on Concrete Pavement Design and Rehabilitation was held at Purdue University on April 18-20, 1989. The proceedings contain 56 papers. Most phases of highway and airport pavement evaluation, design, construction and rehabilitation were presented and discussed.

- "Evaluation of Stainless-Steel Pipes for Use as Dowel Bars" was published in the September 1988 issue of Public Roads.
- "The Design of Plain Doweled Jointed Concrete Pavement" was published in the Proceedings for the Fourth International Conference. This report concluded that dowels are essential for most highways carrying more than one million Equivalent Standard Axleloads (ESALs) during their expected life.
- The FHWA research staff participated in the development of a new four-week Highway Pavements course. Additional courses are planned for February 26-March 23, 1990 and July 30-August 24, 1990 at Michigan State University in East Lansing, Michigan.
- Regular presentations of the NHI Training Courses, "Pavement Design Principles and Practices" and "Techniques for Pavement Rehabilitation" were held in FY 89. These popular courses will be continued in FY 90 and beyond.
- NCHRP Synthesis of Highway Practice 134, "D-Cracking of Concrete Pavements" has been published.
- NCHRP Project 10-24, "Rapid Replacement of PCC Pavement Segments" has been completed and was summarized in a Research Results Digest which has been circulated.
- NCHRP Report 304, "Determining Deteriorated Areas in Portland Cement Concrete Pavements Using Radar and Video Imaging," has been published.
- A state-of-the-art report for Experiment Project No. 12, "Concrete Pavement Drainage Rehabilitation" has been completed and published by the FHWA Office of Engineering and Highway Operations.
- A synthesis report listing States using permeable bases, their design, costs and specifications was prepared and distributed by the FHWA Office of Engineering and Highway Operations.
- The FHWA Demonstration Projects Division published a report "Summary of the November 1988 FHWA/SHRP Pavement Instrumentation Working Meeting." This report discussed instrumentation of flexible and rigid pavements.
- A paper summarizing dowel placement accuracy (baskets/dowel inserters in Idaho, Texas and Wisconsin) is included in the "Proceedings for the Fourth International Conference on Concrete Pavement Design and Rehabilitation (April 1989)."

- The FHWA Office of Highway Operations, Construction, and Maintenance Division prepared a "Portland Cement Concrete Materials Manual" (FHWA-ED-89-006).

Work Underway: There are approximately 50 studies underway in NCP Program C.1. The following is a partial list of these studies with interim results where appropriate:

- "Performance/Rehabilitation of Rigid Pavement" (FHWA contract) has obtained information on ride, deflection, coring and boring, traffic (weigh-in-motion), condition and drainage surveys on about 150 new and rehabilitated pavement sections throughout the United States. Phase I involves the evaluation of 95 experimental or recently constructed concrete pavements to evaluate the effects of sealing, subsurface drainage and deflection on the performance of rigid pavements. Phase II includes additional evaluations of bonded concrete overlays and crack and seat and AC overlay, development of guidelines for sawing and sealing joints in AC overlays over the underlying Portland Cement Concrete (PCC) joints and additional work to improve an existing prototype advisory system to help determine the most appropriate PCC rehabilitation strategy.
- NCHRP Synthesis of Highway Practice is underway in each of the following areas: design, construction and maintenance of PCC joints and recycling of PCC pavements.
- NCHRP Project 1-26, "Calibrated Mechanistic Structural Analysis Procedures for Pavements." Improved rigid or flexible pavement design procedures are being developed for inclusion in future versions of the 1986 AASHTO Guide for the Design of Pavement Structures.
- NCHRP Projects were also initiated to evaluate pavement overlay design procedures and develop more complete guidelines for State pavement management systems to update the "1986 AASHTO Guide."
- Numerous Highway Planning and Research studies are underway by the various States evaluating various aspects of drainage, developing procedures to implement the "1986 AASHTO Guide," and evaluating the performance of various pavement design features and rehabilitation techniques and strategies.

SHRP-Related Activities: The SHRP Long Term Pavement Performance, Concrete and Maintenance Effectiveness areas will provide significant information regarding the design and evaluation of rigid pavements. A description of the contracts underway in these areas are included in NCP C.4, E.2 and E.5. Summaries of implementation-

related activities involving or affecting rigid pavements are included in NCP C.9 and E.9.

Plans for Next Year: It is estimated that 15 to 20 new studies will begin in Fiscal Year 1990, including:

- National pooled funds study concerning the design, construction, and maintenance of CRCP.
- Construction of SHRP concrete related Specific Pavement Studies (SPS) sections.

Significant expected accomplishments include:

- Publication of reports from "Performance/Rehabilitation of Rigid Pavements Study."
- Publication of NCHRP report on "State of the Art of Mechanistic Pavement Design."

Program Status: The program manager's assessment of the status of each project is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Performance	Continuing
b	Design and Drainage	Continuing
c	Rehabilitation	Continuing

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PROGRAM NUMBER: C.2
PROGRAM TITLE: Evaluation of Flexible Pavements
PROGRAM MANAGER: Charles J. Churilla

OBJECTIVE: The objectives of this project are to develop procedures to estimate service life of various design and rehabilitation alternatives; estimate the remaining life of existing flexible pavements to help determine the most cost-effective maintenance, rehabilitation, or reconstruction strategy; and develop performance models to predict critical distress modes of new and rehabilitated flexible pavements.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: Approximately 115 studies were completed and published during the prior years under NCP Project C.2 and its predecessor FCP Project 4.C. The following are a few significant results from the past year:

- Arizona has been performing research and using asphalt-rubber since 1967. The status of the research, experimental projects and field tests of asphalt-rubber was reviewed and evaluated. The performance of the asphalt-rubber sections identified in the pavement management data base was analyzed and compared to conventional treatments. The performance and economic analysis show stress absorbing membranes need to last twice as long as surface treatments to be cost-effective while a stress absorbing membrane interlayer is comparable to a 4-in overlay.
- An extension to the current Texas asphalt concrete mixture design procedure was developed. The extended mixture design/analysis procedure addresses the potential of hot mix asphalt concrete mixture to permanently deform flexural fatigue cracking potential, subgrade protection, and thermal cracking potential. The methodology is presented in an "easy-to-use" tabular and design chart format which can be incorporated into a mixture design/analysis sequence. The tests used to characterize mixture material properties are relatively simple and do not require sophisticated testing equipment. The properties required by the extended procedure include compressive creep compliance, diametral resilient modulus, and indirect tensile strength.

- Development of improved asphalt concrete overlay design procedures is a critical component in providing more cost-effective pavements. During the past year, Washington and Alaska completed the development of mechanistic based overlay design procedures. The Washington design procedure incorporates indestructive testing to estimate layer resilient moduli, seasonal moduli adjustments, and failure criteria of asphalt concrete fatigue cracking and subgrade rutting. All necessary computations can be done with two primary microcomputer oriented software packages. The Alaska procedure considers traffic, surface distress, the structural properties of the pavement, and most importantly, the effects of a freezing and thawing of the base, subbase, and subgrade layers. The study recommends two methods for further consideration: a simplified mechanistic method using equations developed in Pennsylvania, and a mechanistic procedure employing a backcalculation computer program.
- Two NCHRP studies related to asphalt pavements were completed. Compaction is the single most important factor affecting performance of asphalt pavement. The study provides a synthesis of the current state of the practice of asphalt pavement compaction. Another study evaluated the benefits of the use of geosynthetics as a reinforcement of an aggregate base of an asphalt pavement. The study found little economical improvement is gained by using geosynthetics in asphalt surfaced pavements.
- Significant progress was made in the accelerated evaluation of asphalt pavement performance. The Accelerated Loading Facility (ALF) completed testing of the asphalt pavements at Turner-Fairbank Highway Research Center. The most significant findings related to the rutting potential and the effects of tire pressure on asphalt pavements.

Work Underway: There are 96 studies underway in NCP Program Area C.2. The following is a partial list of these studies with interim results where appropriate.

- "Asphalt Concrete Stripping Problems and Corrective Treatments" evaluates the long-term performance of 15 experimental asphalt concrete pavements containing lime as an anti-strip additive. These pavements were constructed as part of a previous FHWA research study. In addition, laboratory and field performance data will be collected to improve the reliability of test methods used to identify moisture-susceptible asphalt-aggregate combinations.
- The Transportation Research Board began a study to produce an asphalt paving handbook. The study is being sponsored by FHWA, American Association of State Highway and Transportation Officials, the Federal Aviation Administration and the National Asphalt Paving Association. The

handbook is directed towards field personnel, owner and contractor, and will serve as a comprehensive guide to the construction of high quality asphalt pavements.

- "Calibrated Mechanistic Structural Analytic Procedures for Pavements" will develop mechanistic models to accurately predict the relationship between load, environment, material properties and the resulting performance for both flexible and rigid pavements. The study has selected the most appropriate mechanistic models and will begin the verification and calibration of the procedures.
- "Identification of Significant Factors Contributing to the Extended Performance of Flexible Pavements" will evaluate the factors associated with better performing pavements located throughout Maine.

SHRP-Related Activities: The SHRP Long-Term Pavement Performance and Asphalt research areas will provide significant input towards obtaining the NCP C.2 objective. During FY 1989, SHRP awarded the majority of its proposed contracts in each of these areas. A description of the SHRP activities is included in NCP E.1 and C.4 for the Asphalt and Pavement Performance areas, respectively.

Plans for Next Year: Based upon the past year's activity, it is anticipated that approximately 15 to 20 new studies will begin next year. These studies will be conducted by States, using HP&R funds and by NCHRP. A pooled fund HP&R study will be started in FY 1990 which will evaluate alternative methods of asphalt content control at hot mix asphalt concrete plants.

Program Status: The program manager's assessment of the status of each project (percent complete) is:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Performance of Flexible Pavements	30 percent complete
b	Design and Drainage	60 percent complete
c	Rehabilitation	25 percent complete

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PROGRAM NUMBER: C.3
PROGRAM TITLE: Field and Laboratory Test Methods
PROGRAM MANAGER: Rudolph R. Hegmon

OBJECTIVES: To develop standard test methods, equipment, and instrumentation for measuring pavement conditions on the network and project levels, and to develop standard test methods for in-situ pavement instrumentation; to establish criteria for measuring equipment specifications used in network and project level pavement performance measurements, and criteria for the installation and performance of pavement instrumentation; to develop calibration and operating procedures for meeting these criteria; and to develop the equipment and the experimental design for accelerated testing of pavement sections or test samples, methods of data analysis, and for relating test results to field performance.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: About 20 studies have been completed in Program area C.3 and final reports prepared. A few significant results from last year are summarized below.

- Procedures for the calibration of road roughness measuring equipment were developed. In the research phase of this study the characteristics and error sources for profiling equipment and for response type measuring equipment were established. Profiling equipment is capable of recording the roughness profile with minor distortion, while response type equipment produces a roughness index which depends on the measuring speed.
- The performance of profilographs, used exclusively in acceptance testing of new or overlaid pavements, was evaluated. The resolution and accuracy of this equipment need to be much better than the equipment used in roughness surveys of in-service roads. The results show that profilographs and the method of data evaluation are prone to relatively large errors. Such errors may become unacceptable as the smoothness specifications are tightened. The final report includes calibration procedures for profilographs.
- The Pavement Testing Facility (PTF) is an outdoor, full-scale accelerated pavement testing laboratory at Turner-Fairbank Highway Research Center. The

first phase of research at the PTF evaluated the performance of two asphalt concrete pavements. Significant results to date include the assessment of the impacts of truck tire type, load and pressure on pavement response, and performance, determination of the rutting potential of the asphalt concrete layers, and durability and accuracy of a piezoelectric weigh-in-motion system. The Accelerated Loading Facility (ALF) machine continues to be a reliable, cost-effective means of conducting full scale accelerated pavement tests and performing specialized pavement response and equipment evaluation tests.

Work Underway: About 50 studies are at various states of progress, including seven SHRP studies, three NCHRP studies, and three staff studies. A partial list of studies and objectives follows:

- The development of a design for an integrated pavement condition survey system is nearing completion. The design includes measuring equipment for road roughness profiling, rut depth measurement, pavement friction and surface texture. Provisions are made for the addition of a crack measuring system when this technology becomes available. An option for measuring cross slopes and grades, as well as rate of curvature, is also included.
- Two pavement sections have been instrumented and monitored during the passage of heavy trucks. The instrumentation includes strain gauges, pressure gauges, deflection gauges, and temperature and moisture sensors. The findings of this first test series are expected to be useful in the development of improved gauges, suitable for extended exposure and continued data collection.
- Using the FHWA ALF, a pilot in-service accelerated pavement test was begun in cooperation with 13 western states. Two test sections were selected on Interstate 90 in Montana and Wyoming for accelerated testing between May and October. The results of the pilot tests in terms of pavement performance, ALF operation and cost will be used to develop an implementation plan for the future use of ALF in evaluating in-service pavements throughout the United States. FHWA will use the results to promote regional in-service pavement test centers. Research using ALF at TFHRC during 1990 will focus on the impact of super single truck tires on pavement response and performance. Comparisons of dual versus single tire response and performance tests will be conducted with ALF.

SHRP-Related Activities: The seven SHRP studies monitored include identification and evaluation of measuring systems for rating pavement maintenance effectiveness; selection of pavement deflection measuring equipment; use of lasers for non-contact pavement inspection; development of a system for the detection and classification of pavement cracks; non-contact measurement of transverse pavement profiles; develop

specifications for the purchase and operation of road roughness profiling systems; and development and testing of a fiber-optics weigh-in-motion prototype sensor.

Plans for Next Year: There is one new study planned in fiscal year 1990: "ALF Transverse Rail Modification."

Significant expected accomplishments include:

- The modification which will enable operation of ALF with single and dual tired truck wheels, or on two adjacent pavement test sections with minimum delay between tests. This will also assure almost identical environmental conditions (primarily temperature and moisture) and reduce thereby the variables in comparing pavement performance.

Program Status: The program manager's assessment of the status of each project.

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Equipment and Instrumentation	70 percent complete
b	Experimental Design and Analysis Methods (no current activities)	0 percent complete
c	Accelerated Test Methods	40 percent complete
d	New Concept Evaluation (no current activities)	0 percent complete

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PROGRAM NUMBER: C.4

PROGRAM TITLE: Pavement Management Strategies

PROGRAM MANAGER: William J. Kenis

OBJECTIVES: The objectives of this program are to develop functional relationships between vehicle configurations, suspension systems, truck axle-tire configurations, and pavement damage; develop and refine models which can be used to reliably predict the performance of flexible and rigid pavements; and develop analysis techniques for the cost-effective design, construction, maintenance, and rehabilitation of pavements.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: Approximately 70 studies assigned to NCP Program C.4 since 1986 have been completed. In order to optimize FHWA's limited research resources and to maximize the productivity of our program, a High Priority National Program Area (HPNPA) addressing "Truck/Pavement Interactions" was initiated in fiscal year 1988. FHWA's administrative contract funds are focused on special studies within this HPNPA to provide truck pavement interaction relationships to support decisions for national policy on truck size and weight, axle tire characteristics, and cost allocation and to develop alternative pavement design, maintenance, and rehabilitation strategies. The following are a few of the significant results from the past year:

- "Design and Performance of Highway Shoulders" (Kentucky HP&R) summarizes findings of a long-term evaluation of asphaltic concrete and portland cement concrete shoulders. Minimum thickness of each type were selected and criteria formulated to permit use of existing pavement thickness design procedures for the structural design of shoulders.
- "A Micro Computer Based Procedure for Backcalculating Layer Moduli from Falling Weight Deflectometers Data" and "Field Evaluation of the Multi-Depth Deflectometers" (Texas HP&R) were published. The computer program called MODULUS uses a linear elastic theory to generate a database of deflection bowls. A pattern search is used to fit measured and calculated bowls from which the backcalculated moduli are determined. The compendium report describes a device which is retrofitted to an in-service pavement for measuring

layer deflection when a load is applied to the pavements surface. The device called a multi-depth deflectometer (MDD) can measure relative elastic deflections or total permanent deformation of each layer.

- Proceedings of FHWA's "Load Equivalency Workshop," held at TFHRC in September 1988, were distributed in 1989. This transfer of technological information will serve to achieve the workshop goals, to review the FHWA approach to truck pavement interaction, and to establish an international research network to increase the value of research contributions.
- The Kentucky Division of Design will begin using the thickness design curves presented in the final report for the study "Development of Thickness Design Curves for Composite Pavements."
- The fourth and final report was produced for a Minnesota study to determine the effect of concrete shoulders, lane widening, and frozen subgrade on concrete pavement performance. In this portion of the study, falling weight deflectometer tests were conducted seasonally over a two-year period to determine the seasonal variation in pavement deflection. Tests were also conducted to determine the change in pavement reflection throughout the day.
- A rational overlay design method for flexible pavements in Arizona has been developed which includes roughness, fatigue and plastic deformation models. The method is incorporated in a microcomputer program which is also capable of analyzing the economics of other rehabilitation alternatives.
- The final report for the New Jersey I-80 and I-95 test sections documents the twenty-year performance of two AASHTO satellite experimental pavements which consisted of nine test sections of various base course materials and two surface courses.
- The resilient behavior of 15 soils was studied in an Arkansas HP&R study. Moisture content, freeze-thaw, and deviator stress were found to significantly affect the soils' resilient moduli. Moisture content was the most critical variable for Arkansas subgrades.

Work Underway: There are 75 studies underway in NCP Program C.4. The following is a partial list of these studies:

- Construction and instrumentation of Turner-Fairbank Highway Research Center (TFHRC) Test Road.
- Design and construction of a Dynamic Truck Actuation (DYNTRAC) System at

TFHRC.

- Testing of subgrade and asphalt concrete materials used in TFHRC Pavement Test Facility and in the Test Road.

SHRP-Related Activities:

During FY 89 significant progress was made in the SHRP Long Term Pavement Performance (LTPP) program. SHRP has awarded 18 contracts covering a wide range of activities in the LTPP program. The General Pavement Studies (GPS) portion of LTPP consists of eight pavement categories containing approximately 750 sections distributed across the United States and Canada. The LTPP plan includes the performance monitoring of the GPS test sections for 20 years. The Specific Pavement Studies (SPS) portion of LTPP currently consists of nine experiments. During FY 89 the SPS experiments on pavement rehabilitation techniques were implemented and several test sections were constructed in 1989. Additional SPS test sections, covering all nine experiments, will be constructed in 1990 through 1992. These SPS sections will also be monitored for 20 years. During FY 1990 SHRP will award a contract for the analyses of the LTPP data.

Plans for Next Year: There are three new contracts planned for fiscal year 1990.

- "Using Pavement Performance Data to Develop Mechanistic Empirical Concepts for Deteriorated and Rehabilitated Pavements" (FHWA contract) involves integration of current and new pavement maintenance and rehabilitation techniques with appropriate data sets being collected at various levels, SHRP and Highway Pavement Monitoring Systems (HPMS).
- "Verification and Extension of Previously Developed Damage Models" (FHWA contract) involves calibration of mechanistic models by comparing predicted values of stress, deflection, cracking, and rutting with measured values from full-scale pavement systems.
- "Dynamic Vehicle Forces" (FHWA contract) involves subjecting trucks having different characteristics, for example soft versus hard suspension (high versus low tire pressure) to simulated road roughness, and measuring the resulting forces transmitted to the pavement.

Significant expected accomplishments include:

- Comparisons of damage caused by high and low pressure tires, are expected from a jointly sponsored contract with the U.S. Forest Service. The contract involves construction and trafficking of a two-mile dual-lane oval test track, located in Vicksburg, Mississippi, containing untreated aggregate and asphalt concrete sections.

- "Verification and Extension of Previously Developed Pavement Analysis and Drainage Models," a final report on climatic factors and their effects on pavement performance with a computer program, will result in a combined climate-materials-structural performance model. The model will have the potential to predict changes in temperature and moisture in a pavement system due to local climatic changes as a function of the geometry and material properties of the system, and will incorporate a new method of simulating weather trends from long-term records, freeing users from the task of assembling data sets.
- A Users Manual to support the VESYS 3 AM flexible pavement analysis microcomputer program will allow the user to evaluate flexible pavement performance in rutting, cracking, present serviceability index and stress, and strain and deflection.
- Report on the Construction and Instrumentation of TFHRC Test Road.
- Report on analysis of load equivalency factors based on damage, performance and primary response criteria.

Program Status: The program manager's assessment of the status of each project (percent complete is as follows):

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Tire Pressure, Axle Configurations, and Vehicle Dynamics	38 percent complete
b	Pavement Response Models and Calibration	48 percent complete
c	Pavement Management Decision Support	55 percent complete

**NATIONALLY COORDINATED PROGRAM OF HIGHWAY RD&T
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YEAR ENDING SEPTEMBER 30, 1989**

PROGRAM NUMBER: C.9

PROGRAM TITLE: Technology Transfer for Pavements

PROGRAM COORDINATORS: Charles W. Niessner--Implementation
David M. Burk--Experimental Projects
Theodore Ferragut--Demonstration Projects
William Bellinger--National Highway Institute

OBJECTIVES: Develop guidelines, technical manuals, slide tapes, films, videotapes, and training courses related to pavement management strategies and the performance, design, construction, and rehabilitation of rigid and flexible pavements; provide technical assistance to highway agencies by furnishing reports, presenting technical briefings, trouble-shooting, and providing technical expertise in the above listed topics.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Technology transfer activities in pavement design, rehabilitation, construction, and management areas included under this program begin by identifying suitable products from research studies; continue by testing and evaluating them, often through the cooperative efforts of the State highway agencies; and conclude by providing the results and recommendations to other highway agencies using tech share reports, implementation packages, demonstrations, training courses, slide/tape or videotape presentations, and workshops. The overall goal of any technology transfer activity is to provide the necessary evidence to either improve existing practices, procedures, specifications, policies, or to validate/verify their continued use.

Major accomplishments and activities carried out in fiscal year 1989 include:

IMPLEMENTATION

- Initiated contracts with California, Washington, New Mexico, and Kansas to evaluate selected pavement distress survey devices.
- Initiated contracts with Oregon, Louisiana, Kansas, and Minnesota to evaluate a new indirect tensile testing device.

- Initiated the planning phase for a National Conference on Automated Pavement Distress Equipment.
- Completed contracts with New York, Ohio, and Washington to evaluate "EXPEAR," an advisory system for concrete pavement evaluation and rehabilitation.
- Initiated a contract to conduct a workshop on methods of evaluating portland cement concrete pavements.
- Completed a contract with Iowa to evaluate PREDICT and Symphony 1.1 Worksheet Solutions to the 1986 American Association of State Highway and Transportation Officials (AASHTO) Pavement Design Equations.
- Completed a contract with Washington to develop a videotape on resilient modulus testing.
- Conducted an open house and developed a videotape on the Accelerated Loading Facility (ALF) testing of in-service pavements.

DEMONSTRATION AND EXPERIMENTAL PROJECTS

- **Demonstration Project No. 69:** Portland Cement Concrete Pavement Restoration-- A field inspection guide was completed and distributed.
- **Demonstration Project No. 76:** Automated Traffic/Truck Weight Monitoring Equipment (Weigh-in-Motion)--The work plan was approved and the project mobilization phase is near completion. A full-scale pilot was conducted in Harrisburg, Pennsylvania, including field demonstrations of Weigh-in-Motion/Automatic Vehicle Classification (WIM/AVC) equipment. A large transport vehicle is being refurbished to house the equipment. A technical services contractor will be available to resolve any equipment problems that may arise once the project is announced and formal presentations begin.
- **Demonstration Project No. 975:** Permeable Bases--This project is currently being mobilized. It will present design and construction information on bound and unbound granular bases under PCC pavement. It should be announced to the field in the spring of 1990.
- **Experimental Project No. 2:** Bonded Concrete Overlays--Evaluations of the 9 projects continued.

- **Experimental Project No. 3:** Asphalt Additives--The evaluation of 22 projects continued and three new evaluations were initiated.
- **Experimental Project No. 8:** Improved Joint Sealants for Concrete Pavements--A review of problems encountered by 2 States with silicone sealant materials was conducted. As a result of that review, follow-up reviews have been completed in 11 States. A final report is being prepared.
- **Experimental Project No. 9:** Pavement Rehabilitation Techniques--The original objective of this project was to encourage the evaluation and reporting on selected techniques; however, the project has been redirected to serve as a "start-up" for emerging technologies that could address National problems. Two efforts are currently underway: "Use of Large Stone Asphalt Bases," and "Techniques for Extending the Service Life of Pavements."

Large Stone Asphalt Base field reviews have been completed in Oklahoma, Texas, and Kentucky. Reviews are scheduled for Arkansas, Indiana, Colorado, California, and Tennessee. The Work Plan for evaluating micro-surfacing as a potential means for extending the service life of pavements is being finalized.

- **Experimental Project No. 12:** Concrete Pavement Drainage Rehabilitation--The objectives are to evaluate and document the effectiveness of retrofit longitudinal edgedrains, and to evaluate nondestructive methods for inspecting and evaluating pavement drainage systems performance. Instrumentation of the 10 field sites is complete. Monitoring and data collection of rainfall, runoff, subbase saturation, and soil moisture contents are well underway at each site. In May 1989 a state of the practice report was distributed to the field and State highway agencies. Monitoring and data collection will continue in fiscal year 1990 and supplemented with field post-mortem autopsies.
- **Experimental Project No. 621:** Pavement Instrumentation - The project was initiated in response to the Strategic Highway Research Program (SHRP) transition Task Force recommendations. The objectives are to gain additional experience with pavement instrumentation and to gather data on the type, availability, cost, and reliability of the various types of pavement instruments. Pavement instruments were installed on the fourth State pilot project in fiscal year 1989. Instruments were also installed on the FHWA/Forest Service Test Track at Vicksburg, Mississippi, and the FHWA test strip at the Turner-Fairbank Highway Research Center in McLean, Virginia. An FHWA/SHRP pavement instrumentation meeting was held in November 1988 and a summary report and an installation report on the Illinois project were issued.

- **SP 201 and SP 202:** Special studies on "Accelerated Rigid Paving Techniques," and "Break and Seat of Jointed Reinforced Concrete Pavements," respectively, have been initiated. Interested States have agreed to participate in a team study and evaluation of both processes. Construction of 6 to 8 projects each, under state-of-the-art specifications, will be included in the studies.

NATIONAL HIGHWAY INSTITUTE

- Thirty-eight presentations of courses on highway pavements and related subjects were made throughout the year. The courses receiving the most interest include:
 - Pavement Management - A Management Perspective.
 - Pavement Design, and Techniques for Pavement Rehabilitation.

RURAL TECHNICAL ASSISTANCE PROGRAM

- Completed an Rural Technical Assistance Program (RTAP) contract with the North Carolina Institute for Transportation Research and Education to develop videotapes and videodisc training on pavement structure repair techniques.
- Completed an RTAP study to update the training course "Road Surface Management for Local Governments."
- Presented two 4 week sessions of the training course on "Highway Pavements" at Michigan State University.
- Completed an RTAP study to develop a "Pavement Design and Rehabilitation" short course.
- Completed the development of a 1-1/2 day training course on "Pavement Recycling Guidelines for Local Governments."

NATIONALLY COORDINATED PROGRAM OF HIGHWAY RD&T
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PROGRAM NUMBER: D.1
PROGRAM TITLE: Bridge Design
PROGRAM MANAGER: John D. O'Fallon

OBJECTIVE: NCP Program Area D.1 seeks to find a realistic means of quantifying bridge loads of all types, develop a better understanding of structural response and better design criteria that will more accurately correspond to the loads and load paths, identify the factors affecting bridge life and find a rational approach to its determination, develop new approaches, including both form and materials, for analyzing, designing, and building bridges, and obtain better and more cost-effective culverts through improved design, construction, and materials. (Structural research relating to bridge rating and rehabilitation is covered by NCP Program Area D.2.)

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results To Date: Approximately 70 studies were completed and published during the prior years under NCP Program D.1. The following are a few of the significant results from the past year:

- "Large-Scale Quasi-Dynamic Bridge Column Tests" furnished invaluable data concerning behavior of single-column ridge piers under extreme lateral (seismic) loading. It has been published as a California HP&R report, and also by the National Institute of Standards and Technology.
- "Design of Simple Span Pre-Cast Prestressed Bridge Girders Made Continuous" indicated that live load continuity can be obtained, but its degree of success is dependent upon the age of the prestressed concrete (PS/C) beam when the deck and diaphragm concrete are cast.
- "Evaluation of Corrugated Metal Pipe Arches" (CMPA) identified the predominant causes of CMPA culvert problems and recommended palliative measures. Corrosion of the metal and structure cracking were the most common problems.
- "Brittle-Ductile Transition of Bridge Steels" confirms the Charpy Impact requirements of the American Association of State Highway and Transportation

Officials (AASHTO) Guide Specifications for Non-Redundant, Fracture-Critical Steel Bridge Members, but also indicates that the Guide Specs may be unconservative in this same area for thick heat-treated plates.

- "Elastomeric Bearing Design, Construction and Materials" concluded its long effort with a report on low-temperature behavior and acceptance criteria for these bearings.
- "Localized Stresses in a Post-Tensioned Steel Girder Web--Field Verification" compared analytical results with those finite element computer models.

Work Underway: There are 115 studies underway in NCP Program D.1. The following is a partial list of these studies with interim results where appropriate.

- "Vessel Passage at Navigable Waterway Bridge Crossings" is analyzing the risk of vessel-bridge collisions and developing criteria for the prevention or mitigation of such collisions. A draft guide specification is ready for submission to AASHTO this year.
- "Load Prediction and Structural Response" is well into its bridge testing program. Half of the 30 bridges scheduled for WIM testing and static strain measurement have been tested.

Plans for Next Year: Although there are no new contract starts planned for FY 1990, initial development work will be underway in the following FY 1991 studies.

- "Development of Load Models" (FHWA contract).
- "Risk Analysis and Probabilistic Specifications" (FHWA contract).

Significant expected accomplishments include:

- Publication of reports on "Update of AASHTO Standard Specifications for Highway Bridges; Division II-Construction," "Transfer of Composite Technology to Design and Construction of Bridges," and "Effective Width of Composite Sections of a Prestressed Concrete Deck Tested in Conjunction with the FHWA Model Bridge Study."

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Loads	20 percent complete
b	Life Expectancy	30 percent complete
c	New Concepts	10 percent complete
d	Culverts	20 percent complete

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PROGRAM NUMBER: D.2
PROGRAM TITLE: Bridge Management
PROGRAM MANAGER: Eric Munley

OBJECTIVE: NCP Program Area D.2 aims to develop a comprehensive Bridge Management System (BMS) which will rationally and effectively allocate the expenditure of bridge program funds for all types of highway bridges under the following functional areas: planning, design, construction and maintenance; inspection, condition assessment, and rating; and rehabilitation and replacement. (Design-related research is covered by NCP Program Area D.1)

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results To Date: Numerous studies were completed and published during the prior years under NCP Program D.2. The following are a few of the significant results from the past year.

- "Guidelines for Investigating and Rehabilitating Localized Failures in Steel Bridges," a three-volume report on the subject, will be useful to bridge engineers and inspectors. A set of slides, suitable for a 30-minute presentation, is also available.
- "An Acoustic Emission Monitoring System for Highway Bridges" developed a digital system, compatible with point contact transducers, to monitor welding of steel bridge components during shop fabrication, and to detect flaws and permit timely repairs on existing bridges. It will incorporate pattern recognition and source classification and will be able to distinguish between relevant and irrelevant events.

Work Underway: There are 57 studies underway in NCP Program D.2. The following is a partial list of these studies with interim results, where appropriate.

- "Bridge Column Retrofitting" will provide guidelines for strengthening columns on existing bridges against seismic loading.
- "Recommended Revisions to the AASHTO Manual for Maintenance Inspection

of Bridges" will provide updated guidance for inspection, evaluation, and load rating of existing bridges.

- "Non-Destructive Methods for Field Inspection of Embedded or Encased High-Strength Steel Rods and Cables."
- "Bridge Inspection Automation" will develop an automated prototype electronic reporting system for bridge inspection information.
- "Structural Evaluation of In-Service Bridges Using Weigh-In-Motion Technology" (W-I-M) will determine what bridge response and truck loading information is necessary for structural evaluation. Bridge W-I-M instrumentation will be modified and field-tested to obtain this data.
- "Instrumentation and Field Monitoring of the Red River Segmental Prestressed Concrete Bridge" and "Instrumentation of the James River Cable-Stayed Bridge" will measure time-dependent deformation, thermal stress, live-load stress, and concrete creep and shrinkage data to better predict the long-term performance of this type of bridge.
- "Simple Load Capacity Tests for Bridges to Determine Safe Load Posting Levels" will develop a simple instrumentation system and a procedure for its use.
- "Estimation of Bridge Design Life" will develop an estimation procedure sensitive to differences in materials and to variable lives of bridge components.

Plans for Next Year: Research will continue on the project areas of NCP Program Area D.2. HP&R and NCHRP studies will be initiated to address specific topics. Research studies will be completed on development and improvement of bridge inspection equipment, criteria for evaluating the strength and load capacity of deteriorated bridges, techniques for strengthening and retrofitting bridges for increased load capacity, and computer-based programs for various elements of a comprehensive bridge management system.

Significant expected accomplishments include completion of studies on:

- "Non-Destructive Inspection and Monitoring of Structural Cables and Strands for Stayed and Suspension Highway Bridges." (FHWA Contract)
- "Structural Modifications for Enhanced Aerodynamic Performance of Long-Span Bridges." (FHWA Contract)
- "Acceptance Criteria for Steel Bridge Welds." (NCHRP)
- "Evaluating Corrosion Effects in Existing Steel Bridges." (NCHRP)
- "Bridge Management Systems." (NCHRP)

- "Non-Destructive Load Testing for Bridge Evaluation." (NCHRP)
- "Inelastic Rating Procedures for Steel Beam and Girder Bridges." (NCHRP)

Program Status: The program manager has made the following assessment of the status of each project (percent complete):

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Inspection, Equipment and Criteria	35 percent complete
b	Inventory, Condition Assessment and Rating	75 percent complete
c	Maintenance, Rehabilitation and Upgrading	35 percent complete
d	Management System and Economics	25 percent complete

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PROGRAM NUMBER: D.3

PROGRAM TITLE: Hydraulics and Hydrology

PROGRAM MANAGER: Roy E. Trent

OBJECTIVE: To develop cost-effective drainage design and stream stabilization procedures to protect highway systems against flood hazards.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results To Date: The following are a few of the significant results from the past year:

- The "Finite Element Surface-Water Modeling System: Two-Dimensional (Flow in a Horizontal Plane)" (FESWMS-2DH) has been functionally enhanced and downloaded to a microcomputer, and was made available by McTrans for distribution along with the users manual and research report.
- A practical method was developed to determine where bridge deck scuppers are or are not needed, and a procedure developed for testing where the danger of vehicle hydroplaning should be addressed.
- The large scale model study "Embankment Overtopping Damage Minimization" and follow-up task to further test cable-tied concrete block systems were also completed. Two reports from this are being processed for publication.
- An FHWA laboratory study on "Riprap Sizes for Protection of Bridge Piers from Scour" was completed. Experiments were conducted to get velocity profiles around piers of different shapes and to test stability of model riprap of different sizes.

Work Underway: There are 46 studies underway in NCP Program D.3. The following is a partial list of these studies with interim results where appropriate.

- The pooled-fund study "Integrated Drainage Design Computer System" is in a second phase which will streamline the input/output shells and generally enhance the set of highway drainage design microcomputer programs.

- The regional pooled-fund study on arid area hydrology in the Western United States is being continued. The peak-flow data file for all gages has been assembled, updated, and evaluated. Useful parameters are being identified, and new concepts are being investigated.
- A study is underway to apply the Two-Dimensional Finite Elements Surface Water Modeling System to Schoharie Creek at the New York State Thruway Bridge and compare with other model results from studies of the site.
- A study on hydraulic energy losses at storm sewer junctions; Graduate Research Fellowship studies on scour at bridge abutments, and a study of practical assumptions for scour at irregular bridge piers and footings were initiated at the TFHRC Hydraulics Laboratory.
- A National Symposium on Bridge Scour cosponsored by FHWA and the Interagency Subcommittee on Sedimentation was announced to provide a forum for highway agencies, academia, other government agencies and the private sector to exchange information on current techniques, field experience, and research needs on stream stability and scour problems at bridges.
- "Performance of Bridges during Flooding" is a Nationally coordinated effort to collect consistent field data for bridge scour and to establish a data base to develop improved prediction equations. This National study is supported by about a dozen HP&R and by State highway agency studies.
- Two studies are aimed at development of scour instrumentation. A contract with USGS "Seismic and Radar Scour Instrumentation" is looking for improved methods to measure scour holes after they have been refilled (after the flood) using geophysical techniques. An NCHRP study, "Instrumentation for Measuring Scour at Bridge Piers and Abutments" will develop, test and evaluate fixed instrumentation to monitor scour at critical bridges.

Plans for Next Year: There will be 3 new FHWA contracts initiated, and laboratory and staff studies will continue in fiscal year 1990, including:

- A study to develop a practical Nationwide procedure for estimating the 500-year flood for use in assessing bridges for scour potential (FHWA contract).
- TFHRC Hydraulics Laboratory will continue abutment scour studies, and initiate a new study of rigid basin energy dissipators for highway culvert outlets (FHWA contract).
- "Feasibility of Determining the Condition of Unknown Bridge Foundations," will evaluate the feasibility of developing advanced equipment and practicality of

using standard procedures to determine unknown foundations (FHWA contract).

- A new study on the effects of cohesion and natural bed material gradation will be initiated to follow-up studies in New Zealand and in Washington State, where it was found that gradation is a major factor in bridge scour which is not accounted for in most of the scour prediction equations (FHWA contract).

Significant expected accomplishments include:

- A computer model for general scour at highway stream crossings will be completed from the study NCHRP study "Hydraulic Analysis of Bridges on Streams with Moveable Beds." A training package and a microcomputer-based expert system are planned to follow the development of the model.
- The computer program Finite Element Surface Water Modeling System (FESWMS-2DH) will be finalized.

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Hydrology	68 percent complete
b	Drainage Structures	78 percent complete
c	Stream Stability	40 percent complete
d	River Mechanics	50 percent complete

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PROGRAM NUMBER: D.4
PROGRAM TITLE: Corrosion Protection
PROGRAM MANAGER: Y. Paul Virmani

OBJECTIVE: This program coordinates research and development for cost-effective procedures and systems to protect new concrete members from adverse environmental effects, and to rehabilitate deteriorated bridge members subjected to adverse environments.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to date: Program Area D.4 includes research performed by the Strategic Highway Research Program (SHRP) in the area of "Concrete and Structures." SHRP research studies are concentrated only on reinforced concrete bridge structures in contrast to Program D.4 which is performing concentrated research protection of prestressed concrete in addition to reinforced concrete structures. Program Area D.4 has identified prestressed concrete protection as a High Priority National Problem Area (HPNPA). The following are a few of the significant results from the past year:

- "Further Improvements in Cathodic Protection" evaluated the performance of seven cathodic protection (CP) systems installed on two mild steel reinforced concrete bridges. Based on the data and testing conducted for 2 years, it was apparent that the polarization decay of 100 mv may have resulted in under protection. Moreover, the E Log I method was helpful to provide a realistic method for determining the operating current required for CP operation.
- "Salt Penetration and Corrosion in Prestressed Concrete Members" revealed that there is a significant amount of corrosion induced concrete deterioration of prestressed concrete (PS/C) members when they are exposed to adverse environments. More often, concrete deterioration was observed in the bridge elements adjacent to leaky joints, faulty drains, or where directly exposed to deicer application and sea water spray.
- "Cathodic Protection and Environmental Cracking of Steel Tendons in Prestressed Concrete" revealed that hydrogen gas was being produced and

diffused into the 7-wire strands when subjected to voltages greater than -0.9 volts with respect to calomel electrode. The diffused hydrogen gas into 7-wire strands reduced the fracture stress compared to a control specimen.

- "Injection of Synergistic Corrosion Inhibitors" was successful in moving the corrosion inhibiting positive ion from the outer concrete surface towards corroding embedded rebar under applied electric current. At the same time, negative chloride ions migrated away from the rebar.
- Development, Testing and Field Application of Metallized Cathodic Protection Coatings on Reinforced Concrete Substructures" has concluded that metallized zinc coating performed well as anode material for installation of a cathodic protection system on reinforced concrete bridge components (excluding decks).

Work Underway: There are approximately 68 studies underway in NCP Program D.4. The following is a partial list of these studies with interim results where appropriate.

- "Cathodic Protection (CP) Developments for Prestressed Components" is evaluating the feasibility of applying CP systems to prestressed systems.
- "Materials and Methods for Regrouting Partially Filled Ducts" is developing methods for assessing the grout coverage over prestressing steel in the ducts of posttensioned prestressed concrete (PS/C) bridges and then regrouting them.
- "Corrosion Protection Systems for Bridge Stay Cables and Anchorages" is evaluating the effectiveness of currently available protection systems and develop recommendations for future stay cables.
- "Mechanism of Corrosion of Epoxy-Coated Reinforcing Steel in Concrete" will develop suitable repair methods for the rehabilitation of structures in marine environment.
- "Design Considerations for Bridge Deck Joint Sealing Systems" is studying the design methodology for joint seals for highway bridges.

SHRP-Related Activities: This program has direct application to SHRP projects on "Concrete and Structures." Some of the studies underway include: "Assessment of Physical Condition of Concrete Bridge Components"; "Concrete Bridge Protection and Rehabilitation: Chemical and Physical Techniques"; "Electrochemical Chloride Removal and Protection of Concrete Bridge Components"; "Cathodic Protection of Concrete

Bridge Components"; "An Electrochemical Method for Detecting On-Going Corrosion of Steel in Concrete Structures with CP Applied"; "Injection of Conductive Material for CP Application."

Plans for Next Year: Several new studies are planned for fiscal year 1990, including:

- "Field Evaluation of Cathodic Protection (CP) on Prestressed Concrete Bridge Components" (FHWA Contract).
- "Rehabilitation of Prestressed Concrete Bridge Components by Non-Electrical (Conventional) Methods" (FHWA Contract).
- "Improvements in Epoxy-Coating for Reinforcing Steel" (NCHRP Study).
- "Methodology for Protection and Rehabilitation of Existing Structures" (SHRP Study).

Significant expected accomplishments include:

- Final report on the study, "Conductive Polymer Concrete Overlays for Cathodic Protection."
- Final report on the study, "In Situ Chloride Determination in Hardened Concrete."

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows.

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Condition of Concrete Structures	40 percent complete
b	Rehabilitation by Electrochemical Methods	50 percent complete
c	Rehabilitation by Non-Electrochemical Methods	60 percent complete
d	Methodology for Protection and Rehabilitation	Continuing
e	Protective Systems for New Concrete Bridges	35 percent complete

**NATIONALLY COORDINATED PROGRAM OF HIGHWAY RD&T
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PROGRAM MANAGER: D.9

PROGRAM TITLE: Technology Transfer for Structural,
Geotechnical and Hydraulic Technology
Pavements

PROGRAM COORDINATORS: John M. Hooks--Implementation
Thomas Krylowski--Implementation
David M. Burk--Experimental Projects
Charles Stockfich--Demonstration Projects
Theodore Ferragut--Demonstration Projects
Larry Jones--National Highway Institute

OBJECTIVES: To promote the cost-effective use of new and innovative technology related to bridge loading and design criteria, procedures for design and construction of bridges, analysis of hydrology and hydraulic design of culverts and bridges, bridge rehabilitation technology, bridge decks, investigation, design and construction of bridge foundations, bridge maintenance, and protection against corrosion damage to concrete members; to develop and promote technology transfer products or media such as guidelines, technical manuals, computer programs, slide tapes, films, videotapes, evaluation reports, and conferences related to this technology; and to develop and conduct demonstration and experimental projects, and training courses to achieve technology transfer.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

This program is intended to accelerate the application of new technology related to bridge structures, bridge foundations, geotechnical engineering, and hydraulics and hydrology in the functional areas of design, construction, inspection, maintenance and rehabilitation. New technology is derived from other NCP Category D, Research and Development studies, including Highway Planning and Research and the National Cooperative Highway Research Program studies, and also from problem statements which are generated by field and operating offices. Promising technology is packaged in technology transfer products which are easily understood and applied by potential users, and are then directed to the appropriate personnel at Federal, State, and local levels. The program involves a wide range of activities including: field test and evaluate promising hardware, test methods or construction procedures, prepare user's manuals for hardware and test methods; develop new design and/or construction

procedures, and prepare implementation packages, develop and conduct demonstration projects and experimental projects; develop and implement new inspection hardware and techniques, conduct conferences and workshops as a forum for technology transfer, develop new computer programs, evaluate their usefulness, provide technical support to users; document the design and/or construction of unique or unusual structures, and develop and conduct training courses on selected topics in bridge engineering.

Major accomplishments and activities carried out in fiscal year 1989 include:

IMPLEMENTATION

- Developed a Technical Advisory on the "Use of Uncoated Weathering Steel in Highway Structures."
- Completed and distributed culvert design programs BOXCAR and PIPECAR.
- Published "Guidelines for Developing Inspection Manuals for Segmental Concrete Bridges."
- Completed development of a training course on "Seismic Design of Highway Bridges."
- Published "Advanced Nondestructive Testing of Steel Bridges - Applications and Guidelines."
- Conducted 3 Tri-Regional Workshops on Bridge Management, Bridge Inspection, and changes to the National Bridge Inspection Standards.
- Initiated a contract to develop a comprehensive training program for bridge inspectors.
- Initiated a contract to develop four regional workshops on the computer program HYDRAIN.
- Published Implementation Package IP-89-016, "Design of RIPRAP Revetment."

DEMONSTRATION AND EXPERIMENTAL PROJECTS

- Demonstration Project No. 71: Bridge Management Systems--A new, extended phase of the project commenced in May 1988, to develop a multi-year network optimization model. Work on model development commenced in September 1989. Submodels should be available for evaluation by State highway agencies by September 1990. Project completion is scheduled for January 1992.

- **Demonstration Project No. 73:** Highway Drainage Design--The project was presented to participants in 10 States in fiscal year 1989. There are an additional 7 presentations of the project which will be completed in early 1990.
- **Demonstration Project No. 80:** Bridge Inspection Techniques and Equipment-- The project was announced in January 1989 and was presented in 17 States during fiscal year 1989. The project team also responded to two National Transportation Safety Board requests for assistance at bridge collapses in Tennessee and Ohio. An additional 28 States have requested the project and these workshops will be completed in fiscal year 1990.
- **Demonstration Project No. 923:** Cathodic Protection for Substructures-- Pilot projects are currently under evaluation. If successful, announcement of the project should be in the spring of 1991.
- **Demonstration Project 81:** Load Factor Bridge Design by Computer--This project was developed to promote the Load Factor Design philosophy and concepts. A 2-1/2 day "hands on" workshop, a reference notebook, and a Maryland State Highway Administration Steel Girder Bridge Design Computer Program are available. The project was announced to the field in fiscal year 1989 and a workshop was presented to participants from 12 States. Additional workshops will be held during fiscal year 1990.
- **Demonstration Project 84:** Corrosion Survey Techniques--The latest equipment and techniques will be demonstrated. The project will be announced to the field in the spring of 1990.
- **Demonstration Project No. 1:** Ground Modification Systems--Monitoring of the performance of 15 active projects in 11 States continues. Ten projects have been completed to date.
- **Experimental Project No. 4:** Protective Coatings for Structural Steel-- Monitoring the performance of 11 projects continues.
- **Experimental Project No. 605:** Bridge Deck Protective Systems--Monitoring of the performance of 5 active projects in 5 States continues. Five projects have been completed to date.

NATIONAL HIGHWAY INSTITUTE

- Offered training courses on 15 different topics relating to highway structures and conducted a total of 75 presentations. The courses in highest demand were:
 - Inspection of Fracture Critical Bridge Members
 - Culvert Inspection
 - Hydrology

- Two new courses became available for scheduling in fiscal year 1989:
 - Seismic Design of Highway Structures
 - Economical and Fatigue Resistant Steel Bridge Details

- Courses in various stages of development for future presentation include:
 - Stream Stability and Scour at Highway Bridges
 - Engineering Concepts for Bridge Inspectors
 - Safety Inspection of In-Service Bridges
 - AASHTO/AWS Bridge Welding Code

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PROGRAM NUMBER: E.1

PROGRAM TITLE: Asphalt and Asphaltic Mixtures

PROGRAM MANAGER: Ernest J. Bastian, Jr.

PROGRAM PERSONNEL: Brian H. Chollar, Kevin D. Stuart, and Joseph A. Zenewitz

OBJECTIVE: This program is to investigate materials, techniques, and specifications to improve the quality and handling of petroleum asphalt paving mixes used in highway construction and maintenance, and to evaluate synthetic binders for use in high quality flexible paving mixes.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: There are 51 studies active in this program. The following are a few of the significant recent results:

- "Asphalt Behavior at Low Service Temperatures" involved measuring, predicting, and understanding its low temperature (thermal) cracking potential. As part of this study, a new, simple bending beam device was developed to measure the low temperature stiffness of asphalt.
- "Changes Occurring in Asphalts in Drum Dryer and Batch (Pug Mill) Mixing Operations" resulted in 3 major major technical conclusions: steam distillation of asphalt is not a significant process in drum dryer mixers; drum dryer mixers were found to "age" and harden asphalt to a slightly but definitely greater extent than batch (pug mill) mixers; and asphalts recovering from recent drum dryer mixer operations are harder than those recovered from drum dryer operations 15 years ago. This is indicative of a general change in operating conditions of such mixers over the years.
- "Recovery of Asphalt From Methylene Chloride and Trichloroethylene by the Abson Method," concludes that methylene chloride is a viable alternative to trichloroethylene for recovering asphalts from mixes by the Abson method. Its use will be recommended for inclusion in the relevant American Society for Testing and Materials, and the American Association of State Highway and

Transportation Officials standard test methods.

- "Laboratory Evaluation of Verglimit and PlusRide," gives a preliminary evaluation of the effects on mixture properties of these materials which are used to control the formation of ice on pavements. Both Verglimit and PlusRide are shown to have a propensity to degrade certain mixture properties.

Work Underway: The following is a partial list of studies with interim results where appropriate:

- "Integrated Material and Structural Design Method for Flexible Pavements, Volumes I to III" quantified relationships between structural and material mix design parameters and developed an indirect tensile test procedure for examining mix design from a structural viewpoint.
- "The Development of the Indirect Tensile Test for Designing Asphalt Mixtures," a follow-up to the previous study, will measure both static and repeated loading with the indirect tensile test and compare such parameters' use in mix design with the traditional Marshall mix design procedure.
- "Chemical Modification of Asphalts" plans to improve paving asphalt by chemical modifications to improve the properties of asphalt. This approach, potentially more powerful than the mere addition of additives/modifiers to improve the properties of asphalt, takes advantage of asphalt's chemical properties and allows it to react with other chemicals to change and improve its rheological and chemical properties by changing its molecular structure.

SHRP-Related Activities: Research in "Asphalt and Asphalt Mixtures" is currently dominated by the 5-year Strategic Highway Research Program (SHRP). Approximately two years of SHRP have elapsed, and five out of the seven major asphalt contracts are underway. During the past year, "Asphalt Modification" was begun. Additionally, several minor contracts to introduce innovation into the SHRP Asphalt Program outside of the major contracts have begun or are under negotiation. The SHRP asphalt contracts are guided and united by the philosophy that the physical properties of asphalt and asphalt mixes, including rheological and engineering properties and, ultimately, pavement performance, follow from the molecular and higher order structure of asphalt and its mixes. Hence, a major effort is being made in the SHRP Asphalt Program to determine the fundamental chemistry of asphalt and asphalt-aggregate interactions in order to relate them to physical and performance properties of asphalt mixes. In a later contract, the "Development of Performance Based Asphalt-Aggregate Mixture Analysis (AAMAS) Specifications" will be undertaken, which will result in more cost effective asphalt pavement construction.

Plans for Next Year: There are several studies planned for fiscal year 1990, including:

- "Disposal of Waste From Highway Materials Testing Laboratories" (HP&R pooled fund contract).
- "The Use of HP-GPC and FTIR to Investigate Chemically Modified Asphalts." (FHWA Grants for Research Fellowship study).

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Asphalt Properties	50 percent complete
b	Performance-Based Testing and Measuring Systems	50 percent complete
c	Pavement Performance Studies	65 percent complete
d	Preparation of Performance-Based Specifications for Asphalt and an Asphalt-Aggregate Mixture Analysis System (AAMAS)	50 percent complete
e	Coordination of SHRP Studies	30 percent complete
f	Assessment of Synthetic Bitumens	95 percent complete

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PROGRAM NUMBER: E.2
PROGRAM TITLE: Cement and Concrete
PROGRAM MANAGER: Stephen W. Forster

OBJECTIVES: Investigate and better define the physical and chemical development of concrete, mechanisms of concrete distress, and characteristics of hardened concrete necessary to combat these distresses, develop concrete formulations and mix designs which will provide concrete more resistant to distress, and investigate means of improving the functional capability and durability of concrete through better quality control and new technology to enhance the mechanical properties of concrete.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: In 1987, NCP Program Area E.2, "Cement and Concrete," was formed by combining the work planned for SHRP Technical Area 5; "Cement and Concrete," and existing studies. The following are a few of the significant results from the past year:

- "Concrete Joint Sawing Study" presents the results of an information search on the properties of early age concrete as they relate to sawing and early loading. It also contains work plans for laboratory studies to be conducted.
- "PCC Mix Design, presents the basics of materials selection and use, and procedures for PCC mix design in a format suitable for the practitioner.
- "Coarse Aggregate for PCC-Pilot Study Evaluation" gives the results of an investigation of the effect of coarse aggregate type on the properties of PCC.
- "Fly Ash Concrete" includes the experiences Louisiana has had with the use of fly ash in PCC, and its effects on the properties of the concrete.

Work Underway: There are 50 studies underway in NCP Program Area E.2. The following is a partial list of these studies with interim results where appropriate:

- "Concrete Joint Sawing Operations," is investigating all aspects of concrete joint sawing operations for rigid pavements. The objectives are to establish guidelines for joint sawing and allowable loads on new pavements prior to opening to

traffic. These guidelines will be based on correlations developed between measurable early age concrete properties and the concrete pavement's ability to undergo sawing or loading at early ages. A completed information review indicates there are knowledge gaps to be filled during the testing portion of the study. This study has completed 1 year of its planned 2-year duration.

- "Development of an Air Entrainment Meter for Fresh Concrete" is developing a means of measuring the amount of entrained air in concrete by expansion. The main benefit is the equipment proposed would be much lighter and easier to use than the current pressure meter device.
- Aggregate-induced distresses are of particular concern in many areas of the United States. The two basic categories of distress are alkali-aggregate reactivity and D-cracking. There are several currently active HP&R studies in each of these categories investigating means of evaluating the distress, arresting further development, and preventing occurrence.

SHRP-Related Activities: This program area is closely aligned with the SHRP. The first contract on concrete microstructure was awarded in the fall of 1987. It is investigating the fundamental properties of concrete, concentrating on microstructure development and how microstructure can be optimized to greatly improve concrete's performance. SHRP also has active research dealing with concrete distress, with emphasis on alkali-silica reactivity. One major objective is to develop a reliable test method to definitively determine reaction-susceptible aggregate. Concrete freeze-thaw durability and non-destructive methods of concrete condition evaluation and quality control are being studied also. Other contracts are investigating concrete quality control and condition analysis, and the properties of high performance concrete.

Plans for Next Year: There are three planned new studies for fiscal year 1990:

- "Modulus of Rupture and Permeability of Structural Concrete" (Florida HP&R).
- "Petrographic Characteristics of Limestone Aggregate Used in Concrete" (Florida HP&R).
- "Training Course on Concrete Proportioning" (Illinois HP&R).

Significant expected accomplishments in the next year include:

- "Guidelines for Concrete Joint Sawing and Early-Age Loading, (FHWA contract)."
- "Advanced Chemical Techniques for the Analysis" of Hardened Concrete" (Florida HP&R).
- "Use of Supplemental Cementations Materials for Optimum Resistance of Hydraulic Cement Concrete to Chloride

- Penetration" (Virginia HP&R).
- "Techniques to Evaluate Concrete Structures for Alkali-Aggregate Reactivity" (California HP&R).

Program Status: The program manager's assessment of the status of each project is:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Chemistry and Physics of Cement & Concrete	20 percent complete
b	Concrete Distress and Durability	20 percent complete
c	Quality Assurance and Condition Evaluation of Concrete	10 percent complete
d	Mechanical Behavior of New Technology Concrete	5 percent complete

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PROGRAM NUMBER: E.3
PROGRAM TITLE: Geotechnology
PROGRAM MANAGER: Albert F. DiMillio

OBJECTIVE: This program is to develop improved design and predictive techniques for bridge foundations and ground improvement methods such as reinforced soil, stone columns, dynamic compaction, soil nailing, and prefabricated vertical drains.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: Approximately 40 studies have been completed and published to date under NCP Program E.3. The following are a few of the significant results from the past year:

- "Settlement Analysis of Spread Footings on Sand" developed a computer-aided data base capable of generating settlement predictions, correlations, analyses, plots, and site summaries for 46 case history examples.
- "Model Study of Piles and Pile Groups" demonstrated that model pile data can be used to verify load/settlement prediction models.
- "Behavior of Reinforced Soil Structures" completed a series of small-scale laboratory model tests and full-scale field tests on six retaining walls and three reinforced soil embankments. Results of these tests were used to develop a comprehensive manual of guidelines for design and construction of reinforced soil structures.

Work Underway: There are 32 studies presently underway in NCP Program E.3. The following is a partial list of these studies with interim results where appropriate:

- "Corrosion and Durability of Soil Reinforcing Elements" developed equipment and techniques for measuring corrosion of metallic elements and deterioration of non-metallic elements of reinforced soil structures. Verification testing of the equipment at five field sites showed very positive results. A manual of guidelines is being developed.

- "Soil Nailing to Stabilize Highway Cutslopes and Excavations" shows that, based on recently completed laboratory model tests and full-scale field evaluation tests, soil nailing is a viable alternative to conventional stabilization techniques. A draft guidelines manual has been developed.
- "Drilled Shafts for Bridge Foundations" is developing improved methods for integrity testing of the drilled shaft structural system.
- "Permanent Ground Anchor Walls" is developing improved design procedures from the results of small-scale laboratory model studies and load tests on full-scale field structures.
- "Rockfall Hazard Rating System" is developing a rational procedure for rating and prioritizing hazardous rockfall situations in rugged terrain.

Plans for Next Year: There are 5 studies planned as being new starts for fiscal year 1990, including:

- Field and Laboratory Performance Evaluation of Spread Footings (Ohio HP&R)
- New Test Methods and Acceptance Criteria for Geocomposite Drains (California HP&R)
- Embankment Widening and Grade Raising on Soft Foundations (Indiana HP&R)

Significant expected accomplishments include:

- Improved settlement prediction methods for spread footings
- Improved acceptance criteria for crushing strength and internal flow capability for geocomposite drains
- Improved procedures for predicting settlement and bearing capacity for embankment widening and grade raising

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Foundations for Highway Bridges	92 percent complete
b	Ground Improvement for Highways	85 percent complete

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PROGRAM NUMBER: E.4
PROGRAM TITLE: Paints and Coatings for Highways
PROGRAM MANAGER: John W. Peart

OBJECTIVE: Develop environmentally acceptable and cost effective surface preparation methods and coatings for long-term corrosion protection of bridge steels.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

The Federal Highway Administration's research in this area has been designated as a High Priority National Program Area (HPNPA). A research plan has been formulated to address the problems and is being systematically implemented annually as resources become available.

Significant Results to Date: Approximately 21 studies have been completed to date under NCP Program E.4. The following are a few of the significant results from the past year:

- "Performance of Alternate Coating in the Environment (PACE) Vol. II" shows five-year field evaluations on Improved Coating Formulations have been completed. Results show that abrasive blasting to a near white cleanliness level increases coating life four-fold as compared to power tool cleaning; new power tool cleaning utilizing abrasive discs, abrasive rotary flaps and coated abrasive discs performed much superior to hand tool cleaning methods and very nearly equal to abrasive blasting; and a calcium sulfonate wax and two alkyd systems with alternate pigments performed as well or better than lead pigmented alkyds over hand cleaned steel.
- "Development of Performance Tests, Criteria and Specifications for Coatings" has completed the accelerated testing phase and a report prepared on the assessment of corrosion rates, failure mechanisms and corrosion mitigation methods for weathering steel. Uncoated weathering steel performs poorly in specific environments, and exposure conditions and bridges experiencing these environments will require maintenance painting to achieve their anticipated design life. Accelerated corrosion testing indicates that zinc rich primers based

both on inorganic and organic vehicle systems are superior candidates for this application.

- "Environmentally Acceptable Materials for the Corrosion Protection of Steel Bridges" has identified commercially available bridge maintenance coatings that will comply with proposed standards limiting the volatile organic compounds in bridge maintenance coatings.
- "Lead Containing Paint Removal, Containment and Disposal" was designed and contracted to reduce the cost of removal, containment and disposal of lead containing paint from highway structures. Special emphasis will be placed on the reuse of the materials generated to reduce the quantities of hazardous materials requiring disposal.

Work Underway: There are 20 studies underway in NCP Program E.4. The following is a partial list of these studies:

- "Environmentally Acceptable Materials for the Corrosion Protection of Steel Bridges."
- "Effect of Substrate Contaminants on Coating Life."
- "Bridge Superstructure Coatings."
- "Evaluating High Solids Materials for Corrosion Protection of Steel Bridges."

Plans for Next Year: There are no new contract studies planned as new starts for fiscal year 1990.

Significant expected accomplishments include:

- Publication of the results of FHWA staff study on "High Solids Coatings for Bridge Maintenance."
- Publication of the results of "Development of New Statistical Analysis Method to Predict Coating Life" (FHWA contract).

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Environmentally Acceptable Coatings	80 percent complete
b	Improved Performance and Testing	90 percent complete
c	Long-Term Corrosion Control	80 percent complete
d	Specialty Coatings - Lane Delineation	70 percent complete

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PROGRAM NUMBER: E.5

PROGRAM TITLE: Highway Maintenance

PROGRAM MANAGER: Peter A. Kopac

PROGRAM PERSONNEL: Douglas L. Smith, Stephen W. Forster, and Deborah M. Freund

OBJECTIVE: The overall objectives of this program are to identify, evaluate, and develop improved methods for routine maintenance of highway facilities, and to improve the efficiency and effectiveness of scheduling, budgeting, and administration of highway maintenance programs.

EXECUTIVE SUMMARY AND PROGRAM STATUS: NCP Program Area E.5 was formed in 1987 by integrating the work plan for the SHRP Technical Area 3 "Maintenance Cost Effectiveness" and the applicable sections of the work plans for SHRP Technical Areas 1 "Asphalt," 2 "Pavement Performance," and 4 "Concrete and Structures" with existing studies concerning pavement maintenance effectiveness, improved maintenance technology, and maintenance management.

Significant Results to Date: Approximately 35 studies were completed and published in this program area during previous years. Significant results from the past year include:

- "Durable Asphalt Emulsion Seal Coats" presented the state of the practice in the design and construction of asphalt emulsion seal coats. The report concluded that while selection of materials and adequate design are important, various aspects of the construction phase combined made up the biggest single factor determining success or failure of an emulsion seal coat project. Instructional material, in the form of a user's manual and a slide tape, accompanied the report.
- Design and construction guidelines for multiple seal coats were also established for the Texas State Department of Highways and Transportation. The recommended design method was tested by fabricating multiple seal coats in the laboratory and field, and, with modifications, was found to produce satisfactory performance.

- A Virginia study to improve concrete pavement patching techniques was completed. One recommendation was the use of impact hammers and maturity calculations to estimate the compressive strength of patches so that more accurate decisions could be made on when to open patches to traffic.

Work Underway: There are 60 studies underway in NCP Program E.5. The following is a partial list of these studies with interim results where appropriate:

- Several studies dealing with the performance of seal coats or surface treatments are underway. These include an NCHRP Project to develop a workable system for applying chip seal coats to high-traffic-volume asphalt concrete overlays; two Pennsylvania HP&R studies, one investigating the effects of emulsion viscosity and residue penetration on the performance of seal coats, and the other investigating the effects of existing pavement surface condition, emulsion application rate, compaction procedure, and control of traffic; a Mississippi HP&R study evaluating the performance of slurry seals with polypropylene fibers; and an Oregon HP&R study investigating the cost-effectiveness and maintenance requirements of various thin pavement surface treatments.
- Joint and crack sealing is another maintenance activity currently being well investigated through the States' HP&R program. A major Ohio study is developing guidelines for evaluation, selection, and installation of joint and crack sealants for both portland cement and asphaltic concrete pavements. An Indiana study is evaluating the performance of six different crack sealing materials on asphalt concrete pavements to develop sufficient application and performance data that will allow the Indiana Department of Highways to make a rational selection of the best seal to use. A Utah study is evaluating the performance of at least 10 currently available silicone and low-modulus hot-pour sealants for portland cement concrete pavements.
- In maintenance management systems, the administrative research contract to evaluate the current Highway Operations and Maintenance Cost Index, and to develop options for its revision, redevelopment, or termination, is nearing completion. The findings were presented at a workshop and will be a final report. "Data Base for New Maintenance Technology," is developing a system design for a cost-effective microcomputer-oriented network to create and access a data base of innovations in highway maintenance operations. In addition, "Improvements in Data Acquisition Technology for Maintenance Management Systems" is identifying and evaluating the latest technological means to effectively and efficiently acquire, record, field-verify, and receive field-related data for maintenance management systems.

SHRP-Related Activities: Four contracts in SHRP Technical Area 3, "Maintenance Cost Effectiveness," have been awarded: "Pavement Maintenance Effectiveness" will use and complement data collected by the Long-Term Pavement Performance (LTPP) contractors to quantify the effectiveness of four flexible pavement maintenance treatments (crack sealing, chip seals, slurry seals and thin overlays) and two rigid pavement maintenance treatments (joint/crack sealing and undersealing); "Maintenance Measuring Systems and Instrumentation for evaluating Pavement Maintenance Effectiveness" is currently being summarized to prepare for additional research to develop promising alternatives. The contract calls for an evaluation of existing systems and preparation for the development of systems that are fast, cost-effective, simple to use, capable of covering more extensive areas, and can generate reproducible measurements; "Innovative Materials and Equipment for Surface Repairs" will identify and evaluate existing materials, procedures, and equipment for pothole repair and joint/crack sealing, and design a plan for the development and evaluation of new and/or improved materials and equipment; and "Maintenance Work Zone Safety" will develop new and more effective ways to protect workers from the hazards of traffic in short-term maintenance work zones.

Plans for Next Year: There are 3 planned studies for fiscal year 1990:

- Pavement Maintenance Field Data Collection (SHRP contract).
- Effective Maintenance Budget Strategies (NCHRP contract).
- Maintenance Contracting (NCHRP contract).

Significant expected accomplishments include:

- Development of instrumentation and procedures to evaluate the effectiveness of maintenance activities on pavement performance, and the effectiveness (quality) of maintenance performed.
- Models to predict the effect of maintenance (timing and activity) on pavement service life.
- Improved guidance on equipment, methods, materials, and management to improve highway maintenance.
- Improved transfer of technology.

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Measuring Systems and Instrumentation for Evaluating Maintenance Effectiveness	15 percent complete
b	Pavement Maintenance Effectiveness	35 percent complete
c	Improved Materials and Equipment for Localized Surface Repair and Crack Filling	40 percent complete
d	Improved Maintenance Technology	40 percent complete
e	Systems to Improve Worker and Motorist Safety	25 percent complete
f	Maintenance Management	40 percent complete
g	Media Evaluation and Implementation	5 percent complete

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PROGRAM NUMBER: E.6
PROGRAM TITLE: Snow and Ice Control
PROGRAM MANAGER: Douglas L. Smith

OBJECTIVES: The overall objectives of this program are: to develop methods of snow and ice control which provide safe, serviceable highways and minimize adverse effects to the highway environment, and to develop procedures for selecting optimum strategies for snow and ice control.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

In 1987, NCP Program Area E.6 was formed by integrating the work plan for the Strategic Highway Research Program (SHRP) Technical Area 6, "Control of Snow and Ice," with existing studies concerning alternative deicing chemicals and control of blowing snow. Federally-sponsored research on the development of calcium magnesium acetate (CMA) has been completed. Research evaluating the effectiveness of CMA will, for all practical purposes be completed next year. Current and future research will focus on the prevention and destruction of ice-pavement bonding, the development of improved snowplow designs, and the control of blowing snow.

Significant Results to Date: Approximately 60 studies were completed. Results under the previous FCP Project 3C and under NCP Program E.6 have demonstrated the overall effectiveness of CMA as a deicing agent. An FHWA contract also showed CMA to be much less deleterious to highway and automotive related materials than sodium chloride. The results are documented in "Effects of Calcium Magnesium Acetate (CMA) on Pavements and Motor Vehicles." The research to date has also shown the importance of handling and storage to minimize problems with dust. Inconclusive results concerning the effects of CMA on reinforcing steel in pavements with high chloride contents has prompted a staff study on the electro-chemical measurements of CMA, which was initiated this past spring. The following are a few significant results from the past year:

- "Snow Accumulation Toleration Limits," identified maximum tolerable snowfall accumulation levels.

- "Inservice Evaluation of Ice Detection System," tested ice detection systems in field operation.
- "Verglimit," evaluated the effectiveness of the commercial pavement additive Verglimit.
- "The Fate of Ethylene Glycol in the Environment," determined the effect and fate of ethylene glycol.
- "Determining the Feasibility of West Virginia Oil and Gas Field Brine as Deicing Agents," conducted final evaluation of waste brines for deicers and implemented full scale application in test districts.

Work Underway: There are 15 studies underway in NCP Program E.6. The following is a partial list of these studies with interim results where appropriate:

- "Control of Blowing Snow" evaluated methods for the control of blowing snow.
- "Industrial Snow Fence vs Wooden Fence" evaluated snow fencing.
- "Field Testing Using Calcium Magnesium Acetate" evaluated the effectiveness of CMA.
- "Evaluation of Asphalt Additives" evaluated several pavement additives for the control of ice on road surfaces.
- "Weather Forecasting Strategies" improved snow and ice control operations management through improved weather forecasting.

SHRP-Related Activities: There are 8 SHRP studies currently under contract: "Novel Biological Macromolecules as Icephobic Agents;" "Ice-Pavement Bond Prevention;" "Ice-Pavement Bond Prevention Surface Modification --Fundamental Study;" "Ice-Pavement Bond Disbonding;" "Ice-Pavement Bond Disbonding Surface Modification and Disbonding--Fundamental Study;" "Evaluation of Deicing Chemicals;" "Improved Displacement Plows and Blowing Snow Control;" and "Storm Monitoring and Communications."

Plans for Next Year: A Congressionally-mandated study of the cost/benefits of sodium chloride and CMA will be initiated next year under a contract with the National Academy of Science's Transportation Research Board. No other new research is planned other than studies conducted under the HP&R program by State highway agencies. It is anticipated that States will continue to evaluate the use and

effectiveness of CMA over the next several years. Much of this work could be done under the HP&R program and therefore fall under NCP Program E.6.

Program Status: The program manager's assessment of the status of each project is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Prevention of Ice-Pavement Bond	35 percent complete
b	Destruction of Ice-Pavement Bond	30 percent complete
c	Equipment Development	25 percent complete
d	Control of Blowing Snow	15 percent complete
e	Management of Snow and Ice Control Operations	15 percent complete

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PROGRAM NUMBER: E.7

PROGRAM TITLE: Environmental Design

PROGRAM MANAGER: Howard A. Jongedyk

PROGRAM PERSONNEL: Douglas L. Smith, James F. Koca, and Kevin N. Black

OBJECTIVES: This program assesses impacts of highway construction, operation, and maintenance on air and water resources, noise levels, roadside land, water, ecological conditions, and other environmental factors. In addition, techniques to evaluate roadside material resources, landscape, and other various environmental concerns for highways are included. This program develops tools and procedures, including remote sensing, to evaluate impacts, and prescribe cost effective measures for controls and mitigation.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: In excess of 300 studies were completed during prior years under NCP Program E.7 and its predecessor FCP Projects. The following are a few of the significant results from the past year:

- Guidelines and specifications for reduction of highway runoff pollutant impacts by detention and retention basin and slow overland flow systems.
- An improved photogrammetric mapping system for area plan views, profile and contour maps, or prospective plots from conjugate points imaged on two or more photos.
- Experiments and a predictive procedure for stop and go traffic noise levels.
- An interactive user-friendly procedure for estimation of impacts of highway stormwater runoff and PC version of Synoptic Rainfall Data Analysis Program (SYNOP).
- Assessments of needs for passive protective systems to prevent damages from spills of hazardous materials.

- Highway air pollutant dispersion models developed for sites where open terrain air pollutant dispersion models are not applicable and for a wide diversity of confined roadway site configurations based on extensive evaluations of air flows.
- Evaluations of highway noise source heights and effects of tires and pavements on highway noise.

Work Underway: There are currently 53 studies in NCP Program E.7. Although most all of the program area is represented the largest number of studies involve:

- Highway Runoff Pollution and its Mitigation (10 studies)
- Highway-Adjacent Land and Water Area Interactions (Wetlands) (8 studies)
- Highway Noise Barriers (5 studies)
- Evaluation of Highway Noise Sources (6 studies)
- Environmental Mapping (4 studies)

The following is a list of significant results from a few of these studies:

- Observations in 15 diverse States for determinations of the effectiveness of measures utilized to mitigate highway impacts to wetlands.
- Evaluations of measures to protect endangered species wildlife through vehicle collision reductions and habitat considerations.
- Measurements of noise impacts at receptors for experimental highway noise barriers using moving trucks and controlled stationary sources for single, double, and parallel barriers and for the effects of absorptive coverings and tilting of parallel barriers.
- Measurements of movements of ground water pollutants and roles of drainage systems to reduce their impacts.
- Methods to reduce water quality impacts from acid producing soil materials exposed from highway construction or maintenance activities.
- Procedures to locate aggregates for highway materials in areas of shortage.

Plans for Next Year: There are 2 studies planned for new starts for FY 1990, including:

- Corridor Preservation Criteria and Their Analytical Selections
- Assessments of Highway Particulate Impacts

Significant expected accomplishments include:

- Measurable criteria to analyze the advisability, lead time, costs, and effectiveness of potential highway corridor preservations and techniques for preservation of highway corridors.
- Assessments of respirable particulate concentrations in the air for highway sites, their relationships to air quality guidelines, and mitigation measure to reduce pertinent air quality impacts.

Program Status: The program manager's assessment of the status of each project is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Mitigation of Impacts on Water and Air Quality	Continuing
b	Mitigation of Noise and Vibration Impacts	Continuing
c	Mitigation of Impacts on Roadside Ecology	Continuing
d	Mitigation of General, Social, Economic, and Cultural Environmental Effects	Continuing
e	Environmental Surveying and Mapping	Continuing

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PROGRAM NUMBER: E.8
PROGRAM TITLE: Construction Control and Management
PROGRAM MANAGER: Terry M. Mitchell
PROGRAM PERSONNEL: Peter A. Kopac

OBJECTIVE: This program has three objectives: to develop rapid and/or more significant test procedures for controlling the quality of highway construction; to develop quality control specifications and associated test procedures that relate directly to performance; and to develop economic and technical data, statistical tools, and other support information to help highway agencies improve their construction management.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: Some 80 studies have been completed since the early 1970's on the subject areas in the Federally Coordinated Program (FCP) and in NCP Program E.8. One portion of the current program, Project E.8.b, "Performance-Related Specifications (PRS) for Highway Construction," is designated as one of FHWA's High Priority National Program Areas. The following are a few of the significant results from the past year:

- "PRS for Hot-Mix Asphalt Concrete (AC)" produced a conceptual framework for the development of PRS and explored several elements of the proposed specification. The latter included a limited scale laboratory study showing the relationship of asphalt content, aggregate gradation, and density to AC performance; an evaluation of existing data bases for developing PRS from actual construction data; and recommendations for the future research necessary to flesh out the framework.
- "Development of PRS for Portland Cement Concrete (PCC) Pavement Construction" proceeded in much the same manner as the study described above. The framework for the development of PRS for AC was refined; a complete system of relationships between materials and construction (M&C) factors and pavement performance was defined; and a computerized demonstration was provided of the development of PRS using initial pavement

profile, slab thickness, and flexural strength as the principal intermediaries between M&C factors and pavement distresses.

These two studies are providing the groundwork for large scale laboratory programs and accelerated field tests for the development of complete systems of PRS.

- "Instantaneous Determination of Water-Cement Ratio in Fresh Concrete" explored possibilities for use of a probe containing specific ion electrodes for this measurement. Although the probe techniques were not satisfactory, significant improvements were suggested in methods for measuring water and cement contents separately in relatively short times.
- "Development of Statistical Procedures," (New Jersey HP&R) produced computer software that enables engineers to correctly use regression analyses when both variables contain measurement error. A typical use for the technique will be in correlating results obtained from a new test method with those obtained from an existing standard method.

Work Underway: There are 25 studies underway currently in NCP program E.8. The following is a list of significant results from a few of these studies:

- "Evaluation of New Nuclear Density Gauges on AC" completed both laboratory and field trials of roller-mounted gauges for continuously monitoring the density of AC, and of static nuclear gauges for measuring the density of thin layers of AC.
- "Development of PRS for Asphalt Concrete: Phase II" is continuing the laboratory studies relating material and construction variables to the performance of AC pavements; the researchers are also preparing a detailed plan for an accelerated field test of both conforming and nonconforming (to material and construction specifications) pavement sections.

SHRP-Related Activities: Three technical areas in the Strategic Highway Research Program (SHRP) include research directly related to NCP Program E.8. The SHRP research on asphalt-aggregate systems includes test method development and field performance studies that will contribute to Program E.8's goal of developing PRS. The FHWA contracts on PRS employ SHRP asphalts, aggregates, test methods, and interim results wherever possible. PRS development will also benefit to a limited degree from the SHRP research on long term pavement performance. Finally, the SHRP research on cement and concrete has a project on quality control and condition analysis through

nondestructive efforts; current studies in Project E.8.a on water-cement ratio measurement and consolidation monitoring will contribute significantly to the SHRP plan.

Plans for Next Year: Only one study is planned as a new start in FY 1990:

- "PRS for Portland Cement Concrete Pavements: Phase II" (FHWA contract).

Significant expected accomplishments include:

- Publication of reports on the evaluation of roller-mounted nuclear gauges for monitoring AC pavement compaction, and static gauges for measuring the density of thin layers; instantaneous determination of water-cement ratio of fresh concrete; the framework and initial laboratory studies for PRS for AC and PCC; and the impact of aggregate gradation and type on AC pavement performance.

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Development of Equipment and Methods	80 percent complete
b	Development of Performance-Related Specifications	25 percent complete
c	Development of Construction Management Support	Continuing

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PROGRAM NUMBER: E.9

PROGRAM TITLE: Technology Transfer for Materials and Operations

PROGRAM COORDINATORS: Charles W. Niessner--Implementation
Terry Halkyard--Implementation
Chien-Tan Chang--Implementation
David Burk--Experimental Projects
Theodore Ferragut--Demonstration Projects
Alfred Miller--National Highway Institute
William Bellinger--National Highway Institute

OBJECTIVES: The objectives of this program are: to assess the usefulness of new materials, products, and procedures, and promote the adoption of cost-effective technology in highway materials and operations; to provide technical assistance to the users of the new technology, and to develop technology transfer products such as guidelines, computer programs, technical manuals, audiovisual products, demonstration projects and training courses in the materials and operations area for use by Federal, State, and local highway agencies.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

The implementation of new technology in the above areas has been conducted by the development and presentation of training courses, demonstration projects, presentation of workshops, equipment development, field evaluation of new materials and techniques, and the preparation of technology sharing reports and implementation packages.

Major accomplishments and activities carried out in fiscal year 1989 include:

IMPLEMENTATION

- Entered into a cooperative agreement with AASHTO to develop a Cost Estimation System (CES) Module for the Bid Analysis Management System (BAMS).
- Completed revisions to a manual of guidelines on geotextile design and construction.

- Published "Geotextile Specifications for Highway Applications."
- Published "The Pressuremeter Test for Highway Applications."
- Developed promotional materials for six new approaches to ground modification for highway and bridge construction.
- Completed initial testing of a rockfall hazard rating system.

DEMONSTRATION AND EXPERIMENTAL PROJECTS

- **Demonstration Project No. 66:** Pile Foundation Design and Construction-- Workshops and load frame demonstrations will continue through 1989. Emphasis will slowly shift to drilled shafts.
- **Demonstration Project No. 68:** Permanent Ground Anchors--The project is complete and the final report is being developed.
- **Demonstration Project No. 74:** Field Management of Asphalt Mixes--A mobile laboratory trailer has been completely refurbished and is being used to demonstrate innovative concepts in asphalt mix management.
- **Demonstration Project No. 75:** Field Management of Concrete Mixes--A mobile laboratory trailer has been completely refurbished and is being used to demonstrate innovative concepts in PCC mix management.
- **Demonstration Project No. 11:** Rapid Testing and Inspection Techniques-- This project was announced in January 1988. The project was developed to encourage State highway agencies (SHA) to use and evaluate new rapid testing equipment and procedures along with inspection techniques. Three evaluations were initiated in fiscal year 1989. Evaluations of ground penetrating radar, infrared thermography, and the thin-lift asphalt nuclear density gauge were completed in fiscal year 1989.
- **Demonstration Project No. 13:** Ice Detection and Highway Weather Information Systems--The objective of this project is to encourage SHA's to conduct usage evaluations of their existing systems. The project was announced in September 1988.

NATIONAL HIGHWAY INSTITUTE

- Fifty-nine presentations of courses on highway materials and operations related

subjects were made during the year. The courses receiving the most interest in fiscal year 1989 include:

- Rock Blasting
 - Geotextile Engineering
 - Bridge Paint Inspection
 - Drilled Shafts
 - Soils and Foundations
 - Slope Maintenance and Slide Restoration (RTAP)
- Courses in various stages of development for future presentations include:
 - Geotechnical Contract Claims - Preparation for Litigation
 - Advanced Slope Stability and Stabilization

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PROGRAM NUMBER: F.1

PROGRAM TITLE: Defining the Appropriate Federal Role for the 1990's and Beyond

PROGRAM MANAGER: James W. March

OBJECTIVE: Since the 1987 highway reauthorizing legislation essentially funded complete construction of the Interstate System, fundamental changes in the structure of the Federal-aid program will be necessary in the 1990's. This program is to examine the Federal role as it relates to continued development and improvement of the highway system, and to improve the process by which highway investment decisions are made.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: Results and findings from studies conducted during prior years include:

- A major study concerning how various segments of the motor carrier industry have been affected by recent changes in Federal economic regulations, taxes, and size and weight policies was recently completed. The study also examined how those motor carrier industry groups might be affected by future potential changes in Federal size and weight policy.
- A project to incorporate incremental benefit-cost considerations into a Nationwide highway needs estimation model has been completed. This model will allow better assessments of the consequences of highway investment decisions.

Work Underway: There are four major studies presently underway in Program F.1.

- The Highway Revenue Forecasting Model used in conjunction with the Department of the Treasury is being updated to more accurately predict Highway Trust Fund receipts and to improve its responsiveness to economic and travel changes.
- A study is underway to assess the feasibility of separating heavy truck traffic

from passenger car and light truck traffic by constructing highway facilities either exclusively for cars or exclusively for trucks.

- A model is being developed to enhance our understanding of the relationship between highway conditions and national economic performance. The model will relate changes in highway investment, user fees, vehicle miles of travel, and highway performance measures to the national economy and to specific industrial sectors.
- A study is underway to analyze the importance of good highway transportation to selected industrial sectors and to estimate the relationship between transportation costs to total manufacturing and distribution costs for those industries.

Plans for Next Year: Three major studies are planned to start in fiscal year 1990.

- A study to enhance the highway economic needs estimation procedure and make it more sensitive to key highway policy issues.
- A study to analyze the role of highway expenditures in regional economic activities and economic development.
- A study to identify and evaluate potential alternative sources of Federal and State highway revenues that may be used to supplement traditional revenue sources.

Program Status: A specific project breakdown has not yet been established, but work is proceeding on schedule.

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PROGRAM NUMBER: F. 2
PROGRAM TITLE: Transportation Planning
PROGRAM MANAGER: Christopher R. Fleet

OBJECTIVE: Research, develop, and disseminate improved planning methods to assist State and local transportation agencies to enhance transportation system performance and foster economic development.

EXECUTIVE SUMMARY AND PROGRAM STATUS :

Significant Results To Date: The following are some of the significant results from the past year:

- "Models of Mode and Occupancy-Choice in the Shirley Highway Corridor" investigates the application of conventional mode choice estimation procedures in forecasting High Occupancy Vehicle (HOV) facility usage.
- The National Conference on Planning Techniques for Small and Medium-Sized Urban Areas was successfully held December 6-8, 1988, in Phoenix, Arizona and proceedings have been published.
- "Evaluation of Demand Management Measures (TDM) to Relieve Congestion" evaluates the effectiveness of travel demand management programs across the country. The report focused on determining specific impacts of TDM in reducing vehicle tripmaking.
- A synthesis of literature on the relationships between urban form, transportation and economic efficiency and planning options to give more efficient and effective transportation systems were developed.
- A synthesis of literature was produced on the relationship between transportation and economic development.
- Calibration and validation of a travel demand model for forecasting HOV use in the I-66 and I-395 corridors were completed.

- Information for updating the unit capital improvement costs for the Highway Performance Monitoring System (HPMS) Analytical Process was gathered.
- Geographic Information Systems software was investigated and acquired. HPMS, bridge, truck and census data will be used in applications and demonstrations of the capabilities of these systems.
- A demonstration of the Census Topologically Integrated Geographic Encoding Referencing System (TIGER) file for transportation application has been completed by Columbia, Missouri. The project developed a report and demonstration software that clearly documents how Census TIGER files can be used for transportation.
- The National Conference on Application of Transportation Planning Methods was held April 1989 and proceedings were distributed widely.
- A revised FHWA Emergency Communications System Procedures Manual, which reflects experience gained in a national exercise, was issued in early 1989.

Work Underway:

- Tests with microcomputers incorporated into the FHWA Emergency Communication System are being conducted.
- A paper on "Calibration of System Models" is being reviewed by five consultants. The manual describes the various default parameters that are used in travel model development, gives guidelines on the values of these parameters, and lists various problems that areas may encounter and possible solutions.
- Efforts are underway to develop microcomputer capabilities for the HPMS Submittal Software and Analytical Process. It is anticipated that working microcomputer versions will be completed during FY 1990.
- Efforts are underway to enhance the subarea focusing microcomputer models and update the documentation. A separate effort is underway to develop a tutorial for the program.
- Three case studies are underway to demonstrate the usefulness of Census TIGER line files for transportation applications. The results of these efforts will show how geographic information systems and TIGER line files can improve access to information and analytical capabilities for transportation planning.
- Efforts are underway to develop a two day seminar on the role of Metropolitan

Planning Organizations (MPOs) in urban pavement management. Many MPOs are getting involved in pavement management and have expressed interest. The results of this seminar will be a better understanding of how MPO's can support pavement management at the regional level, and integrate pavement management into the planning process.

- An effort has been initiated to develop a series of urbanized area case studies documenting transportation system and urban development changes over the last 25 years in major metropolitan areas. The growth in travel, change in system performance, and economic impacts from the mid-1960's to the present will be studied.

Plans for Next Year:

- The transportation efficiency of alternative urban form/transportation system strategies will be evaluated, and guidance will be developed for land use and transportation planners and decision makers to assist them in setting land development and transportation policy.
- The economic efficiency of alternative mixes of new highway capacity, by facility class, will be evaluated, and guidance developed for highway supply investments.
- An effort will be undertaken to incorporate overlay thickness and climatic considerations into the HPMS pavement deterioration relationships.
- Enhanced truck analysis tools and training aids will be developed.
- Proceedings for the 1990 Geographic Information System Symposium for Transportation will be produced and distributed.
- FHWA and UMTA will continue to provide funds to the Bureau of the Census for the development of software to produce the 1990 Census Transportation Planning Package (CTPP).
- Demonstration of innovative uses of geographic information systems will continue.
- Efforts to better quantify the effect of highway improvements on State level economic development will be initiated.
- Tests will continue on the use of microcomputers in the FHWA Emergency Communication System.
- The feasibility of alternative back-up systems to the FHWA Emergency Communication System will be studied and testing to determine the best operating frequency for the network will continue.
- A study will be conducted to incorporate the 1985 Highway Capacity Manual Procedures into the system planning modeling process.

Program Status: A specific project breakdown has not yet been established, but work is proceeding on schedule.

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PROGRAM NUMBER: F.3

PROGRAM TITLE: Information Assembly, Analysis and Dissemination

PROGRAM MANAGER: David R. McElhaney

OBJECTIVE: This program ensures that accurate information regarding highway performance, use, and financing is available to transportation policy makers at the Federal, State, and local levels. This includes fostering more efficient methods of highway information acquisition and dissemination, such as use of sampling or operations research techniques, as well as improved methods of sharing databases.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: This program was identified under the NCP in fiscal year 1986. Nearly a dozen projects have been undertaken since that time. The following significant work was completed in the past year:

- Traffic monitoring software, for use by the States in the analysis of truck weight data, was distributed for use on microcomputers.
- The Highway Statistics Information Retrieval System was adapted by contract to a local area network environment.
- Planning and design activity for the 1990 National Personal Transportation Study was completed. The pretest was successfully conducted during August 1989.
- A local area network was developed to enhance access to microcomputer based truck weight and characteristics data.

Work Underway:

- Work is continuing to develop microcomputer software for analysis of continuous traffic count data.
- Microcomputer software is being developed under contract for Federal Highway and State use to edit, review, update and report the Highway Performance

Monitoring System universe and sample section data. The contract will also convert the Highway Performance Monitoring System Analytical Process Models to a microcomputer environment.

- Contract work leading to the development of improved editing procedures for truck weight data has begun.
- Acceptance testing of the Highway Statistics Information Retrieval System is underway, and an implementation plan is in place. The System will be implemented during FY 1990.
- Based on the pretest results for the National Personal Transportation Study, modifications to the 1990 survey instrument are being evaluated. A clearance request to conduct the 1990 survey has been submitted to the Office of Management and Budget.

Plans for Next Year: The following new studies are scheduled for next year.

- Work will begin to develop procedures using expert systems for traffic data during the editing process.
- The Highway Statistics Information Retrieval System implementation will take place. Contract research to provide better links between mainframe databases and the microcomputer databases in the System is planned.
- The National Personal Transportation Study data collection is anticipated to start in January 1990 and will cover a 12-month period. The survey will be conducted using computer assisted telephone interviewing procedures. Planning for the report's format and content will be initiated.
- Using FHWA personnel, microcomputer software will be developed for the processing of State highway finance data.

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Continuous Count Software	75 percent complete
b	Highway Performance System	Continuing
c	National Personal Transportation Study	Continuing
d	Highway Statistics Information Retrieval System	Continuing
e	Truck Weight Editing	5 percent complete

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PROGRAM NUMBER: G.1
PROGRAM TITLE: Improving Stopping Capability
PROGRAM MANAGER: T. Kozlowski

OBJECTIVE: This program provides research on the braking performance of large commercial vehicles with regard to the effectiveness of the current brake adjustment criteria, anti-lock brakes, inspection procedures, and automatic slack adjusters and brake indicators.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: Five studies have been completed in recent years in this program area. Last year stopping capability was identified as a High Priority National Problem Area (HPNPA). Research in this area was initiated this fiscal year.

Work Underway: There is one study underway in NCP Program G.1. The following is a description of that study:

- "Evaluation of Brake Adjustment Criteria" will determine if the current brake out-of-service criteria are practical and efficient. The study will assess what effect vehicle use has on brake adjustment and how often brakes need readjusting to remain within the requirements.

SHRP-Related Activities: None

Plans for Next Year: There are two studies planned for fiscal year 1990, including:

- Adequacy of Roadside Inspection Criteria.
- Effectiveness of Automatic Slack Adjustors and Indicators.

Significant expected accomplishments include:

- Sound basis for inspecting and placing vehicles out-of-service for brake problems.
- Guidelines on brake adjustment for different segments for the industry.

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Brake Adjustment Criteria complete.	5 percent

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PROGRAM NUMBER: G.2

PROGRAM TITLE: Appropriate Medical Qualifications for Commercial Motor Vehicle Drivers (CMV)

PROGRAM MANAGER: T. Kozlowski

OBJECTIVE: The objectives of this research area are to establish a more systematic and scientific basis for the medical standards of the Office of Motor Carriers, and to ensure that commercial motor vehicle drivers are medically qualified to operate commercial vehicles in a safe manner.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: NCP Program G.2 has also been identified as a HPNPA. Approximately 15 studies have been completed relative to this program area in prior years. The following are two significant results from the past year:

- "Conference on Neurological Disorders and Commercial Drivers" was published
- A report on "Insulin Using Diabetics In Commercial Driving."

Work Underway: There are three studies underway. They are described as follows:

- "Psychiatric and Pulmonary/Respiratory Disorders and Commercial Drivers" will hold two interchange conferences of medical experts to produce two documents concerning the current state of knowledge about psychiatric and pulmonary conditions as they relate to the safe performance of commercial drivers.
- The study "Random Substance Testing" will determine which types of controlled substances should be tested; evaluate different methods for testing for controlled substances; develop a sampling plan for conducting random drug tests and a driver survey; conduct a pilot survey and random drug test; and conduct a nationwide survey to estimate the level of use of controlled substances by commercial drivers.

- "MEDPACT" will design and develop medical standards and administrative procedures to determine the medical qualifications of commercial motor vehicle drivers as part of the Commercial Driver's License application and licensing procedures.

SHRP-Related Activities: None.

Plans for Next Year: There are two new projects planned for fiscal year 1990. The projects are as follows:

- Conference to evaluate medical qualification procedures on vision and hearing.
- Implement a series of pilots in 7 States of the medical procedures developed by the Wisconsin MEDPAC project and other models.

Significant expected accomplishments include:

- State-of-the-knowledge reports on psychiatric and pulmonary/respiratory disorders.
- A sampling plan for conducting controlled substance and driver surveys, and a National estimate of use.
- Medical standards and procedures to medically qualify commercial drivers.

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Psychiatric and Pulmonary/ Respiratory Disorders	5 percent complete
b	Random Drug Testing complete	0 percent
c	MEDPACT	90 percent complete

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PROGRAM NUMBER: G.3
PROGRAM TITLE: Driver Fatigue
PROGRAM MANAGER: T. Kozlowski

OBJECTIVE: The objectives of this program area are to acquire an understanding of fatigue/alertness and related psychological, physiological and cognitive factors; identify and promote countermeasures; and evaluate the current hours-of-service standards in light of advances in medical science and the changing nature of the motor carrier industry.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: This program area was identified in fiscal year 1988 as a HPNPA. Several studies were conducted during the 1970's; however, no new research was initiated until 1988. Prior research has established evidence of fatigue's impact on commercial motor vehicle safety, yet results have been inconclusive. The FHWA sponsored a symposium on driver fatigue with participants from industry, universities, other countries and modes in order to learn the state of the knowledge and key issues relative to driver fatigue.

Work Underway: There are two studies underway and one about to start this fiscal year. Below is a brief summary:

- The objective of the study "Enforcement of Hours-of- Service Rules" is to develop data on the current state of the various hours of service enforcement programs in the interstate motor carrier industry and to make recommendations for enhancement of these programs.
- The "Fatigue and Driver Alertness" study will identify potentially effective countermeasures to combat loss of driver alertness, test the countermeasures under simulated and actual working conditions, and help motor carriers and their drivers to implement successfully tested countermeasures.

- "Motor Carrier Industry Characteristics and The Hours- of-Service Rules" will develop information on the industry's operation under the hours-of-service rules to determine if certain segments of industry are more in compliance than others and investigate hours-of- service rules in other countries and for other modes.

SHRP-Related Activities: None.

Plans for Next Year: There are no new projects planned for fiscal year 1990. The Fatigue and Driver Alertness study that is scheduled to start this year will continue until 1993.

Significant expected accomplishments include:

- Recommended procedures and technology to improve alertness, a sound basis for the hours-of-service rules, and reduction in fatigue-related accidents.

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Hours of Service	5 percent complete
b	Industry Characteristics	5 percent complete
c	Fatigue/Alertness Study	0 percent complete

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PROGRAM NUMBER: G.4
PROGRAM TITLE: Regulatory and Program Analysis
PROGRAM MANAGER: D. McKelvey

OBJECTIVE: The objectives of this research are to provide the Office of Motor Carriers (OMC) with accurate and timely data necessary to support analysis of specific regulations and to evaluate the effectiveness and efficiency of existing programs.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: Approximately 15 projects have been completed in this program area in recent years. The following is a description of those completed this past year:

- "Comparison of Federal/State Motor Carrier Safety Programs" developed a computer program to facilitate review of Federal/ State safety regulations, and recommended changes to improve comparability.
- "Data to Facilitate Updating Minimum Age Requirements" determined the relationship between commercial motor vehicle drivers under age 21 and accidents.
- "Data to Facilitate Commercial Motor Vehicle Safety Act of 1986 Waiver Process" compiled measures of accident involvement per vehicle miles traveled for a number of subclasses of farm trucks and compared these values with those obtained for other categories of trucks.

Work Underway: There are five projects underway in NCP Program G.4. They include the following:

- "Evaluate Out-of-Service Criteria" involves the review, aggregation, and analysis of existing data to determine their impact on safety.

- "Information and Technology Transfer" supports the development of educational and technical assistance materials regarding our regulations, safety programs and special safety problems.
- "Evaluate the Use, Acceptance and Effect of FHWA's TractorTrailer Driver Training Standards and Curriculum" collects information necessary to evaluate the acceptance of the standards and curriculum.
- "Estimating Vehicle Miles of Travel for Interstate Motor Carriers" will evaluate existing methods for collecting truck VMT, and develop a procedure to reliably estimate it annually.
- "Truck Data Safety Needs" is a Transportation Research Board study that will develop a plan for compiling the necessary data required to monitor truck accident trends at the National level.

SHRP-Related Activities: None.

Plans for Next Year: There are no new studies proposed to start next year. The projects "Evaluate Out-of-Service Criteria" and "Information and Technology Transfer" studies will continue in 1990.

Significant expected accomplishments include:

- Report on the effectiveness of the brake out-of-service criteria
- Report on the acceptance of the tractor-trailer driver training standards and curriculum.
- Method for collecting truck VMT data.
- Plan for monitoring truck accident trends.

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Out-of-Service Criteria	5 percent complete
b	Technology Transfer	Continuing
c	Standards and Curriculum	90 percent complete
d	VMT Estimates	70 percent complete
e	Truck Safety Needs	80 percent complete

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PROGRAM NUMBER: G.5
PROGRAM TITLE: Vehicle Maintenance and Operation
PROGRAM MANAGER: D. McKelvey

OBJECTIVE: The objectives of this program area are to reduce the risks of commercial motor vehicle-related accidents, and to determine whether there should be new or modified regulations to accommodate advanced technology and changes in vehicle operations and maintenance.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: More than 20 studies were completed during prior years under this program area. The following study was completed this year:

- "In-Cab Displays for Heavy Vehicles" described the supplemental display systems available for heavy vehicles. It also developed performance measures for assessing information monitoring and processing, created by real-time supplemental information displays, for use in the cabs of heavy vehicles.

Work Underway: There is one study currently ongoing. Below is a brief summary:

- "Evaluation of Innovative Converter Dollies" will compare the performance, cost and safety of A-dollies, which are prevalent in the industry, with other dolly designs, especially innovative ones that have come on the market recently.

Plans for Next Year: There are no new projects proposed for funding in fiscal year 1990.

Significant expected accomplishments include:

- Report on the cost, performance and safety of the various types of dollies in use.

Program Status: The program manager's assessment of the status of each project (percent complete) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Innovative Dollies	5 percent complete

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PROGRAM NUMBER: G.6

PROGRAM TITLE: Motor Carrier Information Systems and Analysis

PROGRAM MANAGER: J. MacGowan

OBJECTIVE: The objectives of this program are to develop a complete data file on all interstate motor carriers, including accident, carrier review, and vehicle inspection data obtained from States participating in the Motor Carrier Safety Assistance Program (MCSAP), and the Commercial Drivers' License Program, and to improve the efficiency of the gathering and the processing of these data.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: Several studies were completed during prior years under NCP Program G.6. The following are a few of the significant results from this program area:

- "SAFETYNET Technical Support" provided technical support to designated users and performed activities necessary to enhance and maintain the SAFETYNET system.
- The "SAFETYNET Inspection System" effort updated equipment in the States' microcomputer systems to more readily access the mainframe computer in FHWA headquarters.
- "Federal/State Accident Information Reporting System" designed, developed and tested an integrated Federal/State commercial accident module within SAFETYNET in support of the Motor Carrier Safety Assistance Program.

Work Underway: There are two studies currently underway. The following is a description of these studies:

- "Accident Reporting System Augmentation" project will evaluate ways to improve motor carrier reported accidents and do a preliminary assessment of alternatives for future years.

- "Operation of the Information and Dissemination and Quality Control Programs of the Motor Carrier Management Information System (MCMIS)" will assess the effectiveness of the current operational capabilities of the MCMIS to respond to the data needs of the FHWA and make recommendations for improving the overall system's efficiency and effectiveness.

Plans for Next Year: There are three studies planned for fiscal year 1990. They are shown as follows:

- "Training and Technical Support for Field Safety Specialist.
- "Automated Carrier Compliance Monitoring"
- "Analysis and Reporting of MCSAP Inspections"

Significant expected accomplishments include:

- Improvements in the operational efficiency of current MCMIS and SAFETYNET databases.
- Cross-reference motor carrier reported accidents with State accident data.

Program Status: The program manager's assessment of this project (percent completed) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Quality Programs	Continuing
b	Accident Augmentation	50 percent complete

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PROGRAM NUMBER: G.7

PROGRAM TITLE: Uniform State Procedures

PROGRAM MANAGER: B. Bass

OBJECTIVE: The objective of this program area is to facilitate the movement of interstate and foreign commerce on highways by encouraging States and Canadian Provinces to simplify and standardize their regulations of motor carriers.

EXECUTIVE SUMMARY AND PROGRAM STATUS:

Significant Results to Date: Some of the results to date include:

- The National Governors' Association and FHWA developed a series of policy and procedural recommendations to simplify State motor carrier registration and taxation requirements known as the Consensus Agenda.
- Thirteen States have established one-stop operations.
- Forty States have established Motor Carrier Advisory Committees.
- Forty States have joined the International Registration Plan.
- Sixteen States have joined a base state fuel tax agreement.

Work Underway: There are 4 projects underway in NCP Program G.7. They are described as follows:

- "Model Uniform Oversize/Overweight Truck Permit Program" will: (1) study the New England Agreement and determine which features are applicable to nationwide permit program; (2) develop a model oversize/overweight truck permit program and (3) promote the adoption of a uniform oversize/overweight permit program.

- The objective of the study, "Standardize Audit Procedures for Highway Use Taxes" is to develop a manual to train State auditors using uniform procedures for conducting combined vehicle registration and fuel tax audits.
- "Implementation of National Governors' Association's (NGA) Truck Accident Data Elements" will (1) continue to promote the implementation of the NGA's truck data elements among the States; (2) develop a truck accident data dictionary for the NGA uniform truck accident data elements; and (3) document the experiences of three States in their efforts to implement the NGA data elements.
- "Training in Collection of Uniform Truck Accident Data" will develop training materials to instruct State and local law enforcement personnel in the proper data collection procedures for the NGA truck accident data elements.

Plans for Next Year: There are no projects planned for next year. Significant expected accomplishments include:

- Development of a national oversize/overweight model agreement.
- Standardized training for conducting combined base State registration/fuel tax audits.
- Implementation of the NGA truck accident reporting project in 8 - 10 States.
- Development of a standardized training package for State and local police officers in collecting uniform truck accident data.

Program Status: The program manager's assessment of this project (percent completed) is as follows:

<u>Project</u>	<u>Title</u>	<u>Status</u>
a	Oversize/Overweight Program	5 percent complete
b	Audit Procedures	30 percent complete
c	Accident Data Elements	25 percent complete
d	State/Local Police Training	5 percent complete

